U.S. Department of the Interior
Office of Surface Mining Reclamation and Enforcement

DRAFT

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Stream Protection Rule

Environmental Impact Statement

Draft Environmental Impact Statement
for the Stream Protection Rule
Draft (X) Final ()

Lead Agency: U.S. Department of the Interior,
Office of Surface Mining Reclamation and Enforcement (OSMRE)

Cooperating Agencies:

Federal Agencies:
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

State SMCRA Regulatory Authorities:
Utah Division of Oil, Gas and Mining*
New Mexico Mining and Minerals Division*
Kentucky Department for Natural Resources*
Railroad Commission of Texas*
Wyoming Department of Environmental Quality
West Virginia Department of Environmental Protection*
Alabama Surface Mining Commission*
Indiana Department of Natural Resources

*These state regulatory authorities subsequently terminated their role as cooperators.

State Historic Preservation Offices:
Virginia Department of Historic Resources

State Wildlife Agency:
West Virginia Department of Natural Resources

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Abstract

The Office of Surface Mining Reclamation and Enforcement (OSMRE) has prepared a draft Environmental Impact Statement (DEIS) on proposed revisions to regulations (at 30 CFR Chapter VII) for implementation of the Surface Mining Control and Reclamation Act (SMCRA or the Act) of 1977. The proposed revisions would better protect streams, fish, wildlife, and related environmental values from the adverse impacts of surface coal mining operations and provide mine operators with a regulatory framework to avoid water pollution and the long-term costs associated with water treatment, more completely implement the requirements of SMCRA, remedy deficiencies in existing rules, and remove obsolete or unneeded provisions from existing rules. The DEIS analyzes the proposed revisions in accordance with the National Environmental Policy Act (NEPA) of 1969 as amended, 42 U.S.C. 4321-4347; the Council on Environmental Quality's (CEQ's) regulations for implementing NEPA, 40 CFR Parts 1500 through 1508; and the U.S. Department of the Interior's NEPA regulations, 43 CFR Part 46.

The proposed action is intended to balance all relevant purposes of the Act, as listed in Section 102 of SMCRA, 30 U.S.C. § 1202. Those purposes include ensuring that surface coal mining operations are conducted in a manner that protects the environment, establishing a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations, and ensuring a coal supply adequate for our Nation's energy needs.

EXECUTIVE SUMMARY

ES.1 Background and Overview

The Office of Surface Mining Reclamation and Enforcement (OSMRE) has prepared a draft Environmental Impact Statement (DEIS) on proposed revisions to regulations (at 30 CFR Chapter VII) for implementation of the Surface Mining Control and Reclamation Act (SMCRA or the Act) of 1977. The proposed revisions would better protect streams, fish, wildlife, and related environmental values from the adverse impacts of surface coal mining operations and provide mine operators with a regulatory framework to avoid water pollution and the long-term costs associated with water treatment, more completely implement the requirements of SMCRA, remedy deficiencies in existing rules, and remove obsolete or unneeded provisions from existing rules. The DEIS analyzes the proposed revisions in accordance with the National Environmental Policy Act (NEPA) of 1969 as amended, 42 U.S.C. 4321-4347; the Council on Environmental Quality's (CEQ's) regulations for implementing NEPA, 40 CFR Parts 1500 through 1508; and the U.S. Department of the Interior's NEPA regulations, 43 CFR Part 46.

Scientific studies published since the adoption in 1983 of our principal regulations have indicated that surface coal mining operations continue to have significant negative impacts on streams, fish, and wildlife despite the enactment of SMCRA and the federal regulations implementing that law. The principal purpose of the current proposed action is to update and revise the regulations to reflect the best available science in order to avoid or minimize these negative impacts, and provide regulatory certainty to industry.

The DEIS analyzes the impacts of implementing rule changes that propose to do the following:

- Define the term "material damage to the hydrologic balance outside the permit area" and require that each permit establish the point at which adverse mining-related impacts on groundwater and surface water reach an unacceptable level; i.e., the point at which adverse impacts from mining would cause material damage to the hydrologic balance outside the permit area.
- Set forth how to collect adequate premining data about the site of the proposed mining operation and adjacent areas to establish a comprehensive baseline that will facilitate evaluation of the effects of mining operations.
- Set forth how to conduct effective, comprehensive monitoring of groundwater and surface water during and after both mining and reclamation and during the revegetation responsibility period to provide real-time information documenting mining-related changes in water quality and quantity.
- Address the need for required monitoring of the biological condition of streams during and after mining and reclamation to evaluate changes in aquatic life. Proper monitoring

would enable timely detection of any adverse trends and allow timely implementation of any necessary corrective measures.

- Promote the protection or restoration of perennial and intermittent streams and related resources, especially the headwater streams that are critical to maintaining the ecological health and productivity of downstream waters.

- Ensure that permittees and regulatory authorities make use of advances in information, technology, science, and methodologies related to surface and groundwater hydrology, surface-runoff management, stream restoration, soils, and revegetation, all of which relate directly or indirectly to protection of water resources.

- Ensure that land disturbed by surface coal mining operations is restored to a condition capable of supporting the uses that it was capable of supporting before mining. Soil characteristics and the degree and type of revegetation have a significant impact on surface-water runoff quantity and quality as well as on aquatic life and the terrestrial ecosystems dependent upon perennial and intermittent streams.

- Update and codify requirements and procedures to protect threatened and endangered species and designated critical habitat under the Endangered Species Act of 1973,[1] and better explain how the fish and wildlife protection and enhancement provisions of SMCRA should be implemented.

As with the existing regulations, implementation of the revised regulations would be the responsibility of the applicable regulatory authority. OSMRE is headquartered in Washington, D.C. and is the regulatory authority in the states of Tennessee and Washington, and on Indian lands. All other coal-producing states have received approval on their proposed regulatory program and thus function as the regulatory authority in their respective state. OSMRE has oversight responsibility of the states' implementation of their OSMRE-approved regulatory programs. When a state or Indian tribe submits and receives approval of its proposed regulatory program from us, it becomes the primary regulator within that state or on reservation lands, respectively, and assumes responsibility over permitting, inspection, and enforcement activities. OSMRE then provides oversight of the state's or tribe's implementation of the regulatory program, technical assistance and support. To date OSMRE remains the regulatory authority in the states of Tennessee and Washington, and for the Navajo, Hopi, and Crow nations. All other coal-producing states have received approval on their proposed regulatory program and thus function as the regulatory authority in their respective state.

The proposed action would also help fulfill OSMRE's responsibilities under a Memorandum of Understanding (MOU) that the Secretary of the Department of the Interior, the Administrator of the U.S. Environmental Protection Agency (EPA), and the Acting Assistant Secretary of the Army (Civil Works) entered into on June 11, 2009. This MOU implemented an interagency action plan designed to significantly reduce the harmful environmental consequences of surface

[1] 16 U.S.C. 1531 et seq.

coal mining operations in six Appalachian states, while ensuring that future mining remains consistent with federal law. Specifically, Part III.A. of the MOU provides that the parties to the MOU will review "existing regulatory authorities and procedures to determine whether regulatory modifications should be proposed to better protect the environment and public health from the impacts of Appalachian surface coal mining." It also provides that, at a minimum, revisions will be considered to the Stream Buffer Zone (SBZ) Rule published December 12, 2008 and the regulatory requirements concerning approximate original contour.

Finally, the proposed action is intended to balance all relevant purposes of the Act, as listed in Section 102 of SMCRA, 30 U.S.C. § 1202. Those purposes include ensuring that surface coal mining operations are conducted in a manner that protects the environment, establishing a nationwide program to protect society and the environment from the adverse effects of surface coal mining operations, and ensuring a coal supply adequate for our Nation's energy needs.

ES.2 Public Involvement

On November 30, 2009, OSMRE published an Advance Notice of Proposed Rulemaking (ANPR) soliciting comments on ten potential rulemaking Alternatives. Approximately 32,750 comments were received during the 30-day comment period on various issues related to stream protection. After evaluating the comments, it was determined that development of a comprehensive stream protection rule (one that is much broader in scope than the 2008 rule) would be the most appropriate and effective method of achieving the goals set forth in the MOU and the ANPR. OSMRE published a notice of intent (NOI) to prepare an EIS in the *Federal Register* on April 30, 2010 (75 FR 22723) followed by an additional notice on June 18, 2010 (75 FR 34666). The additional notice informed the public of scoping opportunities to include open houses and to outline possible Alternatives that were being considered. Approximately 400 people attended the open houses and provided almost 450 written and oral comments. In addition, 20,126 comments were received through the mail and website. The scoping period closed July 30, 2010.

Most comments were specific to the elements of the Proposed Rule and possible Alternatives set out in the June 18, 2010 NOI. Some commenters recommended clarifications to existing rules as opposed to a new rulemaking, made suggestions pertaining to specific elements or Alternatives within the Proposed Rulemaking, or raised new issues or rule elements for consideration.

Comments were generally divided into two categories: (1) comments in support of rule revisions that would provide greater environmental protection for streams and other natural resources; and (2) comments that support the adequacy of the existing regulations. Some commenters favoring greater environmental protections advocated interpretation of the 1983 Stream Buffer Zone Rule as an absolute prohibition on stream impacts. This group of comments described the 1983 rules as a bright-line prohibition against any adverse impacts within the stream buffer zone, although the courts have not always agreed with this interpretation by the commenters as explained below in the scope section. Other comments suggested that this DEIS assess the effects of an Alternative that would ban surface mining of coal in or near streams.

Comments that opposed changes to current rules asserted that additional regulation would impair mining operations, increase costs, endanger jobs at a time of high unemployment, and provide little, if any, additional protection for the environment. Some comments questioned OSMRE's authority under SMCRA to adopt certain measures under consideration. Others asserted that OSMRE had failed to articulate a need for new regulations so soon after adopting the 2008 Stream Buffer Zone Rule.

Some comments from the coal-producing regions of the Midwest and the West also questioned the need to promulgate a nationwide stream protection rule, arguing that there is no evidence of adverse impacts on streams outside of Appalachia. These comments also argued that because of regional differences, many elements under consideration would be inapplicable, cumbersome, costly, or impractical to apply outside Appalachia.

ES.3 Scope of the Proposed Stream Protection Rule

Historically, we and some state regulatory authorities applied the 1983 stream buffer zone rule in a manner that allowed the placement of excess spoil fills, refuse piles, slurry impoundments, and sedimentation ponds in intermittent and perennial streams within the permit area. However, as discussed at length in the preamble to a 2004 proposed rule,[2] which we never finalized, there has been considerable controversy over the proper interpretation of both the Clean Water Act and our 1983 rules as they apply to the placement of fill material in or near perennial and intermittent streams.

One interpretation of the 1983 stream buffer zone rules appears in our annual oversight reports for West Virginia for 1999 and 2000, which state that the stream buffer zone rule does not apply to the footprint of a fill placed in a perennial or intermittent stream as part of a surface coal mining operation. On June 4, 1999, in West Virginia Highlands Conservancy v. Babbitt, Civ. No. 1:99CV01423 (D.D.C.), the plaintiffs challenged the validity of that interpretation, alleging that it constituted rulemaking in violation of the Administrative Procedure Act.

However, on August 9, 1999, OSMRE, the U.S. Army Corps of Engineers, EPA, and the West Virginia Division of Environmental Protection (WVDEP) signed a memorandum of understanding (MOU) in which all four agencies in effect agreed to an interpretation that allowed valley fills in intermittent or perennial streams to be approved only if the buffer zone findings were made for the filled stream segments. The MOU also stated that the Clean Water Act Section 404(b)(1) Guidelines at 40 CFR part 230 contain requirements comparable to the findings required by the combination of OSMRE's 1983 stream buffer zone rule and the West Virginia stream buffer zone rule. Consequently, the MOU found that, "where a proposed fill is consistent with the requirements of the Section 404(b)(1) Guidelines and applicable requirements for Section 401 certification of compliance with water quality standards, the fill would also satisfy the criteria for granting a stream buffer zone variance under SMCRA and WVDEP regulations."[3] As a result of the signing of the MOU, the court approved an unopposed motion to dismiss the case mentioned above[4] as moot in an order filed September 23, 1999.

[2] See 69 FR 1038-1042 (Jan. 7, 2004).

[3] Memorandum Of Understanding among the U.S. Office of Surface Mining, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, and West Virginia Division Of Environmental Protection for the Purpose of

In a lawsuit filed in the U.S. District Court for the Southern District of West Virginia in July 1998, plaintiffs asserted that the 1983 stream buffer zone rule should be interpreted to allow mining activities through a perennial or intermittent stream or within the buffer zone for a perennial or intermittent stream only if the activities are minor incursions.[5] They argued that the rule did not allow substantial segments of a perennial or intermittent stream to be buried underneath excess spoil fills or other mining-related structures.[6] On October 20, 1999, the district court ruled in favor of the plaintiffs on this point, holding that the West Virginia version of the stream buffer zone rule applies to all segments of a stream, including those segments within the footprint of an excess spoil fill, not just to the stream as a whole.[7] The court stated that the construction of fills in perennial or intermittent streams is inconsistent with the language of the West Virginia counterpart to 30 CFR 816.57(a)(1), which provides that the regulatory authority may authorize surface mining activities within a stream buffer zone only after making certain findings, including a finding that the proposed activities would not "adversely affect the normal flow or gradient of the stream, adversely affect fish migration or related environmental values, materially damage the water quantity or quality of the stream…."[8] The court also concluded that, contrary to the August 1999 MOU, satisfaction of the Section 404(b)(1) Guidelines is not equivalent to satisfaction of the SMCRA buffer zone rule.[9]

On appeal, the U.S. Court of Appeals for the Fourth Circuit vacated the judgment of the district court and remanded the case with instructions to dismiss the counts concerning the stream buffer zone rule as barred by the Eleventh Amendment to the U.S. Constitution. See Bragg v. West Virginia Coal Ass'n, 248 F.3d 275, 296 (4th Cir. 2001), cert. denied, 534 U.S. 1113 (2002). While the Fourth Circuit did not interpret the 1983 version of the stream buffer zone rule, the brief for the federal appellants in that case included another interpretation of the regulation in their brief. In sum, the federal appellants supported an interpretation based on the district court decision and stated that 30 CFR 816.57 "prohibits the burial of substantial portions of intermittent and perennial streams beneath excess mining spoil."[10]

Clarifying the Application of Regulations Related to Stream Buffer Zones under the Surface Mining Control and Reclamation Act for Surface Coal Mining Operations that Result in Valley Fills, August 9, 1999, p. 4.

[4] West Virginia Highlands Conservancy v. Babbitt, Civ. No. 1:99CV01423 (D.D.C.).

[5] See Bragg v. Robertson, 72 F. Supp. 2d 642, 660-663 (S.D. W. Va. 1999).

[6] Id.

[7] Id.

[8] Id. at 650-653, 661. In a related matter, a consent decree filed on January 3, 2000, and approved on February 17, 2000, stated that the West Virginia stream buffer zone rules only apply downstream from the toes of downstream faces of embankments of sediment control structures in perennial and intermittent streams. Bragg v. Robertson, 83 F. Supp. 2d 713, 718 n.4 (S.D. W. Va. 2000).

[9] Id. at 660.

[10] Brief for Federal Appellants at 2, Bragg v. West Virginia Coal Ass'n, 248 F.3d 275 (4th Cir. 2001) (No. 99-2683) (footnote omitted).

In a different case related to the issuance of a nationwide section 404 permit under the Clean Water Act, the U.S. District Court for the Southern District of West Virginia stated in an opinion that SMCRA and the 1983 stream buffer zone rule do not authorize disposal of overburden in streams: "SMCRA contains no provision authorizing disposal of overburden waste in streams, a conclusion further supported by the buffer zone rule."[11] Yet, on appeal, the U.S. Court of Appeals for the Fourth Circuit rejected the district court's conclusion, stating that "SMCRA does not prohibit the discharge of surface coal mining excess spoil in waters of the United States."[12] The court further stated that "it is beyond dispute that SMCRA recognizes the possibility of placing excess spoil material in waters of the United States even though those materials do not have a beneficial purpose."[13]

In subsequent litigation, the federal appellants stated that "OSM has historically interpreted its 'stream buffer zone' rule . . . to allow for the construction of valley fills in intermittent and perennial streams, even if such fills cover a stream segment. The traditional interpretation of the [stream buffer zone] is in harmony with this Court's decision in Rivenburgh."[14] Additionally, the U.S. Court of Appeals for the Fourth Circuit has discussed SMCRA's role in the regulation of valley fills in the context of a challenge to individual permits under section 404 of the Clean Water Act.[15] See Ohio Valley Envtl. Coal. v. Aracoma Coal Co., 556 F.3d 177, 195 (4th Cir. 2009) ("Congress clearly contemplated that the regulation of the disposal of excess spoil and the creation of valley fills falls under the SMCRA rubric.").

By 2004, OSMRE had concluded that "[t]he issues and allegations raised indicate that there remains considerable misunderstanding regarding the meaning of the [1983 stream buffer zone] regulation . . . particularly as it applies to the placement of excess spoil fills within and near intermittent and perennial streams." *See* 69 Fed. Reg. 1,038-40. As a result it began a rulemaking effort to replace the 1983 SBZ rule, which resulted in adoption of a new stream buffer zone rule in 2008. 73 Fed. Reg. 75,818 (the 2008 rule).

The 2008 SBZ rule was immediately challenged by 10 environmental groups in two lawsuits. In July 2013, the government moved for partial summary judgment against on the grounds that it had failed to comply with the Endangered Species Act (ESA) when it adopted the rule. In the context of briefing that motion, the National Mining Association (NMA) recognized the confusion created by the 1983 SBZ rule: "Vacating the entire [2008 SBZ] Rule would undo the clarification it provides on non-ESA issues and return the regulatory program to its previous confused and uncertain state, which would remain in place for years to come until OSM issues a

[11] Kentuckians for the Commonwealth, Inc. v. Rivenburgh, 204 F. Supp. 2d 927, 942 (S.D. W. Va. 2002).

[12] Kentuckians for the Commonwealth, Inc. v. Rivenburgh, 317 F.3d 425, 442 (4th Cir. 2003).

[13] Id. at 443. The preamble to a proposed rule, which we published on January 7, 2004, but which we never adopted in final form, contains additional discussion of litigation and related matters arising from the 1983 stream buffer zone rule through 2003. See especially Part I.B.1. at 69 FR 1038-1040.

[14] Corrected Brief for Federal Appellants at 9 n.2, Ohio Valley Envtl. Coal. v. Bulen, 556 F.3d 177 (4th Cir. 2009) (Nos. 04-2129 (L), 04-2137, 04-2402) (footnote omitted).

[15] 33 U.S.C. 1344.

new notice of proposed rulemaking (currently promised for 2014) and, eventually, a new final rule." Brief of the Intervenor-Defendant at 32-33, *Nat'l Parks Conservation Ass'n v. Jewell*, 2014 U.S. Dist. LEXIS 152383 (D.D.C. Aug. 30, 2013) (No. 09-115). Despite NMA's protest, on February 20, 2014, the district court vacated the 2008 SBZ rule and reinstated the 1983 version. *Nat'l Parks Conservation Ass'n v. Jewell*, 2014 U.S. Dist. LEXIS 152383 at *31, *35 (D.D.C. Feb. 20, 2014)). The court in that case did not discuss any interpretation of the 1983 SBZ rule and instead focused on OSMRE's failure to comply with the Endangered Species Act.

Although the 2008 Stream Buffer Zone Rule that was in place when the 2009 ANPR was published has since been vacated (*NPCA v. Jewell*, No. 09-115, Memorandum Decision at 13-14 (D.D.C. Feb. 20, 2014)), and the prior rules have been reinstated, the conclusion that a comprehensive stream protection rule is needed is still valid. Through the process of considering comments received on the Proposed Rulemaking and issues identified during scoping, it was determined that improved protection of the hydrologic balance, especially streams, fish, wildlife, and related environmental values is needed throughout the country. One of the reasons SMCRA was enacted was to ensure a minimum level of environmental protection nationwide by establishing national surface coal mining and reclamation standards to prevent competition for coal markets from undermining the ability of states to maintain adequate regulatory programs for coal mining operations within their borders. See Section 101(g) of SMCRA, 30 U.S.C. § 1201(g). Thus, OSMRE concluded that a nationwide rule is required.

Both the 2008 Stream Buffer Zone Rule and its predecessors focused primarily on activities in or within 100 feet of the stream itself and, in the case of the 2008 rule, on minimization of excess spoil creation and limiting the footprint of excess spoil fills. Yet, mining activities beyond the 100-foot stream buffer zone can have significant impacts on the quality and quantity of water in streams by disturbing aquifers and altering the physical and chemical nature of recharge zones, as well as surface-water runoff rates, drainage patterns, and fish, wildlife, and related environmental values.

Thus, there are many components of our regulations, not just the ones related to stream buffer zones, that could be revised to improve implementation of SMCRA with regard to stream protection and conservation of fish, wildlife, and related environmental values. In particular, six areas have been identified in which regulations to better protect streams and associated environmental values have been proposed.

First, while ephemeral streams derive their flow from surface runoff from precipitation events, perennial and intermittent streams derive their flow from both groundwater discharges and surface runoff from precipitation events. Therefore, there is a need to clearly define the point at which adverse mining-related impacts on both groundwater and surface water reach an unacceptable level; that is, the point at which adverse impacts from mining cause material damage to the hydrologic balance outside the permit area. Neither SMCRA nor the existing regulations define the term "material damage to the hydrologic balance outside the permit area" or establish criteria for determining what level of adverse impacts would constitute material damage. In particular, there is no requirement that the SMCRA regulatory authority establish a specific standard for conductivity or selenium, both of which can have deleterious effects on aquatic life at elevated levels.

Second, there is a need to collect adequate premining data about the site of the proposed mining operation and adjacent areas to establish a comprehensive baseline that will facilitate evaluation of the effects of mining. The existing rules require data only for a limited number of water-quality parameters rather than the full suite needed to establish a complete baseline against which the impacts of mining can be compared. The existing rules also contain no requirement for determining the biological condition of streams within the proposed permit and adjacent areas, so there is no assurance that the permit application will include baseline data on aquatic life.

Third, there is a need for effective, comprehensive monitoring of groundwater and surface water during and after both mining and reclamation and during the revegetation responsibility period to provide real-time information documenting mining-related changes in the values of the parameters being monitored. Similarly, there is a need to require monitoring of the biological condition of streams during and after mining and reclamation to evaluate changes in aquatic life. Proper monitoring will enable timely detection of any adverse trends and timely implementation of any necessary corrective measures. The existing rules require monitoring of only water quantity and a limited number of water-quality parameters, not all parameters necessary to evaluate the impact of mining and reclamation. The existing rules do not ensure that the number and location of monitoring points will be adequate to determine the impact of mining and reclamation. They also allow discontinuance or reduction of water monitoring too early to ascertain the impacts of mining and reclamation on water quality with a reasonable degree of confidence, especially for groundwater.

Fourth, there is a need to ensure protection or restoration of streams and related resources, including the headwater streams that are important to maintaining the ecological health and productivity of downstream waters. The existing rules have not always been applied in a manner sufficient to ensure protection or restoration of streams, especially with respect to the ecological function of streams. Maintenance, restoration, or establishment of riparian corridors or buffers, comprised of native species, for streams is a critical element of stream protection. In forested areas, riparian buffers for streams moderate the temperature of water in the stream, provide food (in the form of fallen leaves and other plant parts) for the aquatic food web, roots that stabilize stream banks, reduce surface runoff, and filter sediment and nutrients in surface runoff.

Fifth, there is a need to ensure that permittees and regulatory authorities make use of advances in information, technology, science, and methodologies related to surface and groundwater hydrology, surface-runoff management, stream restoration, soils, and revegetation, all of which relate directly or indirectly to protection of water resources.

Sixth, there is a need to ensure that land disturbed by surface coal mining operations is restored to a condition capable of supporting the uses that it was capable of supporting before any mining, including both those uses dependent upon stream protection or restoration and those uses that promote or support protection and restoration of streams and related environmental values. Existing rules and permitting practices have focused primarily on the land's suitability for a single approved postmining land use and they have not always been applied in a manner that results in the construction of postmining soils that provide a growth medium suitable for restoration of premining site productivity. A corollary need is to ensure that reclaimed minesites are revegetated with native species unless and until a conflicting postmining land use, such as intensive agriculture, is implemented. Soil characteristics and the degree and type of revegetation have a major impact on surface-water runoff quantity and quality as well as on aquatic life and the terrestrial ecosystems dependent upon perennial and intermittent streams. Under the existing rules, sites with certain postmining land uses have been revegetated with non-native species even when the postmining land use is not implemented prior to final bond release and even on those portions of the site where non-native species are not necessary to achieve the postmining land use.

These needs form the basis for our development of a reasonable range of Alternatives for the proposed Stream Protection Rule. Nine Alternatives were carried forward for analysis in the DEIS, including the No Action Alternative and the Preferred Alternative. The Alternatives consist of a spectrum of combinations of the rule elements, with each Alternative including shared characteristics with other Alternatives but differing in some aspects of new requirements or the degree of improvement to existing regulations.

The following sections briefly describe the No Action Alternative, the Preferred Alternative, and then provide a comparison of all nine alternatives carried forward in the DEIS. The sections are organized into four major groups of rule elements: protection of the hydrologic balance, activities in or near streams, approximate original contour (AOC) and AOC variances, and revegetation, topsoil, and fish and wildlife protection and enhancement.

ES.4 Alternative 1 (No Action Alternative)

The No Action Alternative consists of the existing regulatory environment; it provides a baseline against which to compare the Action Alternatives. If the No Action Alterative is selected for implementation no proposed regulatory revisions would be implemented. Thus, mining under this Alternative would continue to occur under our existing 1983 regulations. For reasons of brevity, we've described below only the requirements for surface coal mining operations. However, in most instances, analogous requirements apply to underground mining operations.

Protection of the Hydrologic Balance (No Action Alternative)

Baseline Data Collection and Analysis (No Action Alternative)

Under the current regulations, the applicant for a mining permit is required to submit, at a minimum, the following baseline information, and any additional hydrologic or geologic information required by the regulatory authority.[16]

Groundwater**:** Under 30 CFR 780.21, the applicant must submit data for existing wells, springs, and other groundwater resources within or adjacent to the proposed permit area. These data characterize the quality and quantity of groundwater and provide information on usage sufficient to demonstrate seasonal variation. Information on water quality must include total dissolved solids (TDS) or specific conductance, pH, total iron, and total manganese. Groundwater quantity information must include approximate rates of discharge or usage, as well as depth to the water

[16] Unless otherwise specifically stated, the term "regulatory authority" as used in this DEIS refers to the SMCRA regulatory authority.

in the coal seam, each water-bearing stratum above the coal seam, and each potentially affected stratum below the coal seam.

Surface water*:* Under 30 CFR 780.21, the applicant must submit information on surface water quality and quantity sufficient to demonstrate seasonal variation and water usage. At a minimum, water-quality information must include baseline information on total suspended solids (TSS), TDS or specific conductance, pH, total iron, and total manganese. The applicant must provide additional information on baseline acidity and alkalinity if there is a potential for acidic drainage from the proposed mining operation. Water quantity information must contain information on seasonal flow rates.

Geology*:* Under 30 CFR 780.22, the permit application must describe the geology of the proposed permit area and the adjacent area down to and including the deeper of either (1) the stratum immediately below the lowest coal seam to be mined or (2) any aquifer below that seam that could be adversely affected by mining. The description must include the areal and structural geology of the proposed permit area and the adjacent area. The description must also address other parameters that influence the required reclamation and the occurrence, availability, movement, quantity, and quality of potentially impacted surface water and groundwater. The geologic information must also include analyses of samples collected from test borings, drill cores, or samples from rock outcrops from the permit area. This requirement includes lithologic characterization and chemical analysis of strata and the coal seam for acid-forming or toxic-forming materials (including total sulfur, pyritic sulfur, and alkalinity-producing materials). The regulatory authority may waive analysis for alkalinity-producing materials and pyritic sulfur if sufficient data exists to document that the data is not needed.

Monitoring During Mining and Reclamation (No Action Alternative)

The current regulations at 30 CFR 780.21(i) and (j) and 816.41(c) and (e) require monitoring of the quantity and quality of surface water and groundwater. The monitoring plan must include parameters related to the suitability of the water for current and approved postmining land uses, the hydrologic reclamation plan, and (for surface water) the effluent limitations in 40 CFR Part 434. At a minimum, pH, total iron, total manganese, TDS or specific conductance, water levels (for groundwater), flow (for surface water), and TSS (for surface water) must be monitored every three months until final bond release. The permittee must monitor point-source discharges in accordance with their National Pollutant Discharge Elimination System (NPDES) permit. The monitoring plan must identify the monitoring locations, but the regulations do not establish criteria for the number or placement of monitoring locations.

The regulatory authority may modify or waive the monitoring requirements at any time if the permittee demonstrates that monitoring, in whole or in part, is no longer necessary to achieve the purposes set forth in the monitoring plan, that the operation has minimized disturbance to the hydrologic balance within the permit area and prevented material damage to the hydrologic balance outside the permit area, that water quality and quantity are suitable to support the approved postmining land uses, and that the water rights of other users have been protected or adequately replaced. However, the regulatory authority may not modify or waive NPDES monitoring requirements.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area (No Action Alternative)

The current regulations do not define material damage to the hydrologic balance outside the permit area. However, the preamble to existing 30 CFR 780.21(g) and 784.14(f) states that "because the gauges for measuring material damage may vary from area to area and from operation to operation," OSMRE has not established fixed criteria, except for those established under §§ 816.42 and 817.42 related to compliance with water quality standards and effluent limitations (48 FR 43973, Sept. 26, 1983). OSMRE further noted in the preamble to the existing rules that each regulatory authority should establish criteria to measure material damage to the hydrologic balance for purposes of cumulative hydrologic impact assessments (48 FR 43973, Sept. 26, 1983). Most state regulatory programs have not defined this term.

Corrective Action Thresholds (No Action Alternative)

The current regulations contain no requirement for specific corrective action thresholds. However, permit applicants proposing to conduct surface or underground coal mining are required under § 780.21(h) or § 784.14(g) respectively, to provide a plan of measures the applicant would take to avoid adverse potential adverse hydrologic consequences, including preventative and remedial measures. Under 30 CFR 816.41(c)(2) and (e)(2) and 817.41(c)(2) and (e)(2), if monitoring results demonstrate noncompliance with permit conditions or federal, state, or tribal water quality laws and regulations, the permittee must promptly notify the regulatory authority. The applicant must then take all possible steps to minimize any adverse impact to the environment or public health and safety, and must immediately implement measures necessary to comply with permit condition (30 CFR 773.17(e)).

Activities in or near Streams (No Action Alternative)

Stream Definitions (No Action Alternative)

The current regulatory definitions of perennial, intermittent, and ephemeral streams use hydrologic characteristics and watershed size to define these waters (30 CFR 701.5). The current definitions do not include biological or chemical characteristics.

- Under the current regulations, a perennial stream is a stream or part of a stream that flows continuously during all of the calendar year because of groundwater discharge or surface runoff.
- An intermittent stream is (1) a stream or reach of a stream that drains a watershed of at least one square mile, *or* (2) a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains flow from both surface runoff and groundwater discharge.
- An ephemeral stream is a stream that flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table.

The second bullet has sometimes been incorrectly applied as if the "or" was an "and;" i.e., the one-square-mile criterion has sometimes been applied as a threshold for all intermittent streams, when, in fact, a stream in a smaller watershed that meets the second criterion is an intermittent stream regardless of the size of its watershed.

Activities in or near Streams (Including Disposal of Excess Spoil and Coal Mine Waste Facilities) (No Action Alternative)

The 1983 SBZ rule, 30 CFR 816.57, which is now back in effect[17], provides that mining activities may not disturb land within 100 feet of a perennial or an intermittent stream unless the regulatory authority specifically authorizes activities closer to, or through, such a stream. The regulatory authority may authorize such activities only after finding that the proposed activities would not cause or contribute to a violation of applicable federal or state water quality standards under the Clean Water Act and would not adversely affect the water quantity and quality or other environmental resources of the stream.

The 1983 SBZ rule does not specifically mention placement of excess spoil and coal mine waste in or within 100 feet of streams, but OSMRE and most state regulatory authorities generally have applied the 1983 SBZ rule in a manner that allows the construction of excess spoil fills, refuse piles, slurry impoundments, and sedimentation ponds in all types of streams and their buffer zones.

The existing regulations at 30 CFR 816.71 through 816.74 require that excess spoil fills be constructed by controlled placement of the excess spoil in lifts no greater than four feet thick, except that durable rock fills may be constructed by end-dumping, which is intended to result in the formation of underdrains by gravity segregation.

In general, only surface coal mining operations in steep-slope terrain generate excess spoil. Although not expressly required by regulation, most states with mining operations in steep-slope terrain have adopted policies intended to minimize the generation of excess spoil and thus reduce the size of excess spoil fills, which in turn would reduce the length of stream covered by those fills. In addition, the agencies administering the Clean Water Act have implemented policies that have reduced both the number of excess spoil fills and the length of stream covered by those fills. Furthermore, the regulations in 40 CFR Part 230 for implementation of section 404(b)(1) of the Clean Water Act require an analysis of all practicable alternatives to placement of fill material in waters of the United States, which would include most streams. Under those regulations, the applicant must select the alternative with the least adverse effect on the aquatic ecosystem and mitigate any remaining adverse impacts on the aquatic environment.

Mining Through Streams (No Action Alternative)

The 1983 version of the stream-channel diversion rules at 30 CFR 816.43 is now back in effect. Under 30 CFR 816.43(b)(1), the regulatory authority may approve diversion of perennial or intermittent streams within the permit area only after making the finding related to stream buffer zones in 30 CFR 816.57 that the diversion would not adversely affect the water quantity and quality and related environmental resources of the stream. Under 30 CFR 816.43(a), the

[17] See 79 FR 76227-76233 (Dec. 22, 2014).

applicant must design the diversion to minimize adverse impacts to the hydrologic balance within the permit and adjacent areas, prevent material damage to the hydrologic balance outside the permit area, and to assure the safety of the public. In addition, the applicant must design, locate, construct, maintain, and use the diversion to prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow outside the permit area.

Under 30 CFR 816.43(b)(4), both the design and construction of stream-channel diversions for perennial and intermittent streams must be certified by a qualified registered professional engineer as meeting applicable performance standards and any design criteria established by the regulatory authority. Under 30 CFR 816.43(a)(3), the design for restored stream channels for perennial and intermittent streams (or permanent diversion channels for those streams) must restore or approximate the premining characteristics of the original stream channel, including the natural riparian vegetation. Under 30 CFR 816.43(b)(2), the design capacity for both temporary and permanent stream-channel diversions must at least equal the capacity of the unmodified stream channel immediately upstream and downstream of the diversion.

Approximate Original Contour (AOC) and AOC Variances (No Action Alternative)

Surface Configuration (No Action Alternative)

Under existing 30 CFR 780.18(b) (3), each permit application must include a plan for backfilling, soil stabilization, and compacting and grading. Contour maps or cross-sections must show the anticipated final surface configuration. The performance standards at 30 CFR 816.102, 816.104, 816.105, 816.106, and 816.107 require that disturbed areas be backfilled and regraded to closely resemble the premining surface configuration, with exceptions for thin and thick overburden situations, previously mined areas, and certain other circumstances. The regulations allow permanent impoundments, including final-cut impoundments, provided they do not otherwise create conflicts with achieving AOC and they meet the design, construction, maintenance, postmining land use, and other requirements in 30 CFR 800.40(c)(2), 816.49(b), and 816.133.

AOC Variances (No Action Alternative)

The current regulations provide for the approval of permits for mountaintop removal mining operations, which are exempt from AOC restoration requirements if the postmining land use and postmining surface topography requirements of paragraphs (3) and (4) of Section 515(c) of SMCRA are met. The regulations also provide for the approval of AOC variances for steep-slope mining operations under certain conditions.

As described in 30 CFR 785.14(b), mountaintop removal mining operations are surface mining activities in which the mining operation removes an entire coal seam or seams running through the upper fraction of a mountain, ridge or hill by removing substantially all of the overburden off the bench and creating a level plateau or gently rolling contour, with no highwalls remaining. To obtain a permit for mountaintop removal mining operations, the proposed postmining land use must be a commercial, industrial, residential, agricultural, or public facility land use. The regulatory authority must find that the proposed postmining land use meets all requirements for alternative postmining land uses and is an equal or better economic or public use of the land compared to its premining use. The permit application must include specific plans for the proposed postmining land use, including assurance of investment in public facilities and documentation of private financial capability to ensure completion. The current regulations do not require implementation of the approved postmining land use prior to final bond release or thereafter.

Under 30 CFR 824.11(a)(9), the regulatory authority may approve a permit for a mountaintop removal mining operation only upon a demonstration that there would be no damage to natural watercourses below the lowest coal seam to be mined. The regulations do not define the term "no damage." Natural watercourses above the lowest coal seam mined are not protected from damage.

Under 30 CFR 824.11(a) (6), the permittee must leave an outcrop barrier in place at the toe of the lowest coal seam mined to ensure stability.

As defined in 30 CFR 701.5, steep slopes are any slope of more than 20° or a lesser slope designated by the regulatory authority after consideration of soil, climate, and other characteristics of a region or State. To obtain an AOC variance for steep-slope mining operations under 30 CFR 785.16, the proposed postmining land use must be of an industrial, commercial, residential, or public (including recreational facilities) nature. It also must meet the requirements in 30 CFR 816.133 for approval of alternative postmining land uses, which, among other things, means that the postmining use must be an equal or better economic or public use. The applicant must demonstrate that the proposed operation will improve the watershed when compared to either premining conditions or the conditions that would exist if the applicant restored the area to AOC after mining. The regulatory authority can concur that the operation would improve the watershed only if the operation would reduce the amount TSS or other pollutants discharged from the permit area to surface water or groundwater *or* reduce the flood hazards within the watershed by a reduction of the peak-flow discharge from precipitation events or thaws. In both cases, the total volume of flow from the proposed permit area during every season of the year must not vary in a way that adversely affects the ecology of any surface water or any existing or planned use of surface water or groundwater.

Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement (No Action Alternative)

Revegetation, Reforestation and Topsoil Management (No Action Alternative)

Under 30 CFR 816.133(a), the permittee must restore all disturbed areas to a condition in which they are capable of supporting the uses that they were capable of supporting before any mining or higher or better uses.

Under 30 CFR 816.22, the permittee must salvage and redistribute all topsoil (the A and E soil horizons), unless alternative overburden materials are approved as being equal to or better than the existing available topsoil to support vegetation. The permittee also must demonstrate that the selected overburden materials they propose to use as topsoil substitutes and supplements are the best available material within the permit area. Paragraph (e) of 30 CFR 816.22 provides that the regulatory authority may require salvage and redistribution of the subsoil (the B and C soil horizons) or other underlying strata if it finds that those layers are necessary to comply with the revegetation performance standards in 30 CFR 816.111 through 816.116.

Paragraph (d) of 30 CFR 816.22 requires that the permittee redistribute topsoil and topsoil substitutes and supplements in a manner that achieves an approximately uniform, stable thickness when consistent with the approved postmining land use, contours, and surface water drainage systems. Soil thickness may vary to the extent necessary to meet the specific revegetation goals identified in the permit. The permittee also must redistribute soil materials in a manner that prevents excess compaction and protects the materials from wind and water erosion before and after seeding and planting.

Under 30 CFR 816.116, revegetation success standards must be based upon the effectiveness of the vegetation to support the approved postmining land use, the extent of ground cover compared to the cover provided by the natural vegetation of the area, and the general requirements of 30 CFR 816.111. These general requirements provide that the vegetative cover must be diverse, effective, and permanent; comprised of species native to the area (with certain exceptions); at least equal in extent of cover to the natural vegetation of the area; capable of stabilizing the soil surface from erosion; compatible with the postmining land use; have the same seasonal characteristics of growth as the original vegetation; be capable of self-regeneration and plant succession; be compatible with the plant and animal species of the area; and meet the requirements of state and federal laws and regulations concerning seeds, poisonous and noxious plants, and introduced species. The regulations provide exceptions to some of these requirements for agricultural crops and for plantings used to establish temporary cover.

Fish and Wildlife Protection and Enhancement (No Action Alternative)

Under 30 CFR 780.16(a), each permit application must include fish and wildlife resource information for the proposed permit area and the adjacent area. The regulatory authority must determine the scope and level of detail of that information in consultation with state and federal agencies with responsibility for fish and wildlife. Paragraph (b) of 30 CFR 780.16 requires that the permit application also include a fish and wildlife protection and enhancement plan. Paragraph (c) of 30 CFR 780.16 requires that the regulatory authority provide the fish and wildlife resource information and the fish and wildlife protection and enhancement plan to the U.S. Fish and Wildlife Service (U.S. FWS) upon request.

Under the current regulations at 30 CFR 816.97(a), the mine operator must, to the extent possible using the best technology currently available minimize disturbances and adverse impacts to fish, wildlife, and related environmental values and enhance such resources where practicable.

Under 30 CFR 816.97(b), surface mining activities must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of designated critical habitats of such species in violation of the Endangered Species Act of 1973 (16 U.S.C. §§1531 to 1599). On September 24, 1996, the U.S. FWS issued a biological opinion (BO) and conference report to OSMRE (1996 BO) on the continuation and approval and conduct of surface coal mining and reclamation operations under state and federal regulatory programs adopted pursuant SMCRA where such operations may adversely affect species listed as threatened or endangered or designated critical habitat under the Endangered Species Act (ESA).

The 1996 BO explains how this requirement is designed to be implemented; it also provides an incidental take statement. The 1996 BO states that the regulatory authority must "implement and require compliance with any species-specific protective measures developed by the U.S. FWS field office and the regulatory authority (with the involvement, as appropriate, of the permittee and OSM[RE])." The 1996 BO further provides that, "[w]henever the regulatory authority decides not to implement one or more of the species-specific measures recommended by the U.S. FWS, it must provide a written explanation to the U.S. FWS. If the U.S. FWS field office concurs with the regulatory authority's action, it would provide a concurrence letter as soon as possible. However, if the U.S. FWS does not concur, the issue must be elevated through the chain of command of the regulatory authority, the U.S. FWS, and (to the extent appropriate) OSM[RE] for resolution." However, neither the regulations nor the 1996 BO contain a clear description of the process for resolving disputes between the U.S. FWS and the regulatory authority; the 1996 BO and current regulations are unclear about the respective roles and responsibilities of OSMRE, the U.S. FWS, and regulatory authority. To rectify this situation, OSMRE and the U.S. FWS are developing a Memorandum of Understanding (MOU). The MOU, once signed, adds no new requirements but instead merely clarifies existing ones.

Under 30 CFR 816.97(f), the permittee must avoid disturbances to wetlands and riparian vegetation along rivers and streams and bordering ponds and lakes; permittees must enhance where practicable, restore, or replace these resources. Likewise, surface mining activities must also avoid disturbances to habitats of unusually high value for fish and wildlife; these resources must be restored or enhanced where practicable.

Where fish and wildlife habitat is to be a postmining land use, 30 CFR 816.97(g) requires that the plant species to be used on reclaimed areas be selected based upon their proven nutritional value for fish or wildlife, their use as cover for fish or wildlife, and their ability to support and enhance fish or wildlife habitat after bond release. Paragraph (g) also requires that the plants selected be grouped and distributed in a manner that optimizes edge effect, cover, and other benefits to fish and wildlife.

The remaining paragraphs of 30 CFR 816.97 identify assorted other measures that permittees must implement during and after mining to minimize damage to fish and wildlife resources and their habitats or to ensure that all postmining land uses provide some fish and wildlife habitat or travel corridors to the extent practicable.

ES.5 Alternative 8 (Preferred Alternative)

The Preferred Alternative (Alternative 8 in the DEIS) is comprised of selected primary stream protection and fish and wildlife conservation elements of the other Action Alternatives analyzed. These elements include: defining material damage to the hydrologic balance outside the permit area, enhancing baseline data collection, monitoring and regulatory authority review, requiring restoration of the ecological function of perennial and intermittent streams that are mined through, requiring fish and wildlife enhancements for perennial and intermittent stream reaches buried by excess spoil or coal mine waste, prohibiting mountaintop removal mining operations from damaging natural watercourses, and requiring reforestation of previously forested areas.

Protection of the Hydrologic Balance (Preferred Alternative)

Baseline Data Collection and Analysis (Preferred Alternative)

Under the Preferred Alternative (Alternative 8) information on stream flow, sediment load, all rainfall/storm events, stream chemical, physical and hydrologic form and stream ecological function would be required on all streams, including a representative number of ephemeral streams. Alternative 8 (Preferred) would require discrete (versus continuous) monthly water sample data collection on all perennial and intermittent streams and a representative number of ephemeral streams at evenly spaced intervals over a 12-month period (12 samples total). It would expand the suite of parameters subject to analysis to include: temperature, aluminum, bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium, hot acidity, alkalinity, pH, selenium, specific conductance, total dissolved solids (TDS), total iron, total manganese, total suspended solids, arsenic, zinc, copper, cadmium, ammonia and nitrogen and any additional parameters for which effluent limitations guidelines and standards have been established in accordance with Section 402 of the CWA.

In addition, Alternative 8 (Preferred) would require identification of aquatic biota in streams and other water bodies to the genus level. Sampling, analysis, and biological assessment methods would follow recognized protocols (for example, the bioassessment protocols must be comprehensive, multi-assemblage and scientifically defensible). The sampling analyte list also could include constituents that are specific to the coal and overburden at the site. Alternative 8 (Preferred) would require discrete measurements of stream flow. Recording all rainfall/storm events using continuous recorders would also be required.

Similarly, Alternative 8 (Preferred) would require groundwater samples over a 12-month period identical to the period in which the surface water samples are taken. Parameter sampling requirements would include water level, measurement of the identical chemical parameters as required for surface water (except total suspended solids), and quantitative measurement of the aquifer including static water levels and groundwater travel times. Scientifically recognized protocols for sampling and analysis of groundwater would be required.

Monitoring During Mining and Reclamation (Preferred Alternative)

Alternative 8 (Preferred) would require monitoring the same analytes and parameters measured during baseline sampling.

- The permittee would be required to obtain quarterly full-suite water samples (including major cations and anions and the additional permit-specific parameters connected to the designated stream use) as well as an annual assessment of biological condition.
- For monitoring and biological assessment, the permittee would be required to use recognized protocols (for example, current bioassessment protocols used in CWA regulatory programs).
- The permittee would be required to continue monitoring all data until final bond release. Bond release would not occur until the data showed no adverse trends in stream flow, surface-water and groundwater water-quality data, and biological data

that would lead to material damage to the hydrologic balance. Monitoring requirements could not be waived before final bond release.

- The monitoring plan would require on-site measurement of precipitation using self-recording devices.
- The permittee would be required to provide a plan for designing and monitoring the drainage control structures including provisions for inspection and certification (by a certified professional engineer) for surface water runoff control structures following every two-year recurrence or greater interval precipitation event.
- The regulatory authority would review and analyze all monitoring data to identify adverse trends and determine whether any changes are needed to the mining and reclamation plan every five years or upon permit renewal (whichever is less) or upon receipt of any significant permit revision.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area (Preferred Alternative)

Alternative 8 (Preferred) would define material damage to the hydrologic balance outside the permit area as any quantifiable adverse impact from surface mining or underground mining operations on the quantity or quality of surface water or groundwater, or on the biological condition of a stream, that would preclude attainment or continuance of any designated surface-water use under Sections 101(a) and 303(c) of the CWA or any existing or reasonably foreseeable use of surface water or groundwater outside the permit area. The definition would not be limited to the direct impacts from surface mining activities or the impacts of activities conducted on the surface of land (that is., where surface facilities are located) in connection with an underground coal mine. It would also apply to the indirect adverse impacts from subsidence and other adverse impacts (for example, permanent dewatering of a stream caused by underground mining through a fracture zone).

Corrective Action Thresholds (Preferred Alternative)

The Preferred Alternative would not require corrective action thresholds.

Activities in or near Streams (Preferred Alternative)

Stream Definitions (Preferred Alternative)

Alternative 8 (Preferred) would redefine ephemeral, intermittent and perennial streams in a manner that is substantively identical to the manner in which the U.S. Army Corps of Engineers defines that term in Part F of the 2012 reissuance of the nationwide permits under section 404 of the Clean Water Act. See 77 FR 10184, 10288 (Feb. 21, 2012).

Activities in or near Streams (Including Disposal of Excess Spoil and Coal Mine Waste) (Preferred Alternative)

Alternative 8 (Preferred) would prohibit mining activities in or through perennial and intermittent streams or on the surface of land within 100 feet of those streams unless the applicant makes certain demonstrations and the regulatory authority makes the corresponding findings listed below, that the proposed activity would not—

(1) Preclude attainment or maintenance of any existing, reasonably foreseeable, or designated use under section 101(a) or 303(c) of the Clean Water Act, of the affected stream segment following the completion of mining and reclamation;

(2) Result in conversion of the stream segment from intermittent to ephemeral, from perennial to intermittent, or from perennial to ephemeral;

(3) Cause or contribute to a violation of federal, state, or tribal water quality standards; or

(4) Cause material damage to the hydrologic balance outside the permit area.

These requirements apply to all mining activities except the construction of excess spoil fills and coal mine waste disposal facilities that cover perennial or intermittent streams. (Excess spoil fills and coal mine waste disposal facilities that extend into the buffer zone, but not the stream itself, are not exempt.)

In addition, the permittee must establish a 100-foot-wide or wider riparian corridor on each side of every perennial, intermittent, and ephemeral stream following the completion of mining activities. The corridor must be comprised of native species, including species with riparian characteristics. The permittee must plant native trees and shrubs in areas that are forested at the time of permit application or that would revert to forest under conditions of natural succession. This revegetation requirement does not apply to prime farmland historically used for cropland or to situations in which revegetation would be incompatible with an approved postmining land use that is implemented during the revegetation responsibility period before final bond release.

Alternative 8 (Preferred) would allow mining through any type of stream, provided that the applicant satisfactorily demonstrates to the regulatory authority all of the following with respect to perennial and intermittent streams:

(1) There is no reasonable alternative that would avoid mining through or diverting the stream;

(2) The operational design would minimize the extent of stream mined through or diverted; and

(3) The hydrological form and ecological function of the affected stream segment could and would restored using the techniques in the proposed reclamation plan.

Alternative 8 (Preferred) would establish a different set of requirements for proposals to construct excess spoil fills and coal mine waste disposal facilities in perennial or intermittent streams. Specifically, the applicant must make the following demonstrations and the regulatory authority must make the following findings:

> (1) There is no reasonable alternative that would avoid placement of excess spoil or coal mine waste in a perennial or intermittent stream;
>
> (2) To the extent possible using the best technology currently available, the proposed excess spoil fill or coal mine waste disposal facility has been designed to minimize the amount of excess spoil or coal mine waste to be placed in a perennial or intermittent stream;
>
> (3) The fish and wildlife enhancement plan includes measures that would fully and permanently offset any long-term adverse impacts that the fill, refuse pile, or coal mine waste impoundment would have on fish, wildlife, and related environmental values within the footprint of the fill, refuse pile, or impoundment;
>
> (4) The excess spoil fill or coal mine waste disposal facility has been designed in a manner that will not cause or contribute to a violation of water quality standards or result in the formation of toxic mine drainage; and
>
> (5) The revegetation plan requires reforestation of the completed excess spoil fill if the land is forested at the time of application or if it would revert to forest under conditions of natural succession.

Alternative 8 (Preferred) would require the applicant to demonstrate that (1) the operation has been designed to minimize, to the extent possible, the volume of excess spoil that the operation would generate and (2) the designed maximum cumulative volume of all proposed excess spoil fills is no larger than the capacity needed to accommodate the anticipated cumulative volume of excess spoil that the operation would generate. Both requirements are intended to reduce the length of stream that the operation will cover.

In addition, this Alternative would prohibit construction of durable rock fills, which use end-dumping as a means of spoil placement and rely upon gravity segregation to form underdrains.

Under Alternative 8 (Preferred), the permittee must construct excess spoil fills in lifts not to exceed four feet in thickness. The use of end-dumping for final placement would be prohibited and the current regulation at 30 CFR 816.73 allowing construction of durable rock fills that rely upon end-dumping and the construction of underdrains by gravity segregation of the end-dumped material would be eliminated.

This Alternative would require daily monitoring during excess spoil placement. It would revise the existing rules to require that the quarterly inspection reports filed with the regulatory authority include the daily monitoring logs.

Alternative 8 (Preferred) would prohibit the construction of excess spoil fills with flat decks on the top surface. The final surface configuration must resemble the surrounding terrain. Alternative 8 (Preferred) would provide that, to the extent that stability considerations allow, excess spoil fills must be constructed with aquitards as a barrier to groundwater infiltration and to facilitate stream construction. Placement of a layer of lower-permeability spoil or other material near the surface but below the root zone for trees and shrubs could provide the subsurface flow needed to restore flow in intermittent and ephemeral stream segments.

Mining through Streams (Preferred Alternative)

Under Alternative 8 (Preferred), mining would be allowed through intermittent and perennial streams upon demonstration by the applicant that the reclamation plan would achieve complete restoration of the hydrologic form and ecological function of all perennial and intermittent streams. In addition, it would require minimization of the extent of the mine-through and a provision that the cost of restoration of both form and function be assured through the reclamation bond. It would require restoration of stream form only for ephemeral streams. However, for streams including ephemeral, this Alternative would require establishment of a 100-foot riparian corridor along the entire reach of any restored stream. Alternative 8 (Preferred) would require the use of natural channel design techniques, with specific performance standards, for stream restoration. It would require that the SMCRA regulatory authority establish restoration standards in coordination with CWA permitting authority and that baseline conditions be used in determining those standards.

Approximate Original Contour (AOC) and AOC Variances (Preferred Alternative)

Surface Configuration (Preferred Alternative)

The Preferred Alternative would retain the current definition of AOC. It would not require the use of digital terrain modeling or impose objective numerical standards on final elevations and landforming. This Alternative is the same as the No Action Alternative for these elements.

AOC Variances (Preferred Alternative)

Alternative 8 (Preferred) would allow mountaintop removal mining operations and AOC variances for steep-slope mining operations under conditions generally similar to those in Alternative 1, the No Action Alternative. However, Alternative 8 (Preferred) would impose additional requirements to better protect streams, aquatic ecology, and biological communities. In addition, it would require that the permittee post bond in an amount sufficient to return the site to AOC if the approved postmining land use were not implemented before expiration of the revegetation responsibility period.

For approval of mountaintop removal mining operations, Alternative 8 (Preferred) would require the permit applicant to demonstrate that no damage would result to natural watercourses within the watershed(s) of the proposed permit and adjacent areas. The applicant can meet this requirement by making all of the following demonstrations:

- There would be no adverse changes in parameters of concern in discharges to surface water and groundwater;
- No change would occur in the size or frequency of peak flows as compared to the peak flows that would occur if the permittee mined the site and restored it to AOC; and

- The total volume of flow during any season of the year would not vary; i.e., the seasonal flow regime would not change and there would be no increase in potential damage from flooding.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application, unless reforestation would be inconsistent with the postmining land use.

Finally, the permittee must install drains through the outcrop barrier to prevent saturation of the backfill.

For approval of steep-slope variances, Alternative 8 (Preferred) would require permit applicants to demonstrate that all of the following criteria are met:

- The operation, including any fish and wildlife enhancement measures, will result in fewer adverse impacts to the aquatic ecology of the cumulative impact area than would occur if the site were mined and restored to AOC;

- Surface-water flow in the watershed would be improved over both premining conditions and conditions that would exist if the area were mined and restored to AOC;

- The variance would not result in construction of an excess spoil fill in an intermittent or perennial stream; and

- Any deviations from the premining surface configuration are necessary and appropriate to achieve the postmining land use.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application or would revert to forest under natural succession. This requirement would not apply to permanent impoundments, roads, and other impervious surfaces to be retained following mining and reclamation or to those portions of the permit area covered by the variance.

Revegetation, Soils, Fish and Wildlife Protection and Enhancement (Preferred Alternative)

Revegetation & Soils

Alternative 8 (Preferred) would require salvage and redistribution of all topsoil (A and E soil horizons). In addition this Alternative would require salvage and redistribution of the B and C soil horizons (or other suitable overburden materials) and organic materials to the extent necessary to achieve a suitable growing medium to reestablish native vegetation. It would allow substitution or supplementation with selected overburden materials if the permittee demonstrates to the regulatory authority that: (1) the resulting soil medium is equal to, or more suitable for sustaining vegetation than, the existing topsoil; and (2) the resulting soil medium is the best available in the permit area to support revegetation.

Alternative 8 (Preferred) would require revegetation with native tree and plant species. Non-native species could be used only where necessary to achieve the approved postmining land use provided the postmining land use is actually implemented before the end of the revegetation responsibility period; sufficient bond must be posted to ensure revegetation with native species in the event the approved postmining land use is not implemented prior to final bond release. Reforestation would be mandatory for all previously forested areas, and lands that would revert to forest through natural succession (prime farmland that was under agricultural production prior to mining would be exempt).

Fish and Wildlife Protection and Enhancement

The Preferred Alternative would make enhancement measures mandatory whenever the proposed operation would result in long-term adverse impacts to the environmental resources of a stream due to placement of excess spoil or coal refuse in a perennial or intermittent stream (but not ephemeral streams). Resource enhancement measures must be: (1) commensurate with the long-term adverse impact to affected resources; and (2) located in the same or nearest adjacent watershed as the proposed operation if there are no opportunities for enhancement within the same watershed, and be on permitted area.

Alternative 8 (Preferred) would require creation of a 100-foot riparian corridor, comprised of native non-invasive species, adjacent to all ephemeral, intermittent, or perennial streams within the permit area. The riparian corridor must be established along the entire reach of any stream restored or permanently diverted.

Alternative 8 (Preferred) would: (1) codify the dispute resolution provisions of the biological opinion concerning protection of threatened and endangered species and (2) add a provision to our implementing regulations expressly requiring that the fish and wildlife protection and enhancement plan in the mining permit application include any species-specific protection and enhancement plans developed in accordance with the Endangered Species Act and any U.S. FWS biological opinions.

ES.6 Comparison of all Alternatives Considered

In addition to the No Action Alternative and the Preferred Alternative, seven other Alternatives were analyzed in the DEIS. These Alternatives ranged from the most environmentally protective Alternative (Alternative 2) to Alternative 9, which would put the requirements of the 2008 SBZ rule back in place. Alternatives 2, 3, 8, and 9 would apply in all circumstances. Alternatives 4 and 7 would apply additional or enhanced requirements only in certain circumstances and continue the requirements of the No Action Alternative where those circumstances did not apply. Alternative 5 would be limited to surface and underground mining activities that result in placement of excess spoil outside the mined area or disposal of coal mine waste material in perennial or intermittent streams. Alternative 6 would be limited to mining activity within 100 feet of intermittent or perennial streams. Full descriptions of the Alternatives are contained in Chapter 2 of this DEIS.

The following comparisons of the nine Alternatives represent the major similarities and differences between each of the Alternatives.

Baseline Data Collection and Analysis

Biological Conditions

- The No Action Alternative (also Alternative 9) -- No requirement for baseline biological assessment;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Baseline biological conditions assessment required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Hydrologic Conditions

Water Quality

- The No Action Alternative (also Alternative 9) -- Limited water-quality sampling points and analytical constituents. At a minimum, the analytical suite for surface water and groundwater consists of the following: temperature, total suspended solids (only surface water), pH, specific conductance, total dissolved solids (TDS), total iron, and total manganese;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Baseline water-quality data are required on all intermittent and perennial streams and a representative number of ephemeral streams. Twelve evenly spaced samples are required from a consecutive 12-month period. The analytical suite for surface water and groundwater consists of the following: temperature, total suspended solids (only surface water), aluminum, bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium, (hot) acidity, alkalinity, pH, selenium, specific conductance, TDS, total iron arsenic, zinc, copper, cadmium, ammonia, nitrogen and total manganese; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Surface Water Flow and Groundwater Levels

- The No Action Alternative (also Alternatives 3, 5, 8 (Preferred) and 9) -- Discrete stream flow and groundwater levels measurements required. Twelve evenly spaced samples required over a consecutive 12-month period;
- Alternative 2 (also 4 and 6) -- Continuous stream flow and groundwater levels measurements required; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Rainfall Measurements

- The No Action Alternative (also Alternative 9) -- No onsite rainfall measurements required;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Continuous on-site rainfall measurement requirements; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Stream Hydrologic Form and Ecological Function

- The No Action Alternative (also Alternative 9) -- No documentation required of stream hydrologic form and ecological function;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) --Documentation of stream hydrologic form and ecological function required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Monitoring During Mining and Reclamation

Biological Monitoring

- The No Action Alternative (also Alternative 9) -- No requirements for monitoring of biological condition;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) --Annual monitoring of biological condition required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Water-Quality Monitoring

- The No Action Alternative (also Alternative 9) -- Monitoring for limited suite of analytes [temperature, total suspended solids (only surface water), pH, specific conductance, TDS, total iron, and total manganese] and the regulatory authority can release operator from monitoring before bond release;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Quarterly monitoring until final bond release (assuming no adverse trends in data which would lead to material damage to the hydrologic balance requirement) consisting of the same suite of analytes sampled for during baseline data collection; and

- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Rainfall Measurements

- The No Action Alternative (also Alternative 9) -- No requirement for on-site rainfall measurements;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Continuous on-site rainfall measurements required; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Runoff Control Structures

- The No Action Alternative (also Alternative 9) -- Certification of drainage control structures not required;
- Alternative 2 (also 6) -- Inspect and certify surface runoff control structures by a professional engineer after every one-year return interval precipitation event;
- Alternative 3 (also 4, 5 and 8 (Preferred)) -- Inspect and certify surface runoff control structures by a professional engineer after every two-year return interval precipitation event; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Regulatory Authority Hydrologic Data Review

- The No Action Alternative (also Alternative 9) -- No regularly scheduled hydrologic review required;
- Alternative 2 (also 3, 4, 5, and 6) -- regulatory authority review of monitoring data at permit mid-term review and permit renewal;
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and
- Alternative 8 (Preferred) – regulatory authority review of monitoring data at permit renewal or significant revision.

Definition of Material Damage to the Hydrologic Balance

- The No Action Alternative (also Alternatives 5, 6, 7 and 9) -- No national definition for material damage to the hydrologic balance. Regulatory authority discretion to determine material damage to the hydrologic balance criteria on case-by-case basis; and
- Alternative 2 (also 3, 4 and 8 (Preferred)) -- Material damage to the hydrologic balance defined as any quantifiable adverse impact on the quality or quantity of surface water or groundwater or on the biological condition of intermittent and perennial streams that would preclude attainment or continuance of any designated surface-water use under sections 101(a) and 303(c) of the Clean Water Act or any existing or reasonably foreseeable use of surface water or groundwater outside the permit area. Includes areas overlying the underground workings of underground mines.

Corrective Action Thresholds

- The No Action Alternative (also Alternatives 5, 6, 8 (Preferred) and 9) -- No corrective action thresholds;
- Alternative 2 (also 3 and 4) -- Regulatory authority to develop correction action thresholds that are less than the material damage to the hydrologic balance standards; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Activities In or Near Streams Functional Group

Stream Definitions

- The No Action Alternative (also Alternatives 3, 5, 6 and 9) -- No change in ephemeral, intermittent, and perennial stream definitions;
- Alternative 2 – The definitions of intermittent, ephemeral, and perennial would be functionally replaced; all waterways defined as Waters of the U.S. under the CWA would be protected under this alternative.
- Alternative 4 -- Streams defined based on flow and physical characteristics;
- Alternative 7 -- Existing definitions are not changed except that watershed size is not used as criteria to define intermittent streams; requires coordination with CWA authority; and
- Alternative 8 (Preferred) -- Stream definitions would match the U.S. Army Corps of Engineers definitions. Activities in or near Streams, including Excess Spoil and Coal Refuse

- The No Action Alternative -- Prohibits mining activities within 100 feet of intermittent or perennial streams unless it can be demonstrated that the activity would not cause or contribute to the violation of applicable state or federal water quality standards and would not adversely affect the water quantity and quality or other environmental resources of the stream but does not prohibit mining through a stream or burial with excess spoil or coal mine waste.

- Alternative 2 -- Prohibits surface mining activities in or within 100 feet of perennial streams. Prohibit surface mining activities in or within 100 feet of intermittent streams unless the applicant demonstrates that the activity would not: (1) preclude premining stream uses; (2) have more than a minimal adverse impact on the premining biological condition of the stream segment; or (3) cause material damage to the hydrologic balance outside the permit area. Requires a 100 foot forested riparian corridor for previously forested areas (or other native species for non-forested areas) adjacent to ephemeral or intermittent streams;

- Alternative 2 -- Also prohibits placement of excess spoil within 100 feet of an intermittent stream (excess spoil placement is allowed in or near ephemeral streams). Under Alternative 2 disposal of coal mine waste in or within 100 feet of an intermittent or ephemeral stream is allowed;

- Alternative 3 (also 4 and 5) -- Prohibits surface mining activities in or within 100 feet of intermittent and perennial streams unless the applicant demonstrates that the activity would not: (1) preclude premining stream uses; (2) have more than a minimal adverse impact on the premining biological condition of the stream segment; or (3) cause material damage to the hydrologic balance outside the permit area;

- Alternative 6 (also 8 (Preferred)) --Prohibits mining activities within 100 feet of intermittent or perennial streams unless it can be demonstrated that: (1) the ecological function of the stream would be protected or restored; (2) placement of excess spoil fill or coal mine waste would not result in a discharge of "toxic mine drainage" and long-term adverse impacts to the environmental resources of the stream (within the footprint of the fill) would be offset in the same or adjacent watershed through fish and wildlife enhancement commensurate with the potential direct adverse impact to the stream; (3) other proposed mining activities within the stream buffer, but not within the stream itself would not adversely affect the water quantity and quality or other environmental resources of the stream; and (4) a 100-foot riparian corridor would be required along the entire reach (including ephemeral streams) of any restored stream;

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and

- Alternative 9 -- Prohibits mining activities (other than construction of stream-channel diversions) within a perennial or intermittent stream unless the regulatory authority finds that avoiding disturbance of the stream is not reasonably possible.

Additionally,

- The No Action Alternative -- Excess spoil minimization not expressly required by regulation;

- Alternative 2 (also 3, 4, 5, 6, 8 (Preferred) and 9) --The applicant must demonstrate that (1) the operation has been designed to minimize, to the extent possible, the volume of excess spoil that the operation would generate and (2) the designed maximum cumulative volume of all proposed excess spoil fills would be no larger than the capacity needed to accommodate the anticipated cumulative volume of excess spoil that the operation would generate; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

And also,

- The No Action Alternative (also 9) -- Durable rock fills may be constructed by end-dumping. Placement in streams is not expressly prohibited if all other applicable requirements are met;

- Alternative 2 (also 3, 4, 5, 6 and 8 (Preferred)) --The practice of “end-dumping” or creating a “durable rock fill” of fill material into streams is prohibited wherever a specific Alternative is applicable. In addition, daily monitoring and maintenance of daily log is required during fill construction; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Mining Through Streams

- The No Action Alternative -- Allows diversion of intermittent and perennial streams upon regulatory authority finding that the diversion would not adversely affect the water quantity and quality and related environmental resources of the stream;

- Alternative 2 (also 4) -- No mining activities allowed in or within 100 feet of a perennial stream. Mining allowed through all intermittent streams upon demonstration by the applicant that the reclamation plan would achieve complete restoration of the hydrologic form and ecological function of all perennial and intermittent streams in accordance with standards established by CWA permitting authority and baseline conditions; additional performance bond required for stream restoration. All ephemeral streams must be restored in form;

- Alternative 3 (also 5, and 6) -- Mining allowed through all streams upon demonstration by the applicant that the reclamation plan would achieve complete restoration of the hydrologic form and ecological function of all perennial and intermittent streams in accordance with standards established by CWA permitting authority and baseline conditions; additional performance bond required for stream restoration. Ephemeral streams restored in form to the extent required by geomorphic reclamation;

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative;

- Alternative 8 (Preferred) -- Requires restoration of both the hydrologic form and ecological function of intermittent and perennial streams. Also requires restoration of the hydrologic form of ephemeral streams but not using geomorphic reclamation ; and

- Alternative 9 -- Requires that restored stream channels for perennial and intermittent streams be designed and constructed using natural channel design techniques to restore or approximate the premining characteristics of the original stream channel.

AOC and AOC Variances Functional Group

AOC Variances

Mountaintop Removal Mining Operations

- The No Action Alternative (also 6, 7 and 9) – Achieve or support beneficial postmining land use; demonstrate equal or better land use. Assure investment in public facilities, and documentation of private financial capability to ensure completion. Requires demonstration that natural watercourses below lowest coal seam to be mined would not be damaged;

- Alternative 2 -- Prohibits all mountaintop removal mining operations (could require SMCRA amendment); and

- Alternative 3 (also 4, 5 and 8 (Preferred)) -- Achieve or support beneficial postmining land use; demonstrate equal or better use. Requires implementation of the approved postmining land use prior to final bond release. Sufficient bond must be posted to ensure that, if the proposed postmining land use is not implemented, lands subject to the variance could be returned to AOC. Requires assurance of investment in public facilities, and documentation of private financial capability to ensure completion. Requires demonstration that (1) no increase would occur in parameters of concern in discharges to surface or groundwater; (2) no change would occur in size or frequency of peak flow as compared to what would occur if the operator returned the site to AOC; and (3) the total volume of flow during any season of the year would not vary (flooding potential cannot be altered). Requires demonstration that natural watercourses within the proposed permit and adjacent areas would not be damaged. If site was forested before permit application, then must return to forest and revegetate using native species except where inconsistent with the postmining land use.

AOC Variances for Steep-Slope Operations

- The No Action Alternative (also Alternatives 6, 7 and 9) -- Achieve/support beneficial postmining land use; demonstrate equal or better land use. Demonstrate that surface water flow in the watershed would be improved over premining conditions ***or*** conditions what would have existed had the area been returned to AOC. TSS or pollutants to surface and ground water must be reduced in a manner that improves existing uses or ecology, ***or*** that reduces flood hazards due to reduced peak flow. Total flow volume in every season must not vary so as to adversely affect ecology of surface water or existing or planned use of surface or ground water;

- Alternative 2 -- Prohibits all variances from requirement to return the mined area to its AOC (could require SMCRA amendment); and

- Alternative 3 (also 4, 5 and 8 (Preferred)) -- Must demonstrate that surface water flow in the watershed would be improved over premining conditions ***and*** conditions that would have existed had the areas been returned to AOC. Must demonstrate that the AOC variance would result in fewer impacts to aquatic ecology for the cumulative impact area than would occur if the site were returned to AOC. The AOC variance cannot result in any placement of excess spoil in an intermittent or perennial stream. The applicant must demonstrate that the proposed deviations from AOC are necessary and appropriate to achieve the postmining land use. The operator must post additional bond sufficient to ensure that, if the proposed postmining land use is not implemented, lands subject to the variance would be returned to AOC. If site was forested before permit application, then must return to forest and revegetate using native species except where inconsistent with the postmining land use.

Surface Configuration and Fills

Definition of AOC

- The No Action Alternative (also Alternatives 6, 8 (Preferred) and 9) -- Definition of AOC would not change, includes backfilling and restoring disturbed areas to *closely resemble* premining topography;

- Alternative 2 (also 3, 4, and 5) -- Definition of AOC same as the No Action Alternative with the additional requirement that surface configuration achieved by backfilling and grading of the mined area be documented by landform measurements and analyses conducted before, during, and after mining and reclamation; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Digital Terrain Analysis

- The No Action Alternative (also Alternatives 6, 8 (Preferred) and 9)-- Digital terrain analysis not required, requires mine plans to address postmining land use but introduces no new specific requirements;

- Alternative 2 (also 3, 4, and 5)-- Requires use of digital terrain models during premining and backfilling to confirm premining topography, and adherence to the reclamation plan for backfilling except that remining sites and contiguous permits 40 acres or less are exempt; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Permanent Impoundments and Final Elevations

- The No Action Alternative (also Alternative 3, 6, 8 (Preferred) and 9) -- No limits placed on final elevations. Still allows permanent impoundments, including final-cut impoundments provided they do not conflict with achieving AOC and they meet the postmining land use requirements. No requirements to use landforming principles during reclamation. Backfilling requirements are not applicable to thin overburden;

- Alternative 2 (also 4) -- Allowable deviation in the elevation of the backfilled and graded area postmining in comparison to the premining elevation based on the lowest coal seam mined. The allowable deviation in the postmining elevation could be no more than ±20 percent of the difference between the premining surface elevation and the premining bottom elevation of that lowest coal seam, with allowances for slope stability and minor shifts in the location of premining features. Allows exceedance of 20 percent tolerance to minimize excess spoil generation. In addition, tolerance requirement does not apply to that portion of the permit where steep-slope contour mining is conducted. Requires use of landforming principles (geomorphic reclamation). Still allows permanent impoundments, including final-cut impoundments provided they do not conflict with achieving AOC and they meet the postmining land use requirements;

- Alternative 5 -- Same as the No Action Alternative except that it requires return of as much as spoil material to the mined area as possible (including transport of spoil above the original contour), and that it prohibits flat decks on excess spoil fills and coal refuse facilities; and

- Alternative 7-- Same as Alternative 2 when enhanced permitting requirements (other than steep slope conditions) apply, otherwise same as the No Action Alternative. This Alternative does not require compliance with the ±20 percent tolerance because stability and equipment constraints make it impracticable to impose this requirement on contour mining on steep slopes (defined as slopes greater than 20 degrees).

Revegetation, Topsoil, and Fish and Wildlife Functional Group

Revegetation

- The No Action Alternative (also Alternatives 6 and 9) -- Vegetative cover in accordance with the approved permit and reclamation plan, comprised of species native to the area, or of introduced species where desirable and necessary to achieve the approved postmining land use;
- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires that all reclaimed lands be revegetated with native species unless the postmining land use is actually implemented before the end of the revegetation responsibility period; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Topsoil Management

- The No Action Alternative (also Alternatives 6 and 9) -- Requires salvage and redistribution of all topsoil (A and E soil horizons) or the top 6 inches of soil material if less than that thickness of topsoil is present. Salvage and redistribution of the B and C soil horizons is at the discretion of the regulatory authority (except on prime farmland, where it is mandatory). Selected overburden materials may be substituted for, or used as a supplement to topsoil if the operator demonstrates to the regulatory authority that: (1) the resulting soil medium is equal to, or more suitable for sustaining vegetation than, the existing topsoil; and (2) the resulting soil medium is the best available in the permit area to support revegetation;
- Alternatives 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires salvage and redistribution of all topsoil (A and E soil horizons). Also requires salvage and redistribution of the B and C soil horizons (or other suitable overburden materials) to the extent necessary to achieve a growing medium with the optimal rooting depths required to restore premining land use capability or comply with revegetation requirements. Allows use of selected overburden materials as substitutes for (or supplements to) either topsoil or subsoil or both if the operator demonstrates that either (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed. The operator also must demonstrate that the resulting soil medium would be as or more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soils in a manner that limits compaction, and provides optimal rooting depth to support the approved plan for revegetation and reforestation; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Salvage and Redistribution of Organic Materials

- The No Action Alternative (also Alternatives 6 and 9) -- Does not require salvage and redistribution or reuse of organic materials (duff, other organic litter, and vegetative materials such as tree tops, small logs and root balls) above the A soil horizon;

- Alternative 2 (also 4) -- Requires salvage and redistribution or reuse of ***all*** vegetative organic materials above the A soil horizon to promote reestablishment of locally adapted and genetically diverse native vegetation and soil flora and fauna and to enhance fish and wildlife habitats. Prohibits burning or burying of vegetation or other organic materials;

- Alternatives 3 (also 5) -- Requires salvage and redistribution of materials from native vegetation only (not from all vegetation) above the A soil horizon rootballs in accordance with an approved plan developed by a qualified ecologist or similar expert who would determine the amounts needed to promote reestablishment of native vegetation and soil flora and fauna. Prohibits burning of above ground debris from native vegetation. Organic materials not needed for the approved plan may be used to construct fish and wildlife enhancement features;

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and

- Alternative 8 (Preferred) – Same as Alternative 3 except that it also prohibits burial of above ground native vegetation in addition to burning. Organic materials not needed for the approved plan may be used to construct fish and wildlife enhancement features.

Reforestation

- The No Action Alternative (also Alternatives 6 and 9) -- Lands that have returned to forest through natural succession classified as "undeveloped" are not required to be reforested;

- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires reforestation of previously forested areas and of lands that would revert to forest under conditions of natural succession (a prime farmland exception exists) in a manner that would enhance recovery of the native forest ecosystem as expeditiously as possible; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Fish and Wildlife Protection and Enhancement

Enhancement of Fish and Wildlife

- The No Action Alternative (also Alternative 9) -- Achieve enhancement of fish and wildlife resources where practicable. Surface mining activities must enhance where practicable, or restore, habitats of unusually high value for fish and wildlife;

- Alternative 2--Enhancement required if mitigation required pursuant to the CWA. CWA mitigation incorporated as a condition of the SMCRA permit. Bond release on the SMCRA permit would be conditioned on successful mitigation as determined by the regulatory authority and the agency implementing the CWA. This option may require an amendment of SMCRA;

- Alternative 3 (also 4, 5, and 6) -- Enhancement measures would be mandatory whenever the proposed operation would result in the long-term loss of native forest, loss of other native plant communities, or filling of a segment of a perennial or intermittent stream (but not ephemeral streams). Resource enhancement must be: (1) commensurate with long-term adverse impact to affected resources; and (2) be located in the same or nearest adjacent watershed as the proposed operation if there are no opportunities for enhancement within the same watershed, and be on permitted area. Mining of certain areas where high value habitats are present may be prohibited by the regulatory authority;

- Alternative 8 (Preferred) -- Enhancement measures would be mandatory whenever the proposed operation would result in the filling of a segment of a perennial or intermittent stream (but not ephemeral streams). Resource enhancement must be: (1) commensurate with the long-term adverse impacts to the stream; and (2) be located in the same or nearest adjacent watershed as the proposed operation if there are no opportunities for enhancement within the same watershed, and be on permitted area; and

- Alternative 7 – Same as Alternative 3 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Endangered and Threatened Species Protection

- The No Action Alternative (also Alternatives 6 and 9) -- No surface mining activity can be conducted which is likely to jeopardize the continued existence of endangered or threatened species listed by the Secretary or which is likely to result in the destruction or adverse modification of designated critical habitat of such species in violation of the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 *et seq.)*;

- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Same as Alternatives 1 and 6, in addition would (1) codify the dispute resolution provisions of the biological opinion concerning protection of threatened and endangered species and (2) add a provision to the regulations expressly requiring that the fish and wildlife protection and enhancement plan in the permit application include any species-specific protection and enhancement plans developed in accordance with the Endangered Species Act and any biological opinions implementing that law; and

- Alternative 7 -- Same as Alternative 2 where enhanced permitting conditions apply, otherwise same as the No Action Alternative.

Riparian Corridors

- The No Action Alternative (also Alternative 9) -- The operator must avoid disturbances to, enhance where practicable, restore, or replace, wetlands, and riparian vegetation along rivers and streams and bordering ponds and lakes;
- Alternative 2 (also 5, 6 and 8 (Preferred)) -- Requires creation of a 100-foot riparian corridor, comprised of native non-invasive species, to enhance restoration of the ecological function of ephemeral, intermittent, or perennial streams. The riparian corridor must be established along the entire reach of any stream restored or permanently diverted;
- Alternative 3 (also 4) -- Requires establishment of a 300-foot riparian corridor comprised of native woody species along restored or permanently diverted intermittent and perennial streams, if the land would naturally revert to forest under natural succession (not required if this would conflict with the approved postmining land use); and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

ES.7 Alternatives Considered but not Carried Forward

Three other distinct Alternatives were also considered, but ultimately determined that they did not adequately meet the purpose and need and therefore did not carry them forward for further analysis in the DEIS. These Alternatives included an Alternative that would prohibit mining activities (including placement of excess spoil) in or near streams and mining through all streams and that would limit backfilling elevation to a maximum ±10 percent elevation deviation from the original elevation was considered. The results of the preliminary analysis indicated that this threshold was not realistic and OSMRE instead incorporated a ±20 percent elevation threshold into Alternatives 2, 4 and 7.

Another Alternative would absolutely prohibit all surface coal mining and reclamation activities, including fill placement and coal mine waste, in or within 100 feet of all streams, including ephemeral streams was also considered. The results of the preliminary analysis indicated that implementation of this Alternative would result in a significant reduction in coal recovery in five of the seven coal-producing regions. OSMRE determined that the impacts to coal production from this Alternative were so substantial that they ran counter to the mandate under SMCRA 102(f) to balance the need for energy with the protection of the environment. While the prohibition would provide maximum protection for streams, it would result in an unacceptable impact on the nation's energy production via coal. For this reason, OSMRE determined that this Alternative did not fall within the range of reasonable Alternatives that could achieve the purpose of this proposed action, and dismissed this Alternative from further consideration.

Finally, an Alternative that would define material damage to the hydrologic balance outside the permit area based on a percentage of the watershed impacted by any one coal mining operation was considered. Once that percentage of the watershed had been impacted by coal mining activities, no additional mining could be permitted in those watersheds. Although it would prohibit further impacts in already impacted watersheds, this Alternative would greatly restrict the ability to mine coal in areas of the country that produce a sizeable percentage of the Nation's coal. The preliminary analysis indicated that this Alternative would significantly affect the ability to mine coal in three of the highest coal-producing counties in West Virginia and over half of currently mined watersheds in the Powder River Basin. It would greatly restrict the ability to mine coal in areas of the country that produce a sizeable percentage of the Nation's coal. Additionally, this Alternative would impose these impacts on coal production based on an acreage threshold that has not been scientifically determined to be a suitable nationwide basis for determining the likelihood or extent of material damage to the hydrologic balance. For these reasons, OSMRE determined that this Alternative was not scientifically justifiable, and did not meet the purpose of the proposed action.

ES.8 Impacts of the Alternatives

The DEIS examined each of the Alternatives carried forward, including the No Action Alternative, to determine the potential for each Alternative to impact resources within the human environment. The resources addressed in the DEIS include the following:

- Mineral Resources and Mining;
- Physical Resources (including water resources; topography, geology and soils; air quality, greenhouse gas emissions and climate change);
- Biological Resources;
- Social, Cultural, and Economic Resources (including socioeconomic conditions; land use; utilities; infrastructure; historic and archaeological resources, visual resources; noise; recreation; and public health and safety); and
- Environmental Justice.

The effects of each Alternative on these resources were analyzed within the seven primary coal-bearing regions of the United States.

Under the No Action Alternative, coal mining would continue to be conducted under existing regulations and all impacts associated with mining under these regulations would continue.

Summarized Impacts of the Alternatives

Impacts of the Action Alternatives would generally include adverse effects on socio-economic resources and positive effects on the other resource categories. The DEIS defines categories of impacts using classes ranging from "Major Adverse" through "Negligible" to "Major Beneficial" to assist the reader in putting the impacts and results into context. The categories are determined by comparing anticipated effects of an Action Alternative with the anticipated effects of the No Action Alternative (the baseline). In general, Alternative 2 has the most strongly adverse impacts, which are anticipated for socioeconomic conditions, as well as the most strongly beneficial impacts, which occur for most other resources, when compared to impacts of the No Action Alternative. Alternative 9 shows Negligible impacts when compared to impacts of the No Action Alternative. Remaining Action Alternatives exhibit the same pattern of impacts as Alternative 2, but with varying degrees of adverse effects on socioeconomic conditions and benefits to natural resources. The following sections summarize the results of the analysis by resource in more detail.

Water Resources

Consistent with the intent of the regulations to reduce adverse impacts of mining activities on perennial and intermittent streams, the Action Alternatives (except Alternative 9) would result in benefits to water resources relative to the No Action Alternative at the national scale. In particular, the analysis finds that Action Alternatives would result in Major Beneficial impacts to water resources under Alternatives 2, 3, 4, and 8 at the national scale. Moderate Beneficial impacts to water resources would be expected under Alternatives 6 and 7, with Minor Beneficial impacts under Alternative 5 at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on water resources.

On a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin under Alternatives 2, 3, 4, and 8. Moderate Beneficial impacts are anticipated in the Appalachian Basin for Alternatives 5, 6, and 7, in the Illinois Basin for Alternatives 6 and 7, and in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions for Alternatives 2, 3, 4, 6, 7, and 8. Other effects on water resources are anticipated to be Negligible at the regional scale when compared to the No Action Alternative.

Biological Resources

Action Alternatives are generally anticipated to benefit biological resources at the national scale when compared to the No Action Alternative, with Alternatives 2, 3, 4, 7, and 8 providing Moderate Beneficial impacts, and Alternatives 5 and 6 providing Minor Beneficial impacts at a national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on biological resources.

On a regional scale, and similar to water resources, Major Beneficial impacts are anticipated in the Appalachian Basin and the Illinois Basin under Alternatives 2, 3, 4, and 8. Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 5. Moderate Beneficial impacts are anticipated in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 7, and 8. Moderate Beneficial impacts are also anticipated in the Appalachian Basin and the Illinois Basin under Alternative 7. Other effects on biological resources are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Air Quality, Greenhouse Gas Emissions, and Climate Change

None of the Action Alternatives explicitly target air quality resources. Regardless, implementation of the elements of the Action Alternative may have both beneficial and adverse effects on air quality. On the beneficial side, the Action Alternatives may increase carbon sequestration potential due to reforestation and riparian corridor requirements of Action Alternatives (except for Alternative 9) and reduce greenhouse gas emissions from coal extraction due to reductions in overall production levels (with the exception of Alternatives 2 and 9). However, the Alternatives may also increase the use of equipment and vehicles to haul materials and therefore increase greenhouse gas emissions from these sources and, under Alternative 2, result in a shift from surface to underground mining, which may increase air emissions. While data are not available to quantify the net effect of the Action Alternatives on emissions or ambient air quality, the net effects to air quality, greenhouse gas emissions, and climate change are likely to be Minor Beneficial at the national scale.

On a regional scale, beneficial impacts on air quality are anticipated in Appalachia across all Action Alternatives (except Alternative 9). While a predicted shift from surface to underground production under Alternative 2 may increase methane emissions from coal extraction in Appalachia, this adverse effect is anticipated to be minor and would potentially be offset by the major beneficial effects on air quality of reforestation and riparian corridor requirements. Four regions are also expected to experience beneficial effects on air quality from reforestation (Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains). Other effects on air quality, greenhouse gas emissions, and climate change are anticipated to be negligible at the regional scale when compared to the No Action Alternative.

Topography, Geology, and Soils

Action Alternatives are generally anticipated to benefit topography, geology, and soils when compared to the No Action Alternative, with Minor Beneficial impacts anticipated for Alternatives 2, 3, 4, 5, 7, and 8. Alternatives 6 and 9 are anticipated to result in Negligible effects on topography, geology, and soils at a national scale.

On a regional scale, Moderate Beneficial impacts are anticipated in the Appalachian Basin under Alternatives 2, 4, 5, 7, and 8. Other effects on topography, geology, and soils resources are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Land Use, Utilities, Infrastructure, Visual Resources, and Noise

Alternative 2 is anticipated to result in Minor Beneficial results to land use, utilities, infrastructure, visual resources, and noise at the national scale when compared to the No Action Alternative. Other alternatives are anticipated to result in Negligible impacts at the national scale.

At a regional scale, Moderate Beneficial impacts to land use, utilities, infrastructure, visual resources, and noise are anticipated in the Appalachian Basin under Alternative 2, 3, 4, 5, 7, and 8. Other effects on land use, utilities, infrastructure, visual resources, and noise are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Socioeconomic Conditions

At the national scale, Alternative 2 is anticipated to result in Major Adverse impacts on socioeconomic conditions including, in particular, employment and severance taxes when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 are anticipated to result in Minor Adverse impacts socioeconomic conditions including employment and severance taxes at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on socioeconomic conditions.

At a regional scale, Major Adverse impacts on socioeconomic conditions including employment are anticipated in the Appalachian Basin under Alternative 2. Moderate Adverse impacts on socioeconomic conditions are anticipated in the Appalachian Basin under Alternatives 3, 4, 5, 7, and 8. Impacts to other regions to socioeconomic conditions are anticipated to be Minor Adverse or Negligible across alternatives at the regional scale when compared to the No Action Alternative. The following summary of expected effects helps to illustrate anticipated adverse impacts:

- Under Alternative 2, annual impacts to production-related employment are expected to range from a reduction in demand for 1,100 FTEs to a reduction of 130 across all regions, with an average reduction in annual demand of 590 FTEs.[18] Annual impacts to compliance-related employment are expected to range from a gain of 470 FTEs to a gain of 630 across all regions, with an average increase in annual demand of 580 FTEs;

- Under Alternative 3, annual impacts to production-related employment are expected to range from a reduction in demand for 660 FTEs to a reduction of 78 across all regions, with an average reduction in annual demand of 360 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 310 FTEs to a gain of 390 across all regions, with an average increase in annual demand of 370 FTEs;

- Under Alternative 4, annual impacts to production-related employment are expected to range from a reduction in demand for 580 FTEs to a reduction of 62 across all regions, with an average reduction in annual demand of 310 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 310 FTEs to a gain of 390 across all regions, with an average increase in annual demand of 370 FTEs;

- Under Alternative 5, annual impacts to production-related employment are expected to range from a reduction in demand for 530 FTEs to a reduction of 48 across all regions, with an average reduction in annual demand of 260 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 120 FTEs to a gain of 150 across all regions, with an average increase in annual demand of 140 FTEs;

- Under Alternative 6, annual impacts to production-related employment are expected to range from a reduction in demand for 340 FTEs to a reduction of 14 across all regions, with an average reduction in annual demand of 160 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 110 FTEs to a gain of 150 across all regions, with an average increase in annual demand of 140 FTEs;

[18] The range of annual impacts to employment represents the minimum and maximum effect in any year in the study period. The average effect is the average annual effect on employment of the Alternative over the 21 year study period.

- Under Alternative 7, annual impacts to production-related employment are expected to range from a reduction in demand for 680 FTEs to a reduction of 65 across all regions, with an average reduction in annual demand of 330 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 180 FTEs to a gain of 220 across all regions, with an average increase in annual demand of 210 FTEs;

- Under Alternative 8 (Preferred), annual impacts to production-related employment are expected to range from a reduction in demand for 590 FTEs to a reduction of 41 across all regions, with an average reduction in annual demand of 260 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 210 FTEs to a gain of 270 across all regions, with an average increase in annual demand of 250 FTEs; and

- Under Alternative 9, no changes in either production-related or compliance-related annual employment are expected.

Public Health and Safety

At the national scale, Alternatives 2, 3, 4, and 8 (Preferred) are anticipated to result in Major Beneficial impacts to public health and safety when compared to the No Action Alternative. Alternatives 6 and 7 are anticipated to result in Moderate Beneficial impacts to public health and safety. Alternative 5 is anticipated to result in Minor Beneficial impacts to public health and safety at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on public health and safety.

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin regions under Alternatives 2, 3, 4, and 8 (Preferred). Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 7. Moderate Beneficial impacts are expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 6, 7, and 8 (Preferred). Moderate Beneficial impacts are also anticipated in the Appalachian Basin for Alternatives 5 and 6, and in the Illinois Basin for Alternatives 6 and 7. Other effects on public health and safety are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Archaeology, Paleontology, and Cultural Resources

Nationally, all Alternatives are expected to have Negligible impacts on Archaeology, Paleontology, and Cultural Resources. At a regional level, Negligible impacts are expected in all regions under all Alternatives. To the extent that any particular rule element reduces the extent of ground disturbance associated with mining, it would also reduce the disturbance of cultural resources located within that area. Therefore, cultural resources may benefit from some or all of the rule elements.

Recreation

At the national scale, Alternative 2 is anticipated to result in Moderate Beneficial impacts to recreational activities when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 are anticipated to result in Minor Beneficial impacts to recreation. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on recreational activities.

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin under Alternative 2. Moderate Beneficial impacts are anticipated in the Appalachian Basin region under Alternatives 3, 4, 5, 7, and 8 and in the Colorado Plateau region under Alternatives 2, 3, 4, 7, and 8. Other effects on to recreational activities are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Summarized Impacts of the No Action Alternative

Impacts of the No Action Alternative are discussed for each resource in the DEIS. The categories used above describe a result, i.e. a predicted beneficial or adverse effect that is different upon implementation of the Alternative being considered in relation to the effects that are expected to occur under the No Action Alternative. A determination of impacts of the No Action Alternative is therefore "No Effect" under this analytical framework (as the No Action Alternative is compared to itself). The DEIS provides detailed qualitative discussions of the impacts of mining under the current regulations especially as documented in scientific research and through the experience of the regulatory authorities.

Summarized Benefits of the Preferred Alternative

All of the Action Alternatives (excluding Alternative 9) would have beneficial, long-term effects on resources, except for socioeconomic resources, to varying degrees by Alternative and region. Alternative 8 (Preferred) would have a number of important benefits in comparison to the No Action Alternative. Implementation of the Preferred Alternative would do the following:

- Improve permitting processes and make it easier for the regulatory authority to determine whether mine plans are designed in accordance with the regulatory program. It would also improve assessment of the mine operation's compliance with the approved permit. Permits contain specific protective measures developed through interagency coordination; ensuring compliance with these conditions is critical to protecting the environment.

- Result in earlier detection of adverse impacts to ground and surface water outside the permit area. Earlier detection would allow for earlier correction to conditions that could impact aquatic wildlife and people.

- Limit activities in or near intermittent and perennial streams and reduce the number and length of intermittent and perennial stream segments disturbed by mining. Streams provide habitat, drinking water and recreational space.

- Grant clear authority to the regulatory agency to prohibit adverse impacts to perennial and intermittent stream segments of high environmental value. Stream segments with high environmental value include those that support sensitive species or unique attributes that deserve greater protection.

- Grant clear authority to the regulatory agency to require that surface coal mining operations promote enhancement of fish, wildlife, and related environmental values wherever and whenever practicable. Enhancement of habitats to offset impacts to habitats disturbed during mining would help to ensure that wildlife have sufficient resources to meet their life cycle needs.

- Improve reforestation on sites disturbed by coal mining. This would improve the ability of the landscape to filter contaminants from runoff before the runoff reaches the stream.

- Increase use of native species on sites disturbed by coal mining. Native plant species require less maintenance because they are better adapted to the environment and require less water and fertilization to thrive long-term. They resist damage from freezing, drought, common diseases, and herbivores. They also may fill specific roles in the ecosystem and provide higher forage value to wildlife.

- Increase the extent of forested riparian areas on mine sites. Forested riparian areas enhance streams because they trap sediments before they reach the stream. They connect fragmented habitat and create wildlife movement corridors. They aid stream ecological health by shading the water to help keep cold water streams cold and by providing leaf litter in the streams, which serves as food source for macroinvertebrates and later in the food chain for fish.

Specific to water resources, the Preferred Alternative would provide major benefits in the coal regions of the Appalachian and Illinois Basins. Specifically:

- Major benefits are anticipated in the Appalachian Basin:
  - Four fewer stream miles would be filled annually;
  - Improved mining practices would lead to improved stream quality in approximately 170 stream miles annually and improved groundwater;
  - Percentage of groundwater usage for private consumption is the highest of the regions, suggesting this region would benefit most from improved groundwater protection; and

- Major benefits would occur in the Illinois Basin:
  - Downstream water quality would be improved for 51 stream miles annually;
  - Ephemeral stream restoration would occur for 11 stream miles annually;

- For Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains, regional benefits would be moderate:
  - Six to 36 stream miles would be improved annually;
  - Four to seven ephemeral stream miles would be restored annually;
  - Groundwater protection would be improved; two to four percent of households in this region rely on private groundwater supplies.

While this summary of the impacts of the Preferred Alternative is informative, it does not highlight the impacts that would occur over the long-term. Tables ES-1 and ES-2 provide a quantitative summary of the benefits to streams and forests over the twenty-one year study period for the analysis (2020 through 2040).

Table ES-1
Results of the Preferred Alternative: Annual Stream Impacts (Miles)

Coal Region	Downstream Improved (Miles Per Year)	Downstream Preserved (Miles Per Year)	Not Filled (Miles Per Year)	Restored (Miles Per Year)
Appalachian Basin	174	1	4	1
Colorado Plateau	6	0	0	4
Gulf Coast	36	0	0	7
Illinois Basin	51	0	0	11
Northern Rocky Mountains and Great Plains	22	0	0	6
Northwest	2	0	0	0
Western Interior	2	0	0	0
Total Per Year	**293 miles**	**1 mile**	**4 miles**	**29 miles**
Total Over The 21- Year Study Period (2020 to 2040)	**6,153 miles**	**21 miles**	**84 miles**	**609 miles**

Notes: Downstream water quality improved (miles): Streams that experience water quality improvements with the SPR.
Downstream stream miles preserved: Streams that do not experience water quality impacts due to reduced mining activity.
Stream miles not filled: Streams not filled due to the Stream Protection Rule (SPR).
Stream miles restored: Mined through streams that are restored due the SPR.

Table ES-2
Results of the Preferred Alternative: Annual Forest Impacts (Acres)

Coal Region	Improved (Acres Per Year)	Preserved (Acres Per Year)
Appalachian Basin	1,346	19
Colorado Plateau	431	0
Gulf Coast	483	0
Illinois Basin	377	1
Northern Rocky Mountains and Great Plains	105	0
Northwest	1	0
Western Interior	67	0
Total Per Year	**2,810 acres**	**20 acres**
Total Over The 21- Year Study Period (2020 to 2040)	**59,010 acres**	**420 acres**

Notes: Improved Acres – Land that will benefit from improved forest land cover under the SPR because it would otherwise have been put in grassland, pastureland or an Alternative post mining land use, or would have been reforested under the baseline but the Alternative prescribes better practices to ensure healthier forest postmining.
Preserved Acres – Forest area that is left uncut due to changes in coal mining activity.

Cumulative Impacts

The potential for the rule to have cumulative effects with other actions that might affect the same resources in the past, present or reasonably foreseeable future was also analyzed. After determining a resource-specific spatial and temporal boundary, information on other regulatory actions that would interact with the Action Alternatives was gathered, as well as other non-regulatory actions that would affect the same resources.

The diverse set of affected resources, combined with the broad geographic and temporal scope of the SPR, makes cumulative impact analysis highly challenging. A large set of past, present, and reasonably foreseeable future actions could interact with the Alternatives. These include:

- Regulatory actions directly related to mining and surface (e.g., stream) water quality;
- Coal-fired power plant rules that could affect coal demand;
- Overall trends in the coal mining industry and energy markets;
- Other trends that affect resources in the study area and that may alter the cumulative impacts of the proposed actions; and
- Other secondary regulatory actions.

The cumulative impacts analysis recognizes that in most cases the contribution to the cumulative impacts for a given resource from implementing the Action Alternatives is difficult to discern, at a broad programmatic level across the U.S., given the context and intensity of impacts from the other past, present, and future actions. In most situations, implementation of one of the Action Alternatives would likely help reduce long-term adverse impacts on the resource by providing a certain level of offsetting benefits. This is especially true when the Action Alternatives are considered in combination with other actions of similar intent (e.g., point source discharge permitting, river conservation initiatives, etc.). For resources other than socioeconomics, the analysis concludes that Action Alternatives (except for Alternative 9) would have a "beneficial or countervailing cumulative effect," meaning that, in combination with other actions and trends, the Alternative is expected to result in either a net increase in beneficial impacts or a net reduction in adverse impacts to the resource. Alternative 9 is anticipated to have a neutral cumulative effect.

At the national level, the Action Alternatives are expected to produce minor adverse impacts on the coal mining industry and the communities that depend upon it. These effects primarily stem from anticipated job losses associated with decreased production, particularly in the Appalachian Basin, the Illinois Basins, and the Northern Rocky Mountains and Great Plains region. Furthermore, the analysis shows the potential for reduced growth in severance tax collections over time. While these impacts are forecasted for all the Action Alternatives (except Alternative 9), they are most prevalent under Alternative 2.

The cumulative effects analysis considers these direct socioeconomic impacts in combination with various other trends and actions. Relevant actions include regulations with a direct effect on coal mining, as well as actions and trends that are likely to affect the demand for coal over time. For instance, established mining safety rules may continue to affect the profitability of mining while forthcoming rules on greenhouse gas emissions from coal-fired power plants may encourage a transition away from coal to substitute fuels. These changes are occurring in the context of other energy sector trends such as decreasing natural gas prices resulting from growth in domestic production. On balance, the coal mining industry faces economic and regulatory challenges in the domestic market.

Coal mining accounts for 0.1 percent of national employment and 0.1 percent of national income (U.S. Census Bureau, 2011b; U.S. EIA, 2011). Additionally, a shift toward the more labor-intensive underground mining in the Appalachian Basin region, combined with an overall depletion of the most readily accessed surface reserves, has led to an offsetting increase in coal mining employment in recent years. For context, EIA estimates that 2012 coal industry employment was approximately 90,000 employees (U.S. EIA, 2012). This analysis projects that coal industry employment will decrease by over 15,000 FTEs under baseline conditions from 2020 to 2040. This decrease in employment demand that is expected to occur independent of the Proposed Rule is consistent with the declining demand for U.S. coal from retiring coal-fired power plants and is expected to occur primarily in the Appalachian Basin, the Illinois Basin, and the Northern Rocky Mountains and Great Plains regions.

While the socioeconomic implications of the Action Alternatives are minor, they would be added to existing and anticipated adverse conditions in the coal mining industry. Therefore, the cumulative impact of the Action Alternatives (excluding Alternative 9), in combination with other actions and trends, is classified as negative. Alternative 9 is anticipated to have a neutral cumulative effect.

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Chapter 1

Purpose of and Need for the Federal Action

1.0 INTRODUCTION

1.0.1 Proposed Action

The Office of Surface Mining Reclamation and Enforcement (OSMRE) proposes to revise the regulations implementing the Surface Mining Control and Reclamation Act of 1977 (SMCRA) (30 U.S.C. §§ 1201-1328). These regulations are found within Title 30 Parts 700 through 999 of the Code of Federal Regulations (CFR).

The proposed action seeks to revise the regulations to provide better balance between the Nation's need for coal as an essential energy source with the need to prevent or mitigate adverse environmental effects of present and future surface coal mining operations. The proposed action applies to both surface and underground mines.

This Draft Environmental Impact Statement (DEIS) evaluates several Alternatives. Each Action Alternative considered in detail is made up of various regulatory components (hereafter referred to as elements), such as:

- Providing for the collection of more comprehensive environmental baseline data for proposed coal mining operations;
- Defining "material damage to the hydrologic balance outside the permit area;"
- Establishing more protective standards for mining activities in or near streams (including mining through streams);
- Providing for more comprehensive monitoring of groundwater and surface water;
- Adding a requirement for monitoring the biological condition of streams;
- Improving the effectiveness of monitoring by providing for periodic review and analysis of all monitoring results;
- Requiring the establishment of permit-specific numerical material damage criteria;
- Revising excess spoil disposal and postmining surface configuration requirements to minimize adverse impacts on streams;
- Revising the provisions for approval of variances and exceptions from approximate original contour restoration requirements to more completely implement the statute;
- Updating the definition of an intermittent stream;
- Providing for coordination with Clean Water Act permitting activities to the extent practicable;
- Improving reclamation standards to ensure reconstruction of an appropriate root zone on the reclaimed area;
- Providing that revegetation success standards be established in a manner that documents restoration of premining capability;

- Providing for the increased use of native species;
- Promoting reforestation and fish and wildlife protection and enhancement; and
- Incorporating into regulation the policy requirement that appropriate and adequate financial assurance be posted to guarantee treatment of long-term discharges, and otherwise updating performance bond and bond release requirements.

OSMRE is also proposing a number of changes that would improve the consistency, accuracy, and ease of use of existing regulations. These do not require evaluation in this DEIS due to the administrative nature of the changes. These include:

- Clarified permitting requirements for the Probable Hydrologic Consequences (PHC) and Cumulative Hydrologic Impact Assessment (CHIA) analysis;
- New and clarified requirements for coordination of SMCRA and Clean Water Act permitting activities to the extent practicable (33 U.S.C. §§ 1251-1387);
- Clarified requirements for appropriate and adequate financial assurance to guarantee perpetual treatment of postmining discharges; and
- Clarified language in accordance with Executive Order 12114 on using Plain Language in Government Writing and Section 501(b) of SMCRA.

This DEIS has been prepared in accordance with the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 *et seq.*) and the implementing regulations of the Council on Environmental Quality (CEQ) (40 CFR Part 1500-1508), and the Department of the Interior (43 CFR Part 46).

1.0.2 Organization of this Document

This DEIS is organized into nine chapters:

- **Chapter 1** describes relevant prior NEPA compliance efforts by OSMRE and steps taken to comply with NEPA for this proposed federal action. It also describes the process used to identify the affected public and agency concerns and to define the issues and Alternatives that required detailed examination in this EIS (scoping). In addition, Chapter 1 provides a summary of comments received during the scoping process. Finally, Chapter 1 describes the purpose of and need for the proposed federal action.
- **Chapter 2** describes the nine Alternatives that were examined in detail, including the No Action Alternative (current regulations) and the Preferred Action Alternative. This chapter also describes several additional Alternatives that OSMRE considered but did not carry forward for detailed analysis. This chapter also describes the process used in developing the Alternatives examined in this DEIS.
- **Chapter 3** describes the affected environment—i.e., the general environmental conditions of the seven coal-producing regions in the United States where 95 percent of total U.S. coal production occurs and is anticipated to occur into the future. For the purposes of this DEIS, the regions are: the Appalachian Basin, the Colorado Plateau, the Gulf Coast, the Illinois Basin, the Northern Rocky Mountains and Great Plains, the Northwest, and the Western Interior.
- **Chapter 4** analyzes the environmental consequences of each of the Alternatives analyzed in detail. This chapter also includes a description of the scope and impact of existing

regulations (including regulations other than the implementing regulations for SMCRA) as part of the discussion of the No Action Alternative.

- **Chapter 5** describes the consultation and coordination that OSMRE has undertaken to complete this DEIS.
- **Chapter 6** lists preparers of and contributors to this DEIS.
- **Chapter 7** lists the references cited in this DEIS.
- **Chapter 8** lists acronyms used in this DEIS.
- **Chapter 9** provides a glossary of terms used in this DEIS.

The appendices, which provide additional information and support for the discussion in this DEIS, are provided in a separate volume or in a separate electronic file.

1.0.3 Background - The 1979, 1983, and 2008 Stream Buffer Zone Rules

SMCRA was enacted into law on August 3, 1977. Some of the stated purposes of the Act are:

- To establish a national program to protect society and the environment from the adverse effects of coal mining;
- To prohibit mining where reclamation as required by the Act is not feasible;
- To assure that reclamation occurs as contemporaneously as possible with the mining;
- To strike a balance between protection of the environment and agricultural productivity and the assurance of adequate coal production;
- To assist the States in developing, administering, and enforcing regulatory programs which achieve the purposes of the Act;
- To achieve reclamation of areas previously mined;
- To provide appropriate procedures for public participation I the development of regulations, standards, and programs under SMCRA.

The Act sets forth minimum performance standards for environmental protection and public health and safety which apply to surface coal mining and reclamation operations, surface effects of underground coal mining operations, and surface coal mining in special areas or in special circumstances (such as steep slope mining). Persons who propose to conduct surface coal mining and reclamation operations (which include surface effects of underground mining by definition) must apply for and receive permits which incorporate provisions of the Act and regulations and must post performance bonds to cover the costs of reclamation.

The Act provides that any State may retain primary jurisdiction over the regulation of surface coal mining and reclamation operations on non-Federal and non-Indian lands through submission of a program for administration and enforcement of the provisions of the Act. A State's program becomes effective after review and approval by the Secretary of the Interior. Coal mining is currently occurring in twenty six states. To date, all but two of these states have achieved approval to serve as the regulatory authority over their state programs. OSMRE maintains a limited role in a State with an approved program. This role includes (1) such inspections as necessary to evaluate administration of State programs, (2) enforcement against imminent hazards (Section 521(a)(2) of the Act), (3) substitution of a Federal program for a State program when a State is not enforcing its approved program (Section 504) of the Act) or (4) Federal enforcement during a State program under Section 521(b) of the Act. OSMRE retains direct regulatory authority over the Act in the two coal-producing states, Washington and Tennessee, which do not have approved state programs.

OSMRE's first permanent program performance standards, as published on March 13, 1979, included stream buffer zone (SBZ) rules at 30 CFR 816.57 (for surface mining operations) and 817.57 (for underground mining operations). Except for stream-channel diversions, those rules provided that no surface area within 100 feet of a perennial stream or a stream with a biological community may be disturbed by surface operations or facilities unless the regulatory authority finds that the original stream channel would be restored and that, during and after mining, the activities would not adversely affect the water quantity and quality of the stream segment within 100 feet of those activities.

In 1983, OSMRE revised the stream buffer zone and related rules to delete the requirement that the original stream channel be restored. The 1983 rule replaced the biological community criterion for determining which non-perennial streams must be protected with a requirement for protection of all intermittent streams. It also revised the definition of "intermittent stream" by adding a provision that classifies all streams that drain a watershed of one square mile or larger as intermittent even if those streams do not meet the hydrological criteria for intermittent streams. Finally, the rule specified that the regulatory authority may authorize mining activities through or within 100 feet of a perennial or intermittent stream only after finding that the proposed activities would not cause or contribute to a violation of applicable state or federal water quality standards and would not adversely affect the water quality or quantity or other environmental resources of the stream.

On December 12, 2008, OSMRE published a revised SBZ rule that replaced the findings in the 1983 rule with a requirement that permittees avoid conducting mining activities in perennial and intermittent streams unless the regulatory authority finds that avoiding disturbance of the stream is not reasonably possible. The prohibition did not apply to mining through streams, for which the standard for approval was that the stream-channel diversion be located and designed to minimize adverse impacts on fish, wildlife, and related environmental values to the extent possible, using the best technology currently available. The 2008 rule also prohibited mining activities on the surface of land within 100 feet of perennial and intermittent streams unless the regulatory authority (1) has approved mining activities (such as excess spoil fills or coal mine waste disposal facilities) in the pertinent stream segment itself, (2) finds that avoidance is not reasonably possible, or (3) finds that the prohibition is not needed to meet fish and wildlife and hydrologic balance protection requirements.

The 2008 rule required that permittees (1) design and conduct their operations to minimize the volume of excess spoil generated by mining operations and (2) design and construct fills to be no larger than needed to accommodate the anticipated volume of excess spoil to be generated. As part of the excess spoil minimization requirement, the rule required that mining operations return the excavated overburden to the mined-out area to the extent possible, after taking into consideration applicable regulations concerning restoration of approximate original contour, safety, stability, and environmental protection, as well as the needs of the postmining land use.

The 2008 rule also provided that, to minimize adverse impacts on fish, wildlife, and related environmental values, the operation must be designed to avoid constructing excess spoil fills, refuse piles, or slurry impoundments in perennial and intermittent streams to the extent possible. When avoidance was not possible, the rule required that the permit application identify a range of reasonable alternatives for disposal and placement of the excess spoil or coal mine waste, evaluate their environmental impacts, and select the alternative with the least overall adverse impact on fish, wildlife, and related environmental values. The rule established criteria for determining whether a potential alternative is reasonably possible; as part of those criteria it stated that an alternative generally may be considered unreasonable if its cost is substantially greater than the costs normally associated with this type of project.

Shortly after publication of the 2008 rule, ten environmental organizations challenged the validity of the rule. *See Coal River Mountain Watch v. Jewell*, No. 08-2212 (D.D.C., filed Dec. 22, 2008) and *National Parks Conservation Ass'n v. Jewell*, No. 09-115 (D.D.C., filed Jan. 16, 2009).[1] Because of the litigation, OSMRE never requested that the coal-producing states with primacy amend their programs. Thus, the 2008 SBZ rule took effect only in states with federal regulatory programs (of which only Tennessee and Washington have active coal mining or reasonably foreseeable coal mining) and on Indian lands.

On November 30, 2009, OSMRE published an Advance Notice of Proposed Rulemaking (ANPR) seeking public comment on how current regulations should be revised to reduce "the harmful environmental consequences of surface coal mining operations in Appalachia, while ensuring that future mining remains consistent with federal law" (OSMRE, 2009). The ANPR confirmed that "[t]he Secretary of the Interior remains committed to reducing the adverse impacts of Appalachian surface coal mining operations on streams." The ANPR also indicated that OSMRE would consider whether "revisions to other OSMRE regulations, including approximate original contour (AOC) requirements, are needed to better protect the environment and the public from the impacts of Appalachian surface coal mining." Further, the ANPR solicited comments "identifying significant issues, studies, and specific alternatives that we should consider in the [Supplementary Environmental Impact Statement (EIS)] for this rulemaking initiative" (74 FR 62664-62668, Nov. 30, 2009). OSMRE received approximately 32,750 comments during the 30-day comment period on various issues related to stream protection.

On February 20, 2014, the U.S. District Court for the District of Columbia issued an order that vacated the 2008 SBZ rule, which had the effect of reinstating the pre-2008 version of the vacated rules. *See Nat'l Parks Conservation Ass'n v. Jewell*, 2014 U.S. Dist. LEXIS 152383, at *31-*34 (D.D.C. Feb. 20, 2014). On December 22, 2014, OSMRE formally removed the provisions of the vacated 2008 rule from the Code of Federal Regulations and reinstated the prior regulations (79 FR 76227-76233).

[1] Pursuant to Federal Rule of Civil Procedure 25(d), S.M.R. "Sally" Jewell was automatically substituted for Ken Salazar as Secretary of the Interior.

1.0.3.1 Previous Environmental Impact Statements Related to Stream Protection

After the passage of SMCRA on August 3, 1977, the Secretary of the Interior, through OSMRE, developed regulations for both the initial and permanent regulatory programs required by SMCRA (30 U.S.C. 1211(c)(2)). OSMRE prepared a programmatic environmental impact statement (OSMRE EIS-1) that analyzed the environmental consequences of Alternatives for the permanent program regulations. OSMRE published OSMRE EIS-1 as final in January 1979. The permanent program regulations were published as a final rule on March 13, 1979 (44 FR 15313, Mar. 13, 1979).

In 1981, OSMRE identified a need for changes to the final March 1979 permanent regulations. OSMRE analyzed the effects of the proposed rule changes on the environment in EIS-1 Supplement, released in January 1983.

Beginning in 2003, OSMRE initiated a rulemaking to address regulatory requirements for construction activities on mine sites that propose to use excess material generated during mining as construction fill, and to provide for stream buffer zones. OSMRE prepared an EIS to support this rulemaking and announced the availability of the final EIS in the *Federal Register* on October 24, 2008 (73 FR 63510, Oct. 24, 2008).

CEQ's regulations implementing NEPA encourage agencies to "tier" their EISs to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review (40 CFR 1508.20). Tiering allows OSMRE to incorporate, by reference, one or more analyses in previous EISs. Therefore, in this DEIS, when applicable and appropriate, OSMRE relies on and references analyses in the following EIS documents:

- U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement. Excess Spoil Minimization--Stream Buffer Zones, Proposed Revisions to the Permanent Program Regulations Implementing the Surface Mining Control and Reclamation Act of 1977 Concerning the Creation and Disposal of Excess Spoil and Coal Mine Waste and Stream Buffer Zones. Final Environmental Impact Statement OSMRE-EIS-34, Sept. 2008.[2]
- U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement. Supplement to Final Environmental Statement on Proposed Revisions to the Permanent Program Regulations Implementing Section 501(b) of the Surface Mining Control and Reclamation Act of 1977, Final Environmental Statement OSMRE-EIS-1: Supplement, Jan. 1983.
- U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement. Permanent Regulatory Program Implementing Section 501(b) of the Surface Mining Control and Reclamation Act of 1977, Final Environmental Statement OSMRE-EIS-1, Jan. 1979.

[2] The validity of this EIS was challenged in *Coal River Mountain Watch et al. v. Jewell*, No. 08-2212 (D.D.C., filed Dec. 22, 2008). However, after the court vacated the rule that was the subject of this EIS in *Nat'l Parks Conservation Ass'n v. Jewell*, 2014 U.S. Dist. LEXIS 152383, at *34 (D.D.C. Feb. 20, 2014), the court held that the NEPA challenge was moot. *See Coal River Mountain Watch et al. v. Jewell*, No. 08-2212, Memorandum Decision at 2 (D.D.C., Feb. 20, 2014).

Other EISs prepared by or in cooperation with OSMRE contain information relevant to this DEIS. As appropriate, this DEIS incorporates by reference relevant information or analysis, or refers the reader to specific or general sections of those documents. Information from the documents listed below is specifically incorporated by reference into this DEIS:

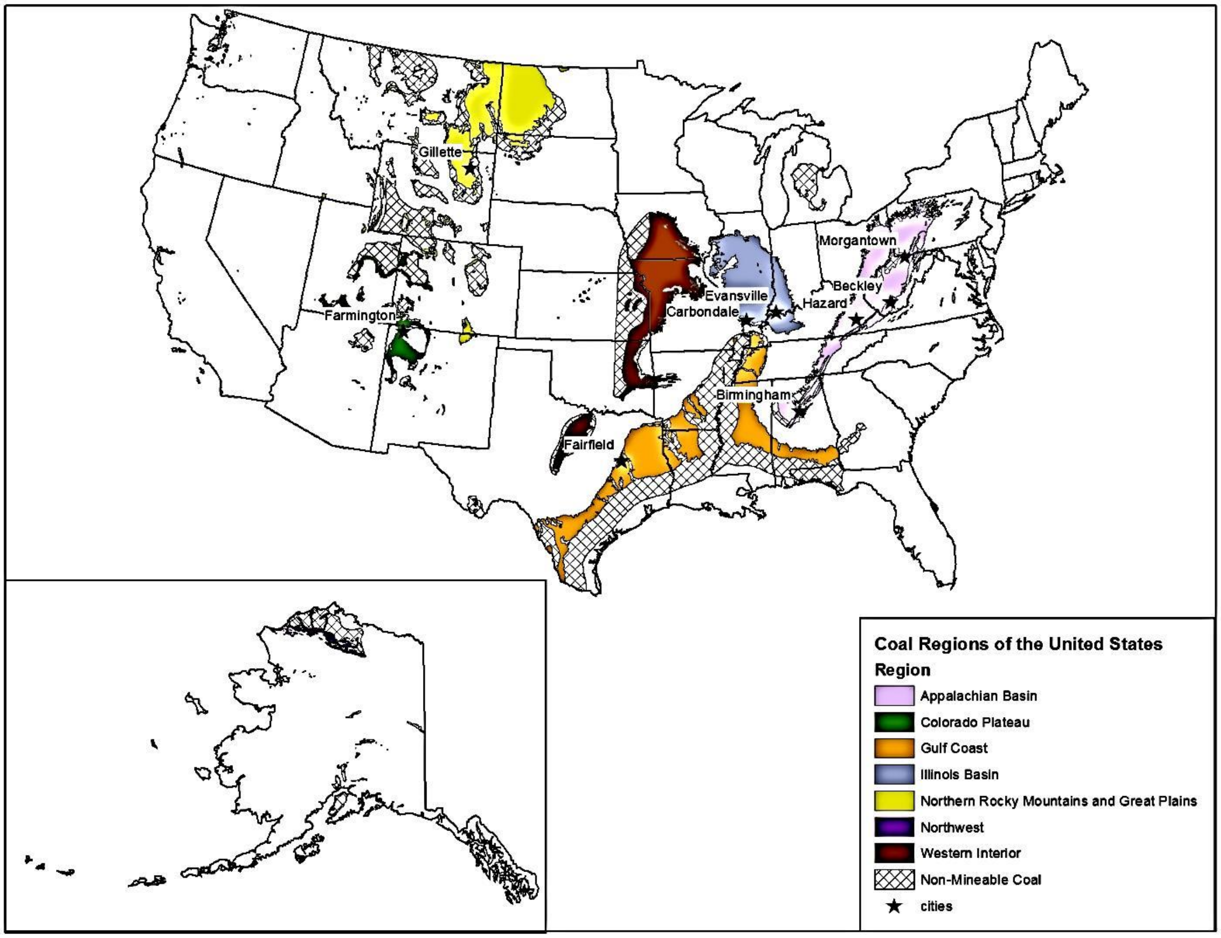
- U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement (OSMRE). Comprehensive Impacts of Permit Decisions under Tennessee Federal Program, OSMRE-EIS-18, March 1985.
- U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement. Valid Existing Rights: Proposed Revisions to Section 522(e) of the Surface Mining Control and Reclamation Act of 1977 and Proposed Rulemaking Clarifying the Applicability of Section 522(e) to Subsidence from Underground Mining, Final Environmental Impact Statement OSMRE-EIS-29, July 1999.
- U.S. Environmental Protection Agency, Mountaintop Mining/Valley Fills in Appalachia, Draft Programmatic Environmental Impact Statement (MTM-VF DPEIS), EPA 9-03-R-00013, EPA Region 3, June 2003 and Final Programmatic Environmental Impact Statement (MTM-VF FPEIS), October 2005.

1.0.3.2 Public Participation in Development of this DEIS

OSMRE published the first Notice of Intent (NOI) to prepare an EIS under Section 102(2)(C) of the NEPA in the *Federal Register* on April 30, 2010 (75 FR 22723). OSMRE also posted that notice on OSMRE's website. OSMRE invited comments and suggestions on the scope of the analysis, including the eleven principal elements of the contemplated action. OSMRE received 25 written comments during this initial scoping period.

On June 18, 2010, OSMRE published a second NOI to announce that nine open house format scoping meetings would be held, to provide information on the proposed Alternatives and elements under consideration in the rulemaking, and to extend the comment period (75 FR 34666). The second NOI invited comments on possible Alternatives based on eleven principal rule elements. During the additional 45-day public scoping period, OSMRE held open houses in Carbondale, IL; Evansville, IN; Birmingham, AL; Fairfield, TX; Hazard, KY; Beckley, WV; Morgantown, WV; Farmington, NM; and Gillette, WY. These nine cities are located in or near the major coal-producing regions of the U.S. and are accessible to the majority of the population living in those regions (Figure 1-1). Approximately 400 people attended the open houses and provided almost 450 written and oral comments. In addition, 20,126 comments were received via electronic and hard copy submissions outside of the open houses.

Figure 1-1. Map of Coal Regions and Scoping Open-House Locations Used in EIS Development



Source: Coal fields layer obtained from *USGS National Atlas*. The coal fields data depicted here was then modified by the U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement, 2011, to distinguish mineable versus non-mineable coal by region.

1.0.3.3 Issues Raised During Scoping

Comments on the EIS

Some of the comments received during scoping were related to Alternatives that OSMRE might consider in both the proposed rulemaking and within the analysis of the DEIS. Most commenters provided specific comments regarding each of the principal elements and possible Alternatives set out in the June 18, 2010 NOI. Of these comments, some recommended clarifications to existing rules as opposed to a new rulemaking, made suggestions pertaining to specific elements or Alternatives within the proposed rulemaking, or raised new issues or rule elements for consideration.

Comments were generally divided into two categories: (1) comments in support of rule revisions that would provide greater environmental protection for streams and other natural resources; and (2) comments that support the adequacy of the existing regulations.

Some commenters favoring greater environmental protections advocated interpretation of the 1983 SBZ rule as an absolute prohibition on stream impacts. This group of comments often described the 1983 SBZ rule as a bright-line prohibition against any adverse impacts within the stream buffer zone. Other comments suggested that this DEIS assess the effects of an Alternative that would ban surface mining of coal entirely.

Of the comments described above regarding Alternatives, OSMRE incorporated most of them into the development of the Alternatives analyzed in the DEIS. The suggestion to include an Alternative that would ban surface coal mining entirely was not incorporated because this Alternative is not authorized under SMCRA and would not meet the purpose and need for the proposed action.

Comments on the proposed rulemaking

Additional substantive comments were received on the ANPR. Some of these comments highlighted the impacts of surface coal mining and current regulatory shortcomings regarding streams:

- Large surface mines in the interior coal basins of the U.S. typically impact numerous streams during the mining process. There is a need for consistent, scientifically viable methods of evaluating the premining condition of these streams, as well as the impacts of mining on them.
- Plans for stream protection and restoration should provide for consistent application of best practices nationwide to assure restoration of form and function as well as maintenance of streams' ecological value. Measurements of success should be uniformly applied.
- When possible, stream restoration plans should provide for enhancements as part of the reclamation process.
- After reclamation, changes in the water table near re-established stream channels may result in loss of intermittent or perennial streams or conversion to ephemeral streams.

Other commenters opposed changes to current rules and asserted that additional regulation would impair mining operations, increase costs, endanger jobs at a time of high unemployment, and provide little, if any, additional protection for the environment. Some comments questioned the authority of OSMRE under SMCRA to adopt certain measures under consideration. Others asserted that OSMRE had failed to articulate a need for new regulations so soon after adopting the 2008 SBZ Rule.

Although some commenters emphasized the need for nationwide stream protection regulations, other commenters, primarily from the coal-producing regions of the Midwest and the West, questioned the need to promulgate a nationwide stream protection rule, arguing that there is no evidence of adverse impacts on streams outside of Appalachia. These comments also argued that because of regional differences, many elements under consideration would be inapplicable, cumbersome, costly, or impractical to apply outside Appalachia.

Comments received in response to the ANPR and impacts of operating under the existing regulations were incorporated into the analysis of this DEIS where appropriate. In addition, they were also incorporated into the proposed rule language as appropriate. More detailed responses to comments on the Rule itself can be found in the preamble to the Proposed Rule.

1.0.4 Scope of Analysis

This DEIS evaluates a range of Alternatives related to stream protection and the conservation of fish, wildlife and related environmental values, including a No Action Alternative, under which the current federal regulations would be unchanged. OSMRE carefully considered all issues raised during the scoping and public outreach process associated with this action when developing the Alternatives.

OSMRE analyzed the effects of each Alternative on the seven most productive coal-bearing regions of the United States (Figure 1 above). Some coal regions have a more extensive mining history than others, leading to variable data availability across the seven regions. In addition, environmental impacts are disparate across the regions, largely due to historical trends in coal production. Data tend to be more readily available in regions with an extensive mining history and legacy coal mining impacts. In some instances, when data are limited, OSMRE relies on reasonable assumptions to evaluate the relative impacts of different Alternatives (see Chapter 4).

In analyzing the Alternatives, OSMRE relied on reports included in previous EISs and considered studies published since preparation of the 2008 EIS (see Chapter 7 for a complete list of references). OSMRE also obtained updated factual information relevant to stream protection from OSMRE field offices and state regulatory agencies (SRA). In addition, OSMRE conducted one new study for this DEIS in cooperation with U.S. Environmental Protection Agency (EPA) (Pond et al. 2014). The study examined biological community composition downstream from reclaimed valley fills. This was a follow-up to a 2008 study (Pond et al. 2008). More details are provided in Chapter 4 Section 4.2.2.

1.1 NEED FOR THE FEDERAL ACTION

The need for this federal action is to improve implementation of SMCRA to ensure protection of the hydrologic balance, and reduce impacts to streams, fish, wildlife, and related environmental values.

OSMRE has identified several subcomponents of that need: First, there is a need to clearly define the point at which adverse mining impacts on groundwater and surface water (both of which provide stream flow) reach an unacceptable level; that is, the point at which they cause material damage to the hydrologic balance outside the permit area. Second, there is a need to collect adequate premining data about the site of the proposed mining operation and adjacent areas to establish a comprehensive baseline against which the impacts of mining can be compared. Third, there is a need for effective monitoring of groundwater and surface water during and after mining and reclamation activities to provide real-time information on the impacts of mining and to enable prompt detection of any adverse trends and implementation of corrective measures before it is either too late to take remedial measures or exceedingly costly to do so. Fourth, there is a need to ensure protection or restoration of perennial and intermittent streams and related resources including fish and wildlife, especially within the headwaters streams that are critical to maintaining the ecological health and productivity of downstream waters. Fifth, there is a need to ensure the use of objective standards in making important regulatory and operational decisions with a potential impact on perennial and intermittent streams. Sixth, there is a need to ensure that permittees and regulatory authorities make use of advances in information, technology, science, and methods related to surface and groundwater hydrology, surface-runoff management, stream restoration, soils, and revegetation.

After evaluating the comments received on the ANPR, OSMRE identified a need for a comprehensive rulemaking to better protect streams nationwide. Refinement of existing regulations is needed to reflect technological improvements in mining and reclamation practices and to respond to new scientific data on the adverse impacts of coal mining on streams. OSMRE believes these regulatory improvements will more completely implement the requirements of SMCRA.

1.1.1 Need for Regulatory Improvements

SMCRA Section 201(c) requires OSMRE to "publish and promulgate such rules and regulations as may be necessary to carry out the purposes and provisions of this Act." Congress identified stream protection as a fundamental purpose of SMCRA. Among its findings in support of the legislation, Congress determined that:

> many surface coal mining operations result in disturbances of surface areas that burden and adversely affect commerce and the public welfare by … polluting the water, by destroying fish and wildlife habitats, by impairing natural beauty, … and by counteracting governmental programs and efforts to conserve soil, water, and other natural resources (30 U.S.C. § 1201(c)).

The federal action analyzed in this DEIS will better prevent or remediate the adverse impacts that Congress described when it made this finding. Despite the enactment of SMCRA and the promulgation of federal regulations implementing the statute, surface coal mining operations continue to have negative effects on streams, fish, and wildlife. These conditions are documented in the literature surveys and studies discussed in Chapter 4. Further evidence is available through several decades of observing the impacts of coal mining operations. These documented and observed problems have prompted OSMRE to consider whether it should take a different approach in the regulations implementing the following SMCRA provisions related to stream protection:

- Section 510(b)(3) of SMCRA requires that each surface coal mining operation be designed to prevent material damage to the hydrologic balance outside the permit area. Current regulations intentionally do not define the extent of damage that is allowable and how much damage constitutes "material damage," an approach that was intended to afford regulatory authorities flexibility in making determinations on a case-by-case basis (48 FR 43973, Sept. 26, 1983).
- Section 515(b)(2) of SMCRA requires that mined land be restored to a condition capable of supporting the uses that it was capable of supporting prior to mining, or higher or better uses of which there is reasonable likelihood, provided certain conditions are met.

Existing rules and permitting practices have focused primarily on the land's suitability for a single approved postmining land use. OSMRE believes it is essential to ensure that land be restored to support all uses that it was capable of supporting before mining.

- Section 515(b)(10) of SMCRA requires that operators minimize disturbances to the prevailing hydrologic balance at the mine site and to the quality of water in surface and ground water systems. As discussed in more detail in Chapter 2, in order to provide the most effective implementation of this statutory requirement, OSMRE is evaluating a number of options. OSMRE is considering how buffer zones may be most effectively used to minimize disturbances to the hydrologic balance and to water quality. OSMRE is evaluating regulatory options for avoidance of acid and toxic drainage from mine sites. OSMRE also seeks the most effective regulation of excess spoil fill construction, because of the potential effects of such fills to effect the hydrologic balance and water quality.
- Sections 515(b)(19) and 516(b)(6) of SMCRA require the operator to establish a diverse, effective, permanent vegetative cover of the same seasonal variety native to the area on all regraded areas and other lands affected by mining. However, evidence indicates that areas which were previously forested have commonly been reclaimed and revegetated as heavily compacted grasslands with scrub trees, vegetation that is not representative of native premining vegetation. OSMRE is considering Alternatives that would implement these SMCRA provisions more effectively.
- Sections 515(b)(24) and 516(b)(11) of SMCRA require, subject to certain limitations, that surface coal mining and reclamation operations minimize disturbances and adverse impacts on fish, wildlife, and related environmental values. These provisions also require operations to "achieve enhancement of such resources where practicable." Reconstructed streams, however, often neither look nor function the way they did before mining. The regulatory emphasis has been primarily upon creating a channel sufficient to convey postmining flows, while minimizing channel erosion and sediment loading. Such limited reclamation results in streams that may no longer support the benthic and other aquatic communities that they did before mining. Additionally, efforts to enhance fish, wildlife, and related environmental values despite the mandate of both the statutes and the regulations, have not been evenly implemented as part of state reclamation programs. Examples exist of highly successful enhancement projects, while in other areas of the nation, these activities are unfortunately limited.
- OSMRE's current rules at 30 CFR 816.73 allow excess spoil fills to be constructed by end-dumping. With end-dumping, operators push or dump rock overburden over the side of the mountain to cascade into the valley below, with the larger rocks rolling to the bottom of the valley to form the underdrain. Based on several decades' experience implementing the existing rules, OSMRE is reexamining the extent to which this technique accords with a number of SMCRA requirements. For instance, some end-dumping may not comply with Section 515(b)(22)(A) of SMCRA which provides that all excess spoil material resulting from surface coal mining operations must be "transported and placed in a controlled manner in position for concurrent compaction and in such a way to assure mass stability and to prevent mass movement." End-dumping, moreover, can result in elevated dissolved ion concentrations in water leaving the site, and significant increases in concentrations of total dissolved solids (TDS) in receiving streams, both of which may adversely affect fish and wildlife in contravention of Section 515(b)(24) of SMCRA. Further, construction of end-dumped rock fills can result in

inconsistent development of the underdrains required under Section 515(b)(2) of SMCRA, leading to structural instability of the fill.

1.1.2 Need for Adequate Data

To effectively evaluate the impacts of a mining operation and to ensure implementation of SMCRA's requirements, the regulatory authority must have both sufficient baseline data and sufficient data about ongoing changes to stream-related resources and biota. Adequate data about the conditions before the mining activity are critical to ascertaining the extent and cause of any changes that do occur after mining is underway; this information in turn is critical to correcting problems if and when they occur. To ensure that the necessary corrections can be made to prevent and mitigate damage, the regulations must specify the types of information that need to be collected, and the locations, timing, and frequency of information collection. As discussed above, Section 510(b)(3) of SMCRA requires that each surface coal mining operation be designed to prevent material damage to the hydrologic balance outside the permit area. Section 515(b)(10) of SMCRA requires, in essence, that surface coal mining and reclamation operations "minimize the disturbances to the prevailing hydrologic balance at the mine site and in associated offsite areas and to the quality and quantity of water in surface and ground water systems both during and after surface coal mining operations and during reclamation." For underground mining, Section 516(b)(9) of SMCRA requires operations to minimize disturbances to the prevailing hydrologic balance at the mine site and associated offsite areas, and to ensure the quantity of water. Sections 515(b)(24) and 516(b)(11) of SMCRA require, subject to certain limitations, that surface coal mining and reclamation operations minimize disturbances and adverse impacts on fish, wildlife, and related environmental values; and also require operations to "achieve enhancement of such resources where practicable."

As discussed previously, studies indicate that environmental degradation is still occurring despite the current requirements within the implementing regulations of SMCRA. OSMRE has determined that this research indicates that effective evaluation of trends and impacts on groundwater, surface water, and stream-related resources and biota, would require additional monitoring of data beyond what is currently required by existing regulations. Additional water quality parameters must be monitored both in the baseline condition and within any effluent leaving mine sites. Similarly, existing regulations do not provide for collection of baseline data sufficient to determine the biological condition of streams. Consequently characteristics of the aquatic community in the stream are not well documented in SMCRA permit files. This impedes regulators' ability to assess whether an operation is adequately minimizing adverse impacts on fish, wildlife, and related environmental values, as required by Sections 515(b)(24) and 516(b)(11). More complete and accurate baseline information is needed to improve regulators' ability to determine whether mine plans are designed in accordance with SMCRA, and whether operations are being conducted in accordance with mining plans. For example, better baseline data would facilitate a more thorough CHIA; would help set objective and measurable material damage standards; and would help identify and address hydrologic problems that may arise after permit issuance.

Additional data are also needed to provide sufficient warning when water impacts are approaching thresholds where corrective actions should be taken to prevent further damage. This change would help operators and regulators evaluate the potential for future violations, such as material damage to the hydrologic balance.

Increased frequency of inspection and improved reporting is needed to ensure effective compliance with SMCRA requirements for restoration of AOC on the site postmining. OSMRE has identified a number of instances where the regulatory authority overlooked inadequate contour restoration until late in the process (at which point correcting the problem would be overly expensive or cause unacceptable disruption of stabilized conditions). To address such problems, OSMRE is evaluating Alternatives to ensure sufficient reporting and inspection regarding contour restoration.

1.1.3 Need for Adequate Objective Standards

In order to effectively implement SMCRA's requirements related to stream protection, regulations must allow permittees and operators, as well as regulatory authorities, to effectively evaluate compliance and limit or prevent adverse impacts, as appropriate.

The regulatory standards must provide an objective threshold with clear and predictable standards for preventing "material damage to the hydrologic balance outside the permit area," as required by Section 510(b)(3) of SMCRA. That section requires that each surface coal mining operation be designed to prevent material damage to the hydrologic balance outside the permit area. However, neither OSMRE nor most states have defined this term. A clear federal definition of "material damage," and federal minimum standards or criteria against which to measure whether material damage has occurred, is needed to provide a basis for oversight of state implementation of this statutory requirement.

As noted above, based on observed changes, OSMRE believes that existing permitting and performance standards implementing Section 515(b)(10) of SMCRA may be inadequate to minimize disturbances to the prevailing hydrologic balance at the mine site and to the quality of water in surface and ground water systems. More specific, more clearly defined and objective standards would ensure implementation of this statutory requirement.

Improved implementation of Section 515(b)(3) of SMCRA is also needed. This section requires, with certain exceptions, that mined land be restored to AOC. Restoration of mined land to a surface configuration that includes convex and concave terrain patterns and landforms typical of premining condition could more effectively meet this requirement. The existing rules governing AOC restoration are general, subjective, and lacking in specificity. Too often, this has resulted in postmining surface configurations that are significantly flatter than the premining configuration; that lack many of the landform features found prior to mining; and that have significantly altered drainage patterns and stream characteristics and functions.

1.1.4 Need to Apply Current Information, Technology, and Methods

This federal action is also designed to incorporate significant advances in scientific knowledge that has occurred since OSMRE's permanent program regulations were adopted in 1979, and then substantially amended, starting in 1983.

First, new information exists on the adverse impacts that coal mining can cause to water resources and stream biota. As discussed in more detail in Chapter 4, there are many recent publications of studies and literature surveys that evaluate the impacts of surface coal mining and reclamation operations on water quantity and quality, as well as related biological resources.

Second, since OSMRE's earlier rulemakings, there have been many improvements in technologies and methods for prediction, prevention, mitigation, and reclamation of coal mining impacts on hydrology, streams, fish, wildlife, and related resources. These advances have included significant improvements in cost-effectiveness and availability. As discussed in more detail in Chapter 4, OSMRE has identified major improvements in technology and methods related to identifying, quantifying, mapping, and modeling mining operations and their impacts on the environment. Examples of such improvements are discussed below.

Advances in identification and prediction of impacts on stream resources. Since the 2008 SBZ rule, there have been significant improvements in analysis of the impacts of mining on stream resources. For instance, coal mining-related regulatory programs have traditionally focused on acid mine drainage and sediment loads as the sources of potential problems. As described in Chapter 4 of this DEIS, however, multiple chemical constituents produced by mining cause significant increases in conductivity and TDS in streams below many surface mines, particularly below excess spoil fills. OSMRE has learned that those changes can have significant toxic effects on streams, leading to a loss of sensitive aquatic organisms even when downstream habitats are otherwise intact. Emerging science indicates that problems can include golden alga blooms and adverse impacts to fish and wildlife from the discharge of chemical constituents not considered in past rulemaking efforts. Further, data now indicate that some pollutants, such as selenium, may bio-accumulate. Accumulation of pollutants in biological systems over time may adversely affect biota and human health. In addition new studies indicate that toxic discharges may continue for decades even after reclamation of the site has otherwise been successful according to current requirements for restoration of the land itself.

Similarly, information is now available connecting the life histories of aquatic taxa with stream flow regimes, and this information allows better characterization of streams. For example, taxa requiring a full year of aquatic larval development in highly oxygenated waters would not be expected to be found in ephemeral streams and many intermittent streams.

Landform elements such as ridges, valleys, hill slopes, and streams can now be measured quantitatively in a way not feasible until recently. Permit reviewers can now use computers and sophisticated software to process huge amounts of elevation data acquired from stereo satellite and airborne images, lidar, and radar to produce much more accurate maps and models of surface configuration than was possible a few short years ago. This information may allow state regulators to determine the total volume of earth that a mining operation has or will displace, based on the position of the coal seams and volume of overburden relative to the premining topography. These data can also be used to plan for restoration of smaller-scale features that blend into the surrounding topography within a watershed. By contrast, reclamation practices under existing regulations often rely on construction of uniformly sized and spaced structures and features.

Advances in reclamation techniques. Emerging science now provides much better information on effective reclamation practices related to stream protection. During the last decade, the scientific community has made great strides in developing geomorphic reclamation strategies that reduce erosion and improve water quality. These improvements are not reflected in current regulations. More traditional approaches to restoration of AOC have created large reclaimed acreages that resemble landscapes of agricultural fields, urban recreational parks, or construction fill sites such as large dam embankments, spillways, or waterway diversions. Modern GPS-enabled equipment can incorporate the use of geomorphic principles in reclamation design, and can provide a closer approximation of the highly dissected and randomly spaced and sized drainage patterns of an undisturbed landscape. The Los Angeles abrasion test (a standard test method for determining resistance to degradation) and the sodium or magnesium sulfate soundness test (which distinguishes between rocks based on their susceptibility to weathering) can be used to assess the appropriateness of material used in fills. Hydrologic modeling programs such as the U.S. Army Corps of Engineers Hydrologic Engineering Center, Hydrologic Modeling System (HEC-HMS) can predict with greater accuracy the flow pattern and volume of runoff that would occur under different rainfall scenarios at defined locations. Use of programs such as the Civil Software Design, LLC Sediment, Erosion, Discharge by Computer Aided Design (SEDCAD) program can more effectively design and evaluate erosion and sediment control systems. Such improvements in reclamation may significantly improve stream restoration and long-term landscape stability.

Advances in reforestation techniques have been shown to decrease the detrimental effects of storm runoff. Science now indicates that high nutrient loads can have negative, cumulative impacts downstream, but that riparian buffer zones can reduce those nutrient loads and associated impacts. OSMRE experience over the past thirty years indicates that extensive herbaceous ground cover on reclaimed areas can inhibit the establishment and growth of trees and shrubs. The dense herbaceous ground covers often used to control erosion compete with newly planted trees and tree seedlings for soil nutrients, water, and sunlight, and provide habitat for rodents and other animals that damage tree seedlings and young trees. Use of the Federal Geographic Data Committee's U.S. National Vegetation Classification Standard, and other generally accepted standards, is needed to promote consistent identification of plant communities and development of appropriate revegetation plans to restore those communities following mining.

1.2 PURPOSE OF THE FEDERAL ACTION

The purpose of this action is to provide a rulemaking that meets the stated purposes of SMCRA (30 U.S.C. § 1202). The rulemaking is intended to improve the ability of coal mine operators, regulatory authorities, and OSMRE to anticipate and prevent adverse impacts to streams and related resources, while ensuring a coal supply adequate for the Nation's energy needs. In addition, this action seeks to ensure consistent nationwide implementation of SMCRA stream protection requirements, and to appropriately balance all relevant purposes of SMCRA.

Chapter 2
Description of All Alternatives Including the No Action Alternative

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Chapter 2
Description of All Alternatives Including the No Action Alternative

2.0 INTRODUCTION

This chapter of the draft Environmental Impact Statement (DEIS) introduces and describes the eight Action Alternatives that the Office of Surface Mining Reclamation and Enforcement (OSMRE) is considering in its proposed stream protection rule. It also discusses the No Action Alternative, which reflects current applicable regulations, policies and practices. In addition, this chapter identifies and describes the eleven principal elements for evaluation (factors for analysis) within each of the nine Alternatives that OSMRE is considering. For ease of discussion and analysis, OSMRE has organized these eleven principal elements into the following four "functional groups" under each of the Alternatives. These functional groups recognize common or related characteristics that address an overarching rulemaking topic or concern:

- Protection of the Hydrologic Balance;
- Activities in or near Streams;
- Approximate Original Contour (AOC) and AOC Variances; and
- Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement.

Table 2.0-1 summarizes the principal elements using these four functional groups. Grouping certain elements together helps to illustrate their relationship and makes the impact analysis clearer and easier to follow. For example, when discussed together, it is easier to draw the connection between *establishing* a baseline for surface water and groundwater characteristics, *monitoring ongoing changes* from the baseline condition during mining and reclamation and *establishing corrective action thresholds* to prevent environmental damage. Further, the functional grouping demonstrates how these elements relate to protection of the hydrologic balance.

Table 2.0-1
Organization of 11 Principal Elements (Factors for Analysis) into Functional Groups

Functional Groups	Protection of the Hydrologic Balance	Activities in or near Streams	AOC and AOC Variances	Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement
Factors for Analysis (Principal Elements)	Baseline data collection and analysis	Stream definitions	Surface configuration	Revegetation, topsoil management, and reforestation
	Monitoring during mining and reclamation	Activities in or near streams, including disposal of excess spoil and coal mine waste	AOC variances	Fish and wildlife protection and enhancement
	Definition of material damage to the hydrologic balance outside the permit area	Mining through streams	---	---
	Corrective action thresholds	---	---	---

2.1 DEVELOPMENT OF THE ALTERNATIVES

OSMRE identified the need for improved stream protection through internal analysis and external scoping and public outreach activities. Public concerns ranged from support for an outright ban on certain coal mining practices to maintaining the current regulations (the No Action Alternative) and providing time to implement the regulatory changes adopted in the 2008 Stream Buffer Zone (SBZ) rule. Some participants focused on environmental issues, while others expressed concerns about the potential costs and impacts from any proposed rulemaking on the coal mining industry, employment, affected regulatory authorities, and local, regional, and national economies.

OSMRE published the first Notice of Intent (NOI) to conduct scoping for this DEIS in the *Federal Register* on April 30, 2010 (75 FR 22723, Apr. 30, 2010). OSMRE invited comments and suggestions on the scope of the analysis, including the principal elements of the contemplated action. OSMRE received 25 written comments during this initial scoping period. On June 18, 2010, OSMRE published a second NOI announcing nine additional scoping "open houses" to provide information on the proposed Alternatives and elements under consideration in the rulemaking and to accept public comments (75 FR 34666, Jun. 18, 2010). The second NOI invited comments on possible Alternatives, based on 11 principal elements.

As part of the scoping process, OSMRE held open houses in Carbondale, IL; Evansville, IN; Birmingham, AL; Fairfield, TX; Hazard, KY; Beckley, WV; Morgantown, WV; Farmington, NM; and Gillette, WY. OSMRE selected these locations based on proximity to the major coal-producing regions of the U.S. and accessibility to the majority of the population living in those regions (Chapter 1, Figure 1). Approximately 400 people attended the open houses and provided

450 written and oral comments. In addition, OSMRE received over 20,000 comments via electronic and hard copy submissions outside the open houses.

In developing a reasonable range of Alternatives, OSMRE also considered responses to an Advance Notice of Proposed Rulemaking (ANPR) published on November 30, 2009, which sought public comment on how OSMRE should revise current regulations to reduce "the harmful environmental consequences of surface coal mining operations in Appalachia, while ensuring that future mining remains consistent with Federal law" (74 FR 62664-62668, November 30, 2009). The ANPR also indicated that OSMRE would consider whether "revisions to other OSMRE regulations, including AOC requirements, are needed to better protect the environment and the public from the impacts of Appalachian surface coal mining." OSMRE received approximately 32,750 comments during the 30-day comment period on various issues, including those related to stream protection.

As a result of interagency discussions, internal reviews, and consideration of the comments received in response to the ANPR and during the extensive DEIS scoping process, OSMRE revised the principal rulemaking elements. In the process, OSMRE also identified the need for application of consistent, scientifically viable methods for evaluating the biological condition of streams, and for restoring their form and ecological function after mining. Section 1.0.1 provides a complete list of rulemaking elements that OSMRE considered.

OSMRE continued to refine the alternatives based on preliminary input from the state and federal cooperating agencies, and later based on federal interagency review of the preferred alternative facilitated through the Office of Information and Regulatory Affairs (OIRA). OIRA is part of the Office of Management and Budget (OMB), which is an agency within the Executive Office of the President. The OMB is tasked per Executive Order 12866, "Regulatory Planning and Review," with the review of federal agency draft and proposed final regulatory actions.

2.2 OVERVIEW OF THE ALTERNATIVES AND CHAPTER ORGANIZATION

This chapter (Chapter 2) describes Alternatives that OSMRE considered with respect to the eleven principal elements outlined in the two NOIs, with modifications based on comments received and analysis of the alternatives. Section 2.3 provides a brief description of the eleven elements. Section 2.4 describes the nine Alternatives in detail, organized by Alternative. Section 2.5 reverses that approach by grouping the Alternatives under the principal elements to assist the reader in identifying the Alternatives that address a particular concern. Finally, Section 2.6 describes Alternatives and elements that OSMRE considered, but subsequently dismissed without further analysis. OSMRE dismissed these Alternatives for several reasons, including that they: (1) were not reasonable; (2) did not meet the purpose and need of the proposed federal action as described in Chapter 1 of this DEIS; and/or (3) were outside the scope of the proposed rulemaking.

2.3 RANGE OF ANALYSIS FOR EACH OF THE ELEVEN PRINCIPAL ELEMENTS

In the NOIs, OSMRE published a list of eleven principal issues (elements) to be analyzed in the DEIS for the stream protection rulemaking initiative. Initially, these eleven elements included baseline data requirements; a definition of material damage to the hydrologic balance outside the permit area; restrictions on activities in, near, or through streams; monitoring requirements; corrective action thresholds; surface configuration; variances to approximate original contour restoration requirements; enhanced reforestation activities; permit coordination among agencies; financial assurances for long-term treatment of postmining discharges; and stream definitions.

OSMRE revised the list of principal elements after further analysis and in light of the comments received during scoping. For example, this DEIS analyzes “mining through streams” and “activities that occur in or near streams” as separate principal elements because OSMRE believes these two categories of mining activities are significantly different. Mining *through* streams typically means that operators would excavate coal deposits beneath the streambed. In this situation, the operator would either permanently divert the stream channel or reconstruct it in its original location after mining. Mining *in or near* streams refers to activities that take place within a stream or its buffer zone. These activities may sometimes cover the stream but never include removal of the streambed to extract coal. Examples of activities that may occur in or near streams include construction of sedimentation ponds, water treatment facilities, excess spoil or coal mine waste disposal facilities, and stream crossings.

The DEIS has also added fish and wildlife protection and enhancement as a principal element and expanded the enhanced reforestation element to include revegetation, reforestation, and soil management.

2.4 DESCRIPTION OF ALTERNATIVES

This section describes each of the nine Alternatives according to the four functional groups discussed above. As noted earlier, each functional group combines elements that have similar or interrelated attributes.

2.4.1 Alternative 1 (No Action Alternative)

Alternative 1, the No Action Alternative, consists of current regulatory requirements, policies, and practices under the Surface Mining Control and Reclamation Act (SMCRA), the Clean Water Act (CWA), and other federal and state laws that are relevant to this federal action. For reasons of brevity, this discussion describes only the requirements for surface coal mining operations. However, in most instances, analogous requirements apply to underground mining operations. If OSMRE were to select this Alternative, existing rules under SMCRA would not change.

2.4.1.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Under the current regulations, the applicant for a mining permit is required to submit, at a minimum, the following baseline information, and any additional hydrologic or geologic information required by the regulatory authority.[1]

Groundwater: Under 30 CFR 780.21, the applicant must submit data for existing wells, springs, and other groundwater resources within or adjacent to the proposed permit area. These data characterize the quality and quantity of groundwater and provide information on usage sufficient to demonstrate seasonal variation. Information on water quality must include total dissolved solids or specific conductance, pH, total iron, and total manganese. Groundwater quantity information must include approximate rates of discharge or usage, as well as depth to the water in the coal seam, each water-bearing stratum above the coal seam, and each potentially affected stratum below the coal seam.

Surface water: Under 30 CFR 780.21, the applicant must submit information on surface water quality and quantity sufficient to demonstrate seasonal variation and water usage. At a minimum, water-quality information must include baseline information on total suspended solids, total dissolved solids or specific conductance, pH, total iron, and total manganese. The applicant must provide additional information on baseline acidity and alkalinity if there is a potential for acidic drainage from the proposed mining operation. Water quantity information must contain information on seasonal flow rates.

Geology: Under 30 CFR 780.22, the permit application must describe the geology of the proposed permit area and the adjacent area down to and including the deeper of either (1) the stratum immediately below the lowest coal seam to be mined or (2) any aquifer below that seam that could be adversely affected by mining. The description must include the areal and structural geology of the proposed permit area and the adjacent area. The description must also address other parameters that influence the required reclamation and the occurrence, availability, movement, quantity, and quality of potentially impacted surface water and groundwater. The geologic information must also include analyses of samples collected from test borings, drill cores, or samples from rock outcrops from the permit area. This requirement includes lithologic characterization and chemical analysis of strata and the coal seam for acid-forming or toxic-forming materials (including total sulfur, pyritic sulfur, and alkalinity-producing materials). The regulatory authority may waive analysis for alkalinity-producing materials and pyritic sulfur if sufficient data exists to document that the data is not needed.

Monitoring During Mining and Reclamation

The current regulations at 30 CFR 780.21(i) and (j) and 816.41(c) and (e) require monitoring of the quantity and quality of surface water and groundwater. The monitoring plan must include parameters related to the suitability of the water for current and approved postmining land uses,

[1] Unless otherwise specifically stated, the term “regulatory authority” as used in this DEIS refers to the SMCRA regulatory authority.

the hydrologic reclamation plan, and (for surface water) the effluent limitations in 40 CFR Part 434. At a minimum, pH, total iron, total manganese, total dissolved solids (TDS) or specific conductance, water levels (for groundwater), flow (for surface water), and total suspended solids (TSS) (for surface water) must be monitored every three months until final bond release. The permittee must monitor point-source discharges in accordance with their National Pollutant Discharge Elimination System (NPDES) permit. The monitoring plan must identify the monitoring locations, but the regulations do not establish criteria for the number or placement of monitoring locations.

The regulatory authority may modify or waive the monitoring requirements at any time if the permittee demonstrates that monitoring, in whole or in part, is no longer necessary to achieve the purposes set forth in the monitoring plan, that the operation has minimized disturbance to the hydrologic balance within the permit area and prevented material damage to the hydrologic balance outside the permit area, that water quality and quantity are suitable to support the approved postmining land uses, and that the water rights of other users have been protected or adequately replaced. However, the regulatory authority may not modify or waive NPDES monitoring requirements.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

The current regulations do not define material damage to the hydrologic balance outside the permit area. However, the preamble to existing 30 CFR 780.21(g) and 784.14(f) states that "because the gauges for measuring material damage may vary from area to area and from operation to operation," OSMRE has not established fixed criteria, except for those established under §§ 816.42 and 817.42 related to compliance with water quality standards and effluent limitations (48 FR 43973, Sept. 26, 1983). OSMRE further noted in the preamble to the existing rules that each regulatory authority should establish criteria to measure material damage to the hydrologic balance for purposes of cumulative hydrologic impact assessments (48 FR 43973, Sept. 26, 1983).

Corrective Action Thresholds

The current regulations contain no requirement for specific corrective action thresholds. However, permit applicants proposing to conduct surface or underground coal mining are required under § 780.21(h) or § 784.14(g) respectively, to provide a plan of measures the applicant would take to avoid adverse potential adverse hydrologic consequences, including preventative and remedial measures. Under 30 CFR 816.41(c)(2) and (e)(2) and 817.41(c)(2) and (e)(2), if monitoring results demonstrate noncompliance with permit conditions or federal, state, or tribal water quality laws and regulations, the permittee must promptly notify the regulatory authority. The applicant must then take all possible steps to minimize any adverse impact to the environment or public health and safety, and must immediately implement measures necessary to comply with permit condition (30 CFR 773.17(e)).

2.4.1.2 Activities in or Near Streams

Stream Definitions

The current regulatory definitions of perennial, intermittent, and ephemeral streams utilize hydrologic characteristics and watershed size to define these waters (30 CFR 701.5). The current definitions do not include biological or chemical characteristics.

- Under the current regulations, a perennial stream is a stream or part of a stream that flows continuously during all of the calendar year because of groundwater discharge or surface runoff.
- An intermittent stream is (1) a stream or reach of a stream that drains a watershed of at least one square mile, <u>or</u> (2) a stream or reach of a stream that is below the local water table for at least some part of the year, and obtains flow from both surface runoff and groundwater discharge.
- An ephemeral stream is a stream that flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table.

The second bullet has sometimes been incorrectly applied as if the “or” was an “and;” i.e., the one-square-mile criterion has sometimes been applied as a threshold for all intermittent streams, when, in fact, a stream in a smaller watershed that meets the second criterion is an intermittent stream regardless of the size of its watershed.

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

The 1983 SBZ rule, 30 CFR 816.57, which is now back in effect after the court vacated the 2008 rule[2], provides that mining activities may not disturb land within 100 feet of a perennial or an intermittent stream unless the regulatory authority specifically authorizes activities closer to, or through, such a stream. The regulatory authority may authorize such activities only after finding that the proposed activities would not cause or contribute to a violation of applicable federal or state water quality standards under the Clean Water Act and would not adversely affect the water quantity and quality or other environmental resources of the stream.

The 1983 SBZ rule does not specifically mention placement of excess spoil and coal mine waste in or within 100 feet of streams, but OSMRE and most state regulatory authorities generally have applied the 1983 SBZ rule in a manner that allows the construction of excess spoil fills, refuse piles, slurry impoundments, and sedimentation ponds in all types of streams and their buffer zones.

The existing regulations at 30 CFR 816.71 through 816.74 require that excess spoil fills be constructed by controlled placement of the excess spoil in lifts no greater than four feet thick,

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[2] See 79 FR 76227-76233 (Dec. 22, 2014).

except that durable rock fills may be constructed by end-dumping, which is intended to result in the formation of underdrains by gravity segregation.

In general, only surface coal mining operations in steep-slope terrain generate excess spoil. Although not expressly required by regulation, most states with mining operations in steep-slope terrain have adopted policies intended to minimize the generation of excess spoil and thus reduce the need for (and size of) excess spoil fills, which in turn would reduce the length of stream covered by those fills. In addition, the agencies administering the Clean Water Act have implemented policies that have sharply reduced both the number of excess spoil fills and the length of stream covered by those fills. Furthermore, the regulations in 40 CFR Part 230 for implementation of section 404(b)(1) of the Clean Water Act require an analysis of all practicable alternatives to placement of fill material in waters of the United States, which would include most streams. Under those regulations, the applicant must select the alternative with the least adverse effect on the aquatic ecosystem and mitigate any remaining adverse impacts on the aquatic environment.

Mining Through Streams

The 1983 version of the stream-channel diversion rules at 30 CFR 816.43 is now back in effect following the court decision vacating the 2008 SBZ rule. Under 30 CFR 816.43(b)(1), the regulatory authority may approve diversion of perennial or intermittent streams within the permit area only after making the finding related to stream buffer zones in 30 CFR 816.57 that the diversion would not adversely affect the water quantity and quality and related environmental resources of the stream. Under 30 CFR 816.43(a), the applicant must design the diversion to minimize adverse impacts to the hydrologic balance within the permit and adjacent areas, prevent material damage to the hydrologic balance outside the permit area, and to assure the safety of the public. In addition, the applicant must design, locate, construct, maintain, and use the diversion to prevent, to the extent possible using the best technology currently available, additional contributions of suspended solids to streamflow outside the permit area.

Under 30 CFR 816.43(b)(4), both the design and construction of stream-channel diversions for perennial and intermittent streams must be certified by a qualified registered professional engineer as meeting applicable performance standards and any design criteria established by the regulatory authority. Under 30 CFR 816.43(a)(3), the design for restored stream channels for perennial and intermittent streams (or permanent diversion channels for those streams) must restore or approximate the premining characteristics of the original stream channel, including the natural riparian vegetation. Under 30 CFR 816.43(b)(2), the design capacity for both temporary and permanent stream-channel diversions must at least equal the capacity of the unmodified stream channel immediately upstream and downstream of the diversion.

2.4.1.3 AOC and AOC Variances

Surface Configuration

Under existing 30 CFR 780.18(b)(3), each permit application must include a plan for backfilling, soil stabilization, and compacting and grading. Contour maps or cross-sections must show the anticipated final surface configuration. The performance standards at 30 CFR 816.102, 816.104, 816.105, 816.106, and 816.107 require that disturbed areas be backfilled and regraded to closely resemble the premining surface configuration, with exceptions for thin and thick overburden situations, previously mined areas, and certain other circumstances. The regulations allow permanent impoundments, including final-cut impoundments, provided they do not otherwise create conflicts with achieving AOC and they meet the design, construction, maintenance, postmining land use, and other requirements in 30 CFR 800.40(c)(2), 816.49(b), and 816.133.

AOC Variances

The current regulations provide for the approval of permits for mountaintop removal mining operations, which are exempt from AOC restoration requirements if the postmining land use and postmining surface topography requirements of paragraphs (3) and (4) of section 515(c) of SMCRA are met. The regulations also provide for the approval of AOC variances for steep-slope mining operations under certain conditions.

As described in 30 CFR 785.14(b), mountaintop removal mining operations are surface mining activities in which the mining operation removes an entire coal seam or seams running through the upper fraction of a mountain, ridge or hill by removing substantially all of the overburden off the bench and creating a level plateau or gently rolling contour, with no highwalls remaining. To obtain a permit for mountaintop removal mining operations, the proposed postmining land use must be a commercial, industrial, residential, agricultural, or public facility land use. The regulatory authority must find that the proposed postmining land use meets all requirements for alternative postmining land uses and is an equal or better economic or public use of the land compared to its premining use. The permit application must include specific plans for the proposed postmining land use, including assurance of investment in public facilities and documentation of private financial capability to ensure completion. The current regulations do not require implementation of the approved postmining land use prior to final bond release.

Under 30 CFR 824.11(a)(9), the regulatory authority may approve a permit for a mountaintop removal mining operation only upon a demonstration that there would be no damage to natural watercourses below the lowest coal seam to be mined. The regulations do not define the term "no damage." Natural watercourses above the lowest coal seam mined are not protected from damage.

Under 30 CFR 824.11(a)(6), the permittee must leave an outcrop barrier in place at the toe of the lowest coal seam mined to ensure stability.

As defined in 30 CFR 701.5, steep slopes are any slope of more than 20° or a lesser slope designated by the regulatory authority after consideration of soil, climate, and other characteristics of a region or State. To obtain an AOC variance for steep-slope mining operations under 30 CFR 785.16, the proposed postmining land use must be of an industrial, commercial, residential, or public (including recreational facilities) nature. It also must meet the requirements in 30 CFR 816.133 for approval of alternative postmining land uses, which, among other things, means that the postmining use must be an equal or better economic or public use. The applicant must demonstrate that the proposed operation will improve the watershed when compared to either premining conditions or the conditions that would exist if the applicant restored the area to AOC after mining. The regulatory authority can concur that the operation would improve the watershed only if the operation would reduce the amount of total suspended solids or other pollutants discharged from the permit area to surface water or groundwater *or* reduce the flood hazards within the watershed by a reduction of the peak-flow discharge from precipitation events or thaws. In both cases, the total volume of flow from the proposed permit area during every season of the year must not vary in a way that adversely affects the ecology of any surface water or any existing or planned use of surface water or groundwater.

2.4.1.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Under 30 CFR 816.133(a), the permittee must restore all disturbed areas to a condition in which they are capable of supporting the uses that they were capable of supporting before any mining or higher or better uses.

Under 30 CFR 816.22, the permittee must salvage and redistribute all topsoil (the A and E soil horizons), unless alternative overburden materials are approved as being equal to or better than the existing available topsoil to support vegetation. The permittee also must demonstrate that the selected overburden materials they propose to use as topsoil substitutes and supplements are the best available material within the permit area. Paragraph (e) of 30 CFR 816.22 provides that the regulatory authority may require salvage and redistribution of the subsoil (the B and C soil horizons) or other underlying strata if it finds that those layers are necessary to comply with the revegetation performance standards in 30 CFR 816.111 through 816.116.

Paragraph (d) of 30 CFR 816.22 requires that the permittee redistribute topsoil and topsoil substitutes and supplements in a manner that achieves an approximately uniform, stable thickness when consistent with the approved postmining land use, contours, and surface water drainage systems. Soil thickness may vary to the extent necessary to meet the specific revegetation goals identified in the permit. The permittee also must redistribute soil materials in a manner that prevents excess compaction and protects the materials from wind and water erosion before and after seeding and planting.

Under 30 CFR 816.116, revegetation success standards must be based upon the effectiveness of the vegetation to support the approved postmining land use, the extent of ground cover compared to the cover provided by the natural vegetation of the area, and the general requirements of 30 CFR 816.111. These general requirements provide that the vegetative cover must be diverse, effective, and permanent; comprised of species native to the area (with certain exceptions); at least equal in extent of cover to the natural vegetation of the area; capable of stabilizing the soil surface from erosion; compatible with the postmining land use; have the same seasonal characteristics of growth as the original vegetation; be capable of self-regeneration and plant succession; be compatible with the plant and animal species of the area; and meet the requirements of state and federal laws and regulations concerning seeds, poisonous and noxious plants, and introduced species. The regulations provide limited exceptions to some of these requirements for agricultural crops and for plantings used to establish temporary cover.

Fish and Wildlife Protection and Enhancement

Under 30 CFR 780.16(a), each permit application must include fish and wildlife resource information for the proposed permit area and the adjacent area. The regulatory authority must determine the scope and level of detail of that information in consultation with state and federal agencies with responsibility for fish and wildlife. Paragraph (b) of 30 CFR 780.16 requires that the permit application also include a fish and wildlife protection and enhancement plan. Paragraph (c) of 30 CFR 780.16 requires that the regulatory authority provide the fish and wildlife resource information and the fish and wildlife protection and enhancement plan to the U.S. Fish and Wildlife Service (U.S. FWS) upon request.

Under the current regulations at 30 CFR 816.97(a), the mine operator must, to the extent possible using the best technology currently available (BTCA), minimize disturbances and adverse impacts to fish, wildlife, and related environmental values and enhance such resources where practicable.

Under 30 CFR 816.97(b), surface mining activities must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of designated critical habitats of such species in violation of the Endangered Species Act of 1973 (16 U.S.C. §§1531 to 1599). On September 24, 1996, the U.S. FWS issued a biological opinion (BO) and conference report to OSMRE (1996 BO) on the continuation and approval and conduct of surface coal mining and reclamation operations under state and federal regulatory programs adopted pursuant SMCRA where such operations may adversely affect species listed as threatened or endangered or designated critical habitat under the ESA. The 1996 BO explains how this requirement is designed to be implemented; it also provides an incidental take statement. The BO states that the regulatory authority must "implement and require compliance with any species-specific protective measures developed by the USFWS field office and the regulatory authority (with the involvement, as appropriate, of the permittee and OSM)." The BO further provides that, "[w]henever the regulatory authority decides not to implement one or more of the species-specific measures recommended by the USFWS, it must provide a written explanation to the USFWS. If the USFWS field office concurs with the regulatory authority's action, it would provide a concurrence letter as soon as possible. However, if the USFWS does not concur, the issue must be elevated through the chain of command of the regulatory authority, the USFWS, and (to the extent appropriate) OSM for resolution." However, neither the regulations nor the BO contain a clear description of the process for resolving disputes between the U.S. FWS and the regulatory authority; the BO and current regulations are unclear about the respective roles and responsibilities of OSMRE, the U.S. FWS, and regulatory authority, and as a result, the elevation process was not functioning as intended. To rectify this situation, OSMRE and the U.S. FWS entered into a Memorandum of Understanding (MOU). The MOU, while only recently signed, is part of the current regulatory environment because it adds no new requirements but instead merely clarifies existing ones.

Under 30 CFR 816.97(f), the permittee must avoid disturbances to wetlands and riparian vegetation along rivers and streams and bordering ponds and lakes; permittees must enhance where practicable, restore, or replace these resources. Likewise, surface mining activities must also avoid disturbances to habitats of unusually high value for fish and wildlife; these resources must be restored or enhanced where practicable.

Where fish and wildlife habitat is to be a postmining land use, 30 CFR 816.97(g) requires that the plant species to be used on reclaimed areas be selected based upon their proven nutritional value for fish or wildlife, their use as cover for fish or wildlife, and their ability to support and enhance fish or wildlife habitat after bond release. Paragraph (g) also requires that the plants selected be grouped and distributed in a manner that optimizes edge effect, cover, and other benefits to fish and wildlife.

The remaining paragraphs of 30 CFR 816.97 identify assorted other measures that permittees must implement during and after mining to minimize damage to fish and wildlife resources and their habitats or to ensure that all postmining land uses provide some fish and wildlife habitat or travel corridors to the extent practicable.

2.4.2 Alternative 2

Alternative 2 would result in the most significant changes to permit requirements and mining operations under SMCRA. Under Alternative 2, and all the Action Alternatives to follow, the proposed regulatory changes pertain to SMCRA only; implementation of any of the proposed Alternatives below would not affect compliance with any other federal, state or tribal laws.

Alternative 2 would change water monitoring and reporting requirements before and during mining operations and during reclamation. The regulatory authority would be required to coordinate with Clean Water Act implementing agencies to harmonize baseline data collection and monitoring requirements to the extent consistent with each agency's statutory authority and responsibilities. This Alternative would prohibit mining operations in or through perennial streams; it also would prohibit the placement of excess spoil in intermittent or perennial streams. In addition, it would prohibit all variances from AOC, which could require amendment of SMCRA. Proposed modifications under Alternative 2 are characterized below.

2.4.2.1 Protection of the Hydrologic Balance

<u>Baseline Data Collection and Analysis</u>

Alternative 2 differs from the No Action Alternative by establishing minimum sample collection intervals and by expanding the suite of parameters for which permittees must analyze all water samples. It also requires documentation of the biological condition of perennial and intermittent streams and the sediment load of the watershed, as well as precipitation.
Under this Alternative, the applicant must collect and submit the following baseline data during the application process:

- <u>Surface water</u>: The applicant must sample all potentially affected perennial and intermittent streams and a representative number of ephemeral streams within the proposed permit and adjacent areas a minimum of 12 times, with the samples evenly spaced over a 12-month period. The applicant must collect samples for a suite of parameters to include temperature, bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium, hot acidity, alkalinity, pH, selenium, specific conductance (or total dissolved solids (TDS)), total iron, total manganese, total suspended solids, arsenic, zinc, copper, cadmium, ammonia, nitrogen, and any additional parameters for which effluent limitations have been established under the NPDES in accordance with section 402 of the Clean Water Act. The applicant must collect continuous streamflow data and must collect stream sediment load data for each watershed.

- Groundwater: The applicant must measure groundwater levels continuously throughout baseline monitoring. The applicant must sample groundwater in perched and regional aquifers at the same frequency and for the same water-quality parameters as surface water (with the exception of total suspended solids). In addition, the baseline monitoring must include static water levels and other quantitative measurements of the aquifer capacity, discharge, and seasonal variation.

- Biological condition of streams: Requires use of comprehensive, multi-assemblage, scientifically defensible bioassessment protocols to document the biological condition of all perennial and intermittent streams and a representative number of ephemeral streams within the proposed permit and adjacent areas over multiple seasons (at a minimum spring, summer, and fall). Requires identification of aquatic biota to the genus taxonomic level.

- Precipitation: Requires use of continuous recording devices to record all precipitation and storm events, including precipitation amounts and the duration of each storm event, not just monthly totals.

- Form and function of streams: Requires documentation of the hydrologic form and ecological function of all perennial and intermittent streams in the proposed permit and adjacent areas.

- Geology: Requires collection of geologic data for the proposed permit and adjacent areas, with a focus on geological characteristics and properties that influence the hydrologic regime or could alter the availability or quality of groundwater and surface water.

Monitoring During Mining and Reclamation

Under Alternative 2, monitoring of surface water and groundwater during mining and reclamation must occur at least quarterly. The permittee must analyze each sample for the same parameters measured during baseline sampling. The permittee must monitor groundwater and surface water at locations designated in the permit.

The permittee must monitor the biological condition of streams annually until the data demonstrate full restoration of the premining biological condition of the stream.

The permittee must review all monitoring data annually to identify adverse trends and sample analyses that approach corrective action thresholds.

The permittee must collect on-site precipitation measurements using self-recording rain gages. The regulatory authority would review the monitoring data midway through the permit term and during permit renewal cycles. The surface water runoff control plan for designing and monitoring the control structures requires an inspection following a one-year or greater recurrence-interval storm event. The permittee must then submit to the regulatory authority within 48 hours a report prepared by a certified professional engineer. The report must describe the performance of the hydraulic control structures, assess and describe any potential material damage to the hydrologic balance, and address any remedial measures taken.

Monitoring must continue until final bond release. The regulatory authority may not release the bond until monitoring results document that there are no adverse trends that could result in material damage to the hydrologic balance outside the permit area.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Section 510(b)(3) of SMCRA provides that the regulatory authority may not approve a permit for surface coal mining operations unless it first finds that the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area. However, neither SMCRA nor the current regulations implementing SMCRA define the term "material damage to the hydrologic balance outside the permit area."

Alternative 2 would define material damage to the hydrologic balance outside the permit area as any adverse impact from surface or underground mining operations on the quantity or quality of surface water or groundwater, or on the biological condition of a perennial or intermittent stream, that would preclude attainment or continuance of any designated surface water use under sections 101(a) and 303(c) of the Clean Water Act or any existing or reasonably foreseeable use of surface water or groundwater outside the permit area.

This definition would also apply to adverse impacts from subsidence and to other adverse impacts resulting from underground mining operations (e.g., permanent dewatering of a stream by mining through a fracture zone) that result in material damage to the hydrologic balance. Thus, the definition would not be limited to the impacts from surface mining activities or the impacts of activities conducted on the surface of land (i.e., where surface facilities are located) in connection with an underground coal mine.

Corrective Action Thresholds

Under Alternative 2, the regulatory authority must establish permit-specific or regional corrective action thresholds for key water-quality parameters based on baseline data and the cumulative hydrologic impact assessment (CHIA). These thresholds would define the point at which environmental degradation would become so significant that the permittee must take corrective action to prevent the operation from causing material damage to the hydrologic balance outside the permit area.

The permittee must conduct a water-quality trend analysis of the monitoring data on a quarterly basis. If the analysis of the monitoring data indicates that trends in values for any surface water or groundwater parameter or analyte have reached the corrective action threshold specified in the permit, the permittee must notify the regulatory authority and evaluate the conditions that caused the threshold parameter to be met or exceeded. If the permittee finds, and the regulatory authority agrees, that the increase was due to the permittee's mining activity, the permittee must develop and implement corrective measures to prevent environmental degradation (i.e., material damage to the hydrologic balance outside the permit area as defined under Alternative 2). Corrective action plans are subject to regulatory authority approval.

The requirement to take corrective action would not apply if the permittee demonstrates, and the regulatory authority concurs in writing, that the adverse values or trends for the parameters of concern are not the result of the permittee's mining operation.

2.4.2.2 Activities in or Near Streams

Stream Definitions

Instead of using the definitions of streams in the current SMCRA regulations, Alternative 2 would use "waters of the United States" as defined and interpreted under 40 CFR section 230.3(s) and CWA section 404(b)(1). This Alternative would protect all waters defined as "waters of the United States". The definition of an intermittent stream would no longer include the one-square-mile watershed criterion.

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

Alternative 2 would prohibit all mining activities in or within 100 feet of perennial streams. It would also prohibit the construction of excess spoil fills in or within 100 feet of intermittent streams. However, it would allow the construction of excess spoil fills in or within 100 feet of ephemeral streams, and the construction of coal mine waste disposal facilities in or within 100 feet of intermittent or ephemeral streams, provided the operation meets certain conditions. Furthermore, this Alternative would allow the regulatory authority to approve operations that propose to mine through intermittent or ephemeral streams, provided the operation meets certain conditions.

Under this Alternative, an applicant for a permit that proposes to conduct any other type of mining activities in or within 100 feet of an intermittent or ephemeral stream must demonstrate that the proposed activity will not cause material damage to the hydrologic balance outside the permit area. That is, the applicant must demonstrate that the proposed activity would not preclude attainment or maintenance of an existing or reasonably foreseeable designated use of the affected stream segment under section 101(a) or section 303(c) of the Clean Water Act after reclamation and that it will not result in conversion of an intermittent stream segment to an ephemeral stream segment. The applicant must demonstrate that the operation would not have more than a minimal adverse effect on the biological condition of the affected stream segment after reclamation.

Alternative 2 requires that applicants design proposed mining operations to minimize the amount of excess spoil generated. It also requires that the permittee design excess spoil fills and coal mine waste disposal facilities to minimize their footprints. Both requirements are intended to reduce the length of stream that the operation will cover.

Each applicant proposing to place excess spoil in or near an ephemeral stream or to place coal mine waste in or near an intermittent or ephemeral stream must identify and analyze a range of reasonable operational alternatives. The applicant must select the alternative that would have the least adverse impact of all reasonable operational alternatives on fish, wildlife, and related environmental values.

Alternative 2 would require development and implementation of fish and wildlife enhancement measures in compliance with any Clean Water Act mitigation plan as a condition of the SMCRA permit.

Under Alternative 2, the permittee must construct any excess spoil fills in lifts not to exceed four feet in thickness. The current regulation at 30 CFR 816.73 allowing construction of durable rock fills that rely upon end-dumping and the construction of underdrains by gravity segregation of the end-dumped material would be eliminated. This Alternative requires daily monitoring during excess spoil placement. It would revise the existing rules to require that the quarterly inspection reports filed with the regulatory authority include the daily monitoring logs.

Under Alternative 2, the regulatory authority would no longer allow construction of excess spoil fills and coal waste disposal facilities with flat decks on top. The final surface configuration must resemble the surrounding terrain.

Alternative 2 provides that, to the extent that stability considerations allow, the permittee must construct excess spoil fills with aquitards as a barrier to groundwater infiltration, and in a manner that facilitates stream construction. Placement of a layer of lower-permeability spoil or other material near the surface but below the root zone for trees and shrubs could provide the subsurface flow needed to restore flow in intermittent and ephemeral stream segments.

Mining Through Streams

Alternative 2 prohibits all mining activities in or within 100 feet of perennial streams. Mining through an intermittent stream would be allowed if the hydrologic form and ecological function of the stream can and will be restored. The regulatory authority would consider a stream to be restored in function when its postmining biological condition is comparable to its premining biological condition and in accordance with specific standards established by the Clean Water Act permitting authority. The regulatory authority could permit mining through an ephemeral stream only if the applicant could and would restore the hydrological form of the stream.

To obtain a permit to mine through or divert an intermittent stream, the applicant must demonstrate that the operational design would minimize the length of stream disturbed. The applicant also must demonstrate that the hydrologic form and ecological function of the stream segment can and would be fully restored. With respect to ephemeral streams, the applicant would only need to restore the hydrologic form of the stream segment. The bond posted for the permit must specifically include the cost of restoration of both the form and function of intermittent streams and the hydrologic form of ephemeral streams. Alternative 2 requires the use of natural-channel design techniques when constructing restored stream channels or permanent stream-channel diversions. The reclamation plan must provide for the establishment or preservation of a permanent riparian corridor, comprised of native non-invasive species (or other native species for non-forested areas), at least 100 feet in width along both banks of the entire reach of restored or permanently diverted ephemeral or intermittent stream channels.

Alternative 2 would require the design and construction of all permanent stream-channel diversions, all temporary stream-channel diversions in use for two or more years, and all restored stream channels to adhere to natural-channel design techniques. Permanent stream-channel diversions and restored intermittent stream channels must approximate the premining characteristics of the original stream channel, including the natural riparian vegetation and the natural hydrological characteristics of the original stream. Finally, Alternative 2 would require that the hydraulic capacity of all temporary and permanent stream-channel diversions be at least equal to the hydraulic capacity of the unmodified stream channel immediately upstream of the diversion and no greater than the hydraulic capacity of the unmodified stream channel immediately downstream of the diversion.

2.4.2.3 AOC and AOC Variances

Surface Configuration

Alternative 2 would require the use of landforming principles, when consistent with stability and postmining land use considerations, to establish a postmining surface configuration within specific tolerances from the premining surface configuration. Landforming is a design and grading technique that attempts to replicate the appearance of the natural terrain and provide a cost-effective, attractive, and environmentally compatible way to construct slopes and other landforms that are stable and that blend in with the natural surroundings. Use of these principles would ensure restoration of dendritic ephemeral drainages and result in a more varied, natural-looking topography. Alternative 2 would require that the applicant use digital terrain modeling to document and restore the premining surface configuration. It also would require use of digital terrain modeling during backfilling and grading and upon completion of final grading to document restoration of the approved final surface configuration.

Under this Alternative, the regulatory authority would determine the allowable deviation in the elevation of the backfilled and graded area postmining in comparison to the premining elevation based on the lowest coal seam mined. The allowable deviation in the postmining elevation could be no more than ±20 percent of the difference between the premining surface elevation and the premining bottom elevation of that lowest coal seam, with allowances for slope stability and minor shifts in the location of premining features. This tolerance would apply only to those portions of the minesite that are subject to the AOC restoration requirement; e.g., the tolerance would not apply to excess spoil fills or coal mine waste disposal facilities.

AOC restoration requirements for steep-slope mining permits would allow the placement of what would otherwise be excess spoil on the mined-out area to heights in excess of the premining elevation if safety and stability requirements were met, and if the final surface configuration would be compatible with the surrounding terrain and consistent with natural premining landforms. This exemption would allow the permittee to exceed premining elevations and otherwise applicable tolerances to achieve the desired topography and would minimize the need to place excess spoil in streams.

Compliance with the ±20 percent tolerance is not practicable in contour mining on steep slopes (defined as slopes greater than 20 degrees) because of stability and equipment constraints. Therefore, the ±20 percent tolerance requirement does not apply to that portion of a contour mine permit where steep-slope mining is conducted. The tolerance and digital terrain modeling requirements also would not apply to remining sites, permits 40 acres or smaller in size, or operations that qualify for the thin overburden standards of 30 CFR 816.104.

This Alternative would allow permanent impoundments, including final-cut impoundments, provided they would not otherwise create conflicts with achieving AOC and they met the approved postmining land use. This Alternative would encourage the construction of aquitards within the backfill to act as a barrier to groundwater infiltration and to facilitate stream construction. Placement of a layer of lower-permeability spoil or other material near the surface but below the root zone for trees and shrubs could provide the subsurface flow needed to restore flow in intermittent and ephemeral stream segments.

Alternative 2 would prohibit flat decks on excess spoil fills and coal waste disposal facilities.

AOC Exceptions

Alternative 2 would eliminate all exceptions from the requirement to return the mined area to its approximate original contour. Thus, Alternative 2 would preclude both mountaintop removal mining operations and AOC variances for steep-slope mining operations. Implementing this Alternative could require an amendment to SMCRA.

2.4.2.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Alternative 2 includes provisions similar to those of the No Action Alternative with respect to soil management and revegetation, but with a greater emphasis on restoration of the site’s ability to support the uses it supported before any mining, regardless of the approved postmining land use. Alternative 2 also places greater emphasis on construction of a growing medium with an adequate root zone for deep-rooted species and on revegetation with native tree and plant species, especially reforestation of previously forested areas.

Like the No Action Alternative, Alternative 2 requires salvage and redistribution of all topsoil (the A and E soil horizons). However, it also requires salvage and redistribution of the B and C soil horizons (or other suitable overburden materials) to the extent necessary to achieve a growing medium with the optimal rooting depths required to restore premining land use capability or comply with revegetation requirements. Under the No Action Alternative, the regulatory authority has the discretion, but not necessarily the obligation, to require salvage and redistribution of the B and C soil horizons or other suitable overburden materials.

Alternative 2 allows use of selected overburden materials as substitutes for (or supplements to) either topsoil or subsoil or both only if the applicant demonstrates that either (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed together with the substitute material. As in the No Action Alternative, the applicant also must demonstrate that the resulting soil medium will be more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. Alternative 2 differs slightly from the No Action Alternative in that the No Action Alternative allows the use of topsoil substitutes or supplements when the resulting soil medium will be equally or more suitable than the existing topsoil to sustain vegetation, while Alternative 2 allows their use only when the resulting soil medium will be more suitable to sustain vegetation.

Under Alternative 2, the permittee must salvage and redistribute all organic matter (duff, other organic litter, and vegetative materials such as tree tops, small logs, and root balls) above the A soil horizon to increase the moisture retention capability of the soil and provide a source of the seeds, plant propagules, mycorrhizae, and other soil flora and fauna needed to support and enhance reestablishment of locally adapted and genetically diverse plant communities as well as to improve soil productivity. Alternative 2 prohibits burning or burying vegetation or other organic materials.

Under Alternative 2 the permittee must reforest lands that were previously forested, or that would naturally revert to forest under conditions of natural succession, in a manner that would enhance recovery of the native forest ecosystem as expeditiously as possible. Prime farmland is exempt from this requirement.

The permittee must revegetate the entire reclaimed area (other than water areas and impervious surfaces like roads and buildings) using native species to restore or reestablish the plant communities native to the area unless a conflicting postmining land use is actually implemented before the end of the revegetation responsibility period.

Fish and Wildlife Protection and Enhancement

Alternative 2 would require incorporation of any Clean Water Act mitigation plan for the operation as a condition of the SMCRA permit. Bond release under SMCRA could not occur until completion of successful mitigation as determined by the regulatory authority and the agency implementing the Clean Water Act. Implementing this Alternative could require an amendment to SMCRA.

Alternative 2 is similar to the No Action Alternative with respect to the protection of threatened and endangered species. However, Alternative 2 would codify the dispute resolution provisions of the 1996 biological opinion concerning protection of threatened and endangered species. It also would expressly require that the fish and wildlife protection and enhancement plan in the permit application include any species-specific protective measures developed in accordance with the Endangered Species Act and any biological opinions implementing that law.

Alternative 2 is similar to the No Action Alternative with respect to the fish and wildlife resource information and protection and enhancement plan required in the permit application. It also includes similar performance standards for protection of fish and wildlife. The principal difference is that Alternative 2 would require creation of a riparian corridor at least 100 feet in width, comprised of native non-invasive species, along the entire reach of any ephemeral, intermittent, or perennial streams that are restored or permanently diverted.

2.4.3 Alternative 3

Alternative 3 differs from Alternative 2 in that it would prohibit the placement of excess spoil or coal mine waste in perennial streams, but not in intermittent streams. Otherwise, Alternative 3 contains no categorical prohibition on mining activities in or near perennial, intermittent, or ephemeral streams.

2.4.3.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2), except that Alternative 3 would require discrete measurement of streamflow and groundwater levels whereas Alternative 2 would require continuous measurements.

Monitoring During Mining and Reclamation

Under Alternative 3, all monitoring requirements are the same as under Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2), with the exception of precipitation monitoring. In that case, the engineer would be required to conduct an inspection of the surface water runoff control system after each storm event with a two-year or greater recurrence-interval, rather than after each storm event with a one-year or greater recurrence interval as under Alternative 2.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as Alternative 2 (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 2).

Corrective Action Thresholds

Same as Alternative 2 (see Corrective Action Thresholds section for Alternative 2).

2.4.3.2 Activities in or Near Streams

Stream Definitions

Same as the No Action Alternative (see Stream Definitions section for Alternative 1).

Activities In or Near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

Same as Alternative 2 except that Alternative 3 would allow the placement of excess spoil in intermittent streams. Alternative 3 lacks Alternative 2's categorical prohibition on mining activities in or near perennial streams, but it would prohibit the construction of excess spoil fills and coal mine waste disposal facilities in perennial streams. Alternative 3 would require that the permittee establish permanent riparian corridors along the banks of restored or diverted perennial or intermittent stream channels, but, unlike Alternative 2, it would not require establishment of riparian corridors along the banks of restored or diverted ephemeral streams. Alternative 3 would require that the riparian corridor be at least 300 feet in width, compared to the minimum 100-foot width under Alternative 2. Unlike Alternative 2, Alternative 3 would not require that the SMCRA permit incorporate any mitigation plan under section 404 of the Clean Water Act.

Alternative 3 would also allow the permittee to construct excess spoil fills with flat decks, rather than requiring the use of landforming principles as under Alternative 2.

Mining Through Streams

Same as Alternative 2, except that Alternative 3 would not prohibit mining through perennial streams. Nor would it require the regulatory authority to make special findings for mining through ephemeral streams, although it would require the permittee to restore the hydrologic function of ephemeral streams to the extent required by geomorphic reclamation principles.

2.4.3.3 AOC and AOC Variances

Surface Configuration

Same as Alternative 2, except that Alternative 3 would not include any numerical limits or tolerances on differences between premining and postmining elevations. In addition, there is no requirement to use landforming principles on the surface of excess spoil fills.

AOC Variances

Alternative 3 would allow mountaintop removal mining operations and AOC variances for steep-slope mining operations under conditions generally similar to those in the No Action Alternative. However, Alternative 3 would impose additional requirements to better protect streams, aquatic ecology, and biological communities. In addition, it would require that the permittee post bond in an amount sufficient to return the site to AOC if the permittee has not implemented the approved postmining land use before expiration of the revegetation responsibility period.

For approval of mountaintop removal mining operations, Alternative 3 would require the permit applicant to demonstrate that:

- No damage would result to natural watercourses within the proposed permit and adjacent areas;
- There would be no adverse changes in parameters of concern in discharges to surface water and groundwater;
- No change would occur in the size or frequency of peak flows as compared to the peak flows that would occur if the permittee mined the site and restored it to AOC; and that
- The total volume of flow during any season of the year would not vary; i.e., there would be no change in the seasonal flow regime and no increase in potential damage from flooding.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application, unless reforestation would be inconsistent with the postmining land use.

Finally, the permittee must install drains through the outcrop barrier to prevent saturation of the backfill.

For approval of steep-slope variances, Alternative 3 would require permit applicants to demonstrate each of the following:

- The operation, including any fish and wildlife enhancement measures, will result in fewer adverse impacts to the aquatic ecology of the cumulative impact area than would occur if the site were mined and restored to AOC;
- Surface-water flow in the watershed would be improved over both premining conditions and conditions that would exist if the area were mined and restored to AOC;
- The variance would not result in construction of an excess spoil fill in an intermittent or perennial stream; and
- Any deviations from the premining surface configuration are necessary and appropriate to achieve the postmining land use.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application or would revert to forest under natural succession. This requirement would not apply to permanent impoundments, roads, and other impervious surfaces to be retained following mining and reclamation or to those portions of the permit area covered by the variance.

2.4.3.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Alternative 3 has the same requirements for soil management and revegetation as Alternative 2, except that Alternative 3 requires salvage and redistribution of all organic matter (duff, other organic litter, and vegetative materials such as treetops, small logs, and root balls) from native species in accordance with an approved plan developed by a qualified ecologist or similar expert. The plan would specify the amount of organic materials the permittee must retain and redistribute to promote reestablishment of native vegetation and soil flora and fauna. Alternative 3 prohibits the burning of native vegetation and vegetative debris, but, unlike Alternative 2, it would allow the permittee to bury these materials.

Fish and Wildlife Protection and Enhancement

Alternative 3 is similar to the No Action Alternative with respect to the protection of threatened and endangered species. However, Alternative 3 would codify the dispute resolution provisions of the 1996 biological opinion concerning protection of threatened and endangered species. It also would expressly require that the fish and wildlife protection and enhancement plan in the permit application include any species-specific protection and enhancement plans developed in accordance with the Endangered Species Act and any biological opinions implementing that law.

Alternative 3 is similar to the No Action Alternative with respect to the fish and wildlife resource information and protection and enhancement plan required in the permit application. It also includes similar performance standards for protection of fish and wildlife. However, Alternative 3 would require that the permittee establish permanent riparian corridors at least 300 feet wide, comprised of native, non-invasive species, along the banks of restored or diverted perennial or intermittent stream channels. The permittee must use appropriate species of woody plants if the land would naturally revert to forest under natural succession.

In addition, fish and wildlife enhancement measures would be mandatory whenever the proposed operation would result in the long-term loss of native forest, loss of other native plant communities, or filling of a segment of an intermittent stream. The enhancement measures must be commensurate with the long-term adverse impact to the affected resources and they must be located in the same watershed as the proposed operation (or the nearest appropriate adjacent watershed if there are no opportunities for enhancement within the same watershed). The permit area would include these areas of enhancement.

Finally, Alternative 3 would allow the regulatory authority to prohibit mining of high-value habitats within the proposed permit area.

2.4.4 Alternative 4

Alternative 4 is similar to Alternative 2 except that it would have slightly more relaxed requirements for the collection of baseline data and monitoring, it would define streams based on different criteria than Alternative 2, and it would be more permissive than Alternative 2 in activities in or near streams, and mining through streams.

However, Alternative 4 would impose additional permitting requirements on operations involving factors that OSMRE has determined pose additional risk to the environment and warrant enhanced permitting requirements. These operations are as follows:

- Surface mining activities (including surface activities of underground mining) in pristine or unique hydrologic environments (any unique historic, hydrologic, geologic, or other natural areas, with a special designation status). Examples include state-designated High-Quality or Exceptional streams and any stream with an elevated Clean Water Act use designation. Other examples include mine sites situated within or adjacent to designated natural, wild, or wilderness areas; or local, state, or national parks;

- Operations in strata that have been known to produce acid or toxic mine drainage to ensure that mining and reclamation can be accomplished such that active or postmining water quality does not cause material damage to the hydrologic balance outside the permit area;

- Mining operations in watersheds with impaired waters or streams when the Regulatory Authority (RA) expects that the coal mining activity would exacerbate the conditions of the parameter(s) causing the impairment;

- Proposed operations on steep slopes (areas with slopes greater than 20 degrees on more than 10 percent of the proposed disturbed acreage); or

- Operations that propose to place excess spoil or coal mine waste in intermittent or perennial streams or their buffer zones.

When the proposed mining activity includes any of these listed operations in all or part of the permit area certain additional permitting requirements would apply over the entire permit area. The RA would identify the additional requirements[3] specific to a proposed operation. The RA could modify or expand these requirements as needed to address the needs of a particular operation. For example, under this Alternative the RA could require any or all of the following when enhanced permitting design was warranted:

- Additional detail in the analysis of the receiving watershed including the location and type of current and past disturbances in the watershed and other activities that may affect water quality;
- Measured stream flows and recorded storm hydrographs to develop premining hydrologic models;
- Modeling of seasonal groundwater fluctuations. Analysis of the correlation between groundwater fluctuations, precipitation events and groundwater quality;
- Establishment of clear environmental goals for the proposed operation. Use of background data and a detailed mine plan to demonstrate how environmental goals would be achieved;
- Development of reclamation goals specific to the proposed operation and the site conditions that would include planning for timely redistribution of topsoil and organics, contemporaneous plantings, and any related actions that would help reduce water quality degradation from the proposed operation;
- Additional detail in the mine plan to show changes in 6-month increments, specific to disturbed and reclaimed areas, roads, sediment controls, topsoil storage, fills, Best Management Practices (BMPs) etc.;
- Use of premining hydrologic models to assess flood potential and need for flood control, to project sediment loads and determine the design criteria for sediment control structures and need for temporary sediment controls; and/or
- Use of on-bench ponds, where possible, in conjunction with in-stream ponds below placement of fill. Design of on-bench ponds to accommodate both a full sediment load and maintenance of a low permanent pool to allow recirculation from in-stream ponds as needed.

The text below discusses Alternative 4 proposed requirements for each element. These requirements would apply to all operations, including those involving enhanced permitting (at a minimum).

[3] The additional permitting and implementation costs on the operator, and the additional permit review and inspection effort for the RA, associated with the listed examples were accounted for in the economic analysis of the DEIS and in the Regulatory Impact Analysis.

2.4.4.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Alternative 4 would require the same baseline data collection and analysis as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2), except that Alternative 4 requires discrete, rather than continuous measurements of streamflow and groundwater levels.

Monitoring During Mining and Reclamation

Under Alternative 4, all monitoring requirements are the same as under Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2), with the exception of precipitation monitoring. Under Alternative 4 the engineer would be required to conduct an inspection of the surface water runoff control system after each storm event with a two-year or greater recurrence-interval, rather than after each storm event with a one-year or greater recurrence interval as under Alternative 2.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as Alternative 2 (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 2).

Corrective Action Thresholds

Same as Alternative 2 (see Corrective Action Thresholds section for Alternative 2).

2.4.4.2 Activities in or Near Streams

Stream Definitions

Alternative 4 defines perennial, intermittent, and ephemeral streams in terms of flow regime, channel and substrate characteristics, and the biological community, if any, found in the stream. The definition of an intermittent stream would no longer include the one-square-mile watershed criterion.

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

Alternative 4 would be the same as Alternative 2, except that Alternative 4 lacks Alternative 2's categorical prohibition on mining activities in or near perennial streams, and it would not prohibit the placement of excess spoil in intermittent streams. Similar to Alternative 2, Alternative 4 would require the permittee to establish permanent riparian corridors along both banks of the entire reach of restored or diverted perennial or intermittent stream channels, but it would not require establishment of riparian corridors along the banks of restored or diverted ephemeral streams. Alternative 4 would require that the riparian corridor be at least 300 feet in width, compared to the minimum 100-foot width under Alternative 2. Unlike Alternative 2, Alternative 4 would not require that the SMCRA permit incorporate any mitigation plan under section 404 of the Clean Water Act.

Mining Through Streams

Same as Alternative 2, except as described in the Activities in or near Streams section for Alternative 4 above. Unlike Alternative 2, Alternative 4 would not prohibit mining through perennial streams. Nor would it require the regulatory authority to make special findings to approve mining through ephemeral streams. It would require restoration of the hydrologic function of ephemeral streams only to the extent required by geomorphic reclamation principles.

2.4.4.3 AOC and AOC Variances

Surface Configuration

Same as Alternative 2 (see Surface Configuration section for Alternative 2).

AOC Variances

Same as Alternative 3 (see AOC Variances section for Alternative 3) for all operations.

2.4.4.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Same as Alternative 2 (see Revegetation, Reforestation and Topsoil Management section for Alternative 2) for all operations.

Fish and Wildlife Protection and Enhancement

Same as Alternative 3 (see Fish and Wildlife Protection and Enhancement section for Alternative 3) for all operations.

2.4.5 Alternative 5

This Alternative applies to surface and underground coal mining operations that would generate or dispose of excess spoil or coal mine waste outside the mined-out area, including the storage of material resulting from the creation of the face-up area for an underground mine. It also applies to all operations that would dispose of coal mine waste in perennial or intermittent streams. This Alternative would apply to the entire permit area whenever any portion of the operation met the criteria set forth above. It would also apply to contiguous permits if they were operated as a single operation with a permit that met the criteria.

However, this Alternative would not apply to any operation that would otherwise not meet the criteria set forth above. These operations would remain under the existing requirements of Alternative 1 (the No Action Alternative).

2.4.5.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2), with the exception that discrete measurements of streamflow and groundwater levels would be required as in Alternative 4.

Monitoring During Mining and Reclamation

Under Alternative 5, all monitoring requirements are the same as under Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2), with the exception of precipitation monitoring. In that case, the engineer would be required to conduct an inspection of the surface water runoff control system after each storm event with a two-year or greater recurrence-interval, rather than after each storm event with a one-year or greater recurrence interval as under Alternative 2.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as the No Action Alternative (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 1).

Corrective Action Thresholds

Same as the No Action Alternative (see Corrective Action Thresholds section for Alternative 1).

2.4.5.2 Activities in or Near Streams

Stream Definitions

Same as the No Action Alternative (see Stream Definitions section for Alternative 1).

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

Same as Alternative 2, except that Alternative 5 lacks Alternative 2's categorical prohibition on mining activities in or near perennial streams and it would not prohibit the placement of excess spoil in intermittent streams. Unlike Alternative 2, Alternative 5 would not require that the SMCRA permit incorporate any mitigation plan under section 404 of the Clean Water Act.

Mining Through Streams

Same as Alternative 2, except as described in the Activities in or near Streams section for Alternative 5 above. Unlike Alternative 2, Alternative 5 would not prohibit mining through perennial streams. Nor would it require special findings for mining through ephemeral streams, although it requires restoration of the hydrologic function of ephemeral streams to the extent required by geomorphic reclamation.

2.4.5.3 AOC and AOC Variances

Surface Configuration

Same as Alternative 2 (see Surface Configuration section for Alternative 2), except that Alternative 5 does not require the use of landforming principles. Nor would it establish any numerical limits or tolerances with respect to the extent to which the postmining elevation may differ from the premining elevation. Alternative 5 would require the permittee to return as much spoil material to the mined-out area as possible to minimize the need for and creation of excess spoil fills.

AOC Variances

Same as Alternative 3 (see AOC Variances section for Alternative 3).

2.4.5.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Same as Alternative 3 (see 2.4.3.4 - Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement for Alternative 3).

Fish and Wildlife Protection and Enhancement

Same as Alternative 3 (see 2.4.3.4 - Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement for Alternative 3).

2.4.6 Alternative 6

This Alternative is limited to mining activities conducted in intermittent or perennial streams or within 100 feet of those streams. It would prohibit all mining activities within those areas unless the regulatory authority makes specific findings concerning the environmental impacts of the proposed operation. Alternative 6 would be the same as Alternative 1 (the No Action Alternative) for mining activities on all other areas of the permit, with the exceptions of new requirements proposed for baseline data collection and monitoring as described below.

2.4.6.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2).

Monitoring During Mining and Reclamation

Same as Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2).

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area (Alternative limited to the Enhanced Stream Buffer Zone)

Same as Alternative 1, the No Action Alternative (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 1).

Corrective Action Thresholds Alternative limited to the Enhanced Stream Buffer Zone)

Same as Alternative 1, the No Action Alternative (see Corrective Action Thresholds section for Alternative 1).

2.4.6.2 Activities in or Near Streams

Stream Definitions

Same as Alternative 1, the No Action Alternative (see Stream Definitions section for Alternative 1).

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

Alternative 6 would prohibit mining activities in or within 100 feet of perennial and intermittent streams unless the applicant demonstrates each of the following:

- The ecological function of the stream would be protected or restored;
- Placement of excess spoil or coal mine waste within that area would not result in the formation of toxic mine drainage as that term is defined at 30 CFR 701.5;
- Long-term adverse impacts, including impacts within the footprint of any fill, to the environmental resources of the stream would be offset through fish and wildlife enhancement measures in the same or an adjacent watershed;
- Mining activities to be conducted within 100 feet of the stream, but not in the stream itself, would not adversely affect the water quality or quantity or other environmental resources of the stream; and
- The revegetation plan requires establishment of a permanent riparian corridor at least 100 feet in width along the entire reach of any restored or permanently diverted perennial, intermittent, or ephemeral stream segment.

Alternative 6 would require the mining operation design to minimize the generation of excess spoil. It also requires the design of excess spoil fills and coal mine waste disposal facilities to minimize their footprints. The intent of both requirements is to reduce the length of stream that the operation would cover.

Each applicant proposing to place excess spoil or coal mine waste in an intermittent or perennial stream or within 100 feet of such a stream must identify and analyze a range of reasonable operational alternatives. The applicant must select the alternative that would have the least adverse impact of all reasonable operational alternatives on fish, wildlife, and related environmental values.

Under Alternative 6, the permittee must construct any excess spoil fills in lifts not to exceed four feet in thickness. Alternative 6 would eliminate the current regulation at 30 CFR 816.73, which allows construction of durable rock fills that rely upon end-dumping and the construction of underdrains by gravity segregation of the end-dumped material. This Alternative would require daily monitoring during excess spoil placement. It would revise the existing rules to require that the quarterly inspection reports filed with the regulatory authority include the daily monitoring logs.

Alternative 6 would allow construction of excess spoil fills with flat decks on top, and includes no landforming requirements for excess spoil fills.

Mining Through Streams

Same as Alternative 2, except that Alternative 6 would not prohibit mining through perennial streams. Nor would it require the regulatory authority to make special findings for mining through ephemeral streams, although it would require the permittee to restore the hydrologic function of ephemeral streams to the extent required by geomorphic reclamation principles. In addition, it would require the permittee to establish a riparian corridor at least 100 feet in width along the entire reach of all streams, including ephemeral streams, within the permit area after completing mining.

2.4.6.3 AOC and AOC Variances

Surface Configuration

Same as Alternative 1, the No Action Alternative (see Surface Configuration section for Alternative 1).

AOC Variances

Same as Alternative 1, the No Action Alternative (see AOC Variances section for Alternative 1).

2.4.6.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Same as Alternative 1, the No Action Alternative (see Revegetation, Reforestation and Topsoil Management section for Alternative 1).

Fish and Wildlife Protection and Enhancement

Same as Alternative 1, the No Action Alternative, with the exceptions discussed below.

Alternative 6 would require that the permittee establish permanent riparian corridors at least 100 feet wide, comprised of native, non-invasive species, along both banks of all perennial, intermittent, and ephemeral stream segments within the permit area after the completion of mining. The permittee must use appropriate species of woody plants to reforest the site if the site would naturally revert to forest under natural succession.

In addition, fish and wildlife enhancement measures are mandatory whenever the proposed operation would result in the long-term loss of native forest, loss of other native plant communities, or filling of a segment of a perennial or intermittent stream. The enhancement measures must be commensurate with the long-term adverse impact to the affected resources and they must be located in the same watershed as the proposed operation (or the nearest appropriate adjacent watershed if there are no opportunities for enhancement within the same watershed). The areas upon which the enhancement measures are conducted must be included within the permit area.

Finally, Alternative 6 would allow the regulatory authority to prohibit mining of high-value habitats within the proposed permit area.

2.4.7 Alternative 7

Similar to Alternative 4, this Alternative would impose additional requirements (see 2.4.4 – Alternative 4) on the operations OSMRE has identified as warranting enhanced permitting. For these operations, Alternative 7 would also include new requirements based on the elements as discussed below.

All other operations (i.e. those that did not fall under the list of operations identified as warranting enhanced permitting) would continue to fall under the existing regulations of the No Action Alternative.

2.4.7.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2), but would apply only when the specified conditions exist that warrant enhanced permitting conditions. Otherwise baseline data collection and analysis requirements would be the same as the No Action Alternative (see Baseline Data Collection and Analysis section for Alternative 1).

Monitoring During Mining and Reclamation

Same as Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2), but would apply only when the specified conditions exist that warrant enhanced permitting conditions. Otherwise baseline data collection and analysis requirements would be the same as the No Action Alternative (see Monitoring During Mining and Reclamation section for Alternative 1).

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as the No Action Alternative (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 1). OSMRE would expect each regulatory authority to establish criteria to measure material damage to the hydrologic balance for purposes of cumulative hydrologic impact assessments.

Corrective Action Thresholds

In areas subject to enhanced permitting requirements, Alternative 7 would require the regulatory authority to develop corrective action thresholds. For these areas, the regulatory authority would be required to establish corrective action thresholds for critical parameters centered on baseline data, and associated conditions, and the analysis conducted for the Cumulative Hydrologic Impact Assessment (CHIA). The regulatory authority would define these thresholds based on the degree of environmental degradation that would require corrective action before the operation causes material damage to the hydrologic balance outside the permit area. The permittee would be required to conduct a water quality trend analysis of the monitoring data on a quarterly basis to determine environmental impacts from the site. If the analysis indicates that values or trends in values, for any surface water or groundwater parameter have reached the corrective action threshold specified in the permit, the permittee must notify the regulatory authority and evaluate the conditions that caused the threshold parameter to be met or exceeded. If the permittee finds, and the regulatory authority agrees, that the increase is due to the permittee's mining activity, then the operator must develop and implement corrective measures to ensure that material damage to the hydrologic balance outside the permit area does not occur. The requirement to take corrective action would not apply if the permittee demonstrates, and the regulatory authority concurs in writing, that the adverse values or trends for the parameters of concern are not the result of the mining operation.

2.4.7.2 Activities in or Near Streams

Stream Definitions

Same as the No Action Alternative, except that Alternative 7 would remove the one-square-mile criterion in the existing definition of an intermittent stream.

Alternative 7 would require coordination with the Clean Water Act authority on defining stream flow condition. Both the permit applicant and the regulatory authority must seek input from the Clean Water Act Authority for all new applications, and incorporate where applicable all CWA authority concerns and criteria.

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

In areas warranting enhanced permitting requirements, Alternative 7 would place the same new limitations and requirements on activities in or near streams as would Alternative 2 (see Activities in or near Streams section for Alternative 2). For all other operations, the requirements of the No Action Alternative (see Activities in or near Streams section for Alternative 1) would continue to apply.

Mining Through Streams

In areas warranting enhanced permitting requirements, this Alternative would place the same limitations and requirements on mining through streams as Alternative 2 (see Mining Through Streams section for Alternative 2). In these areas, Alternative 7 would allow mining through intermittent streams upon demonstration that: (1) the reclamation plan would result in restoration of both the physical form and the hydrologic and ecological function; (2) the extent of the mine-though would be minimized, and; (3) the bond includes separate calculations of the cost of restoration of both form and function. Also, the permittee would be required to reconstruct ephemeral streams (but not restore their ecological function) and to establish a 100-foot riparian corridor along the entire reach (including ephemeral) of any restored stream.

In all other areas outside those warranting the enhanced permitting conditions, the current requirements of the No Action Alternative (see Mining Through Streams section for Alternative 1) would continue to apply.

2.4.7.3 AOC and AOC Variances

Surface Configuration

In areas warranting enhanced permitting requirements, Alternative 7 would impose the same requirements as Alternative 2 (see Surface Configuration section for Alternative 2). In all other areas, the existing requirements of the No Action Alternative (see Surface Configuration section for Alternative 1) would continue to apply.

AOC Variances

Alternative 7 proposes no changes to the current regulations governing mountaintop removal mining operations and AOC variances for steep-slope mining operations. Requirements would be the same as they are under the No Action Alternative (see AOC Variances section for Alternative 1).

2.4.7.4 Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

In areas subject to the enhanced permitting requirements, requirements for revegetation, topsoil management and reforestation would be the same as under Alternative 2 (see Revegetation, Reforestation and Topsoil Management section for Alternative 2). In all other areas, the existing requirements of the No Action Alternative (see Revegetation, Reforestation and Topsoil Management section for Alternative 1) would continue to apply.

Fish and Wildlife Protection and Enhancement

Under Alternative 7, for areas subject to the enhanced permitting requirements, the regulatory authority may prohibit mining of areas where high value habitats are present. All other requirements for fish and wildlife protection and enhancement within these areas would be the same as Alternative 3 (see Fish and Wildlife Protection and Enhancement section for Alternative

3) except that under Alternative 7 the required riparian corridor width would be 100 feet versus 300 under Alternative 3.

2.4.8 Alternative 8 (Preferred)

This Alternative is primarily comprised of selected stream protection elements (as indicated below) of the other Action Alternatives analyzed.

2.4.8.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 2 (see Baseline Data Collection and Analysis section for Alternative 2), except that Alternative 8 (Preferred) requires discrete, rather than continuous measurements of streamflow and groundwater levels.

Monitoring During Mining and Reclamation

Under Alternative 8 (Preferred), all monitoring requirements are the same as under Alternative 2 (see Monitoring During Mining and Reclamation section for Alternative 2), with the exception of precipitation monitoring. In that case, the engineer would be required to conduct an inspection of the surface water runoff control system after each storm event with a two-year or greater recurrence-interval, rather than after each storm event with a one-year or greater recurrence interval as under Alternative 2. In addition, the regulatory authority would be required to review and evaluate monitoring data for trends only during the permit renewal process and when processing applications for significant permit revisions, not during midterm permit reviews.

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as Alternative 2 (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 2).

Corrective Action Thresholds

Same as Alternative 1, the No Action Alternative (see Corrective Action Thresholds section for Alternative 1).

2.4.8.2 Activities in or Near Streams

Stream Definitions

Alternative 8 (Preferred) would redefine "perennial stream" in a manner that is substantively identical to the manner in which the U.S. Army Corps of Engineers defines that term in Part F of the 2012 reissuance of the nationwide permits under section 404 of the Clean Water Act. See 77 FR 10184, 10288 (Feb. 21, 2012

<u>Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)</u>

Alternative 8 (Preferred) would prohibit mining activities in or through perennial and intermittent streams or on the surface of land within 100 feet of those streams unless the applicant makes certain demonstrations and the regulatory authority makes the corresponding findings listed below, that the proposed activity would not—

> (1) Preclude attainment or maintenance of any existing, reasonably foreseeable, or designated use under section 101(a) or 303(c) of the Clean Water Act, of the affected stream segment following the completion of mining and reclamation; (2) Result in conversion of the stream segment from intermittent to ephemeral, from perennial to intermittent, or from perennial to ephemeral;
>
> (3) Cause or contribute to a violation of federal, state, or tribal water quality standards; or
>
> (4) Cause material damage to the hydrologic balance outside the permit area.

These requirements apply to all mining activities except the construction of excess spoil fills and coal mine waste disposal facilities that cover perennial or intermittent streams. (Excess spoil fills and coal mine waste disposal facilities that extend into the buffer zone, but not the stream itself, are not exempt.)

In addition, the permittee must establish a 100-foot-wide or wider riparian corridor on each side of every perennial, intermittent, and ephemeral stream following the completion of mining activities. The corridor must be comprised of native species, including species with riparian characteristics. The permittee must plant native trees and shrubs in areas that are forested at the time of permit application or that would revert to forest under conditions of natural succession. This revegetation requirement does not apply to prime farmland historically used for cropland or to situations in which revegetation would be incompatible with an approved postmining land use that is implemented during the revegetation responsibility period before final bond release.

Alternative 8 (Preferred) would allow mining through any type of stream, provided that the applicant satisfactorily demonstrates to the regulatory authority all of the following with respect to perennial and intermittent streams:

> (1) There is no reasonable alternative that would avoid mining through or diverting the stream;
>
> (2) The operational design would minimize the extent of stream mined through or diverted; and
>
> (3) The hydrological form and ecological function of the affected stream segment could and would restored using the techniques in the proposed reclamation plan.

Alternative 8 (Preferred) would establish a different set of requirements for proposals to construct excess spoil fills and coal mine waste disposal facilities in perennial or intermittent streams. Specifically, the applicant must make the following demonstrations and the regulatory authority must make the following findings:

> (1) After evaluating all potential upland locations in the vicinity of the proposed operation, demonstrate that there is no practicable alternative that would avoid placement of excess spoil or coal mine waste in a perennial or intermittent stream;
>
> (2) The location and configuration selected for the proposed excess spoil fill or coal mine waste disposal facility represents the alternative with the least adverse impact on fish, wildlife, and related environmental values after evaluating all reasonable alternatives;
>
> (3) The fish and wildlife enhancement plan includes measures that would fully and permanently offset any long-term adverse impacts that the fill, refuse pile, or coal mine waste impoundment would have on fish, wildlife, and related environmental values within the footprint of the fill, refuse pile, or impoundment;
>
> (4) The excess spoil fill or coal mine waste disposal facility has been designed in a manner that will not cause or contribute to a violation of water quality standards or result in the formation of toxic mine drainage; and
>
> (5) The revegetation plan requires reforestation of the completed excess spoil fill if the land is forested at the time of application or if it would revert to forest under conditions of natural succession.

Alternative 8 (Preferred) would require the applicant to demonstrate that (1) the operation has been designed to minimize, to the extent possible, the volume of excess spoil that the operation would generate and (2) the designed maximum cumulative volume of all proposed excess spoil fills is no larger than the capacity needed to accommodate the anticipated cumulative volume of excess spoil that the operation would generate. Both requirements are intended to reduce the length of stream that the operation will cover.

In addition, this Alternative would prohibit construction of durable rock fills, which use end-dumping as a means of spoil placement and rely upon gravity segregation to form underdrains.

Under Alternative 8 (Preferred), the permittee must construct excess spoil fills in lifts not to exceed four feet in thickness. The use of end-dumping for final placement would be prohibited and the current regulation at 30 CFR 816.73 allowing construction of durable rock fills that rely upon end-dumping and the construction of underdrains by gravity segregation of the end-dumped material would be eliminated.

This Alternative would require daily monitoring during excess spoil placement. It would revise the existing rules to require that the quarterly inspection reports filed with the regulatory authority include the daily monitoring logs.

Alternative 8 (Preferred) would prohibit the construction of excess spoil fills with flat decks on the top surface. The final surface configuration must resemble the surrounding terrain. Alternative 8 (Preferred) would provide that, to the extent that stability considerations allow, excess spoil fills must be constructed with aquitards as a barrier to groundwater infiltration and to facilitate stream construction. Placement of a layer of lower-permeability spoil or other material near the surface but below the root zone for trees and shrubs could provide the subsurface flow needed to restore flow in intermittent and ephemeral stream segments.

Mining through Streams

Alternative 8 (Preferred) would allow mining through any type of stream (perennial, intermittent, or ephemeral) under the conditions described in the Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities) section for Alternative 8 above. The permittee must restore the hydrological form of all affected stream segments, as well as the ecological function of all affected perennial and intermittent stream segments. The performance bond must include an amount calculated as adequate to ensure fulfillment of that requirement under conditions of forfeiture. The regulatory authority must establish objective standards for determining when the ecological function of a restored or permanently diverted perennial or intermittent stream has been restored. In establishing these standards, the regulatory authority must use the premining baseline data for the biological condition of streams and must coordinate with the Clean Water Act permitting authority. The standards must, at a minimum, meet any existing Clean Water Act stream classification standards under section 101(a) or 303(c) of the Clean Water Act.

The postmining drainage pattern of perennial, intermittent, and ephemeral stream channels must be similar to the premining drainage pattern, unless the regulatory authority approves a different pattern to ensure stability, prevent or minimize downcutting of reconstructed stream channels, or promote enhancement of fish and wildlife habitat. Backfilling and fill construction techniques must include the selective placement of low-permeability materials in the backfill or fill and associated stream channels to create the aquitards necessary to support streamflow when the goal is to reestablish a perennial or intermittent stream, unless the applicant demonstrates the viability of an alternative method of restoring perennial or intermittent streamflow.

Designs for permanent stream-channel diversions, temporary stream-channel diversions that would remain in use for two or more years, and stream channels to be restored after the completion of mining must adhere to design techniques that would restore or approximate the premining characteristics of the original stream channel. These original characteristics would include the natural riparian vegetation and the natural hydrological characteristics of the original stream necessary to promote the recovery and enhancement of the aquatic habitat and to minimize adverse alteration of stream channels on and off the site, including channel deepening or enlargement. The designed hydraulic capacity of all temporary and permanent stream-channel diversions must be at least equal to the hydraulic capacity of the unmodified stream channel immediately upstream of the diversion and no greater than the hydraulic capacity of the unmodified stream channel immediately downstream from the diversion.

The permittee must establish a 100-foot-wide or wider riparian corridor on each side of every perennial, intermittent, and ephemeral stream following the completion of mining activities. The corridor must be comprised of native species, including species with riparian characteristics. Native trees and shrubs must be planted in areas that are forested at the time of permit application or that would revert to forest under conditions of natural succession. This revegetation requirement would not apply to prime farmland historically used for cropland or to situations in which revegetation would be incompatible with an approved postmining land use that is implemented during the revegetation responsibility period before final bond release.

2.4.8.3 AOC and AOC Variances

Surface Configuration

Same as Alternative 1, the No Action Alternative, with minor revisions to the definition of AOC to clarify its meaning, reflect state program amendment actions, and address implementation issues. Alternative 8 (Preferred) also requires that the postmining drainage pattern of perennial, intermittent, and ephemeral stream channels be similar to the premining drainage pattern, unless the regulatory authority approves a different pattern to ensure stability, prevent or minimize downcutting of reconstructed stream channels, or promote enhancement of fish and wildlife habitat.

AOC Variances

Alternative 8 (Preferred) would allow mountaintop removal mining operations and AOC variances for steep-slope mining operations under conditions generally similar to those in Alternative 1, the No Action Alternative. However, Alternative 8 (Preferred) would impose additional requirements to better protect streams, aquatic ecology, and biological communities. In addition, it would require that the permittee post bond in an amount sufficient to return the site to AOC if the approved postmining land use were not implemented before expiration of the revegetation responsibility period.

For approval of mountaintop removal mining operations, Alternative 8 (Preferred) would require the permit applicant to demonstrate that no damage would result to natural watercourses within the watershed(s) of the proposed permit and adjacent areas. The applicant can meet this requirement by making all of the following demonstrations:

- There would be no adverse changes in parameters of concern in discharges to surface water and groundwater;
- No change would occur in the size or frequency of peak flows as compared to the peak flows that would occur if the permittee mined the site and restored it to AOC; and
- The total volume of flow during any season of the year would not vary; i.e., the seasonal flow regime would not change and there would be no increase in potential damage from flooding.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application, unless reforestation would be inconsistent with the postmining land use.

Finally, the permittee must install drains through the outcrop barrier to prevent saturation of the backfill.

For approval of steep-slope variances, Alternative 8 (Preferred) would require permit applicants to demonstrate that all of the following criteria are met:

- The operation, including any fish and wildlife enhancement measures, will result in fewer adverse impacts to the aquatic ecology of the cumulative impact area than would occur if the site were mined and restored to AOC;
- Surface-water flow in the watershed would be improved over both premining conditions and conditions that would exist if the area were mined and restored to AOC;
- The variance would not result in construction of an excess spoil fill in an intermittent or perennial stream; and
- Any deviations from the premining surface configuration are necessary and appropriate to achieve the postmining land use.

In addition, the permittee must reforest the site with native species if the site was forested before submission of the permit application or would revert to forest under natural succession. This requirement would not apply to permanent impoundments, roads, and other impervious surfaces to be retained following mining and reclamation or to those portions of the permit area covered by the variance.

2.4.8.4 Revegetation, Soils, Fish and Wildlife Protection and Enhancement

Revegetation, Reforestation and Topsoil Management

Same as Alternative 3 (see Revegetation, Reforestation and Topsoil Management section for Alternative 3), except that Alternative 8 (Preferred) would prohibit both burning and burial of debris from native vegetation. Under this Alternative the operator would use such materials (not otherwise used in the reclamation plan) to construct fish and wildlife enhancement features.

Fish and Wildlife Protection and Enhancement

Alternative 8 (Preferred) is similar to the No Action Alternative with respect to the protection of threatened and endangered species. However, Alternative 8 (Preferred) would codify the dispute resolution provisions of the 1996 biological opinion concerning protection of threatened and endangered species. It also would expressly require that the fish and wildlife protection and enhancement plan in the permit application include any species-specific protection and enhancement plans developed in accordance with the Endangered Species Act and any biological opinions implementing that law.

Alternative 8 (Preferred) is similar to the No Action Alternative with respect to the fish and wildlife resource information and protection and enhancement plan required in the permit application. It also includes similar performance standards for protection of fish and wildlife. However, Alternative 8 (Preferred) requires that the permittee establish permanent riparian corridors at least 100 feet wide, comprised of native, non-invasive species, along the banks of restored or diverted ephemeral, intermittent or perennial stream channels. The permittee must use appropriate species of woody plants if the land would naturally revert to forest under natural succession.

In addition, fish and wildlife enhancement measures would be mandatory whenever the proposed operation would result in the long-term loss of native forest, loss of other native plant communities, or filling of a segment of an intermittent stream. The enhancement measures must be commensurate with the long-term adverse impact to the affected resources and they must be located in the same watershed as the proposed operation (or the nearest appropriate adjacent watershed if there are no opportunities for enhancement within the same watershed). Enhanced areas must be included within the permit area.

Finally, Alternative 8 (Preferred) would allow the regulatory authority to prohibit mining of high-value habitats within the proposed permit area.

2.4.9 Alternative 9 –2008 Stream Buffer Zone Rule

Alternative 9 is identical to the 2008 SBZ rule, which was vacated by court order on February 20, 2014. See 79 FR 76227-76233 (Dec. 22, 2014).

2.4.9.1 Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Same as Alternative 1, the No Action Alternative (see Baseline Data Collection and Analysis section for Alternative 1).

Monitoring During Mining and Reclamation

Same as Alternative 1, the No Action Alternative (see Monitoring During Mining and Reclamation section for Alternative 1).

Definition of Material Damage to the Hydrologic Balance Outside the Permit Area

Same as Alternative 1, the No Action Alternative (see Definition of Material Damage to the Hydrologic Balance Outside the Permit Area section for Alternative 1).

Corrective Action Thresholds

Same as Alternative 1, the No Action Alternative (see Corrective Action Thresholds section for Alternative 1).

2.4.9.2 Activities in or Near Streams

Stream Definitions

Same as Alternative 1, the No Action Alternative (see Stream Definitions section for Alternative 1).

Activities in or near Streams (Including Excess Spoil Fills and Coal Mine Waste Disposal Facilities)

The requirements in Alternative 9 differ depending upon whether the surface mining activities would occur in perennial or intermittent streams or whether they would be limited to the buffer zone for those streams (the surface of land within 100 feet, measured horizontally, of the stream). Under this Alternative, diversions of perennial and intermittent streams would be governed by a separate set of requirements. Also, as in Alternative 1, the No Action Alternative, coal preparation plants located outside the permit area of a mine would not be subject to these requirements.

Before approving any surface mining activities in a perennial or intermittent stream (other than a diversion of that stream), the regulatory authority must find in writing that avoiding disturbance of the stream is not reasonably possible. The permit also must include a condition requiring a demonstration of compliance with the Clean Water Act before the permittee may conduct any activities in a perennial or intermittent stream that require authorization or certification under the Clean Water Act.

Before approving any surface mining activities on the surface of land within 100 feet of a perennial or intermittent stream in situations where the activities would not take place in the stream segment itself, the SMCRA regulatory authority must find in writing that (1) avoiding disturbance of the surface of land within 100 feet of the stream either is not reasonably possible or is not necessary to meet the fish and wildlife and hydrologic balance protection requirements of the regulatory program and (2) that the measures proposed in the permit application constitute the best technology currently available to prevent the contribution of additional suspended solids to streamflow or runoff outside the permit area to the extent possible, and that the proposed measures would minimize disturbances and adverse impacts on fish, wildlife, and related environmental values to the extent possible There would be no requirement for the regulatory authority to make a separate finding approving activities such as disposal of excess spoil, coal mine waste, or construction of stream crossings or sediment ponds within the buffer zone for these stream segments.

However, the operation must be designed to avoid placement of excess spoil or coal mine waste in or within 100 feet of a perennial or intermittent stream to the extent possible. If avoidance is not reasonably possible then the applicant must identify a reasonable range of alternatives and select the alternative with the least overall adverse impact on fish, wildlife, and related environmental values, including adverse impacts on water quality and aquatic and terrestrial ecosystems. However, an alternative with a cost substantially greater than the costs normally associated with this type of project need not be considered.

In addition, for excess spoil, the applicant must provide a demonstration that (1) the operation has been designed to minimize, to the extent possible, the volume of excess spoil that the operation would generate and (2) the designed maximum cumulative volume of all proposed excess spoil fills is no larger than the capacity needed to accommodate the anticipated cumulative volume of excess spoil that the operation would generate.

Excess spoil fill construction requirements are similar to those in Alternative 1, the No Action Alternative. Durable rock fills may be constructed by end-dumping and formation of underdrains by gravity segregation. Flat decks on the top surface of excess spoil fills are allowed. Inspections conducted at least quarterly and during critical stages of fill construction must be certified by a registered professional engineer. The permittee must submit to the regulatory authority an inspection report after every inspection specifying that the fill has been constructed and maintained as approved.

Mining through Streams

Under Alternative 9, the regulatory authority may approve the diversion of perennial or intermittent streams within the permit area if the diversion is located and designed to minimize adverse impacts on fish, wildlife, and related environmental values to the extent possible, using the best technology currently available.

Design and construction requirements for a permanent stream-channel diversion or a stream channel restored after the completion of mining are similar to those in Alternative 1, the No Action Alternative. The exception is that Alternative 9 would require the use of natural-channel design techniques to minimize adverse alteration of stream channels on and off the site, including channel deepening or enlargement, to the extent possible.

2.4.9.3 AOC and AOC Variances

Same as Alternative 1, the No Action Alternative (see 2.4.1.3 – AOC and AOC Variances for Alternative 1).

Surface Configuration

Same as Alternative 1, the No Action Alternative.

AOC Variances

Same as Alternative 1, the No Action Alternative.

2.4.9.4 Revegetation, Soils, Fish and Wildlife Protection and Enhancement

Same as Alternative 1, the No Action Alternative (see Fish and Wildlife Protection and Enhancement section for Alternative 1).

Revegetation, Reforestation and Topsoil Management

Same as Alternative 1, the No Action Alternative.

Fish and Wildlife Protection and Enhancement

Same as Alternative 1, the No Action Alternative.

2.5 ALTERNATIVE COMPARISON DISCUSSION

The following comparisons of the nine Alternatives represent the major similarities and differences between each of the Alternatives.

2.5.1 Protection of the Hydrologic Balance Functional Group

2.5.1.1 Baseline Data Collection and Analysis

Biological Conditions

- The No Action Alternative (also Alternative 9) -- No requirement for baseline biological assessment;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Baseline biological conditions assessment required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.1.2 Hydrologic Conditions

Water Quality

- The No Action Alternative (also Alternative 9) -- Limited water-quality sampling points and analytical constituents. At a minimum, the analytical suite for surface water and groundwater consists of the following: temperature, total suspended solids (only surface water), pH, specific conductance, total dissolved solids (TDS), total iron, and total manganese;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Baseline water-quality data are required on all intermittent and perennial streams and a representative number of ephemeral streams. Twelve evenly spaced samples are required from a consecutive 12-month period. The analytical suite for surface water and groundwater consists of the following: temperature, total suspended solids (only surface water), aluminum, bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium, (hot) acidity, alkalinity, pH, selenium, specific conductance, TDS, total iron, arsenic, zinc, copper, cadmium, ammonia, nitrogen, and total manganese; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.1.3 Surface Water Flow and Groundwater Levels

- The No Action Alternative (also Alternatives 3, 5, 8 (Preferred) and 9) -- Discrete stream flow and groundwater levels measurements required. Twelve evenly spaced samples required over a consecutive 12-month period;
- Alternative 2 (also 4 and 6) -- Continuous stream flow and groundwater levels measurements required; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.1.4 Rainfall Measurements

- The No Action Alternative (also Alternative 9) -- No onsite rainfall measurements required;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Continuous on-site rainfall measurement requirements; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.1.5 Stream Hydrologic Form and Ecological Function

- The No Action Alternative (also Alternative 9) -- No documentation required of stream hydrologic form and ecological function;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) --Documentation of stream hydrologic form and ecological function required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.2 Monitoring During Mining and Reclamation

2.5.2.1 Biological Monitoring

- The No Action Alternative (also Alternative 9) -- No requirements for monitoring of biological condition;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) --Annual monitoring of biological condition required; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.2.2 Water-Quality Monitoring

- The No Action Alternative (also Alternative 9) -- Monitoring for limited suite of analytes [temperature, total suspended solids (only surface water), pH, specific conductance, TDS, total iron, and total manganese] and the RA can release operator from monitoring before bond release;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Quarterly monitoring until final bond release (assuming no adverse trends in data which would lead to material damage to the hydrologic balance requirement) consisting of the same suite of analytes sampled for during baseline data collection; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.2.3 Rainfall Measurements

- The No Action Alternative (also Alternative 9) -- No requirement for on-site rainfall measurements;
- Alternative 2 (also 3, 4, 5, 6, and 8 (Preferred)) -- Continuous on-site rainfall measurements required; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.2.4 Runoff Control Structures

- The No Action Alternative (also Alternative 9) -- Certification of drainage control structures not required;
- Alternative 2 (also 6) -- Inspect and certify surface runoff control structures by a professional engineer after every one-year return interval precipitation event;
- Alternative 3 (also 4, 5 and 8 (Preferred)) -- Inspect and certify surface runoff control structures by a professional engineer after every two-year return interval precipitation event; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.2.5 RA Hydrologic Data Review

- The No Action Alternative (also Alternative 9) -- No regularly scheduled hydrologic review required;

- Alternative 2 (also 3, 4, 5, and 6) -- RA review of monitoring data at permit mid-term review and permit renewal;
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and
- Alternative 8 (Preferred) – RA review of monitoring data at permit renewal or significant revision.

2.5.2.6 Definition of Material Damage to the Hydrologic Balance

- The No Action Alternative (also Alternatives 5, 6, 7 and 9) -- No national definition for material damage to the hydrologic balance. RA discretion to determine material damage to the hydrologic balance criteria on case-by-case basis; and
- Alternative 2 (also 3, 4 and 8 (Preferred)) -- Material damage to the hydrologic balance defined as any quantifiable adverse impact on the quality or quantity of surface water or groundwater or on the biological condition of intermittent and perennial streams that would preclude attainment or continuance of any designated surface-water use under sections 101(a) and 303(c) of the Clean Water Act or any existing or reasonably foreseeable use of surface water or groundwater outside the permit area. Includes areas overlying the underground workings of underground mines.

2.5.2.7 Corrective Action Thresholds

- The No Action Alternative (also Alternatives 5, 6, 8 (Preferred) and 9) -- No corrective action thresholds;
- Alternative 2 (also 3 and 4) -- RA to develop correction action thresholds that are less than the material damage to the hydrologic balance standards; and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.3 Activities In or Near Streams Functional Group

2.5.3.1 Stream Definitions

- The No Action Alternative (also Alternatives 3, 5, 6 and 9) -- No change in ephemeral, intermittent, and perennial stream definitions;
- Alternative 2 -- The definitions of intermittent, ephemeral, and perennial would be functionally replaced; all waterways defined as Waters of the U.S. under the CWA would be protected under this alternative;

- Alternative 4 -- Streams defined based on flow and physical characteristics;
- Alternative 7 -- Existing definitions are not changed except that watershed size is not used as criteria to define intermittent streams; requires coordination with CWA authority; and
- Alternative 8 (Preferred) -- Stream definitions would match the U.S. Army Corps of Engineers definitions.

2.5.3.2 Activities in or near Streams, including Excess Spoil and Coal Refuse

- The No Action Alternative -- Prohibits mining activities through or within 100 feet of intermittent or perennial streams unless it can be demonstrated that the activity would not cause or contribute to the violation of applicable state or federal water quality standards and would not adversely affect the water quantity and quality or other environmental resources of the stream;
- Alternative 2 -- Prohibits surface mining activities in or within 100 feet of perennial streams. Prohibit surface mining activities in or within 100 feet of intermittent streams unless the applicant demonstrates that the activity would not: (1) preclude premining stream uses; (2) have more than a minimal adverse impact on the premining biological condition of the stream segment; or (3) cause material damage to the hydrologic balance outside the permit area. Requires a 100 foot forested riparian corridor for previously forested areas (or other native species for non-forested areas) adjacent to ephemeral or intermittent streams;
- Alternative 2 also prohibits placement of excess spoil within 100 feet of an intermittent stream (excess spoil placement is allowed in or near ephemeral streams). Under Alternative 2 disposal of coal mine waste in or within 100 feet of an intermittent or ephemeral stream is allowed;
- Alternative 3 (also 4 and 5) -- Prohibits surface mining activities in or within 100 feet of intermittent and perennial streams unless the applicant demonstrates that the activity would not: (1) preclude premining stream uses; (2) have more than a minimal adverse impact on the premining biological condition of the stream segment; or (3) cause material damage to the hydrologic balance outside the permit area;
- Alternative 6 (also 8 (Preferred)) --Prohibits mining activities within 100 feet of intermittent or perennial streams unless it can be demonstrated that: (1) the ecological function of the stream would be protected or restored; (2) placement of excess spoil fill or coal mine waste would not result in a discharge of “toxic mine drainage” and long-term adverse impacts to the environmental resources of the stream (within the footprint of the fill) would be offset in the same or adjacent watershed through fish and wildlife enhancement commensurate with the potential direct adverse impact to the stream; (3) other proposed mining activities within the stream buffer, but not within the stream itself would not adversely affect the water quantity and quality or other environmental

resources of the stream; (4) a 100-foot riparian corridor would be required along the entire reach (including ephemeral streams) of any restored stream;

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and
- Alternative 9 --Prohibits mining activities (other than construction of stream-channel diversions) within a perennial or intermittent stream unless the regulatory authority finds that avoiding disturbance of the stream is not reasonably possible.

Additionally,

- The No Action Alternative – Excess spoil minimization not expressly required by regulation;
- Alternative 2 (also 3, 4, 5, 6, 8 (Preferred) and 9) --The applicant must demonstrate that (1) the operation has been designed to minimize, to the extent possible, the volume of excess spoil that the operation would generate and (2) the designed maximum cumulative volume of all proposed excess spoil fills would be no larger than the capacity needed to accommodate the anticipated cumulative volume of excess spoil that the operation would generate; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

And also,

- The No Action Alternative (also 9) -- Durable rock fills may be constructed by end-dumping. Placement in streams is not expressly prohibited if all other applicable requirements are met;
- Alternative 2 (also 3, 4, 5, 6 and 8 (Preferred)) --The practice of “end-dumping” or creating a “durable rock fill” of fill material into streams is prohibited wherever a specific Alternative is applicable. In addition, daily monitoring and maintenance of daily log is required during fill construction; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.3.3 Mining Through Streams

- The No Action Alternative -- Allows diversion of intermittent and perennial streams upon RA finding that the diversion would not adversely affect the water quantity and quality and related environmental resources of the stream;
- Alternative 2 (also 4) -- No mining activities allowed in or within 100 feet of a perennial stream. Mining allowed through all intermittent streams upon demonstration by the applicant that the reclamation plan would achieve complete restoration of the hydrologic

form and ecological function of all perennial and intermittent streams in accordance with standards established by CWA permitting authority and baseline conditions; additional performance bond required for stream restoration. All ephemeral streams must be restored in form;

- Alternative 3 (also 5, and 6) -- Mining allowed through all streams upon demonstration by the applicant that the reclamation plan would achieve complete restoration of the hydrologic form and ecological function of all perennial and intermittent streams in accordance with standards established by CWA permitting authority and baseline conditions; additional performance bond required for stream restoration. Ephemeral streams restored in form to the extent required by geomorphic reclamation;
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative;
- Alternative 8 (Preferred) -- Requires restoration of both the hydrologic form and ecological function of intermittent and perennial streams. Also requires restoration of the hydrologic form of ephemeral streams but not using geomorphic reclamation ; and
- Alternative 9 -- Requires that restored stream channels for perennial and intermittent streams be designed and constructed using natural channel design techniques to restore or approximate the premining characteristics of the original stream channel.

2.5.4 AOC and AOC Variances Functional Group

2.5.4.1 AOC Variances

<u>Mountaintop Removal Mining Operations</u>

- The No Action Alternative (also 6, 7 and 9) – Achieve or support beneficial postmining land use; demonstrate equal or better land use. Assure investment in public facilities, and documentation of private financial capability to ensure completion. Requires demonstration that natural watercourses below lowest coal seam to be mined would not be damaged;
- Alternative 2 -- Prohibits all mountaintop removal mining operations (could require SMCRA amendment); and
- Alternative 3 (also 4, 5 and 8 (Preferred)) –Achieve or support beneficial postmining land use; demonstrate equal or better use. Requires implementation of the approved postmining land use prior to final bond release. Sufficient bond must be posted to ensure that, if the proposed postmining land use is not implemented, lands subject to the variance could be returned to approximate original contour. Requires assurance of investment in public facilities, and documentation of private financial capability to ensure completion. Requires demonstration that (1) no increase would occur in parameters of concern in discharges to surface or groundwater; (2) no change would occur in size or

frequency of peak flow as compared to what would occur if the operator returned the site to approximate original contour; and (3) the total volume of flow during any season of the year would not vary (flooding potential cannot be altered). Requires demonstration that natural watercourses within the proposed permit and adjacent areas would not be damaged. If site was forested before permit application, then must return to forest and revegetate using native species except where inconsistent with the postmining land use.

AOC Variances for Steep-Slope Operations

- The No Action Alternative (also Alternatives 6, 7 and 9) -- Achieve/support beneficial postmining land use; demonstrate equal or better land use. Demonstrate that surface water flow in the watershed would be improved over premining conditions ***or*** conditions what would have existed had the area been returned to AOC. Total suspended solids or pollutants to surface and ground water must be reduced in a manner that improves existing uses or ecology, ***or*** that reduces flood hazards due to reduced peak flow. Total flow volume in every season must not vary so as to adversely affect ecology of surface water or existing or planned use of surface or ground water;

- Alternative 2 -- Prohibits all variances from requirement to return the mined area to its AOC (could require SMCRA amendment); and

- Alternative 3 (also 4, 5 and 8 (Preferred)) -- Must demonstrate that surface water flow in the watershed would be improved over premining conditions ***and*** conditions that would have existed had the areas been returned to AOC. Must demonstrate that the AOC variance would result in fewer impacts to aquatic ecology for the cumulative impact area than would occur if the site were returned to AOC. The AOC variance cannot result in any placement of excess spoil in an intermittent or perennial stream. The applicant must demonstrate that the proposed deviations from AOC are necessary and appropriate to achieve the postmining land use. The operator must post additional bond sufficient to ensure that, if the proposed postmining land use is not implemented, lands subject to the variance would be returned to AOC. If site was forested before permit application, then must return to forest and revegetate using native species except where inconsistent with the postmining land use.

2.5.5 Surface Configuration and Fills

2.5.5.1 Definition of AOC

- The No Action Alternative (also Alternatives 6, 8 (Preferred) and 9) -- Definition of AOC would not change, includes backfilling and restoring disturbed areas to *closely resemble* premining topography;

- Alternative 2 (also 3, 4, and 5) -- Definition of AOC same as the No Action Alternative with the additional requirement that surface configuration achieved by backfilling and grading of the mined area be documented by landform measurements and analyses conducted before, during, and after mining and reclamation; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.5.2 Digital Terrain Analysis

- The No Action Alternative (also Alternatives 6, 8 (Preferred) and 9)-- Digital terrain analysis not required, requires mine plans to address postmining land use but introduces no new specific requirements;

- Alternative 2 (also 3, 4, and 5)-- Requires use of digital terrain models during premining and backfilling to confirm premining topography, and adherence to the reclamation plan for backfilling except that remining sites and contiguous permits 40 acres or less are exempt; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.5.3 Permanent Impoundments and Final Elevations

- The No Action Alternative (also Alternative 3, 6, 8 (Preferred) and 9) -- No limits placed on final elevations. Still allows permanent impoundments, including final-cut impoundments provided they do not conflict with achieving AOC and they meet the postmining land use requirements. No requirements to use landforming principles during reclamation. Backfilling requirements are not applicable to thin overburden;

- Alternative 2 (also 4) -- Allowable deviation in the elevation of the backfilled and graded area postmining in comparison to the premining elevation based on the lowest coal seam mined. The allowable deviation in the postmining elevation could be no more than ±20 percent of the difference between the premining surface elevation and the premining bottom elevation of that lowest coal seam, with allowances for slope stability and minor shifts in the location of premining features. Allows exceedance of 20 percent tolerance to minimize excess spoil generation. In addition, tolerance requirement does not apply to that portion of the permit where steep-slope contour mining is conducted. Requires use of landforming principles (geomorphic reclamation). Still allows permanent impoundments, including final-cut impoundments provided they do not conflict with achieving AOC and they meet the postmining land use requirements;

- Alternative 5 – Same as the No Action Alternative except that it requires return of as much as spoil material to the mined area as possible (including transport of spoil above the original contour), and that it prohibits flat decks on excess spoil fills and coal refuse facilities; and

- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements (other than steep slope conditions) apply, otherwise same as the No Action Alternative. This Alternative does not require compliance with the ±20 percent tolerance because stability and equipment constraints make it impracticable to impose this requirement on contour mining on steep slopes (defined as slopes greater than 20 degrees).

2.5.6 Revegetation, Topsoil, and Fish and Wildlife Functional Group

2.5.6.1 Revegetation

- The No Action Alternative (also Alternatives 6 and 9) -- Vegetative cover in accordance with the approved permit and reclamation plan, comprised of species native to the area, or of introduced species where desirable and necessary to achieve the approved postmining land use;
- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires that all reclaimed lands be revegetated with native species unless the postmining land use is actually implemented before the end of the revegetation responsibility period; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.6.2 Topsoil management

- The No Action Alternative (also Alternatives 6 and 9) -- Requires salvage and redistribution of all topsoil (A and E soil horizons) or the top 6 inches of soil material if less than that thickness of topsoil is present. Salvage and redistribution of the B and C soil horizons is at the discretion of the regulatory authority (except on prime farmland, where it is mandatory). Selected overburden materials may be substituted for, or used as a supplement to topsoil if the operator demonstrates to the regulatory authority that: (1) the resulting soil medium is equal to, or more suitable for sustaining vegetation than, the existing topsoil; and (2) the resulting soil medium is the best available in the permit area to support revegetation;
- Alternatives 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires salvage and redistribution of all topsoil (A and E soil horizons). Also requires salvage and redistribution of the B and C soil horizons (or other suitable overburden materials) to the extent necessary to achieve a growing medium with the optimal rooting depths required to restore premining land use capability or comply with revegetation requirements. Allows use of selected overburden materials as substitutes for (or supplements to) either topsoil or subsoil or both if the operator demonstrates that either (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed. The operator also must demonstrate that the resulting soil medium would be as or more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soils in a manner

that limits compaction, and provides optimal rooting depth to support the approved plan for revegetation and reforestation; and

- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.6.3 Salvage and Redistribution of Organic Materials

- The No Action Alternative (also Alternatives 6 and 9) -- Does not require salvage and redistribution or reuse of organic materials (duff, other organic litter, and vegetative materials such as tree tops, small logs and root balls) above the A soil horizon;
- Alternative 2 (also 4) -- Requires salvage and redistribution or reuse of ***all*** vegetative organic materials above the A soil horizon to promote reestablishment of locally adapted and genetically diverse native vegetation and soil flora and fauna and to enhance fish and wildlife habitats. Prohibits burning or burying of vegetation or other organic materials;
- Alternatives 3 (also 5) -- Requires salvage and redistribution of materials from native vegetation only (not from all vegetation) above the A soil horizon rootballsin accordance with an approved plan developed by a qualified ecologist or similar expert who would determine the amounts needed to promote reestablishment of native vegetation and soil flora and fauna. Prohibits burning of above ground debris from native vegetation. Organic materials not needed for the approved plan may be used to construct fish and wildlife enhancement features;
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative; and
- Alternative 8 (Preferred) – Same as Alternative 3 except that it also prohibits burial of above ground native vegetation in addition to burning. Organic materials not needed for the approved plan may be used to construct fish and wildlife enhancement features.

2.5.6.4 Reforestation

- The No Action Alternative (also Alternatives 6 and 9) -- Lands that have returned to forest through natural succession classified as "undeveloped" are not required to be reforested;
- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Requires reforestation of previously forested areas and of lands that would revert to forest under conditions of natural succession (a prime farmland exception exists) in a manner that would enhance recovery of the native forest ecosystem as expeditiously as possible; and
- Alternative 7 -- Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.5.6.5 Fish and Wildlife Protection and Enhancement

Enhancement of Fish and Wildlife

- The No Action Alternative (also Alternative 9) -- Achieve enhancement of fish and wildlife resources where practicable. Surface mining activities must enhance where practicable, or restore, habitats of unusually high value for fish and wildlife;

- Alternative 2--Enhancement required if mitigation required pursuant to the CWA. CWA mitigation incorporated as a condition of the SMCRA permit. Bond release on the SMCRA permit would be conditioned on successful mitigation as determined by the regulatory authority and the agency implementing the CWA. This option may require an amendment of SMCRA;

- Alternative 3 (also 4, 5, and 6) -- Enhancement measures would be mandatory whenever the proposed operation would result in the long-term loss of native forest, loss of other native plant communities, or filling of a segment of a perennial or intermittent stream (but not ephemeral streams). Resource enhancement must be: (1) commensurate with long-term adverse impact to affected resources; and (2) be located in the same or nearest adjacent watershed as the proposed operation if there are no opportunities for enhancement within the same watershed, and be on permitted area. Mining of certain areas where high value habitats are present may be prohibited by RA;

- Alternative 8 (Preferred) -- Enhancement measures would be mandatory whenever the proposed operation would result in the filling of a segment of a perennial or intermittent stream (but not ephemeral streams). Resource enhancement must be: (1) commensurate with the long-term adverse impacts to the stream; and (2) be located in the same or nearest adjacent watershed as the proposed operation if there are no opportunities for enhancement within the same watershed, and be on permitted area; and

- Alternative 7 – Same as Alternative 3 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

Endangered and Threatened Species Protection

- The No Action Alternative (also Alternatives 6 and 9) -- No surface mining activity can be conducted which is likely to jeopardize the continued existence of endangered or threatened species listed by the Secretary or which is likely to result in the destruction or adverse modification of designated critical habitat of such species in violation of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.)*;

- Alternative 2 (also 3, 4, 5 and 8 (Preferred)) -- Same as Alternatives 1 and 6, in addition would (1) codify the dispute resolution provisions of the biological opinion concerning protection of threatened and endangered species and (2) add a provision to the regulations expressly requiring that the fish and wildlife protection and enhancement plan in the permit application include any species-specific protection and enhancement plans developed in accordance with the Endangered Species Act and any biological opinions implementing that law; and

- Alternative 7 – Same as Alternative 2 where enhanced permitting conditions apply, otherwise same as the No Action Alternative.

Riparian Corridors

- The No Action Alternative (also Alternative 9) -- The operator must avoid disturbances to, enhance where practicable, restore, or replace, wetlands, and riparian vegetation along rivers and streams and bordering ponds and lakes;
- Alternative 2 (also 5, 6 and 8 (Preferred)) -- Requires creation of a 100-foot riparian corridor, comprised of native non-invasive species, to enhance restoration of the ecological function of ephemeral, intermittent, or perennial streams. The riparian corridor must be established along the entire reach of any stream restored or permanently diverted;
- Alternative 3 (also 4) -- Requires establishment of a 300-foot riparian corridor comprised of native woody species along restored or permanently diverted intermittent and perennial streams, if the land would naturally revert to forest under natural succession (not required if this would conflict with the approved postmining land use); and
- Alternative 7 – Same as Alternative 2 when enhanced permitting requirements apply, otherwise same as the No Action Alternative.

2.6 ALTERNATIVES AND ELEMENTS CONSIDERED BUT DISMISSED

The discussion below summarizes Alternatives and elements that OSMRE considered but did not ultimately carry forward for analysis. As part of the development of this DEIS, OSMRE used a mine plan analysis of 13 model mines representative of all seven coal-producing regions to model the effects of the Alternatives and elements, and based on this analysis determined that the following Alternatives were not reasonable to carry forward. The text below describes the findings on two Alternatives that OSMRE considered but ultimately dismissed from further analysis. The text also describes an element that OSMRE considered including within the Alternatives. OSMRE modified this element from its original form and included it within the Alternatives carried forward; this section describes the reasons behind the modification.

2.6.1 Alternative - Absolutely prohibit all surface coal mining and reclamation activities, including fill placement and coal mine waste, in or within 100 feet of all streams, including ephemeral.

OSMRE preliminarily analyzed, but chose not to carry through, an Alternative that would prohibit all mining and reclamation activities within all streams (ephemeral, intermittent and perennial) and within a 100-foot buffer zone around those streams. The prohibited activities would include the disposal of excess spoil and coal mine waste as well mining through the stream.

According to the model mine analysis, implementation of this Alternative would significantly reduce production nationwide. In 2010, U.S. Energy Information Administration data showed that surface mining methods produced almost 69 percent of coal production in the United States. Table 2.6-1 shows, using modeled surface mines, the impact on coal resource recovery from surface mines under this Alternative. The analysis indicated that this Alternative would result in a net loss of access to 86 percent of mineable surface coal reserves (based on tonnage) in five regions.

Table 2.6-1
Comparison of Recoverable Coal Resources for the No Action Alternative and Alternative Prohibiting Mine Activity In or Within 100 Feet of all Streams

	Tons of Surface Mineable Coal (millions)[1]	Tons of Surface Mineable Coal (millions)[1]	Mineable Acreage	Mineable Acreage	Millions of Tons of Reserves Stranded	Percent Reserves Stranded (based on tons of mineable coal)
Coal Region	**No Action Alternative**	**Alternative w/ No Activity in Stream**	**No Action Alternative**	**Alternative w/ No Activity in Stream**	**Alternative w/ No Activity in Stream**	**Alternative w/ No Activity in Stream**
Central Appalachia (Area)	37	**19**	1260	**758**	**18**	**49%**
Central Appalachia (Contour)	5	**4.4**	458	**324**	**0.6**	**12%**
Northern Appalachia	1.6	**1.6**	205	**201**	**0**	**0%**
Colorado Plateau	92.2	**0**	3311	**3,311**	**92.2**	**100%**
Gulf Coast	40.7	**17**	1988	**804**	**23.7**	**58%**
Illinois Basin	12	**0**	1067	**1,067**	**12**	**100%**
Northern Rocky Mountains and Great Plains	1,000	**123**	6049	**710**	**877**	**88%**
U.S. Total	1,188.5	**165**	14,338	**7,175**	**1,023.5**	

[1]Assumes off-site excess spoil disposal is available if needed.

The prohibition against mining activities within the buffer would leave large quantities of coal stranded, i.e. un-mineable. Coal within the buffer would not be accessible for mining, and the mining would leave some coal stranded in inaccessible pockets between intersecting buffer zones.

High stream densities would strand additional coal in other areas. Providing buffers around all streams in areas with high stream densities would create a situation where the remaining suitable area for mining would be too small to support an economic return. This is the case, for example, in extensive areas of the Colorado Plateau, Illinois Basin and Gulf Coast mining areas. In other areas the modeling showed that mineable area would still occur but the buffer would significantly reduce both mineable area and coal production. In the Northern Rocky Mountains and Great Plains regions, prohibition of mining activities in the buffer zone would leave only about 12 percent of the mineable reserves available for mining.

The analysis of impacts from this Alternative assumed that adequate disposal for excess spoil and coal waste material would be available and economically obtainable off-site. Without this assumption, the prohibition against disposal of excess spoil in or within 100 feet of streams would have created additional impacts on coal production. Coal outside the buffer would be un-mineable in situations where the site topography left insufficient space for placement of spoil other than within the buffer zone. For example, due to the topography of Central Appalachia the availability of area not within 100 feet of either side of a stream is extremely limited and would likely be insufficient to accept the amount of materials produced from mining outside the buffer.

The potential impact to underground mining operations in regions with steeper topography or higher stream densities from a prohibition on coal mine waste disposal in streams was not analyzed but would be considerable. Since disposal facilities typically place coal waste in stream buffer zones, in particular the fine coal waste disposed in slurry impoundments, the expected consequence would be a reduction in underground coal production in these regions.

The results of the preliminary analysis indicated that implementation of this Alternative would result in a significant reduction in coal recovery in five of the seven coal-producing regions. OSMRE determined that the impacts to coal production from this Alternative were so substantial that they ran counter to the mandate under SMCRA 102(f) to balance the need for energy with the protection of the environment. While the prohibition would provide maximum protection for streams, it would result in an unacceptable impact on the nation's energy production via coal. For this reason, OSMRE determined that this Alternative did not fall within the range of reasonable Alternatives, and dismissed this Alternative from further consideration.

2.6.2 Alternative - Prohibit further mining activities in watersheds with 10 percent or more land area impacted by coal mining.

Under this Alternative, the ability to obtain a mining permit would be dependent on the extent of current and past mining within the watershed encompassing the proposed permit area. The regulatory authority would no longer issue permits for surface coal mining activities once 10 percent or more of the acreage within a Hydrologic Unit Code (HUC)-12[4] watershed had been impacted by coal mining either historic or ongoing (acreage on successfully reclaimed sites would also count). No exemptions would apply. OSMRE selected the 10 percent threshold based on a recent study that showed that biodiversity and water quality declined in West Virginia and adjacent states when coal mining related impacts to watersheds exceeded 10 percent by area (Palmer and Bernhardt, undated). The rationale for the selection of 10 percent was that this threshold might represent a point after which cumulative impacts would result in material damage to the hydrologic balance outside the permit area. Definition of actual thresholds for specific watersheds may require additional research; the actual threshold for material damage to the hydrologic balance in any particular watershed may in fact be higher or lower depending on a

[4] A HUC-12 watershed map defines watershed boundaries at the sixth level of subdivision (the subwatershed) using a 12 digit code.

number of parameters. The 10 percent threshold selection allows for a preliminary discussion only.

To analyze the effect this Alternative would have on coal production OSMRE selected two areas of the country with the highest coal production in 2010, the Powder River Basin and three counties in Southern West Virginia. OSMRE utilized U.S. Geological Service (USGS) hydrographic data to map HUC-12 watershed boundaries in comparison to existing coal mine permit boundaries in the study areas. OSMRE then used the overlap of coal mine impacts to the watershed boundaries to allow the selection of those watersheds with greater than 10 percent of their acreage affected by mining.

The results showed that 15 of the 29 HUC-12 watersheds that contain coal resources in the Powder River Basin had greater than 10 percent of their acreage impacted by coal mining. This Alternative would therefore prohibit future mining in over 50 percent of the Powder River Basin watersheds. OSMRE used new and pending applications, as of 2011, for mining in the Powder River Basin to provide a basis for examining the effect the prohibition would have on the approval of future permits with the assumption that these 2011 applications were indicative of where future mining interest would focus.

OSMRE conducted a similar analysis of selected watersheds in southern West Virginia. OSMRE obtained data for watersheds encompassing Mingo, Logan, and Boone counties. These three counties combined produced 50 percent of West Virginia's coal in 2010. In that year, West Virginia produced 93 million tons of coal, which made up about nine percent of total U.S. production.

OSMRE overlaid USGS HUC-12 watershed boundary data over the boundaries of all mining activity (current and reclaimed, but excluding abandoned mine lands) within these counties. The analysis included impacts associated with underground mines also, but only the extent of surface disturbance associated with the underground mine. The results of the analysis show that coal mining had affected less than 10 percent of the available acreage in only 18 of the 46 watersheds within these three counties. Therefore, if OSMRE implemented this Alternative future mining would be prohibited in 28 of 46 (over 60 percent) of the watersheds in these three counties. Additionally five of the 46 watersheds had coal mining impacts on over nine percent of their acreage; therefore limited acreage would remain before the prohibition would apply to these watersheds as well.

As described above, the analysis shows that this Alternative would significantly affect the ability to mine coal in three of the highest coal-producing counties in West Virginia and over half of currently mined watersheds in the Powder River Basin. It would greatly restrict the ability to mine coal in areas of the country that produce a sizeable percentage of the nation's coal. Additionally, this Alternative would impose these impacts on coal production based on an acreage threshold that has not been scientifically determined to be a suitable nationwide basis for determining the likelihood or extent of material damage to the hydrologic balance. For these reasons, OSMRE determined that this Alternative was not scientifically justifiable, and did not meet the purpose of the proposed action.

2.6.3 Element to include in an Alternative - Restrict final elevations for backfilled and graded areas reclaimed after mining to a maximum ± 10 percent of the difference between the premining surface elevation and the bottom elevation of the lowest coal seam mined.

Each Alternative consists of several elements as described in the previous section of this Chapter. In developing the Alternatives OSMRE considered an element that would restrict final elevations for backfilled and graded areas reclaimed after mining to a maximum ± 10 percent of the difference between the premining surface elevation and the bottom elevation of the lowest coal seam mined. The tolerance would not apply to steep slope permits because these permits would require the operator to minimize disposal of excess spoil and instead to maximize placement of spoil material on the mined area. This Alternative would also have allowed minor shifts in the location of premining features and landforms to accommodate certain mining techniques.

The initial analysis showed that the ±10 percent threshold would not be achievable in some western areas where the overburden is so thin in comparison to the thickness of the mined coal seam that it would not be possible to return the final elevation within the mandated tolerance without bringing in additional material to fill the excavated hole. The tolerance threshold would also not apply for most Central Appalachian surface mines, where the predominance of steep slopes would result in most operations being exempt.

Table 2.6-2
Mining Ratios for Model Surface Mines

Coal Region	Ratio of spoil (volume) to coal mined (weight)[1]
Central Appalachia (Area)	16.1
Central Appalachia (Contour)	13.2
Northern Appalachia	12.7
Colorado Plateau	9.8
Gulf Coast	10.3
Illinois Basin	15.5
Northern Rocky Mountains and Great Plains	1.5

[1]All figures represent cubic yards of spoil per ton of coal mined.

The mining ratios presented in Table 2.6-2 are indicative of the ability for mining operations to comply with the proposed tolerance requirements. The mining ratio presented here is the ratio of spoil material (in cubic yards) produced for every ton of coal mined. The higher the ratio, the greater the amount of excess spoil which the operator must return either to the site or place offsite. Where the ratio is above 7.3 cubic yards of spoil per ton of coal mined the amount of excess spoil would produce a final elevation above the 10 percent maximum elevation change. Where the ratio is below 2.6 cubic yards of spoil per ton of coal mined the amount of spoil would be insufficient to replace the volume lost due to the removal of the coal volume. These ratios rely on the assumption that the overburden would swell in volume by 25 percent due to handling, which would create additional spaces between overburden particles when they are placed back versus their arrangement before the mining disturbance.

As shown in the Table 2.6-2, the modeled ratios for spoil to coal are outside the target range (2.6 to 7.3 cubic yards of spoil per ton of coal mined) in all of the regions. Therefore all but one region would have excess spoil and the remaining region (the Northern Rocky Mountains and Great Plains region) would have insufficient spoil. OSMRE therefore rejected the ±10 percent elevation threshold requirement, and instead incorporated a ±20 percent elevation threshold into Alternatives 2, 4 and 7. These Alternatives, including the revised threshold requirement, are carried forward for analysis in this DEIS.

Chapter 3 Affected Environment

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Chapter 3 Affected Environment

3.0 INTRODUCTION

The Affected Environment chapter of the Draft Environmental Impact Statement (DEIS) describes the environment of the area(s) influenced by the Alternatives under consideration, as described in Section 1502.15 of Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA). The descriptions provide information essential to understanding the effects of the Alternatives. Data and analyses are commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced.

3.0.1 Purpose and Organization of the Chapter

The Affected Environment Chapter in this DEIS address the following resources:

- Section 3.1 – Mineral Resources and Mining
- Section 3.2 – Geology
- Section 3.3 – Soils
- Section 3.4 – Topography
- Section 3.5 – Water Resources
- Section 3.6 – Air Quality
- Section 3.7 – Land Use
- Section 3.8 – Terrestrial and Aquatic Biology
- Section 3.9 – Wetlands
- Section 3.10 – Recreation
- Section 3.11 – Visual Resources and Noise
- Section 3.12 – Utilities and Infrastructure
- Section 3.13 – Archaeology, Paleontology, and Cultural Resources
- Section 3.14 – Socioeconomics and Environmental Justice

3.0.2 Area Under Consideration

Coal is the most abundant of the fossil fuels and is widely distributed across the world. According to the United States Energy Information Administration (U.S. EIA), approximately 27 percent of the global coal reserves are located across the U.S. (U.S. EIA, 2011a) (See Section 3.1 for detailed description of U.S. coal resources). For purposes of this DEIS, regional variations of the Affected Environment are summarized to the extent possible.

As further described in Section 3.1, the Office of Surface Mining Reclamation and Enforcement (OSMRE) has identified seven regions representing the coal-mining areas in the U.S. (Figure 3.1-1) for consideration in this DEIS. The physical, biological, and social/cultural variations within these regions are vast. Additionally, coal mining techniques differ within and between regions. The seven coal mining regions, presented in alphabetical order, are as follows:

- Appalachian Basin region: In the Appalachian Basin region, bituminous coal has been mined throughout the last three centuries within Pennsylvania, Ohio, Virginia, West Virginia, Maryland, Eastern Kentucky, Alabama and Tennessee. Based on geologic structure and stratigraphy, the Appalachian Basin region has historically been subdivided into three coal regions: the northern region, the central region, and the southern region. Historically, the northern and central regions have played the dominant role in coal production.
- Colorado Plateau: The Colorado Plateau contains a substantial quantity of high-quality, low-sulfur coal resources. The coal in this region lies within Colorado, Utah, Arizona, and New Mexico.
- Gulf Coast: The Gulf Coast generally yields about one twentieth of coal produced in the U.S. Coal production in this region currently is exclusively lignite with most of this production extracted in Texas, but also including production from Louisiana and Mississippi.
- Illinois Basin region: Coal production in the Illinois Basin began in the early 1800s. The reported 2012 coal production for the Illinois Basin is fairly evenly split between Indiana, Illinois, and Western Kentucky.
- Northern Rocky Mountains and Great Plains: Of the seven coal-bearing areas, this region contains the most coal resources and that coal is extracted primarily by surface mining methods. Most of this coal is located in a coal field referred to as the Powder River Basin, straddling northeastern Wyoming and eastern Montana. Also from this region, coal production comes from parts of Colorado and lignite mining in North Dakota.
- Northwest: For purposes of this DEIS, only coal resources in Alaska, specifically the Nenana and Matanuska fields are included in the analysis. Coal production is not predicted in the reasonably foreseeable future in the other coal resource areas within the Northwest region (Oregon, Washington, and northern Alaska); hence the proposed action would not affect these environments. Oregon has not had coal mining to any degree for the past ten years. Production in the state of Washington is historically very low (a few 100 tons) with poor quality reserves. Also, the only recent mining activity in that state has been the reprocessing coal waste impoundments, which does not create additional land disturbance. Coal in Alaska, while abundant, has not been produced in large quantities because of constraints involving coal depth, transportation options, and coal quality.
- Western Interior: This region includes coal resources mainly within the states of Oklahoma, Missouri, Arkansas and Kansas.

In some cases, this Chapter describes and analyzes existing conditions and characteristics at the state level. The 25 states within the seven coal mining regions included in the study area for this DEIS are:

- Alabama (Appalachian Basin region and Gulf Coast);
- Alaska (Northwest);
- Arizona (Colorado Plateau);
- Arkansas (Gulf Coast and Western Interior);
- Colorado (Colorado Plateau and Northern Rocky Mountains and Great Plains);
- Illinois (Illinois Basin region);
- Indiana (Illinois Basinr region);
- Kansas (Western Interior);
- Kentucky (Appalachian Basin region and Illinois Basin region);
- Louisiana (Gulf Coast);
- Maryland (Appalachian Basin region);
- Mississippi (Gulf Coast);
- Missouri (Western Interior);
- Montana (Northern Rocky Mountains and Great Plains);
- New Mexico (Colorado Plateau);
- North Dakota (Northern Rocky Mountains and Great Plains);
- Ohio (Appalachian Basin region);
- Oklahoma (Western Interior);
- Pennsylvania (Appalachian Basin region);
- Tennessee (Appalachian Basin region);
- Texas (Gulf Coast and Western Interior);
- Utah (Colorado Plateau);
- Virginia (Appalachian Basin region);
- West Virginia (Appalachian Basin region); and
- Wyoming (Northern Rocky Mountains and Great Plains).

In some cases, the analysis in this Chapter was conducted at the county level. The study area includes the counties in which coal mining occurred in 2012 within those 25 states listed above. The most recent data for 2011 can be found in the 2011 Annual Coal Report that is made available by the U.S. EIA, U.S. Department of Energy (U.S. EIA, 2012a). Data for 2012 was obtained from the Mine Safety and Health Administration (MSHA), U.S. Department of Labor.

3.0.3 Previous Environmental Analyses

While Chapter 3 describes the socioeconomic and resource conditions of the affected environment, it is also important to consider the existing regulatory environment in the context of potential changes to existing rules to implement the Surface Mining Control and Reclamation Act (SMCRA). On December 12, 2008 (73 FR 75814-75885), OSMRE published a final rule and Environmental Impact Statement (EIS) modifying the circumstances under which mining activities may be conducted in or near perennial or intermittent streams. That rule and EIS is generally referred to as the 2008 Stream Buffer Zone Rule (2008 SBZ); it took effect on January 12, 2009 (OSMRE, 2008). In summary, the 2008 SBZ rule:

- allowed placement of excess spoil material in intermittent or perennial streams after an analysis of the impacts to fish, wildlife, and aquatic ecosystems and a demonstration that the Alternative with the least environmental impact be selected;
- required that this material placement, both in volume, footprint, and stream impact, be minimized; and
- provided that a SMCRA permit does not authorize disturbance outside or in advance of Clean Water Act permits.

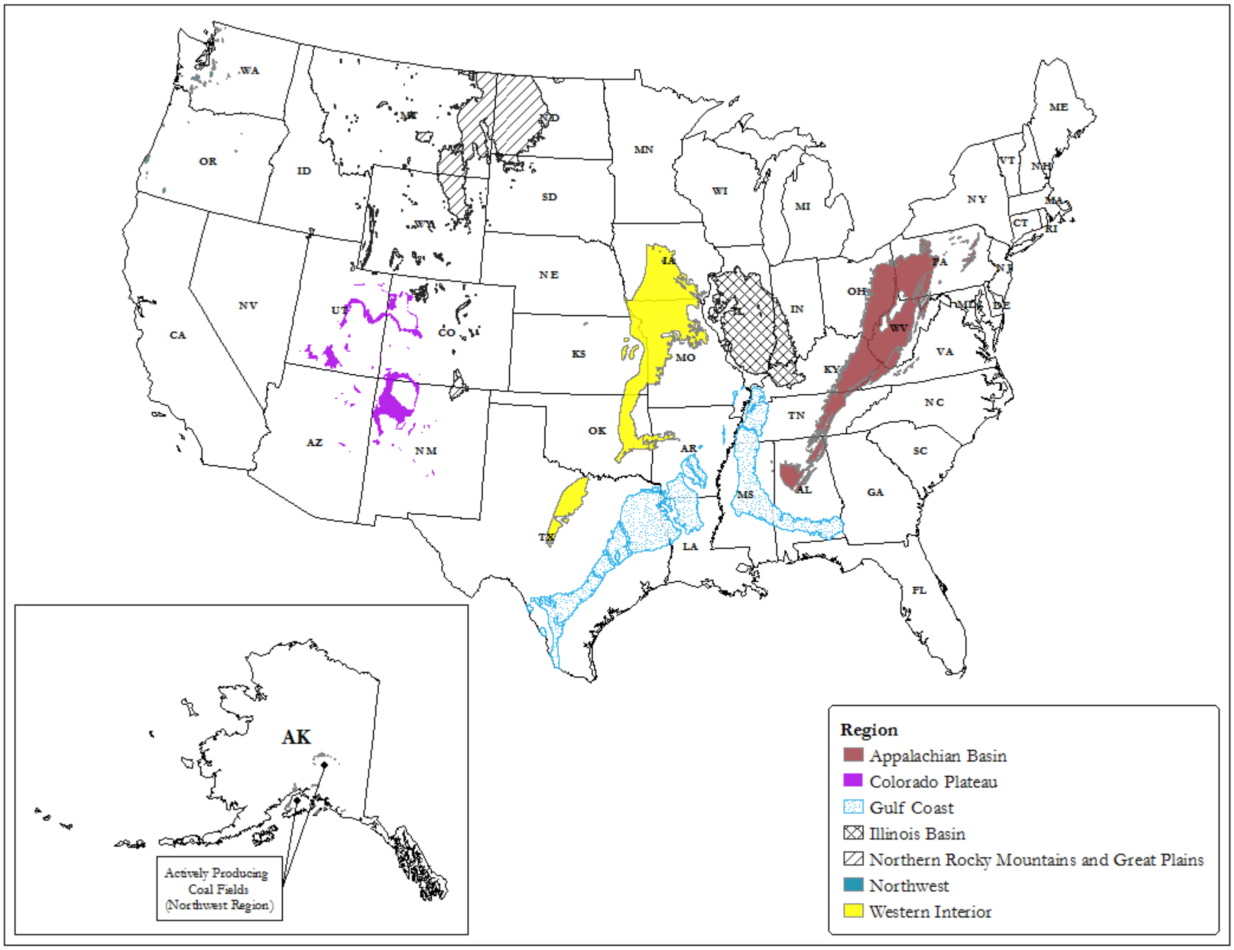
The 2008 SBZ rule was subsequently vacated, see 79 FR 76227-76233 (Dec. 22, 2014). Although the proposed action analyzed in this DEIS is generally more comprehensive than the 2008 SBZ rule, this DEIS relies on and tiers to the relevant analysis of the existing regulatory environment provided in the SBZ EIS that supported the 2008 rule when appropriate. However, this DEIS also incorporates additional analysis necessary to describe the existing regulatory environment relevant to this broader rulemaking.

3.1 MINERAL RESOURCES AND MINING

The affected environment for this DEIS includes any area where mineable coal occurs in the U.S. (Figure 3.1-1). These areas are depicted on the maps below and are located in seven regions analyzed throughout this DEIS: the Appalachian Basin region, the Colorado Plateau, the Gulf Coast, the Illinois Basin region, the Northern Rocky Mountains and Great Plains, the Northwest, and the Western Interior. Note that while the Michigan Basin in shown in the map below, coal has not been produced from that region since 1952; therefore, it is not being included in the analysis completed for this DEIS.

In 2012, coal was mined in 25 states, with production totaling 1,016,292,837 tons, a 7.2 percent decrease from the previous year. Coal production in Central Appalachia declined 20.2 percent while production increased in the Illinois Basin by 9.1 percent (U.S. EIA, 2013a).

Figure 3.1-1 Major Coal-Producing Regions of the United States

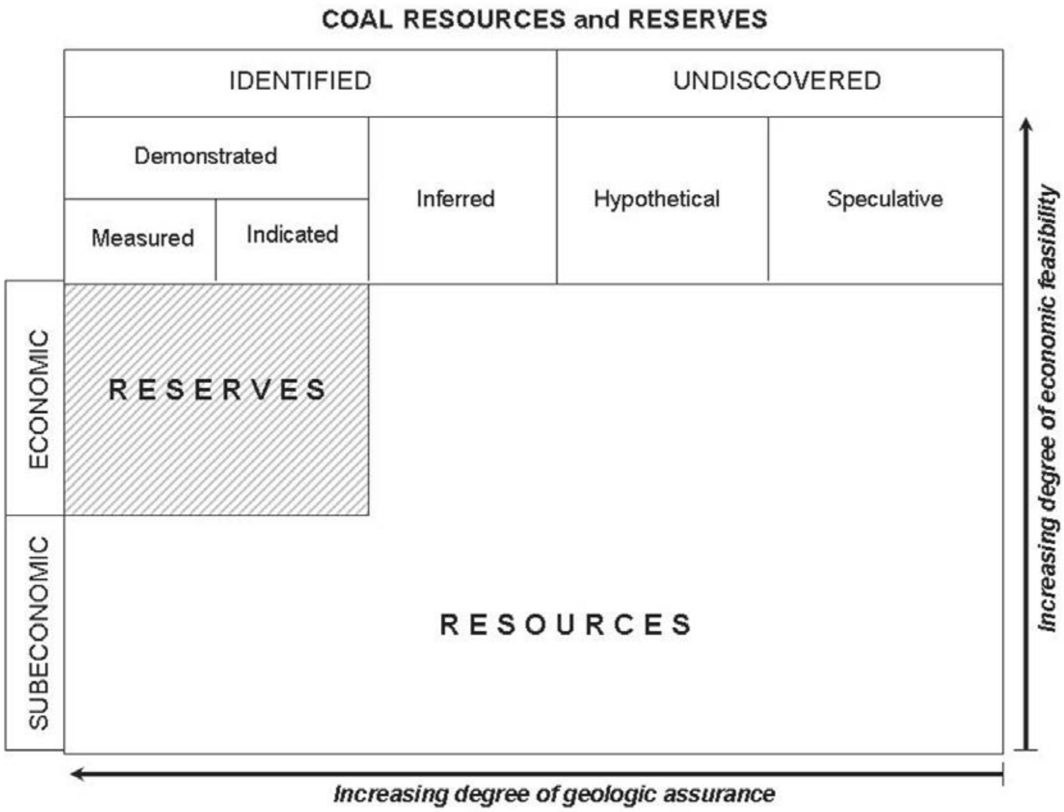


Source: Data- United States Geological Survey (USGS), 2011a, *Coal Fields*, United States Department of the Interior (U.S. DOI), http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

3.1.1 Coal Resources and Coal Reserves

The distinction between a "resource" and a "reserve" is the suitability for mining of the coal bed (Figure 3.1-2). Resources refer to the presence of coal and do not consider suitability for mining. If a coal resource is considered commercially feasible to mine, then that resource is further classified as a reserve. Different terms are used to describe resources and reserves based on the level of geologic confidence and the degree of economic suitability for mining of the coal bed. Coal resource figures can range from the least definite "Total Resources" to the highest geologically and economically proven "Recoverable Reserves at Active Mines."

Figure 3.1-2 Relationship Between Coal Reserves and Coal Resources



Source: Luppens, J. et al., 2009, *Figure 1; Coal Resources and Reserves*, USGS, U.S. DOI , http://pubs.usgs.gov/pp/1625f/downloads/ChapterD.pdf

3.1.1.1 Total Resources

"Total Resources" entails discovered and undiscovered total coal resources in a specific area. It considers both proven reserves and estimated reserves from geologic modeling without considering suitability for mining. Total resources in the U.S. are estimated to be about four trillion tons.[1]

3.1.3.2 Identified Resources

Coal deposits whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements are "Identified Resources." Included are beds of bituminous coal and anthracite (14 or more inches thick) and beds of sub-bituminous coal and lignite (30 or more inches thick) that occur at depths to 6,000 feet. The existence and quantity of

[1] This figure is based upon the most comprehensive assessment of U.S. coal resources, published by the USGS in 1975. More recent regional assessments have been conducted by the USGS; however, no new national level assessment of U.S. coal resources has been conducted since that time.

these beds have been delineated within specified degrees of geologic assurance as measured, indicated, or inferred. Also included are thinner and/or deeper beds that presently are being mined or for which there is evidence that they could be mined commercially. Identified Resources are approximately 1.5 trillion tons.

3.1.3.3 Demonstrated Reserve Base

Not all coal resources are economically feasible to mine and market. The "Demonstrated Reserve Base" estimates the total in-situ coal commercially feasible to mine at a given time, considering coal bed thickness, overburden depth, reported regional mining recovery, and coal seam accessibility. The Demonstrated Reserve Base was first assessed by the U.S. Bureau of Mines in 1974 and is now periodically evaluated and published by the U.S. EIA. The 2011 Demonstrated Reserve Base was 483 billion tons (U.S. EIA, 2013b; U.S. EIA, 2012b), or less than one-eighth of the estimated coal resources in the U.S.

3.1.3.4 Estimated Recoverable Reserves

The "Estimated Recoverable Reserve" represents coal that can be economically mined considering today's mining technology, accessibility constraints, and recovery factors. The Estimated Recoverable Reserve is generally less than the Demonstrated Reserve Base for a specified area. The Estimated Recoverable Reserve for the U.S. is 259 billion tons, about 54 percent of the Demonstrated Reserve Base (U.S. EIA, 2013b; U.S. EIA, 2012a).

Various factors affect the recoverability of a coal resource. These factors include geologic factors, mining operations, economics, processing, and restrictions on mining as explained below (Luppens, et al., 2009):

- *Coal Bed Thickness:* Coal bed thickness is generally considered one of the most important factors affecting coal recoverability. While most U.S. coal regions have thin to moderate bed thickness (ten feet thick or less), some western U.S. coal beds are more than 50 feet thick. Very thin coal beds may not be recoverable, and with current mining technology, minimum bed thickness for surface mining and underground mining are limited to about one foot and two feet, respectively. For underground mining, current technology demands a maximum practical bed thickness of about 15 feet, meaning portions of coal beds exceeding this thickness must be left in place, reducing recovery rates.
- *Coal Bed Depth:* Coal bed depth, or the depth of material overlying the coal bed, is also an important factor affecting coal recovery economics. For surface mining operations, recoverability depends on the depth of overburden to be removed. Greater overburden depth results in less recoverable reserves and vice versa. For underground mines, deeper coal beds can exhibit decreased recoverability due to the retaining of larger coal pillars for roof support (See Section 3.1.3.1 Underground Mining below); higher capital expenditures for mine access and infrastructure; roof/floor/coal stability issues due to increased stress at depth; increasing temperature at depth; and groundwater flow which generally increases with depth, resulting in greater pumping requirements to overcome

the increased mine inflows. The current coal bed depth limit for underground coal mining ranges from 2,000 and 3,500 feet.

- *Stripping Ratio:* The stripping ratio is defined as the ratio of the overburden depth to the coal bed thickness at a given location. The "economic stripping ratio" is a basic, site-specific analysis for evaluating the maximum highwall height that can be economically mined. For example, 12:1 economic stripping ratio means that 12 feet of overburden material can be economically removed for every foot of coal mined. Thus, five feet of minable coal would equate to 60 feet of overburden or a 65 foot highwall.
- *Coal Rank:* Coal rank is a function of the degree of metamorphism and is dependent on the amount of heat, time, and pressure sustained by the coal deposit through burial history. As coal increases in rank, it decreases in moisture content, increases in carbon content, and increases in heating value. Coal rank progresses from peat (not considered coal) to lignite, then to subbituminous, then to bituminous, and finally to anthracite. Coal rank is further detailed in Section 3.1.2.
- *BTU*: The heating value of the coal is very important in power generation. It measures the energy contained in a unit of coal, expressed as British Thermal Units per pound (BTU/lb.). Higher BTU coal demands a higher price than lower BTU coal, all other qualitative parameters considered equal. A lower ranked coal, such as lignite (8,300 BTU/lb. or less), requires more tonnage to match the energy equivalent of a higher ranked coal, such as bituminous coal (13,000 BTU/lb.).
- *Sulfur Content*: Sulfur dioxide gas (SO_2) is released through oxidation of sulfur in the coal when it is burned, degrading air quality and contributing to acid rain production. The amount of SO_2 released depends on both the chemical composition and the concentration of the sulfur in the coal. Clean air standards limit SO_2 emissions from the burning of coal based on the BTU, making coal with lower SO_2 production more desirable.
- *Restrictions on Mining*: Restrictions on mining can limit the ability to recover coal. Outside of SMCRA, there exist federal[2] and other lands with societal or environmental values that have mining restrictions and land use limits imposed. Land use restrictions can also exist near population centers and around protected surface features that may be adversely impacted by surface subsidence related to underground mining. See 30 CFR 784.20 and 817.121.
- *Technological Effects:* Economic necessity for increased production rates has realized the use of larger or more productive mining equipment. For underground mining, limitations on resource recovery are influenced by state regulations, minimum accepted engineering practices, and equipment requirements. Additionally, conditions that may limit mining of underlying and overlying coal seams include weak geology that cannot provide adequate roof or floor support; hydrogeologic concerns; or mining in areas that were previously underground mined using high-extraction methods. In surface mining, large equipment is primarily used and is especially applicable to recovery of multiple

[2] These include the National Park System, National Wildlife Refuge System, National System of Trails, National Wilderness Preservation System, National Wild and Scenic Rivers System, National Recreation Areas, lands acquired with money derived from the Land and Water Conservation Fund, National Forests, and federal lands in incorporated cities, towns, and villages (40 CFR 3461.5(a)).

coal seams in one mining operation, thereby greatly maximizing the resource recovery of these coal reserves.

The underground mining process results in some rock strata immediately above or below the coal bed being recovered along with the raw coal. This results in reduced BTU and inclusion of impurities in the run-of-mine coal product. Seams of non-coal material, called partings, are also typically found laminated within most coal beds and can range from very thin to a few feet in thickness. The underground mining extraction method for removing the coal and partings as comingled material results in further dilution of the raw coal product. These dilutions decrease the overall quality of the mined coal primarily by lowering the BTUs and increasing the ash content of the run-of-mine product. This is partially overcome by processing or cleaning of the raw coal to improve the quality of the final coal product mined. This process involves loss of some of the raw coal and further reduces the resource recovery. The waste product, consisting of coarse and fine refuse slurry, requires disposal and is discussed in Section 3.1.6.3. In summary, coal processing adds cost to the marketed coal product and results in lost coal in the processed waste rock due to the imperfect cleaning process. Underground mining and coal processing losses are typically 17 to 25 percent higher than that of surface mining.

Surface mining generally does not require the same level of processing compared to underground mining. Surface mines by employing methods to selectively mine have the ability to separate parting materials some of which can be immediately disposed of in the pit. In underground mining these same partings would be extracted during mining and would require processing to remove.

3.1.3.5 Recoverable Reserves at Active Mines and National Coal Resource

Recoverable reserves at active mines were estimated at 19.2 billion tons at the end of 2011 (U.S. EIA, 2012a; U.S. EIA, 2012b).

As stated above, the Nation as a whole contains an estimated four trillion tons in total coal resources. The estimated demonstrated reserve base is 483 billion tons, with Estimated Recoverable Reserve of 259 billion tons, or about 54 percent of the demonstrated reserve base. Recoverable reserves at active mines is 19.2 billion tons, or about seven percent of Estimated Recoverable Reserve.

3.1.2 Types of Coal and Extraction Methods

The degree of alteration (or metamorphism) that occurs as coal matures is referred to as the "rank" of the coal. Coal is divided into four different ranks based on the degree of metamorphism caused by heat, pressure, and time applied to the coal, resulting in increased carbon content, decreased moisture, and generally increased heating values (Table 3.1-1). Rank varies from the lowest ranked lignite to subbituminous, then bituminous, up to the highest rank of anthracite. Typically a higher rank equates to higher economic value. High-ranked coal produces more energy per ton and/or has higher carbon content than lower rank coal. However impurities such as sulfur and ash, quality parameters such as volatile matter, and the cost of transportation affect the marketability of any particular coal product.

Table 3.1-1
Percent of Demonstrated Coal Reserves Base in U.S., by Rank

Coal Type	Percent
Bituminous	53.1%
Subbituminous	36.6%
Lignite	8.8%
Anthracite	1.5%

Source: U.S. EIA, 2012b.

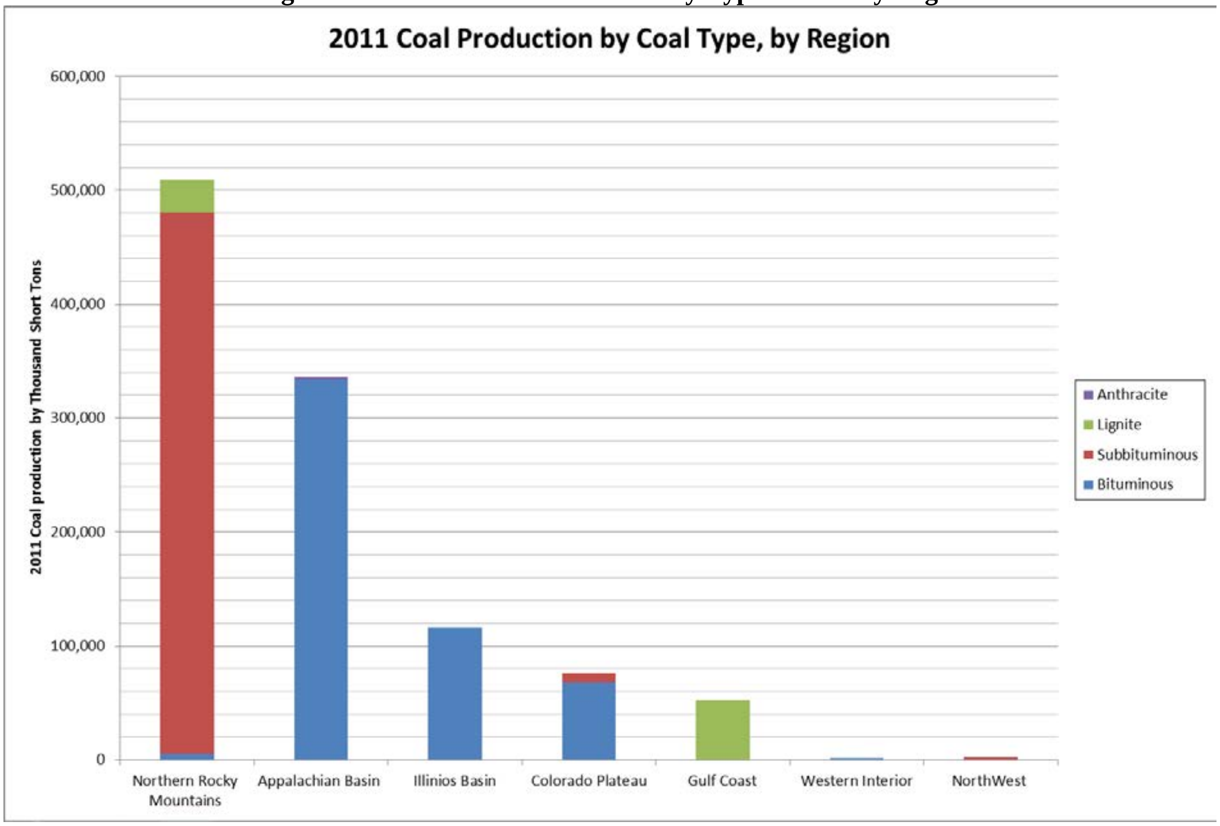
As seen in Table 3.1-1 (above), bituminous accounts for more than half of the Demonstrated Coal Reserves and, as seen in Figure 3.1-3 is concentrated primarily east of the Mississippi River, with the largest amounts found in Illinois, Kentucky, and West Virginia. Wyoming and Montana contain the majority of the subbituminous Demonstrated Coal Reserves Base, while Montana, Texas, and North Dakota comprise the majority of the lignite. Anthracite, the highest ranking coal, makes up only 1.5 percent of the Demonstrated Reserve Base and is concentrated almost entirely in northeastern Pennsylvania (U.S. EIA, 2012b).

Coal production reflects regional differences in coal types. As shown in Figure 3.1-3, the Northern Rocky Mountains and Great Plains region mines large amounts of subbituminous coal, while bituminous dominates in the Appalachian and Illinois regions.

Coal reserves are also categorized as either low, medium, or high sulfur content, in relation to the amount of sulfur dioxide (SO_2) released measured against the BTU content of the coal. The U.S. EIA reports the quantities of low, medium, and high sulfur coals as relatively equivalent for the U.S. Demonstrated Reserve Base, 33 percent, 28 percent, and 39 percent respectively. Most low-sulfur (84 percent) and medium-sulfur (61 percent) coal is located in the western U.S. The Appalachian Basin region contains a mixture of low, medium, and high sulfur coal reserves. Clean air standards limit SO_2 emissions from the burning of coal based on the BTU value, making coal with lower sulfur content desirable by complying with air quality standards without costly desulfurization treatment, typically accomplished through flue gas desulfurization also known as “scrubbers.” However with improved technology and the increasing number of scrubbers being installed, the marketability of the higher sulfur coals is increasing.

Approximately 68 percent of the U.S. Demonstrated Reserve Base is classified as minable by underground methods, while the remaining 32 percent is minable by surface methods. However, the percentage of estimated recoverable reserves by underground mining methods greatly diminishes to 57 percent of the Demonstrated Reserve Base, due to lower recovery ratios inherent to underground mining methods (Section 3.1.3 below). Surface mining normally yields much higher coal bed recovery than underground mining.

Figure 3.1-3 Coal Production by Type of Coal by Region

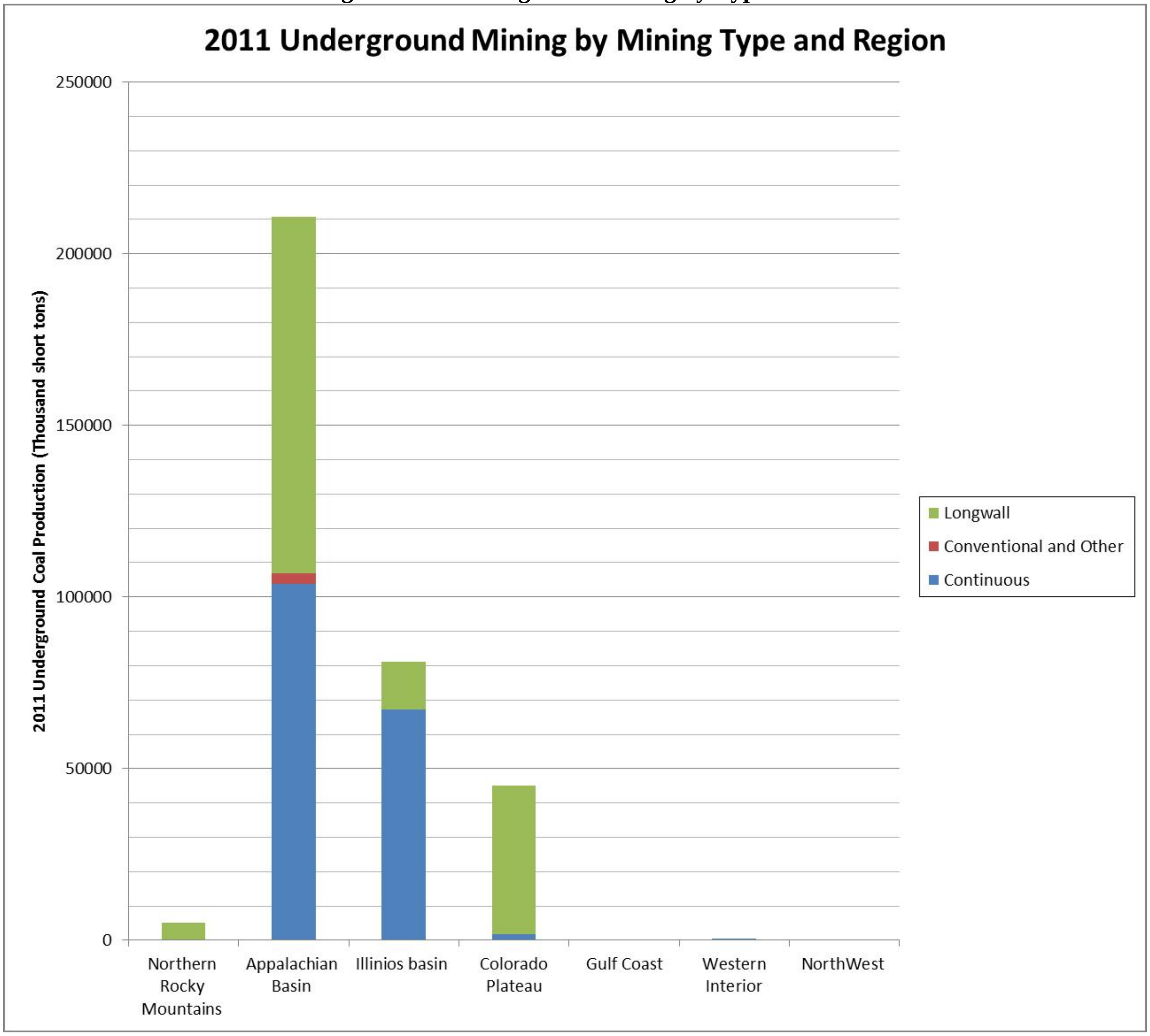


Source: Data: U.S. EIA, 2012a. Annual Coal Report 2011, *Table 6; Coal Production and Number of Mines by State and Coal Rank, 2011*, U.S. Department of Energy,

3.1.3 Mining Methods: Underground

The method of underground coal mining depends on the geologic characteristics of the region, economics, property ownership, and other factors. Figure 3.1-4 illustrates the distribution of underground mining methods by region. The two most common underground mining methods are room-and-pillar and longwall mining. Each leaves some coal in place to maintain the roof stability of the mine during extraction. These pillars temporarily support the rock immediately overlying the intact coal pillar plus some portion of the overlying rock previously supported by the excavated coal. Underground mines typically recover 40 percent to 90 percent of the mined seam, depending on the extraction method.

Figure 3.1-4 Underground Mining by Type – 2011



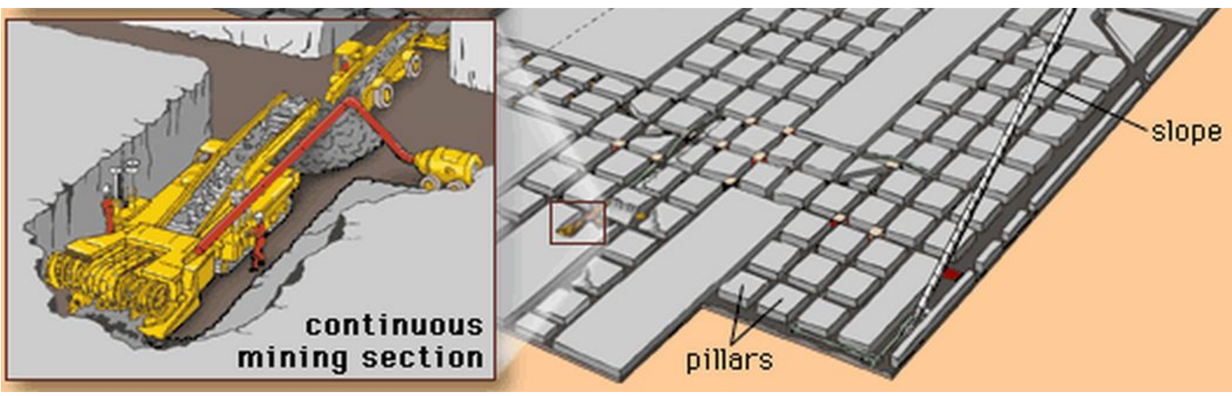
Source: Data: U.S. EIA, 2012a. Annual Coal Report, *Table 3; Underground Coal Production by State and Mining Method, 2011*, U.S. Department of Energy.

For underground mining, access to the underground coal bed is gained by drifts, slopes, and/or shafts, governed chiefly by economics related to the geology, depth, mining method, mine production rates, and other constraints. Following the access development, underground mining is performed within the coal bed horizon without removing the overburden and is generally considered practical for depths greater than 100 feet; shallower mining can encounter difficulties with roof integrity and subsidence (Suboleski, 1999a), which is discussed in greater detail in Section 0. Historically, underground mining was performed throughout most of the U.S. by a type of room and pillar method mining referred to as conventional mining that includes direct drilling and blasting of the coal seam. This method may or may not include secondary pillar extraction (Section 3.1.3.2). The majority of modern underground mining is now accomplished through a method of room and pillar mining called continuous mining that involves the use highly mechanized mining machines. An additional form of underground mining that allows for significantly higher percentages of coal extraction is a method called longwall mining.

3.1.3.1 Room and Pillar Mining

Room and pillar mining is the most common form of underground mining. The room and pillar method leaves blocks of the coal seam in place to support the overlying strata and immediate mine roof while coal is extracted. Room and pillar mines are developed by making a parallel series of tunnel-like excavations called entries that are interconnected with perpendicular tunnel-like excavations called crosscuts. These entries and crosscuts are used to mine the coal reserve in a grid-like pattern; the blocks of coal that remain between the entries and crosscuts are called pillars and they support the overlying strata and immediate mine roof (Figure 3.1-5). This process is used to mine areas called panels, which consist of an engineered number of entries and crosscuts based on the safety it provides to coal miners, the potential need to protect features and structures located above the mine on the land surface and economic factors of the mining conditions.

Figure 3.1-5 Continuous Mining



Source: Encyclopedia Britannica, 2011, Coal Mining, Encyclopedia Britannica Online, http://www.britannica.com/EBchecked/topic/122975/coal-mining

Room and pillar mines are best suited to relatively small reserves where, higher production methods are neither spatially nor economically feasible, surface subsidence is not desired or allowed; variable coal quality requires selective extraction within the seam, or higher extraction methods are hindered by geologic conditions. Room and pillar mining has a much smaller capital investment requirement than a longwall mine, due to the diminished scale and subsequent cost of the associated equipment.

“Conventional Mining” is the traditional room and pillar mining method which employs under-cutting the coal production face, drilling, blasting, loading, and hauling to extract coal. Once the predominant mining method in the Appalachian coal fields, it accounted for only about ten percent of total production in the 1990s (Suboleski, 1999b) and is employed with diminishing frequency today. Advancements in mining equipment and technology have led to higher productivity and lower-cost production without the use of drilling and blasting. Conventional mining is currently used when unique geology economically precludes the use of the more productive mining equipment.

The prevalent technique for room and pillar mining in use today is called continuous mining, and uses a mining machine, commonly referred to as a continuous miner (Figure 3.1-5, above). The machine cuts the coal from the working face with bits attached to a rotating drum-like cutting head. The continuous miner cuts and loads the coal, replacing the separate steps of undercutting, drilling, blasting, and loading used in conventional mining.

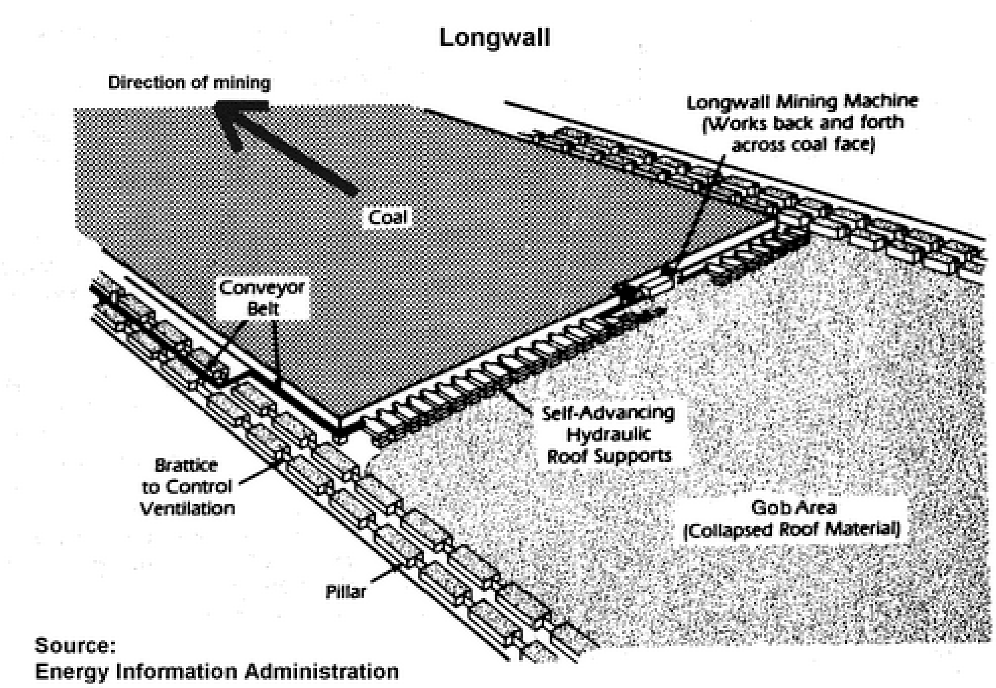
Temporary roof support is established following coal extraction from the working face, typically through roof bolts installed with a machine called a roof bolter. Ventilation controls are then advanced as the mining moves forward to assure that dangerous accumulations of gasses and dust are diluted, rendered harmless, and carried away from the personnel. The cycle of cutting and loading, bolting and advancing ventilation, and cleanup and preparation, require equipment to move from one working face to another. The multiple entries and interconnected cross-cuts in a mine panel are developed by moving the mining equipment from one working face to another to ideally maximize equipment utilization, production, and resources.

After the maximum extent of a room and pillar mining panel has been fully developed, the mining direction may be reversed for secondary partial or total extraction of the coal pillars. This retreat mining process uses the same mining equipment, requiring supplemental roof support to safely control the mine roof and to manage planned caving and subsidence. The pillar extraction process begins at the farthest advanced development of the mine panel and extracts the pillars supporting the overlying strata and immediate mine roof; analysis of the coal and overburden material are used to predict the extent of the controlled roof collapse and resulting surface ground subsidence. Room and pillar mining operations with both primary and secondary (retreat) full-pillar extraction can achieve up to 90 percent recovery of a coal seam in the secondary mining areas, while primary extraction alone can achieve only about 40 to 60 percent.

3.1.3.2 Longwall Mining

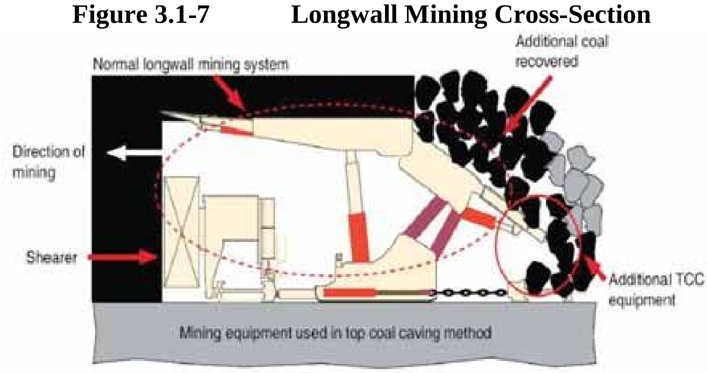
Longwall mining uses multiple self-advancing hydraulic mine roof supports, a traversing coal cutting machine called a shearer, and an articulated armored face conveyor that transports the coal and interconnects the roof supports and the shearer to cumulatively create the longwall mining machine (Figures 3.1-6 and 3.1-7). The longwall machine is designed for complete coal extraction within the working area of the equipment. Initial room and pillar mining is used to delineate an unmined block of coal by excavating three to four entry wide mine developments around the block of coal. This unmined block of coal or longwall panel ranges from 650 to 1,580 feet wide by 2,400 to 21,500 feet long, with the average U.S. longwall panel having a face width of 1,137 feet, a length of 10,802 feet, and a cutting height of 90 inches (Coal Age, 2013).

Figure 3.1-6 Longwall Mining Aerial View



Source: Pennsylvania Department of Environmental Protection, 2008, *Figure VI.3; Schematic Illustrating Longwall Mining*, U.S. EIA, http://www.dep.state.pa.us/dep/deputate/minres/bmr/act54/sec6.htm

Figure 3.1-7 Longwall Mining Cross-Section



Source: Auster Coal, 2007, Figure *2; a simplified schematic showing the longwall as a vertical cross-section,* available at: http://www.womp-int.com/story/2007vol5/story025.htm

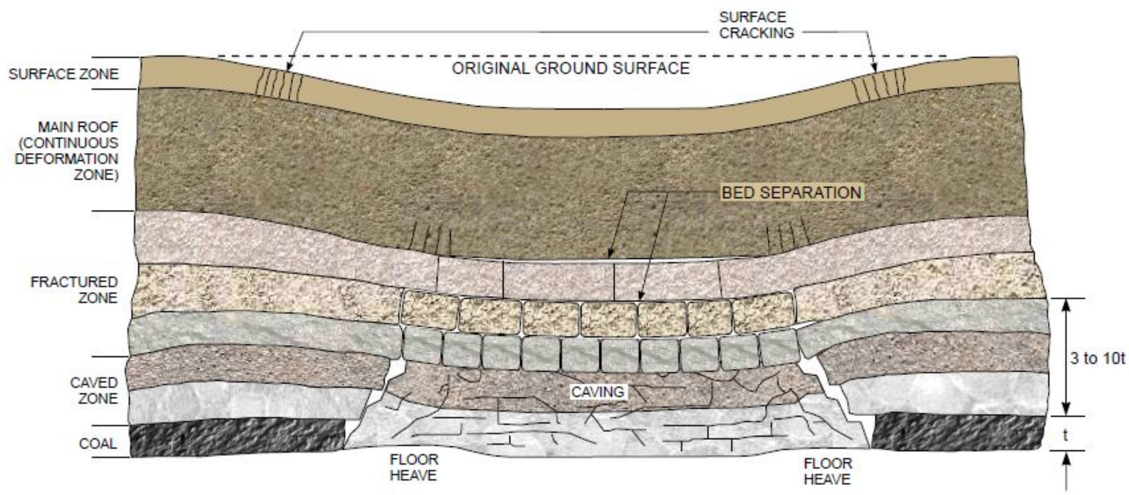
An armored face conveyor and mounted rotating drum shearer travels across the longwall face from one side of the panel to the other, cutting about a 32- to 42-inch deep strip of coal as the conveyor transports the broken coal from the longwall face to the mine's main haulage system. Once the shearer reaches one end of the longwall face, it traverses back to the other end of the face cutting another strip of coal as it moves. The shearer cuts coal in this back-and-forth action along the longwall face until the entire length of the panel has been mined, which results in the total extraction of the longwall panel block of coal. The conveyor and shearer are protected by multiple hydraulic powered roof supports, chocks or shields. These are connected, yet independently articulated, hydraulic roof supports that flank one another to support the overlying strata, and consequently protect the personnel and equipment along the entire longwall face. The shearer cuts the coal in front of a roof support, which leaves a span of newly created unsupported mine roof. The hydraulic shield support is depressurized and collapsed, moved forward, and re-pressurized against the mine roof, thereby minimizing both the unsupported roof exposure time and span created by the continuous cutting action of the traversing shearer. As the roof supports sequentially advance, the mine roof behind the advanced support is now left unsupported. Stresses induced by the unsupported overlying strata cause the roof in this 'mined-out area' to break and collapse, filling the mine void with broken rock known as gob.

When compared to room and pillar mining methods, longwall mining requires both reserves with geology that will accommodate the large rectangular panels as well as a high capital investment in equipment and infrastructure. However, when conditions allow the use of longwall mining, the relatively high coal production rates offset the capital expenditures to make this an efficient production method. There are 43 longwall mines with 48 operating longwall mining machines in the U.S. (Coal Age, 2013). The combined production of these longwall mines equals the combined production of the approximately 500 non-longwall underground mines in the U.S. (U.S. EIA, 2012a). Accounting for only ten million tons of production in 1973, longwall mining accounted for 169 million tons of production, or just about 50 percent of the total U.S. underground production in 2011 (U.S. EIA, 2006; U.S. EIA, 2012a).

3.1.3.3 Surface Effects of Underground Mining

The removal of underground material without leaving adequate underground support for the overburden results in collapse and may induce measureable vertical movement of the surface lands, called subsidence (Figure 3.1-8). The downward movement and stratigraphic interactions can also produce horizontal movement, strain, tilt, surface cracking, and even upward movements of portions of the land surface, depending on the properties of the overlying geology and soil. Subsidence can occur naturally, as with the collapse of portions of cave systems, or can be a planned or unplanned result of the mining process. Both longwall mining and full-pillar extraction room and pillar mining allow for surface ground subsidence. Operators design the mines to control these planned subsidence effects. Full subsidence is normally about two-thirds of the thickness of the seam being mined (Suboleski, 1999a), but can range from near zero movement to subsidence equal to the thickness of the coal seam.

Figure 3.1-8 Subsidence Mechanisms



Source: MSHA, 2009c, *Figure 8.1; Strata Disturbance and Subsidence Caused by Mining,* U.S. Department of Labor Adapted from Singh and Kendorski, 1981; Peng and Chiang, 1984, http://www.msha.gov/Impoundments/DesignManual/Chapter-8.pdf

Surface subsidence manifests itself in two forms, sinkholes and trough (or area) subsidence. Mine-induced sinkholes are generally small in areal extent and commonly related to unplanned subsidence of a small portion of a shallow room and pillar mine. In contrast, trough or area subsidence typifies planned subsidence features from both room and pillar with total pillar extraction and longwall mines. A sinkhole is a circular depression in the ground surface that occurs when the shallow overburden collapses into an underground void. A trough is a ground surface depression formed by bending of the overburden into an underground void. Unplanned trough subsidence can also occur when large areas of a mine intended for long-term stability were under-engineered, resulting in failure.

The surface subsidence area is typically larger than the actual caved excavation area and is a function of the depth and rock properties of the strata overlying the mine workings. In the case of planned subsidence, the affected ground surface area can be determined by using the geology dependent angle of draw, which is the vertical deviation angle from the edge of the underground mined area to the edge of the surface subsidence.

Subsidence can lead to functional impairment of surface lands, facilities and structures, and surface and ground water features and systems. The extent, severity, and timing of subsidence depend on the mining method; the type, size, and condition of the underground support left in place; the size and geometry of a mined-out area; the thickness and properties of the coal seam; the depth to the coal seam; the thickness and structural composition of both the underlying rocks and the overburden (including the presence of geologic faults); the inclination of strata and surface; the soil composition; the locations of ground water; the relation of the mining to previously mined areas; and the method and quantity of any backfilling material placed in the excavation, which is rarely applied in coal mining (Hower et al., 1980; U.S. DOE, 1981).

3.1.4 Mining Method: Surface Mining

Surface mining operations typically recover about 90 percent of the coal reserve. Surface mining involves removal of overburden to expose underlying coal seams for extraction. For purposes of this DEIS, surface mining is categorized by three basic operational methods: contour mining, area mining, and open pit. Mountaintop removal mining, a subset of area mining, is defined as a surface mining operation that removes an entire coal seam or seams running through the upper fraction of a mountain, ridge or hill. Secondary extraction associated with surface mining, collectively known as highwall mining, occurs after the final highwall limits have been reached. Surface mines can employ any combination of these methods to maximize the coal recovery from a given land parcel.

Surface coal mining methods can vary between individual mines, but all share common site development activities:

- *Site Access:* The first step in mine development is construction of a primary haul road to the mine site to provide access for equipment, employees, and supplies.
- *Erosion and Sedimentation Controls*: Control structures include sedimentation ponds constructed to prevent siltation of receiving streams and ditches constructed to convey runoff from disturbed areas to the sedimentation ponds. Diversion ditches are also built around areas affected by mining to divert runoff from upslope areas to natural drainages. These facilities must be constructed prior to initiation of earth disturbance in a given area. In some cases, permanent or temporary stream relocations are employed to reroute streams around the mine.
- *Clearing and Grubbing:* This activity involves the removal of trees, stumps, shrubs, and other vegetation from the area to be affected. This allows for more efficient removal of any topsoil, for later use in reclamation. Topsoil is segregated by a dozer that typically removes the recoverable soil from mining areas to temporary stockpiles, which are temporarily seeded with fast-growing grass species until needed for reclamation. Valley/hollow fill areas are cleared and grubbed to prepare the foundation to ensure stability prior to excess spoil fill placement.
- *Excavation:* This activity is the physical removal of overburden soils and rock overlying the coal seams to allow for removal and haulage of uncovered coal. Unconsolidated surface material and weathered bedrock can usually be excavated by equipment without blasting. The underlying rock is fractured by drilling and blasting, or by ripping with bull dozers. The void left after excavation is referred to as a mine pit. The broken rock that is removed is known as spoil. As a result of the excavation process, this spoil material "bulks" as voids in the material are created. This bulking is commonly referred to as "swell." Where potentially acid-forming or toxic-forming overburden is encountered, this material requires special handling to segregate and bury it, in order to isolate it from oxygen and water, or to encapsulate it in water.

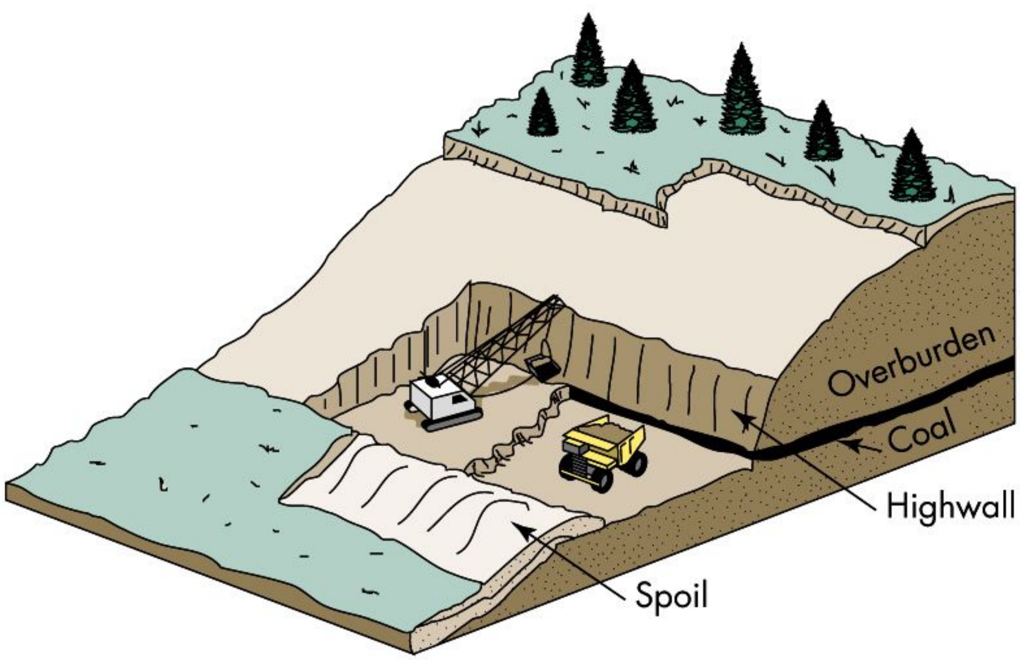
Surface mining practices have changed in the last three decades as larger equipment and larger-scale mines have resulted in higher productivity. Whereas surface mining and underground mining production was about equal in the early 1970s, the production share from underground mining declined by over 30 percent over the next three decades. This increase in surface coal mining has been concentrated predominantly in the western U.S., where large-scale area mines now account for almost 50 percent of the nation's coal production.

3.1.4.1 Contour Mining

Contour mining takes place in mountainous or rolling hill areas and limits mining to the side of a mountain or to the end of a ridge line. In contour mining, operations progress along the outcrop of a coal seam, removing overburden inward towards the mountaintop or ridge core to the highwall limit of that coal seam. This results in mine cuts that wrap around mountaintops or ridge lines parallel to contour in a sinuous pattern dictated by topography. Contour cuts may be conducted on multiple seams on a given mountain or ridge line. Near the tip of a ridge line on a contour mining operation, "point removal" may occur where the coal seam is mined from the outcrop on one side of the narrow point, through the center of the ridge, and to the outcrop on the opposite side of the point. This occurs where the overburden is shallow.

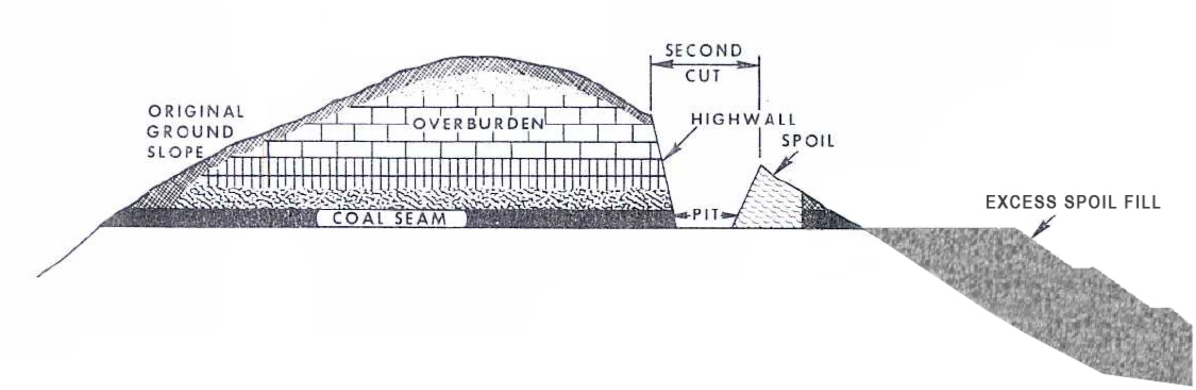
To begin a contour mine, an initial box cut is opened at the coal outcrop and excavated to the highwall limit, forming a mine pit. Spoil material from this first cut may be temporarily stockpiled on site for use in later backfilling, or hauled to an excess spoil disposal area (Figure 3.1-10).

Figure 3.1-9 Example Contour Mine Initial Box Cut Cross Section



Source: Brikowski, T. 2010. *Figure 15.7; Contour Mining*, The University of Texas at Dallas, Spoil from successive cuts are hauled and placed in the void created by the previous cut (Figure 3.1-10). Any spoil that cannot be returned safely to the mined bench must be placed in an excess spoil disposal area. Contour mining may also be employed to recover lower elevation coal seams on steep slopes, and coal seams from areas of excess spoil fills prior to fill placement.

Figure 3.1-10 Contour Mine Second Cut Cross Section Showing Spoil Placement



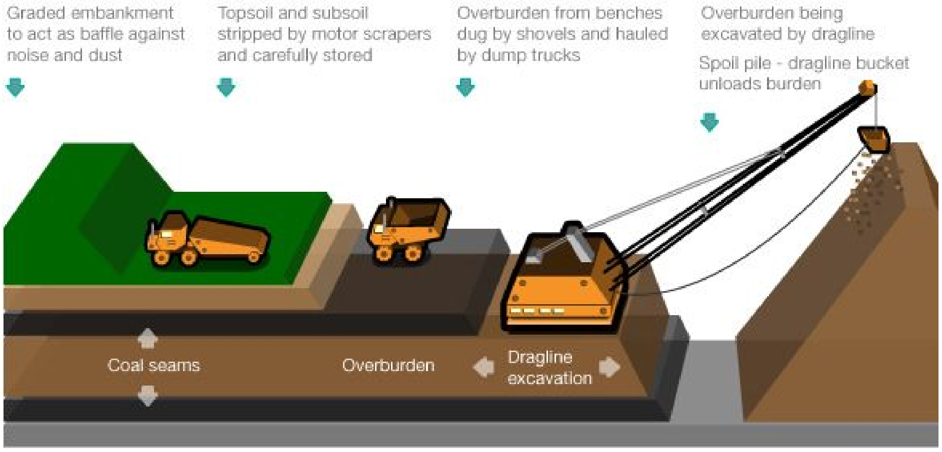
Source: Grim, E.C. and Hill, R.D., 1974, *Environmental Protection in Surface Mining of Coal*, Report No. EPA-670/2-74-093, U.S. Environmental Protection Agency, Cincinnati, OH

3.1.4.2 Area Mining

Area mining occurs where the coal seam or multiple coal seams produce stripping ratios favorable for mining across the topography, rather than around it as in contour mining (Figure 3.1-11). The area mining method will generally have larger working areas than the contour method and may employ large earthmoving machines for primary overburden removal.

Area mining offers the advantages of a high coal recovery rate and high production rate potential. It also allows overburden placement that easily restores a site to the Approximate Original Contour (AOC). However, area mining requires a large capital investment and a large reserve base to be practical. In steep slope areas, area mining may require disposal of large volumes of excess spoil, depending on how the mine operation is planned, as well as specific postmining land uses that allow for a variance from AOC. In areas that have been previously mined, excess spoil may be used to complete reclamation of previously mined benches.

Figure 3.1-11 Area Mine Cross Section



Source: World Coal Association, 2011, *Coal Mining*, http://www.worldcoal.org/coal/coal-mining/

Area mines may begin by excavating an initial cut across the entire width of a flat or gently-sloping area, mountaintop, or ridge line (Figure 3.1-11, above). Where potentially acid-forming or toxic-forming overburden is encountered, this material may require special handling to be segregated and buried (to isolate it from oxygen and water) or to encapsulate it in water.

In steeper sloping areas, this initial cut may start as a contour cut on the basal coal seam and progress inward until a highwall is established. Smaller equipment, such as excavators, loaders and dozers make these initial cuts and work in advance of the highwall to remove upper coal and create a flat working bench. In steep slope areas, such as in the Appalachian Basin region, excess spoil from area mines is often placed in excess spoil disposal areas, or transported to nearby unreclaimed pre-SMCRA open pits.

Area Mining Dragline Method

The dragline method of area mining involves opening an initial box cut, removing the coal exposed in the box cut, and then placing the overburden from the next cut into the mined-out, box cut area. A dragline machine is used in this process; it has a very large shovel capable of moving 100 cubic yards or more of material with each pass (Figure 3.1-12). The box cut procedure is repeated on a cut-by-cut basis. Spoil from the initial box cut is temporarily stored and later spread and blended into the backfilled mined area. This surface mining method is generally employed in flat or moderately dipping coal seams with constant overburden depths.

In a typical cycle of excavation, the dragline bucket is positioned above the material to be excavated. The bucket is then lowered and the drag cable is then drawn so that the bucket is dragged along the surface of the material. The bucket is then lifted by using the hoist cable. A swing operation is then performed to move the bucket to the dump area, generally into the preceding cut.

Figure 3.1-12 Draglines in an Area Mine Operation

Source: CU-Boulder Environmental Studies Program, 2009, *Dragline and Explosives, Navajo Coal Mine,* Environmental Issues in Mining, University of Colorado at Boulder.

Mountaintop Removal Mining

Mountaintop removal mining is a subset of area mining that involves removing an entire coal seam or seams from the outcrop on one side of a mountain or hill through to the outcrop on the other side. Mountaintop removal mining operations run through the upper fraction of a mountain, ridge, or hill by removing substantially all the overburden above the coal seam and creating a level plateau or a gently rolling contour, with no highwalls remaining. Figure 3.1-13 shows an aerial photograph of mountaintop removal operations, with both active mining and ongoing reclamation operations. Pursuant to SMCRA, mining operations can only be permitted as mountain top removal mining if they are granted a variance from returning the mined lands to AOC, providing that the postmining land uses meet SMCRA requirements (30 U.S.C. 1265(c) and 30 CFR Parts 785, 816 and 824). These approved postmining land uses include industrial, commercial, residential, agricultural, or public facilities (including recreational facilities). A portion of the overburden from the top of the mountain (typically the "swell" portion of the broken rock) is transported to permanent placement in excess spoil disposal areas.

Mountaintop removal mining operations can achieve essentially 100 percent recovery of coal reserves, a portion of which might otherwise be permanently isolated beneath the reclaimed mine site. Stripping ratios of 13 to 20 may be economically feasible for large operations (Suboleski, 1999a). Moutaintop removal mining operations require large capital investments and working reserves to be feasible, and can require disposal of substantial amounts of spoil in excess spoil fills.

Figure 3.1-13 Mountaintop Mining and Reclamation Operations

Source: Hamon, J. 2010, *Aerial Overflight of Permit 848-0285 Xinergy Corp, Harlan County, Kentucky,* Division of Mine Reclamation and Enforcement, Kentucky Department for Natural Resources, Middlesboro Office

The term "mountaintop mining" has often been confused with the term "mountaintop removal mining." In the Draft Programmatic Environmental Impact Statement on Mountaintop Mining and Valley Fills (U.S. EPA et al., 2003) mountaintop mining is referred to as "coal mining by surface methods (e.g., contour mining, area mining, and mountaintop removal mining) in the steep terrain of the Central Appalachian coalfields." The term "mountaintop removal mining" refers to those operations that receive a variance from the AOC restoration requirements to facilitate a specific postmining land use. This DEIS does not use the term "mountaintop mining," and all other surface mining operations will be discussed in terms of the mining methods actually being employed at the operation.

SMCRA provisions allow surface coal mining operations in steep slope areas to apply for and receive a waiver from the AOC requirement, specifically for a steep slope variance, again in exchange for creation of specific postmining land use(s) compliant with the statute and current regulations (30 U.S.C. 1265(d)). SMCRA allows a steep slope variance that specifically accepts final configuration different than premining if it can be shown that the proposed Alternative postmining land use would result in an equal or better economic or public use. Under Section 1265(d) of SMCRA and 30 CFR 701.5, a steep slope is defined as any slope of more than 20^{o}. An applicant for a steep slope variance must demonstrate that total suspended solids or pollutants to surface and ground water from the permit area will be reduced, or flood hazards in the watershed of the permit area will be reduced; and that total volume of flow from the permit area will not vary in a way that adversely affects ecology of any surface water or any existing or planned use of surface or ground water.

3.1.4.3 Open Pit Mining

Open pit or terrace mining is generally used in thick-seam areas with low stripping ratios (Figure 3.1-14). This method often places the overburden in temporary off-site storage. Once coal is removed from the initial pit area, the next cut is taken in the direction of the mine advance with the overburden from the new cut hauled to the existing pit and dumped. The coal is removed and the process of hauling back the overburden is repeated as the pit advances. Modern open pit mines use large mechanical equipment. The amount, type, and size of equipment employed in an open pit mine depend on the characteristics of the coal seam and overburden.

Figure 3.1-14 Open Pit Mine

Source: Konz, K. 2009, *Coal Mine,* Kearney Hub, Kearney, NE, http://www.kearneyhub.com/news/local/article_4ad8549e-9a29-11de-8fa3-001cc4c002e0.html

3.1.4.4 Auger and Highwall Mining

Auger and highwall mining are secondary extraction methods that may be employed allowing additional coal extraction horizontally beyond the existing highwalls after their stripping ratio limit has been reached (Figure 3.1-15). This is the last activity to be conducted in a final mine pit before it is backfilled. Depending on the Regulatory Authority, auger and highwall mining may be permitted as either surface or underground mining.

Figure 3.1-15 Auger/Highwall Mining

Source: Friends of the Locust Fork River, 2011, *Figure 2; Auger Mining.*

In auger mining, horizontal holes are drilled into a coal seam with auger stems driven by a rotary shaft with a hydraulic ram, working on the principle of an Archimedes screw. While auger holes can reach a distance of 400 feet, 200 feet or less is a more practical limit, as the auger may intersect the bottom strata or wander laterally into adjacent holes as its depth of penetration increases. Augers have a maximum recovery rate of about 33 percent (Suboleski, 1999a).

A continuous highwall mining machine may be used in place of an auger when coal seam characteristics permit. A continuous highwall miner typically has a front set of rotary cutting heads that cut coal from a seam horizontally beyond the existing highwall and direct it onto conveyor cars for delivery to the pit area. There, a stacking conveyor piles the coal in preparation for truck loading. Continuous highwall miners have a better recovery rate than augers (up to 45 percent of the reserve) and can mine to distances over 1,500 feet (Suboleski, 1999a).

Highwall mining can reach coal reserves that cannot be economically mined by surface methods and is relatively inexpensive compared to other production methods. However, highwall mining has a lower recovery rate due to the coal that must remain between each hole. Maintaining the coal pillar is critical in preventing the intersection of holes, maintaining highwall stability, and preventing loss of equipment in collapsed holes. In many cases, highwall mining negates any possibility of future surface mining at the site because of mechanical damage to the coal seam and lower recovery rate. Normally, highwall mining can only be conducted in a down-dip direction to prevent gravity discharging of ground water.

3.1.4.5 Haul Roads

Haul roads within a mine site are constructed to accommodate the widths of vehicles used on that particular operation. They are usually 50 feet or more wide. The overall grade of a haul road normally does not exceed ten percent for ease of haulage and to minimize brake wear and failure. Lengths of haul roads vary according to the distances necessary to access development, mining, and fill disposal areas. In steep slope areas, ditches are constructed on the uphill sides of haul roads to collect runoff, and culverts are placed at intervals to convey runoff under the road to the downhill side. In flatter terrain, ditches are constructed on both sides of each road, and the road is crowned to allow for drainage to both sides. Temporary haul roads to working areas are usually surfaced with crushed overburden materials, while primary haul roads connecting to public roads are generally surfaced with gravel. Additional ancillary roads (small service roads) may be constructed to access erosion and sedimentation control facilities or support areas (Tannant and Regensburg, 2001).

3.1.5 Underground Mine Waste Disposal

Only a small amount of waste rock generated by the underground mining process can be disposed of in the active mine workings due to space limitations. This disposal is typically performed inside crosscuts. Large underground construction projects can generate excessive amounts of waste rock requiring outside disposal in the coarse refuse disposal areas.

As discussed in Section 3.1.1.4, producing a high-quality, low-sulfur, and low-ash product requires preparation of the raw underground mined coal product. Two kinds of waste result from this process: coarse refuse and fine refuse, commonly referred to as “slurry”. Operators sometimes dispose of fine coal refuse slurry in underground mines on a very limited basis by pumping the slurry into old mine workings through vertical boreholes. This atypical disposal is limited to mines well below the water table that demonstrate diminutive interaction with ground water aquifer systems and adequate outcrop barrier and/or seam depth to prevent a blow-out into the outside environment. This underground injection disposal can be performed in both active and abandoned mines; however, an active mine must develop supplementary safety measures to protect underground personnel from underground blow-outs into active portions of the underground mine. U.S. Environmental Protection Agency (EPA) approval is needed for underground injection of the waste slurry (unless the state has primacy) and an MSHA plan is required for disposal in an active underground mine. A special permit from the state regulatory authority or the EPA pursuant to the Safe Drinking Water Act is required for underground injection operations. These injection wells are considered Class V wells (mining, sand, or other backfill wells) under the federal regulations found at 40 CFR 144 and 146. State regulations pertaining to mine backfill wells vary significantly in their scope and stringency. Coarse coal processing refuse is not disposed of in an underground mine. Surface disposal of coal refuse is discussed below.

3.1.6 Material Handling and Mine Reclamation

3.1.6.1 Mine Reclamation

Mine reclamation is the process of backfilling, regrading, planting vegetation, and other actions necessary to meet permitting requirements, permit conditions, and performance standards under the applicable regulatory program, on a disturbed mine site.

Postmining land uses can range from what existed before mining, to alternate land uses determined to be higher and better, which may include but are not limited to industrial, commercial, agricultural or forestland uses. Reclaiming a mine site entails four essential steps:

- *Backfilling:* After coal removal, mine pits are backfilled with spoil from new excavations to restore the ground surface. Backfilling, also known as "backstacking" in steep slope areas, may be accomplished by a variety of methods, including casting by draglines or shovels, cast blasting, dozer pushes, and truck haulage and dumping. Normally, mining will advance through a mine site in a series of adjacent excavations, or cuts, with the spoil from each new cut being placed in the pit void left by the previous cut. Sites which generate excess spoil must haul that spoil to excess spoil fills or other disposal fill types adjacent to the immediate mining area.
- *Regrading*: This activity is the shaping of spoil areas to final reclamation contours. After spoil casting or haulage and dumping, spoil areas usually have a very irregular surface that must be smoothed to better resemble a natural land surface. Regrading of spoil is primarily accomplished by dozers, with the final site topography determined by the site reclamation plan and the approved postmining land use. These plans aim to fulfill the regulatory obligation to achieve AOC, unless that requirement is waived according to very specific and limited regulatory circumstances, which is discussed in greater detail later in this section.
- *Excess Spoil Generation*: After coal removal, the mine operator places spoil in the mined-out area for reclamation. Under SMCRA the operator must grade the spoil to closely resemble the general surface premining topography **(**30 U.S.C. 1265(b)(3), 30 CFR 701.5 and 816.102(a)(1)). This is referred to as returning the reclaimed mine to the AOC.

  There are situations, particularly in steep terrain, where the volume of spoil is more than sufficient to return the reclaimed land to AOC or due to potential instability of the reclaimed slopes it is not technically feasible to return all the spoil to the mined-out area when reclaiming the site. Surplus spoil material disposed of in locations other than the mined-out area, except for material used to blend spoil with surrounding terrain in achieving AOC in non-steep slope areas, is referred to as "excess spoil." In steep slope terrain, the mine operator may place the excess spoil either in adjacent valleys, or on previously mined sites. There are several types of steep-slope excess spoil fills. For a detailed discussion of excess spoil disposal methods and trends, the reader is referred to Section 3.4 of this DEIS, which deals with topography.

- *Topsoil Redistribution or Substitution:* The final earthmoving activity is redistribution of stockpiled topsoil over the surface, or preparation of a topsoil substitute, if topsoil replacement is not employed. Where topsoil has been stockpiled, it is redistributed by dozers or scrapers at an application rate determined by available quantities. Use of topsoil substitutes requires a variance during the mine permitting process. When redistributing soil materials it is important that compaction of the materials be avoided or minimized so as not to inhibit root growth and development when reestablishing vegetation in the reclaimed mine area. Areas in which over compaction occurs may require the ripping of soil materials to alleviate compaction problems. This issue is particularly critical in locations requiring the successful reestablishment of deeply rooted plants such as trees and some restored agricultural land use types, frequently lands identified as prime farmlands.

- *Revegetation:* Following spreading or preparation, the topsoil or topsoil substitute is planted and seeded with species mixes reflecting the intended postmining land use. Many coal mine sites occur in forested areas, and tree planting is sometimes part of the revegetation process. Other shrub and herbaceous species may be included in the revegetation mix for wildlife habitat. Planting may be conducted by hand or with tractor-towed mechanical planters, and seeding accomplished using hydroseeders that concurrently apply a stabilizing cellulose mulch and fertilizer. Revegetation planting and seeding mixes are approved as part of the mine permitting process. If vegetation types or postmining land uses are proposed that differ from the premining land use of a site, then the change must be approved by the regulatory authority.

Forestry Reclamation Approach: In addition to the steps outlined above, the recently introduced Forestry Reclamation Approach is one method of reclaiming surface coal mines to forested postmining land use (ARRI, 2011). This approach entails several steps:

1) Create a suitable rooting medium for good tree growth that is no less than four feet deep and comprised of topsoil, weathered sandstone and/or the best available material;

2) Loosely grade the topsoil or topsoil substitute established in step one to create an appropriate growth medium;

3) Use ground covers that are compatible with growing trees;

4) Plant two types of trees: early succession species for wildlife and soil stability, and commercially valuable crop trees; and

5) Use proper tree planting techniques.

Many coal-bearing lands were forested prior to mining. As a result of research and recent changes in regulatory policy, many surface coal mines are now being restored with native forest species after mining using the Forestry Reclamation Approach.

3.1.6.2 Processing Facilities

Coal mined by both underground and surface mining methods may contain waste rock or excessive sulfur and not be suitable for immediate consumer use. This coal must be processed to reduce the impurities and may be blended with higher quality coal before delivery. Most underground mined coal must be processed, but some surface mined coal can be sold without processing. Coal mined by underground methods may contain up to 50 percent rock because of rock seam partings removed with the raw coal or because it is necessary to mine rock from the roof or floor to gain access height. Surface operations can often selectively mine the coal and remove waste rock without mixing the two; this is dependent on the geology and equipment used.

Processing facilities may include screens to separate coal into acceptable size grades; crushers to further reduce coal to desired size grades; and washing plants to clean rock and sulfur impurities from coal. Washing plants may use a high-density medium (usually fine magnetite) in water to separate low-density clean coal from contaminants with a closed-loop magnetite recycling system. Reject materials from screens and crushers and residue from washing plants are hauled or pumped to coal refuse disposal facilities.

Processed coal can then be blended with other coal stock to achieve the desired market quality grades. Blending may be accomplished by mobile equipment, such as loaders, or using a system of mobile stacking conveyors. Stockpiles and/or silos are typically present on site to store raw, cleaned, and blended coal prior to transport.

3.1.6.3 Coal Refuse Disposal Facilities

Coal mine waste or refuse (rock separated during the cleaning of coal, frequently shale) is typically disposed off-site adjacent to a coal processing facility. Most coal refuse disposal facilities are impoundments formed by constructing an embankment or dam across an existing hollow or valley in steep slope topography or in above-ground impoundments in flat or gently sloping areas. The embankment is often constructed from the coarser refuse material in a series of lifts as refuse slurry accumulates behind the embankment.

Coal refuse disposal facilities are long-term investments because of their size, support facilities, and reclamation requirements. The typical life of a coal refuse disposal facility is approximately 20 years. One or more mines may contribute to a single coal processing facility and/or shipping point.

Refuse with small particle sizes, known as “fines,” is usually pumped in slurry form from the processing facility to a refuse slurry impoundment. Aside from storage, the refuse impoundments serve to settle fines and decant water. As a mixture, these slurries may also include other materials including, sand, mill tailings, or other materials (e.g., coal combustion byproducts, coal cleaning wastes, acid mine drainage (AMD) treatment sludge). At surface mines in less mountainous areas, final pit areas are frequently used to dispose of fine coal wastes and do not require the construction of an impounding embankment.

In addition to being stored in impoundments, slurry refuse can also be pumped or injected into abandoned underground mine workings after EPA and MSHA approval. Underground injection wells are used in many mining regions throughout the country to inject slurry refuse into mined-out portions of underground mines. On occasion, injection also occurs into the rubble disposal areas at surface mining sites. Mine shafts and pipelines in an underground mine, as well as more "conventional" drilled wells, are used to dispose of slurries and solids. This form of backfilling may be used to provide surface subsidence control (the most common purpose), enhanced ventilation control, mine fire control, disposal of mine waste, enhanced recovery of minerals, mitigation of AMD, and improved safety.

According to a 1999 state and EPA Regional survey, there are approximately 5,000 documented mine backfill wells and more than 7,800 additional wells estimated to exist in the U.S. A total of 17 states report having underground injection wells. More than 90 percent of the documented wells reported are in four states: Ohio (3,570), Idaho (575), West Virginia (401), and North Dakota (200) (U.S. EPA, 1999).

A special permit from the state regulatory authority or the EPA pursuant to the Safe Drinking Water Act is required for underground injection operations. These injection wells are considered Class V wells (mining, sand, or other backfill wells) under the federal regulations found at 40 CFR 144 and 146. State regulations pertaining to mine backfill wells vary significantly in their scope and stringency. Some states impose few restrictions while others require permitting, or impose requirements by contract rather than regulation. Some of these approaches include permit by rule (e.g., West Virginia, Idaho, North Dakota), general or area permits (e.g., Wyoming), and individual permits (e.g., Ohio). In states that have not obtained primacy under SMCRA and for surface coal mining operations on federal and Indian Program lands, federal permit requirements for mining must include information on injection or backfill activities (U.S. EPA, 1999).

3.1.6.4 Coal Refuse Secondary Recovery Operations

Coal refuse placed before 1970 often contains a low BTU-value material that can be reprocessed to recover the coal or burned as is in specialized fluidized bed reactors. The refuse is referred to by various names, including: "gob" (garbage of bituminous) or "boney" in the bituminous coal mining regions of western Pennsylvania, West Virginia and elsewhere; and "culm" in the eastern Pennsylvania anthracite region. These secondary operations may recover either course or fine coal refuse materials for market sales.

Large volumes of this coal refuse accumulated at mining sites from the time mining first began in the Appalachians through the late 1970s. Permit applications for reprocessing or removing this coal refuse include plans to safely excavate and reduce the loose, potentially combustible, and/or acid-forming potential of coal refuse. Final reclamation plans include geotechnical and hydraulic engineering design criteria to ensure long-term stability of any remaining material, eliminate a source of pollutional discharge and reclaim the land to a higher use (MSHA, 2009a).

Beginning in the late 1970s, coal preparation became more efficient, thus improving the coal product while lowering the BTU of the generated waste. Current mining operations continue to generate coal refuse, though likely at lower quantities than in previous decades.

3.1.7 Bonding and Financial Assurance

3.1.7.1 General Bonding Requirements

One of the major purposes of SMCRA is to ensure adequate reclamation of all areas disturbed by coal mining operations. Section 509 of SMCRA, and its implementing regulations at 30 CFR Part 800, require that, prior to permit issuance, the applicant file a performance bond with the regulatory authority. The bond guarantees that sufficient funds will be available to complete the approved reclamation plan in the event the permittee fails to do so.

The bond amount required for each bonded area must be determined by the regulatory authority, and depends on the requirements of the approved permit and reclamation plan. The amount of bond must be sufficient to assure completion of the reclamation plan if the regulatory authority must perform the work.

The method for determining required bond amounts varies with the regulatory authorities program requirements. Where OSMRE is the regulatory authority, OSMRE's Handbook for Calculation of Bond Amounts provides guidance for the bond calculation method (OSMRE, 2000c). The method is a standard engineering cost estimating procedure in which reclamation costs for the "worst case" reclamation scenario are determined. The "worst case" is the hypothetical point of maximum reclamation cost liability within the approved mining and reclamation plan. Some regulatory authorities use a similar approach, while others base bond amounts on unit costs per permitted acreage. The regulatory authority evaluates bond adequacy and adjusts bond amounts as appropriate at the time of permit revision, or when the cost of future reclamation changes. Bond reduction as a result of reclamation work accomplished is processed as an application for bond release.

There are three major types of reclamation bonds:

- corporate surety bonds;
- collateral bonds (cash; certificates of deposit; first-lien interests in real estate; letters of credit; federal, state, or municipal bonds; and investment-grade securities); and
- self bonds (legally binding corporate promises without separate surety or collateral, available only to permittees who meet certain financial tests).

Regulatory programs vary somewhat in terms of which financial instruments are acceptable. Some programs have excluded the self-bond option. Subject to regulatory authority approval, a permittee may post any combination of bond types and instruments recognized by that regulatory program, provided the total sum equals the required reclamation bond amount at all times. Each regulatory authority prescribes and furnishes forms for filing reclamation bonds. The forms differ for each type of bond. All bonds are payable to, or pledged to, the regulatory authority.

Reclamation performance bonds are posted to cover all mining and reclamation operations during the term of the permit. Prior to permit issuance, the permittee posts a bond to cover the entire permit area or an identified increment of land within the permit area upon which the operator will initiate and conduct surface coal mining and reclamation operations during the initial term of the permit. Prior to conducting operations on succeeding increments, the operator will file additional bond to cover such increments. Either a cumulative bond or an incremental bonding schedule may be used for bonding increments of land within the approved permit.

Reclamation bonds are typically released in three phases. Phase 1 bond releases are granted after satisfactory backfilling and regrading have been completed on the disturbed area. Phase 2 releases are granted after completion of revegetation activities. Phase 3 releases are granted after the operator has successfully completed all surface coal mining and reclamation activities and met water quality standards for runoff leaving the permit area. However, the remaining portion of bond may not be released before the expiration of the period of extended responsibility specified at 30 CFR 816/817.116 for establishing successful revegetation.

3.1.7.2 Alternative Bonding Systems

In lieu of requiring permittees to post an individual bond covering the entire estimated cost of completing the approved reclamation plan, some states authorize or require permittees to participate in an alternative bonding system, which is commonly known as a "bond pool." Under these systems, the permittee normally posts a conventional bond (surety bond, letter of credit, etc.) for an amount determined by multiplying the number of acres in the permit area by a flat per-acre assessment. The bond amount may vary depending on the type and site-specific characteristics of the planned mining operation. In addition, the permittee generally must pay an annual acreage fee or a tonnage fee as coal is mined. These funds are used to reclaim any site for which a participant in the alternative bonding system fails to complete all reclamation obligations and available conventional bond funds (surety, letter of credit, etc.) are inadequate to complete the required reclamation. Under OSMRE regulations, all alternative bonding systems must provide a significant economic incentive for the permittee to comply with reclamation requirements. They must also ensure that the regulatory authority has adequate resources to complete the reclamation plan for any sites that may be in default at any time.

3.1.7.3 Bonding for Long-term Treatment

Regulatory authorities only approve those permit applications in which the operation is designed to prevent off-site material damage to the hydrologic balance. In no case should a permit be approved if the determination of probable hydrologic consequences predicts the formation of a postmining pollution discharge that would require continuing long-term treatment without a defined endpoint. However, it is recognized that unanticipated discharge could develop on occasion despite the use of the best science available. In these cases a permit revision is required to incorporate the long-term treatment plan in the permit and the permittee must post sufficient financial assurance to cover all foreseeable long-term costs. The permittee may, subject to regulatory authority approval, establish a financial guarantee separate from the existing bond to cover these long-term costs. This assurance takes the form of a conventional bond, a trust fund or other appropriate instrument that meets the requirements of 30 CFR Part 800.

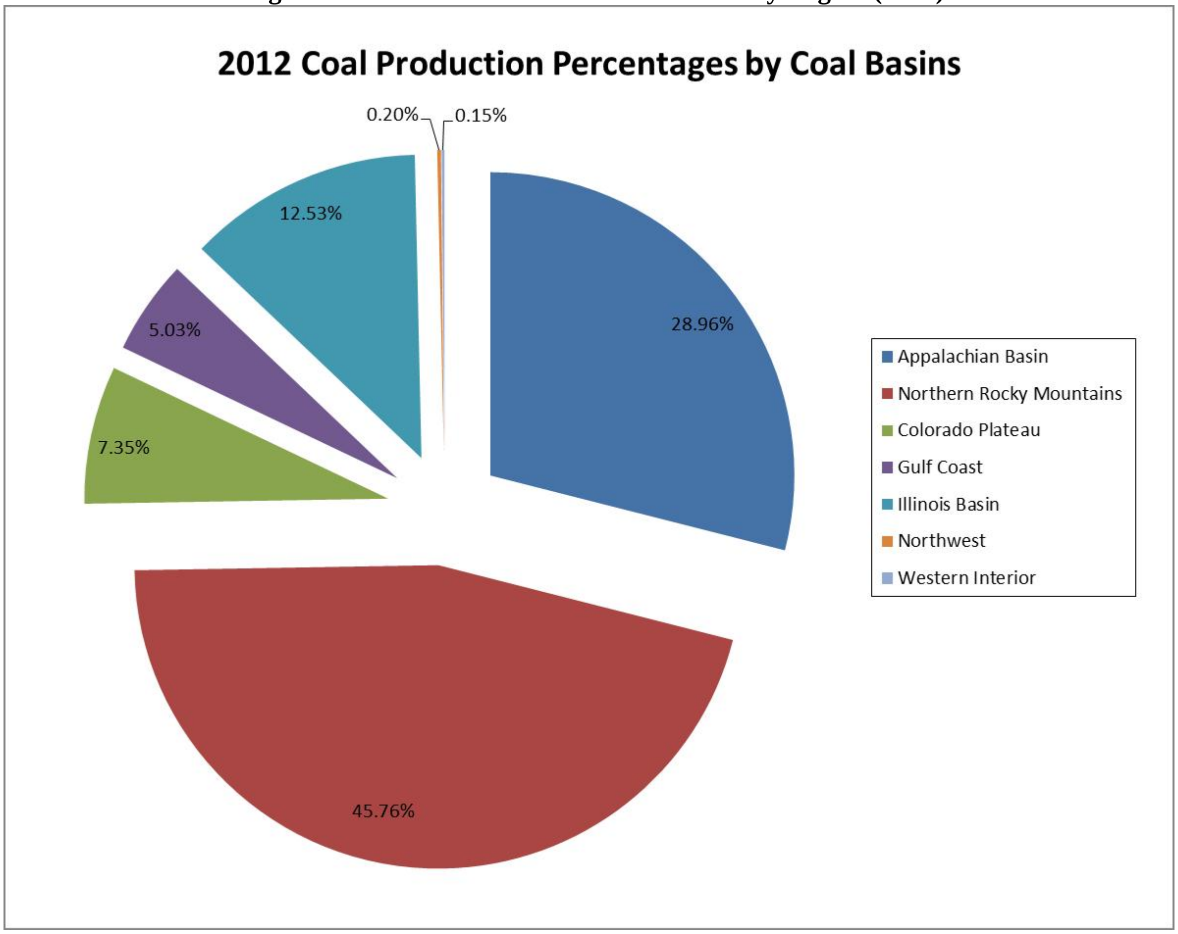
3.1.7.4 Liability Insurance

The regulatory authority requires that each permit application include a certification that the applicant has a public liability insurance policy in force for coal mining and reclamation activities for which the permit is sought. The certificate must be issued by an insurance company authorized to do business in the U.S. Such a policy provides for personal injury and property damage protection in an amount adequate to compensate any persons injured or property damaged as a result of the surface coal mining and reclamation activities, including the use of explosives, and who are entitled to compensation under the applicable provisions of state law. The policy remains in full force during the life of the permit. Minimum insurance coverage for bodily injury and property damage must be $300,000 for each occurrence and $500,000 aggregate.

3.1.8 Coal Resources and Coal Mining by Region

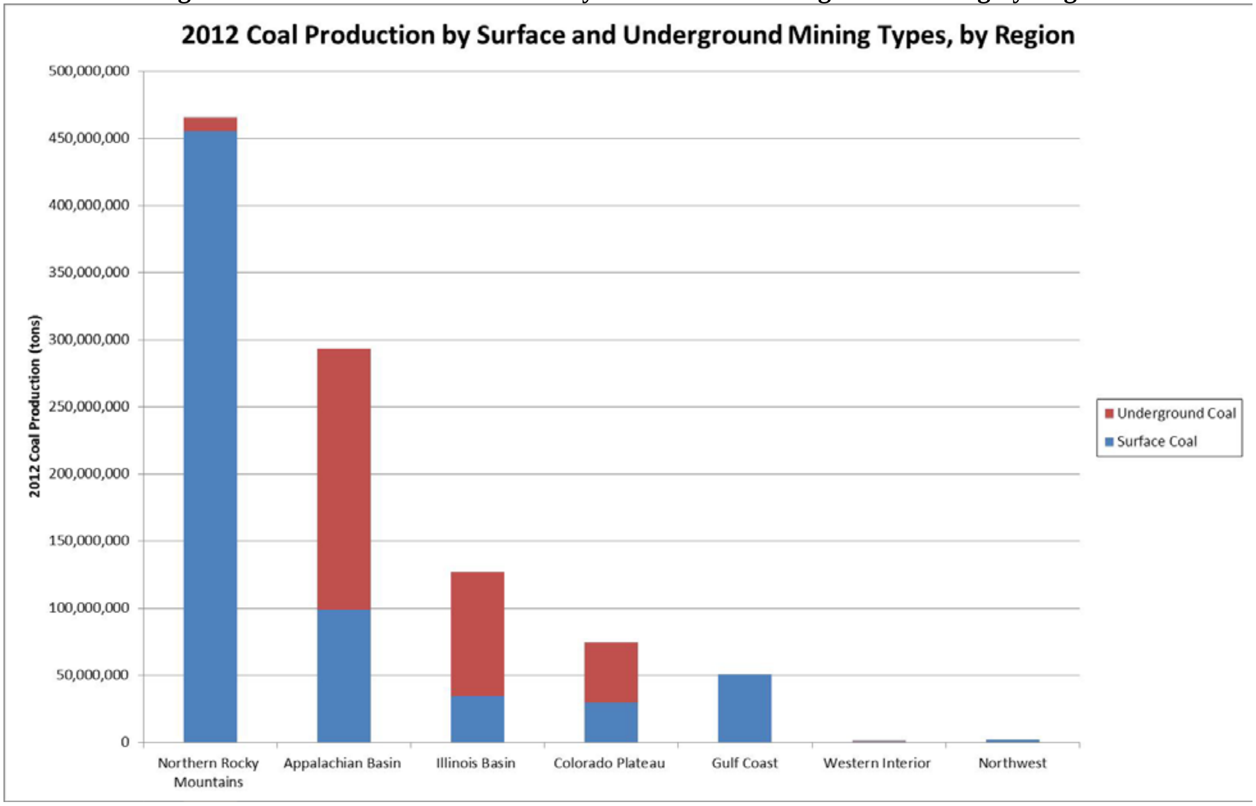
This section outlines the types of coal resources and reserves present in each of the seven study regions and coal production within each region. The charts below provide an overview of production and the type of mining method used by region (Figures 3.1-16 and 3.1-17).

Figure 3.1-16 Percent Coal Production by Region (2012)



Source: Data: MSHA, 2012, MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013.

Figure 3.1-17 Coal Production by Surface and Underground Mining by Region

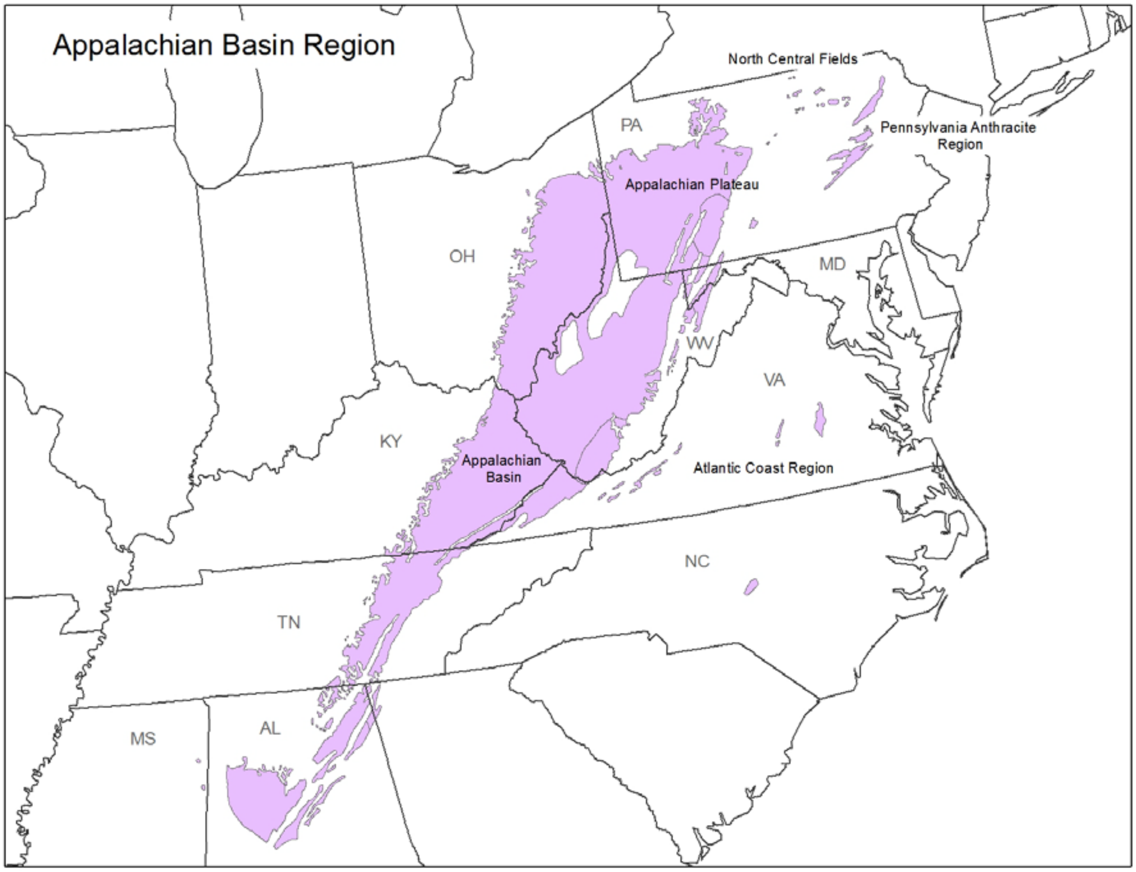


Source: Data: MSHA, 2012, MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013.

3.1.8.1 Appalachian Basin Region Mining

The Appalachian Basin region includes coal reserves located in Alabama, Georgia, eastern Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (Figure 3.1-18). This region accounts for approximately 20 percent of the Nation's overall demonstrated reserves, 35 percent of the Nation's demonstrated bituminous reserves, and 98 percent of the Nation's demonstrated anthracite reserves.

Figure 3.1-18 Appalachian Basin Coal-Bearing Region

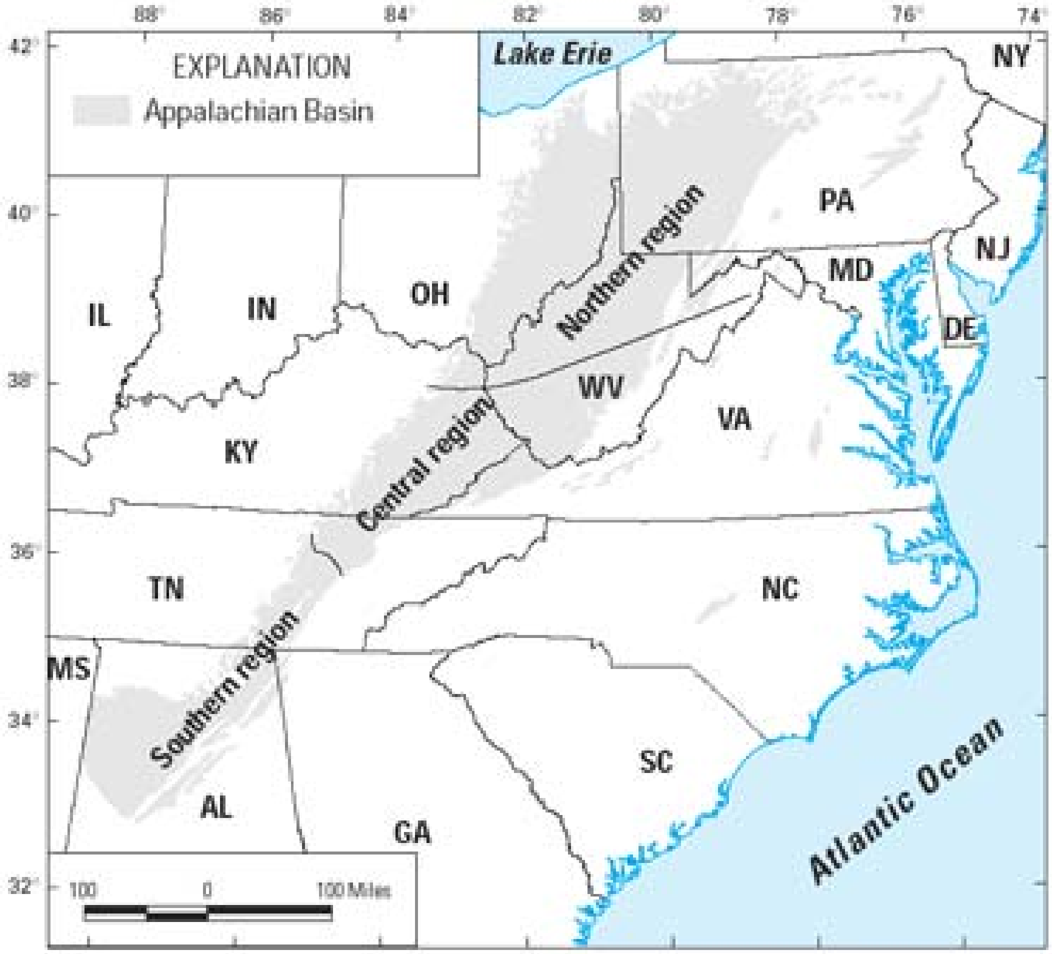


Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Location of Regional Coal Reserves

In practice, the Appalachian region has traditionally been divided into three coal-producing regions based on geologic structure and stratigraphy: the Northern Appalachian region, located in western Pennsylvania, eastern Ohio, western Maryland, and northern West Virginia; the Central Appalachian region, located in west-central and southwestern West Virginia, eastern Kentucky, northern Tennessee, and southwestern Virginia; and the Southern Appalachian region, located in southern Tennessee, northern Alabama, and northwestern Georgia (Figure 3.1-19).

Figure 3.1-19 Locations of the Three Appalachian Basin Coal Regions



Source: Ruppert, L., et al., 2005, Coal Resources of Selected Coal Beds and Zones in the Northern and Central Appalachian Basin, Figure 1, USGS, Fact Sheet 004-02. http://pubs.usgs.gov/fs/fs004-02/fs004-02.html

Property Ownership

Federal surface lands along the eastern seaboard of the U.S. include U.S. military properties, national parks and forests, water bodies, and other recreational areas and monuments. The U.S. also holds some land in trust for Indian tribes or individual Indians. A U.S. Geological Survey (USGS) study determined that within four coal beds in the Appalachian Basin region, the federal surface ownership accounts for less than five percent of their total resource areas (USGS, 2005a).

While surface ownership does not necessarily imply ownership of mineral rights, remaining coal resources underlying federal surface ownership have been estimated by the USGS at about 8.3 billion tons in five coal beds in the Appalachian Basin region, of which only a portion is likely available or economically feasible to mine. These statistics show that a significant amount of coal resources appear to be located under federal lands in this region.

Types of Coal Resources

Bituminous and anthracite coal are mined in the Appalachian Basin region. Bituminous coal is found throughout the Appalachian Basin region, while anthracite is found almost exclusively in northeastern Pennsylvania. The majority of the coal resources in this region are located in thick beds with low to medium sulfur content and high BTU content. The remaining resources are located in medium to thin beds and generally have higher sulfur contents. High BTU resources remain recoverable through underground methods, while few large surface mineable resources remain (Luppens et al., 2009).

Extraction Method

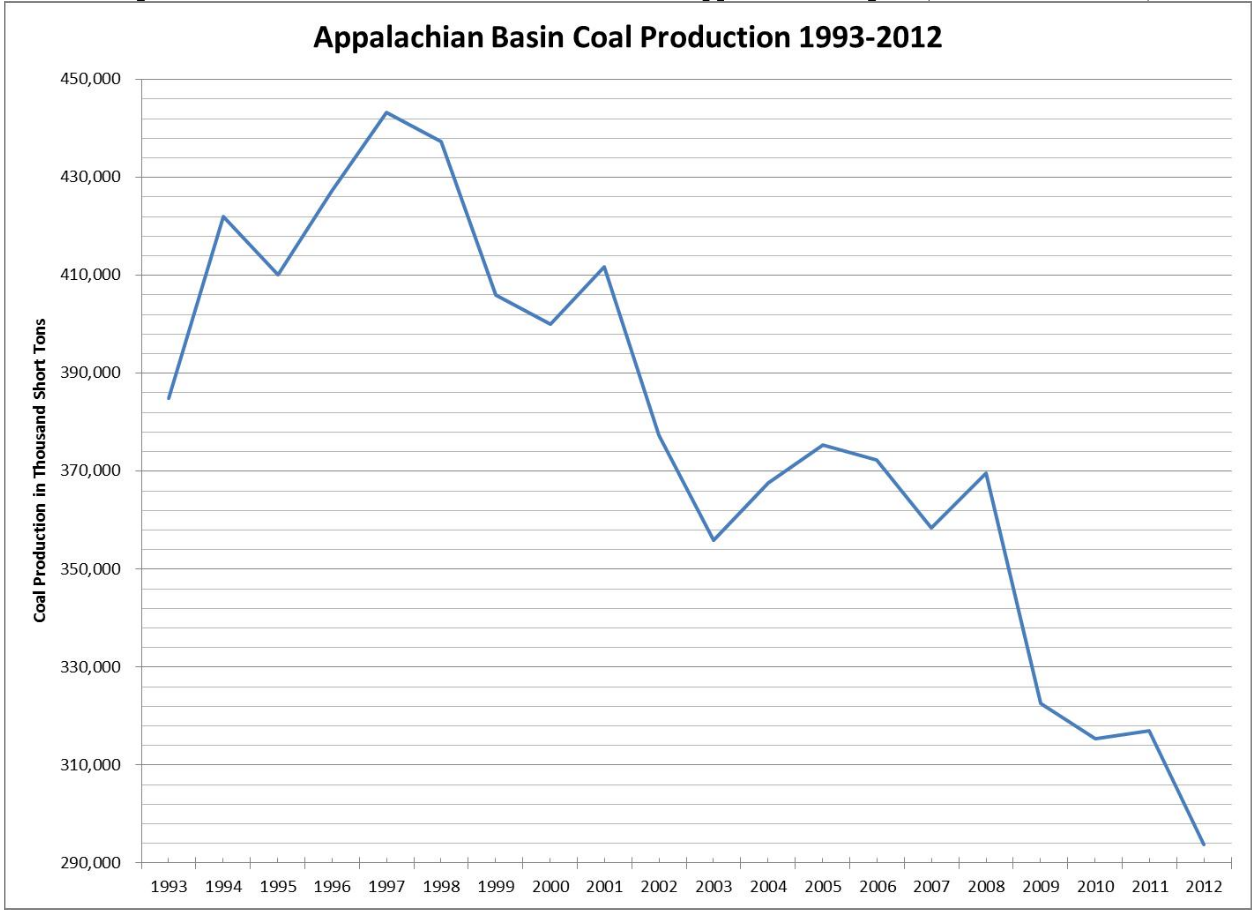
Surface mining accounted for 34 percent of the production in the Appalachian Basin region in 2012, with over 12.4 billion tons of surface mining recoverable coal reserves remaining. Underground mining accounted for 66 percent of the production in the Appalachian Basin region in 2012, with estimated recoverable underground reserves of approximately 35 billion tons. Longwall mining operations produced 47 percent of the 2011 underground coal in this region. Appalachia leads the nation in underground coal production and has 18 of the 41 total U.S. longwall installations, more than any other region.

Coal Production, Production Trends, and Number of Mines

Overall, Appalachia produced approximately 293 million tons of coal in 2012, a decrease of 13 percent (or 43 million tons) from 2011 (Figure 3.1-20). Fourth quarter 2012 production in the Appalachian Basin region totaled 67.9 million short tons, declining 1.7 percent and 17.3 percent from the third quarter 2012 and fourth quarter 2011, respectively.

In 2012, the Appalachian Basin region contained 701 active surface mines which produced approximately 99 million tons, while 466 underground mines produced approximately 194 million tons.

Figure 3.1-20 Coal Production Trends in the Appalachian Region (Thousands of Tons)

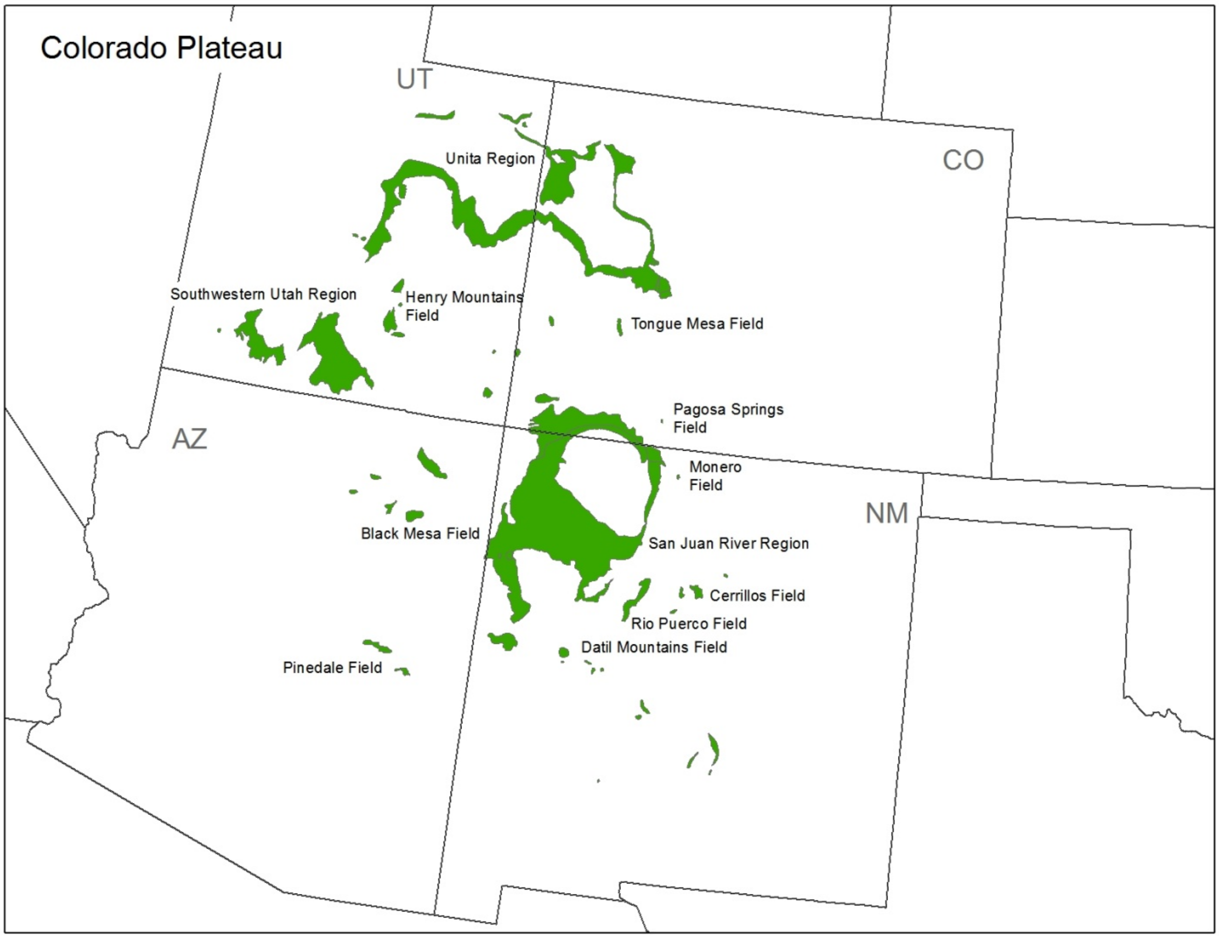


Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011*, U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

3.1.8.2 Colorado Plateau Mining

The Colorado Plateau physiographic region includes coal reserves in Colorado, Utah, New Mexico and Arizona (Figure 3.1-21). Colorado, Utah, and New Mexico account for the majority of coal production within the Colorado Plateau. The total estimated demonstrated reserves within this region are 33.2 billion tons, 19.1 billion of which are considered recoverable. Recoverable reserves include mostly bituminous and subbituminous coal with a minimal amount of anthracite. Coal from this region is high in calorific value (BTU/lb.) and low in sulfur content.

Figure 3.1-21 Colorado Plateau Coal-Bearing Region



Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Location of Regional Coal Reserves

The coal-bearing regions in the Colorado Plateau are predominantly located in western Colorado, eastern Utah, and northwestern New Mexico. As shown, major coal fields in this region are the Uinta Region, Henry Mountains, the Southwestern Utah Region in Utah; the San Juan River Region coal fields, which straddles the border between Colorado and New Mexico; the Black Mesa coal field in northern Arizona and the Datil Mountains; the Rio Puerco; the Cerrillos Field; and Monero Fields in Western New Mexico. The creation of the Grand Staircase – Escalante National Monument in 1996 in southern Utah has limited coal recovery in the Southwestern Utah Region.

Property Ownership

Coal is present beneath federal, tribal, state, and private lands in the Colorado Plateau region. About 50 percent of the surface coal-bearing areas in the Colorado Plateau region are administered by the Bureau of Land Management, the U.S. Forest Service, the National Park Service, or other federal agencies. About 23 percent of the coal-bearing area consists of tribal lands, which, although held in trust by the U.S. government, are not considered federal lands.

About 26 percent of the coal-bearing region is administered by state agencies or is privately owned.

In 1997, about 30 percent or 330 million tons of coal mined in the U.S. came from federal lands; 52 million of those tons came from the Colorado Plateau region. Approximately 71 percent of the region's total coal resources (more than 360 billion tons) are federal coal (USGS, 2000a; USGS, 2001b).

Types of Coal Resources

The Colorado Plateau contains both bituminous coal, which spans the border of Colorado and Utah and the Black Mesa coal field in Arizona, and subbituminous coal, which exists predominantly in New Mexico and parts of Colorado. The San Juan Basin continues to contain large amounts of low to medium sulfur, low BTU, high ash coal that is recoverable through dragline or truck and shovel methods. Longwall operation is used for most deep mining, where coal seams are thicker, low in sulfur, and contain high BTU values.

Extraction Method

Surface mining accounted for about 40 percent of production in the Colorado Plateau in 2012; most of these operations employed medium or large open pit or area mines. It's estimated that about eight billion tons of coal are recoverable by surface methods (U.S. EIA, 2012a).

Underground mining accounted for 60 percent of production in 2012, with 96 percent of that coming from longwall mining operations. The other four percent of underground production uses the continuous and conventional mining methods. The U.S. EIA estimates that about 11.1 billion tons are recoverable by underground methods in the region.

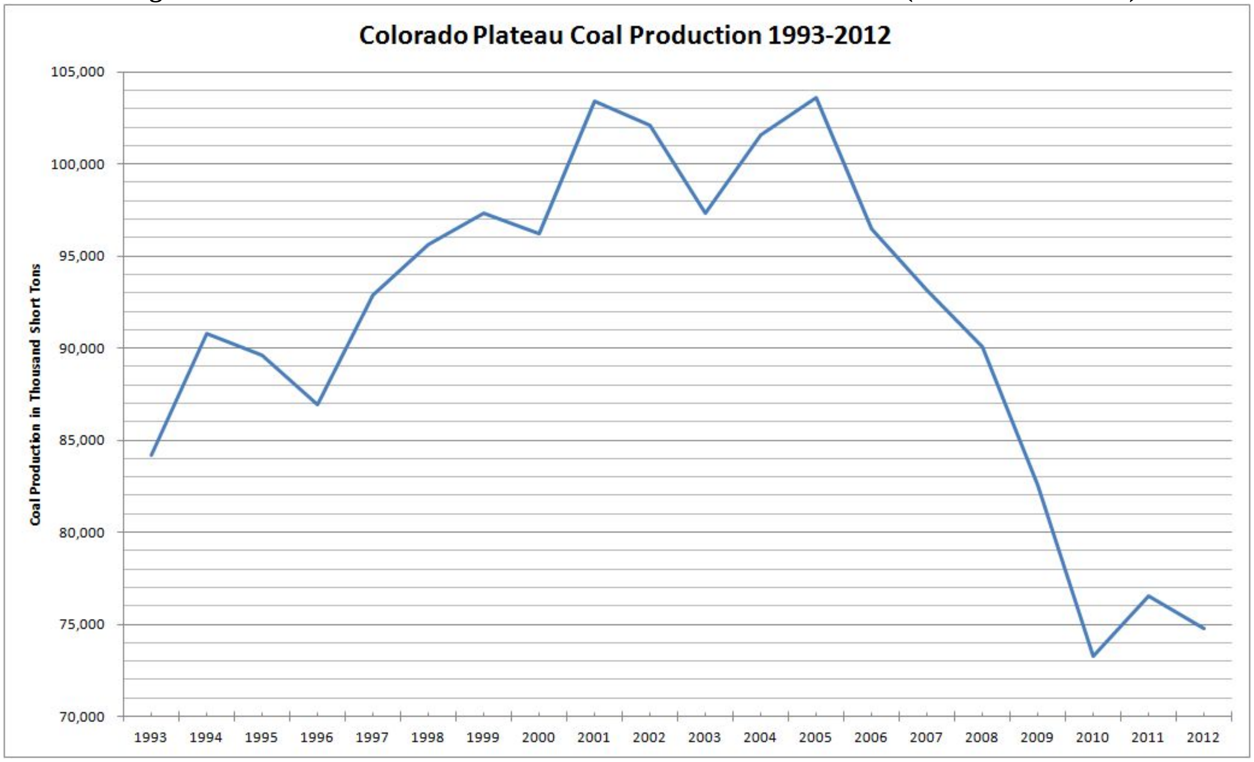
Coal Production, Production Trends, and Number of Mines

In 2012, the Colorado Plateau region produced a total of 74.8 million tons of coal (Figure 3.1-22).

In 2012, the Colorado Plateau contained 24 underground mines which produced approximately 45 million tons of coal and eight surface mines which produced approximately 30 million tons.

The U.S. EIA estimates that about 19.1 billion tons of coal is recoverable within this region, making up 58 percent of the region's demonstrated reserves. These reserves represent about seven percent of the nation's recoverable reserves.

Figure 3.1-22 Coal Production Trends in the Colorado Plateau (Thousands of Tons)



Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011*, U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

3.1.8.3 Gulf Coast Region Mining

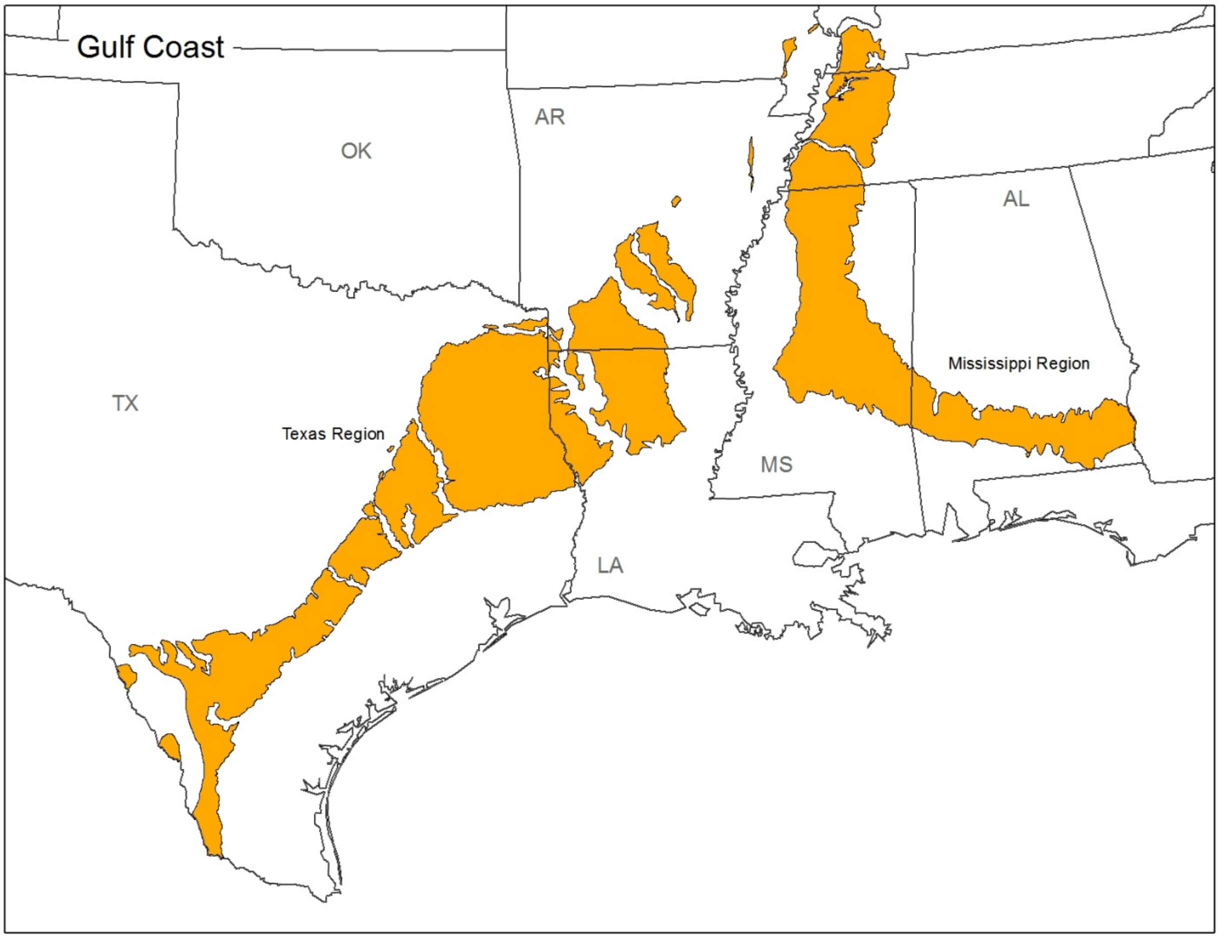
Location of Regional Coal Reserves

The Gulf Coast region is home to a widespread area of primarily lignite coal reserves, the majority of which are located in Texas, the largest coal-producing state in the region. The coal-bearing area runs mainly through southeastern Texas, northern and central Louisiana, Mississippi, southern Alabama, and southern and eastern Arkansas (Figure 3.1-23). These lignite-producing areas include coal measures from the Tertiary Period – Eocene Epoch of the Claiborne Group, the Wilcox Group, the Jackson Group, the Naheola Formation, and the Olmos Formation.

Property Ownership

Federal surface lands in the Gulf Coast region include lands managed by the U.S. Department of Defense, U.S. Department of Agriculture Forest Service, and the U.S. Fish and Wildlife Service. The U.S. also holds some land in trust for Indian tribes or individual Indians. Although no systematic inventory of federal mineral ownership exists for this region, initial studies indicate that about half of the federal surface estate in the Gulf Coast region is underlain by federally owned minerals.

Figure 3.1-23 Gulf Coast Coal-Bearing Region



Source: Data: USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Types of Coal Resources

Virtually all of the remaining reserves in this region are lignite, the lowest rank of coal with the lowest amount of energy (BTUs). The demonstrated reserve base in the Gulf Coast region is estimated to be 16.6 billion tons. Remaining recoverable reserves in the region are estimated to be 12.3 billion tons, or 74.3 percent of the demonstrated reserve base. All of the remaining reserves in the region are lignite.

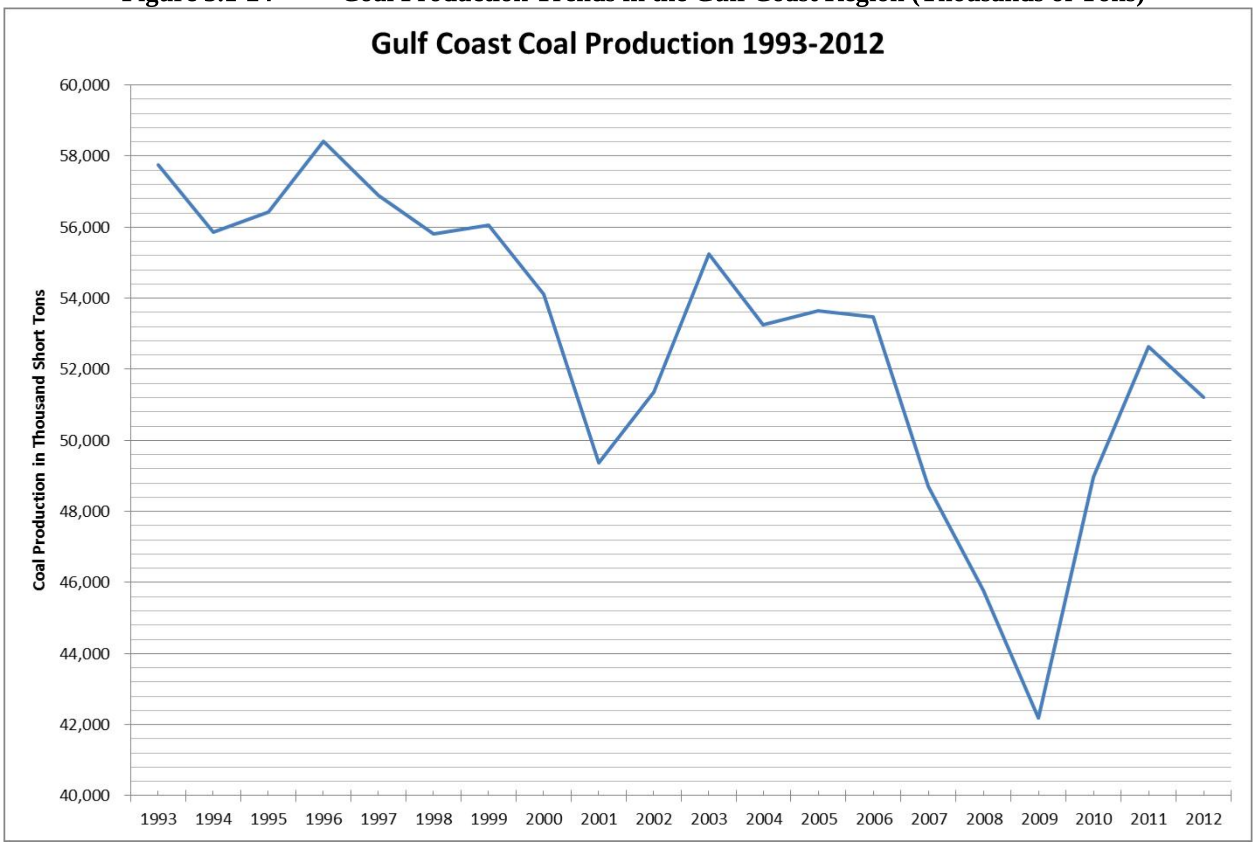
Extraction Method

Mining currently in this region occurs exclusively by surface methods, although historically prior to SMCRA underground mining occurred in Texas. The predominant mining technique is by dragline which is ideal due to the relatively unconsolidated overburden and flat digging conditions. Scrapers may be used in some operations with smaller outputs where thinner seams are mined. Most remaining deposits are multi-bedded and would require a combination of dragline and truck and shovel methods to extract. Bucket wheel excavator stripping operations are employed, as well, but limited to special conditions and circumstances (Kahle and Mosely, 1983).

Coal Production, Production Trends, and Number of Mines

Overall, the Gulf Coast produced 51.1 million tons of coal in 2012, 86 percent of which was mined in Texas. The remaining 14 percent was mined in Mississippi and Louisiana (Figure 3.1-24). As of 2012, the Gulf Coast region had 19 active surface mines.

Figure 3.1-24 Coal Production Trends in the Gulf Coast Region (Thousands of Tons)



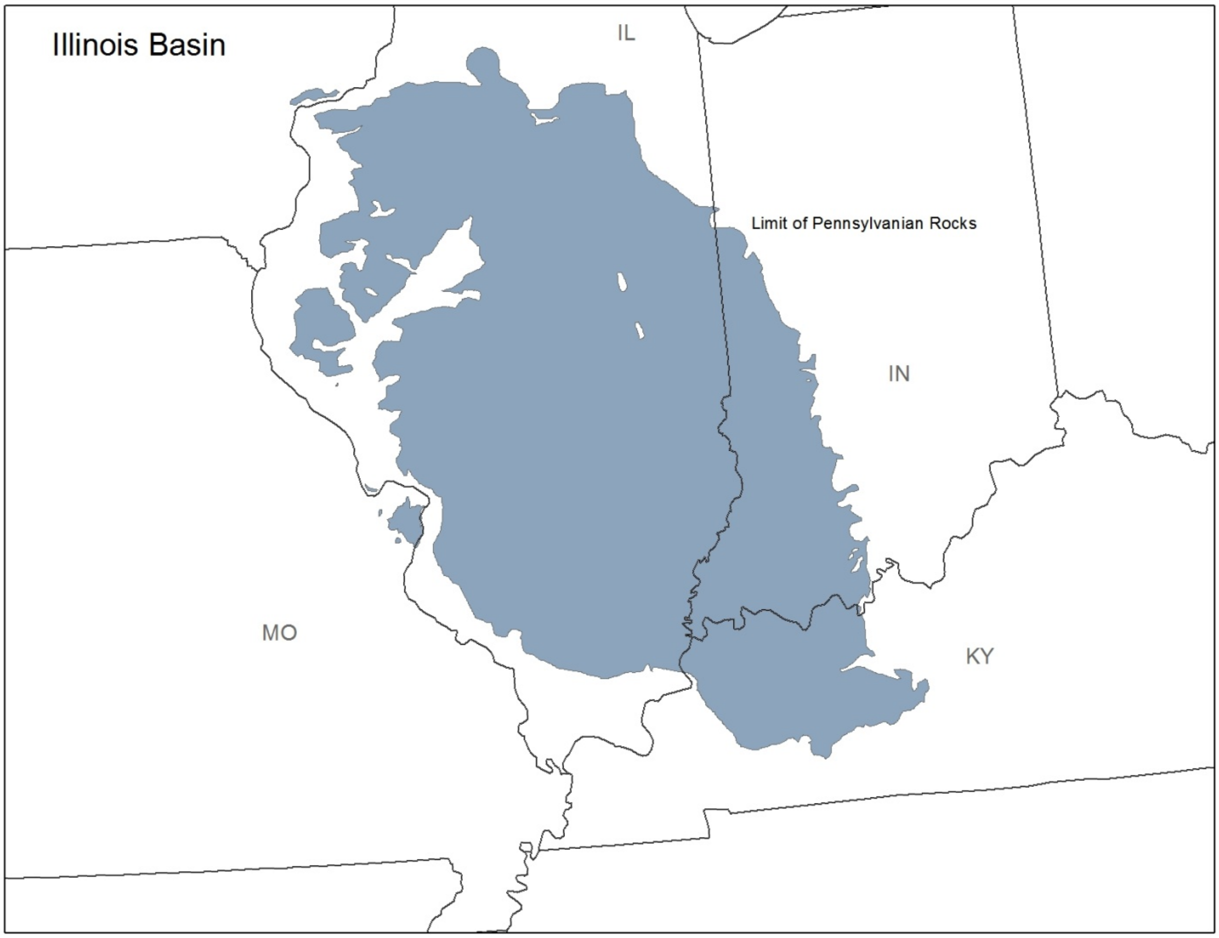
Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011,* U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013.

3.1.8.4 Illinois Basin Region Mining

Location of Regional Coal Reserves

The Illinois Basin region includes Illinois, Indiana, and Western Kentucky (Figure 3.1-25). Michigan, which has one coal-bearing region, while not part of the Illinois Basin region, is mentioned here, but will otherwise not be discussed as part of the DEIS as there is currently no active mining in the state.

Figure 3.1-25 Illinois Basin Coal-Bearing Region



Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Property Ownership

Federal land ownership in the Illinois Basin region is minimal, but includes the Shawnee National Forest in Southern Illinois, the Hoosier National Forest in Indiana, and several small National Wildlife Refuges.

Description of Coal Reserves

All coal in the Illinois Basin region is bituminous. About 78 percent of the coal resources in this region are located in Illinois. The vast majority of potential coal reserves in the region (about 93 percent) are considered high-sulfur, with just six percent and one percent of medium- and low-sulfur coal, respectively (USGS, 2009).

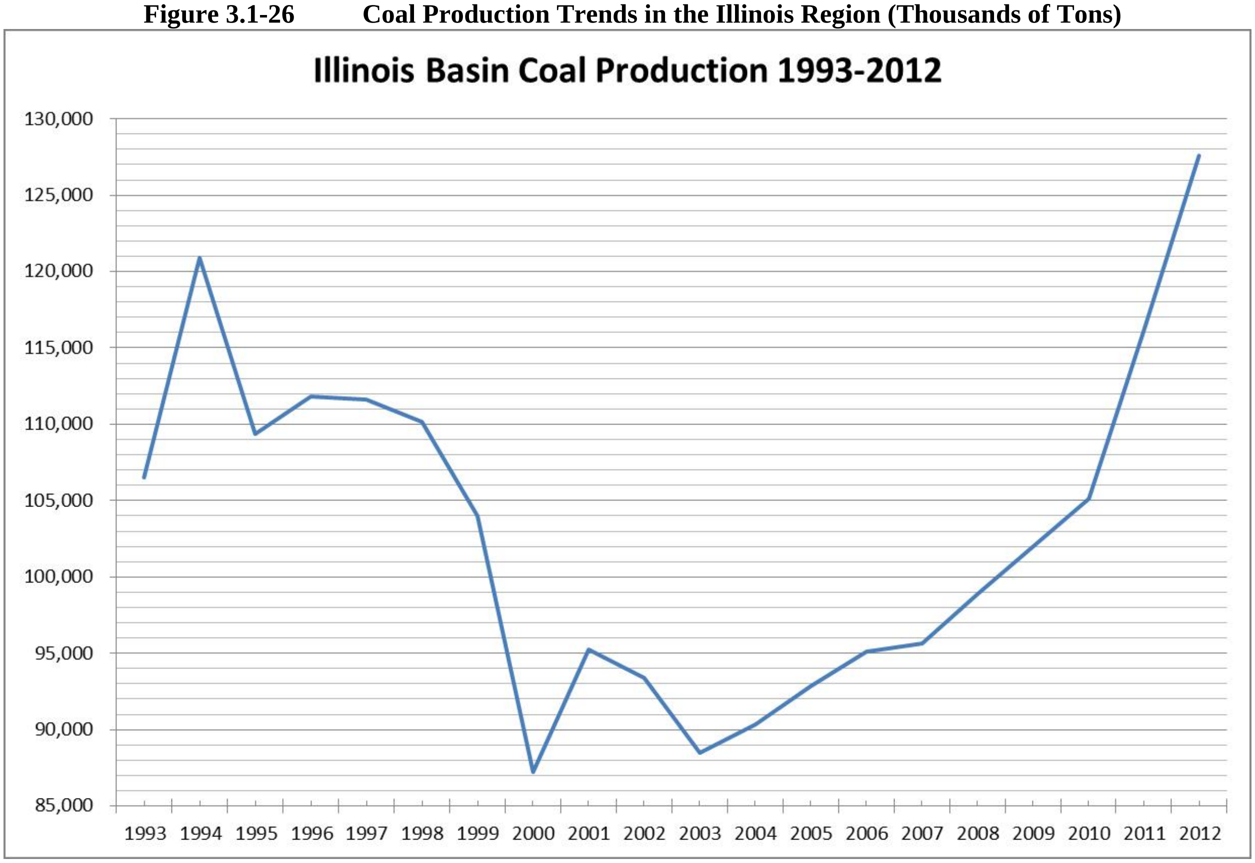
Extraction Method

Surface mining accounted for 27 percent of the production in the Illinois Basin region in 2012, with estimated recoverable surface mineable reserves at 12.6 billion tons. The dragline method had been the primary surface mining method in this region, but as smaller surface mines have become more predominant the use of more flexibly and less expensive truck-shovel mining techniques have increased. Underground mining is the dominant mining method in this region, making up 73 percent of the production in the region in 2012. Approximately 38 billion tons are estimated to be recoverable through underground mining in the Illinois Basin region. Most of the coal produced by underground mining (83 percent) uses the continuous room and pillar mining method, while the remainder is produced by longwall mining.

Coal Production, Production Trends, and Number of Mines

The Illinois Basin region produced 127 million tons of coal in 2012 (Figure 3.1-26). Of the demonstrated reserves in this region, about 38 percent, or 50.7 billion tons, are estimated by the U.S. EIA to be recoverable. The Illinois Basin region has seen a fairly significant increase in coal production over the last ten years due to the installation of scrubber technology by Midwestern power generators that allow the use of higher sulfur coals typically produced in the basin. This technological conversion by utilities has allowed them to turn from lower sulfur energy sources, typically from the Powder River Basin in Wyoming, to sources from within the Illinois Basin.

Figure 3.1-26 Coal Production Trends in the Illinois Region (Thousands of Tons)



Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011*, U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

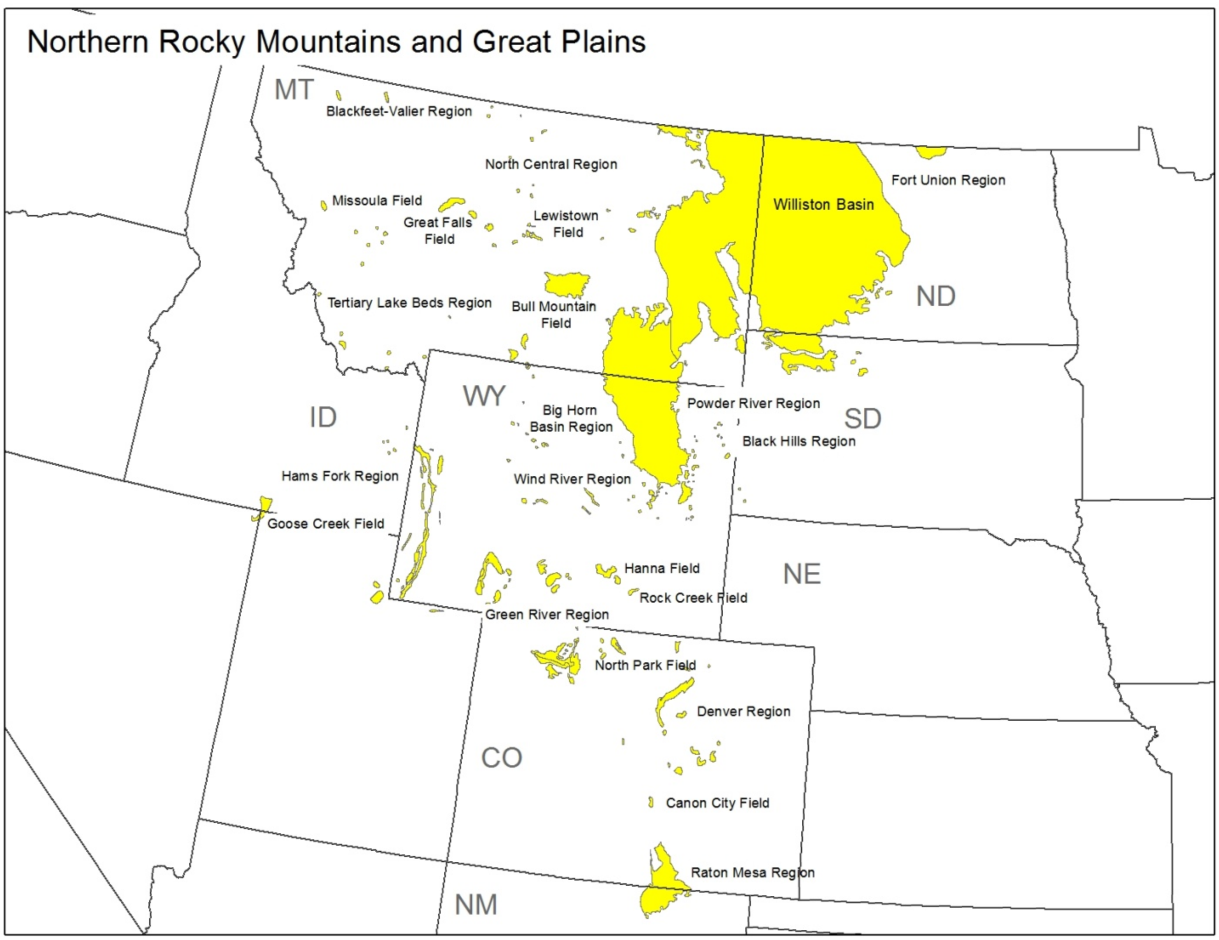
In 2012, there were 50 surface mines in the region, which produced approximately 35 million tons of coal, while 43 underground mines produced approximately 92 million tons.

3.1.8.5 Northern Rocky Mountains & Great Plains Region Mining

Location of Regional Coal Reserves

The Northern Rocky Mountains and Great Plains has coal reserves distributed through parts of Wyoming, Montana, North Dakota, South Dakota, and Colorado (Figure 3.1-27). As shown, the predominant coal fields in this region are the Raton Basin, Green River Region, Powder River Region, Bull Mountain Field, and Williston Basin. The Power River Region, which straddles Montana and Wyoming, and the Williston Region in North Dakota and Montana represent some of the most abundant coal deposits in the U.S.

Figure 3.1-27 Northern Rocky Mountains and Great Plains Coal-Bearing Region



Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Property Ownership

Most federal coal production comes from coal regions in the Northern Rocky Mountains and Great Plains region. The surface of about 32 percent of the 313 million acres of land in this region is federally managed. About 80 percent of coal in this region, 520 billion tons, is federally owned. Federal coal production in 1997 came predominantly from Wyoming and Montana and totaled about 280 million tons. Federal coal production generates more than a quarter billion dollars in royalties annually (USGS, 2000a).

Sixty-eight percent of surface property in this region is owned by tribal, state, and private entities.

Types of Coal Resources

The Northern Rocky Mountains & Great Plains region contains all ranks of coal, excluding anthracite. Bituminous and subbituminous resources are found in Wyoming and Montana, and lignite resources are found in the Montana, North Dakota, and South Dakota. Approximately 94 percent of the coal mined in this region is subbituminous, five percent being lignite and approximately one percent being bituminous (U.S. EIA, 2012a). The Powder River Basin is by far the nation's largest source of low sulfur coal (USGS, 2000a).

Extraction Method

About 98 percent of the mining in this region is surface mining. These mines tend to have a low stripping ratio, generally 1:1 to 4:1. Such minimal ratios are due to the combined benefits of shallow overburden and thicker coal seams. Recoverable reserves by strip mining are estimated to be 65.4 billion tons as of 2009.

Surface mines in this region are primarily medium or large open pit mines. In parts of the region, 70-foot or thicker seams exist and overburden to coal ratios of 1:1 or less are not uncommon. Open-pit mining in these seams begins with uncovering a sufficient area of coal to allow extraction and to provide an open area for future overburden placement. Initial overburden is spread and stored on adjacent land areas and revegetated. Coal thickness usually necessitates a benching operation for removal with a loading shovel or similar equipment. Expansion of the pit can proceed in any direction from this initial point, usually along only one course at a time until a limit is reached, such as a natural barrier, property line or outcrop. Overburden is sometimes removed by a dragline, and trucked and dumped in mined-out areas of the pit and later graded to a contour compatible with surrounding terrain.

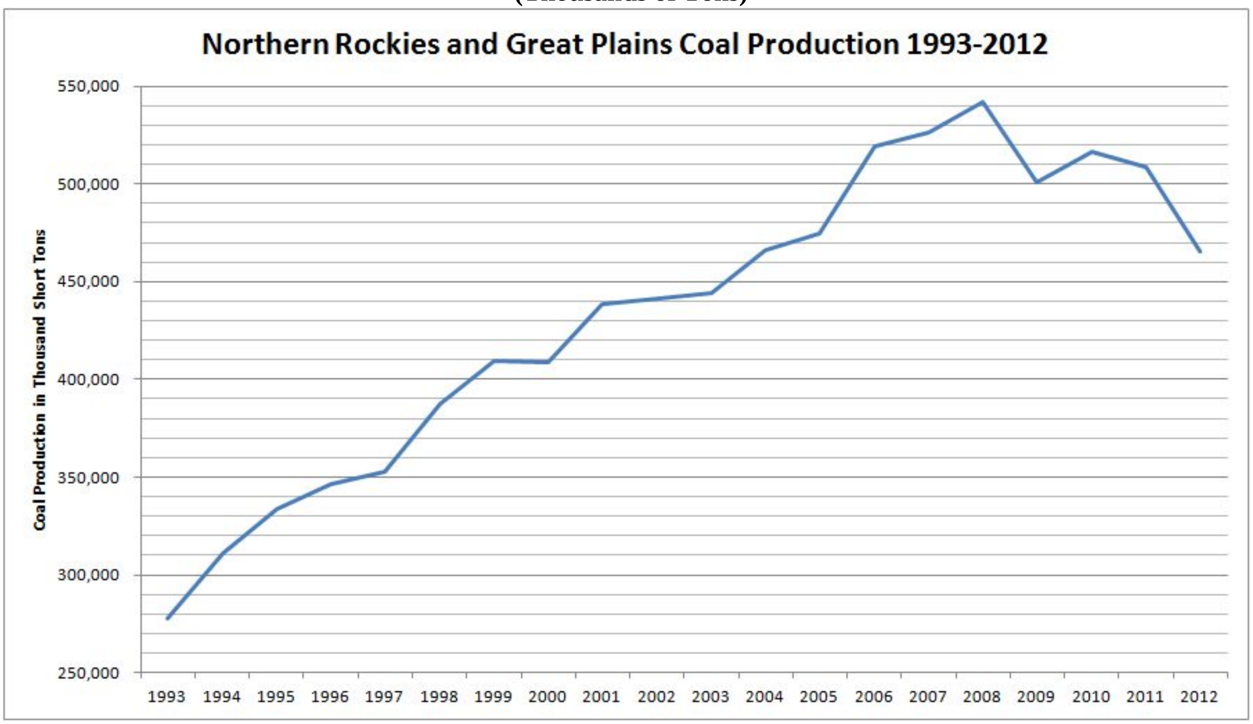
Underground mining accounted for the remaining two percent of coal production in 2012. However, the resources estimated to be recoverable by underground mining in this region were 58.8 billion tons (U.S. EIA, 2012a).

Coal Production, Production Trends, and Number of Mines

In 2012, the region had 27 surface mines producing 455 million tons of coal and two underground mines producing ten million tons of coal (Figure 3.1-28). In 2012, ten mines from this region were the top ten producing mines in the U.S. Of these top ten producing mines, nine are located in Wyoming, and the remaining one is in Montana. These ten mines produced 38 percent of the coal in the entire nation in 2012. The top two producing mines in Wyoming accounted for 20 percent of the coal produced in the U.S. in 2012.

The region contains about 206 billion tons in demonstrated reserves, 63.2 percent of which are estimated to be recoverable. About 82 percent of the demonstrated reserves consist of subbituminous coal found in Wyoming and Montana. At active mine sites, the region contains about nine billion tons in recoverable reserves, equal to about 53 percent of the unmined recoverable reserves at permitted mines in the United States. Montana has the largest amount of coal resources and coal reserves of any state in the nation, and Wyoming mines about 40 percent of the nation's coal, mostly coming from the Powder River Basin.

Figure 3.1-28 Coal Production Trends in the Northern Rocky Mountains and Great Plains Region (Thousands of Tons)



Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011*, U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

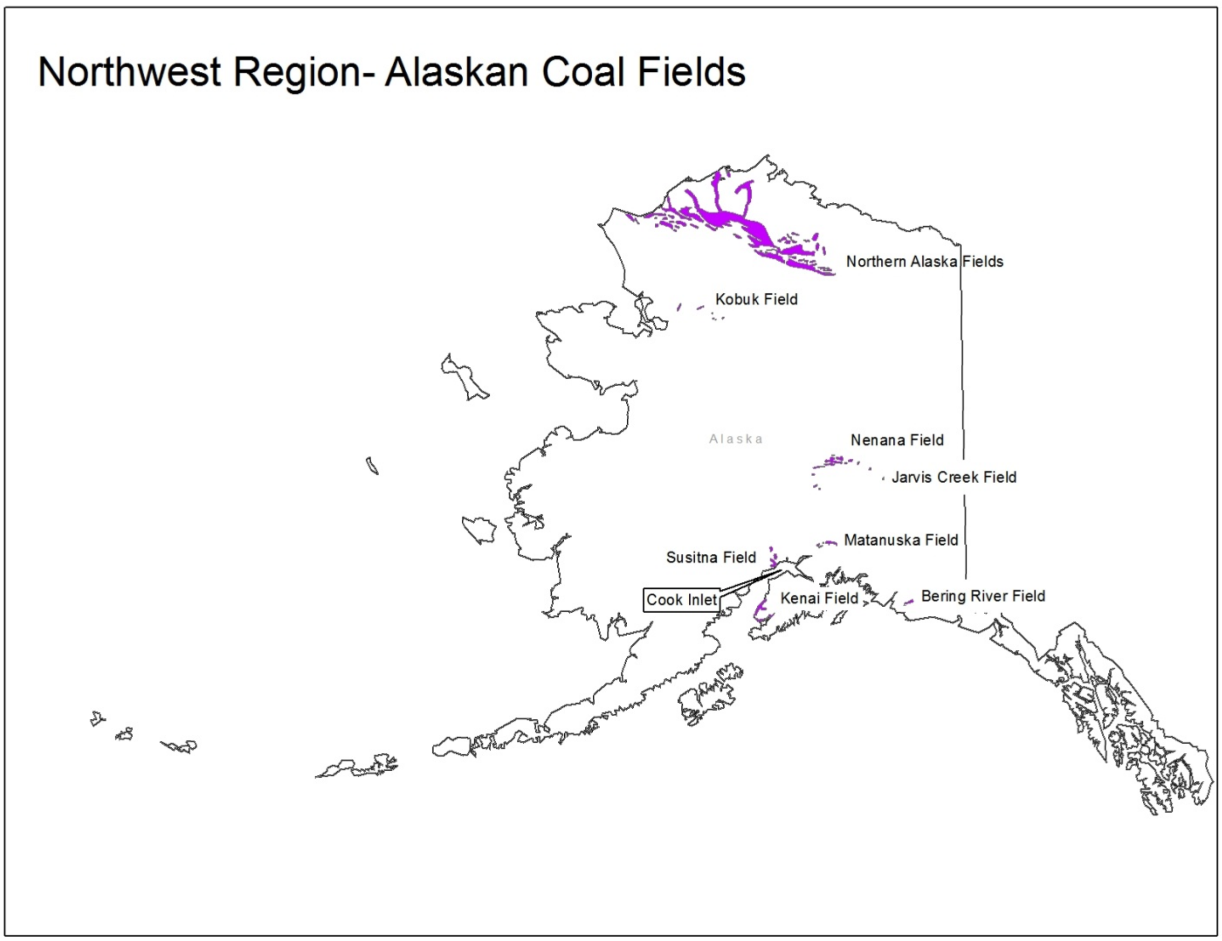
3.1.8.6 Northwest Region Mining

Location of Coal Reserves

The Northwest Coal region includes potentially mineable coal resources in Oregon, Washington and Alaska. The description of the affected environment in this DEIS will be limited to two fields in Alaska (Nenana and Matanuska Fields) because there is no active mining, nor evidence of continued production in Oregon, Washington, or northern Alaska. Oregon has not had any mining in the past ten years nor is any expected in the future. Future significant production is not reasonably foreseeable in the state of Washington as coal production here is historically very low with poor quality reserves. There is currently no active coal extraction in Washington; the only mining activity is reprocessing coal waste impoundments. Coal in Alaska, while abundant, has not been produced in large quantities because of constraints involving coal depth, transportation options, and coal quality. Coal exportation is limited in the northern Alaska coal field due to restricted access in the winter due to remoteness of the area, complexity of mine development and difficulty in transporting coal to regional markets and coastal shipping locations.

The coal resources of Alaska discussed in this DEIS are the Nenana and Matanuska coalfields of the interior (Figure 3.1-29). The interior coalfields exist primarily within the northern foothills of the Alaska Range. The terrain includes steep bluffs and rolling plateau topography with deep stream valleys and steep slopes. At lower elevation the topography transitions to irregular hummocky terrain. Elevations range from 1,200 to 4,400 feet above mean sea level. Usibelli Coal Mine is currently the sole surface coal mine operator in Alaska and holds several active surface coal mine permits located adjacent and concurrent to each other in the Nenana coal field. Usibelli Coal Mine also holds a surface coal mine permit for a location in the Matanuska field, but no active mining is currently taking place.

Figure 3.1-29 Northwest Coal-Bearing Region, Alaska



Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Property Ownership

The Northwest region has federal, tribal, state and private surface ownership. Only a small percentage of Alaska's National Parks, National Wild and Scenic Rivers, National Wildlife Refuges, and National Wilderness Preservation Systems are coal-bearing. Approximately two percent of these lands, or about 142,000,000 acres, are coal-bearing, and contain only 0.6 percent of the nation's demonstrated reserve base. In total, these areas contain approximately 4,086 million tons of mineable coal.

Types of Coal Resources

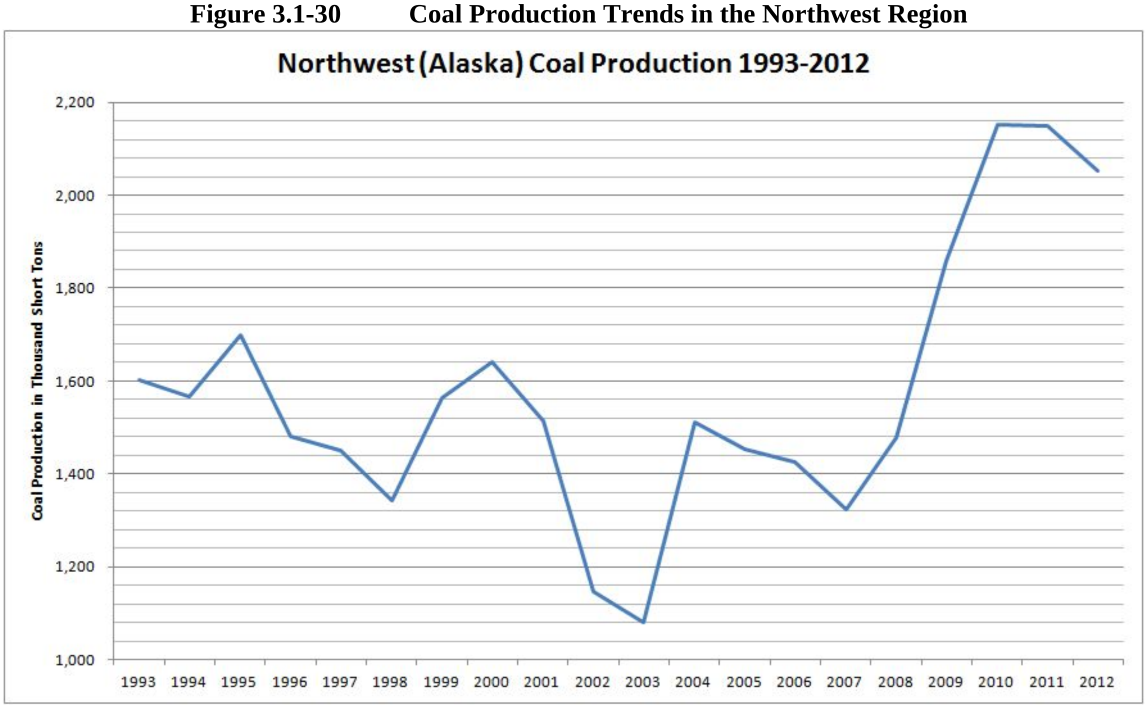
The Northwest region contains bituminous and lignite resources in Alaska. The total estimated recoverable reserves mineable by surface methods in Alaska are 489 million tons, while 2335 million tons are estimated to be recoverable by underground methods, with only about 674 million tons of the demonstrated reserve estimated to be mineable by surface methods (U.S. EIA, 2012a).

The Alaska's only active mine is the Usibelli surface coal mine, located about ten miles from the entrance to Denali National Park in the Healy-Nenana coal fields. While low in sulfur, the coal from the Usibelli mine has a low calorific value averaging 7,650 BTU/lb (Coal Age, 2009).

Coal Production, and Production Trends

The one active mine in 2012 produced approximately 2.052 million tons of coal (Figure 3.1-30).

Figure 3.1-30 Coal Production Trends in the Northwest Region



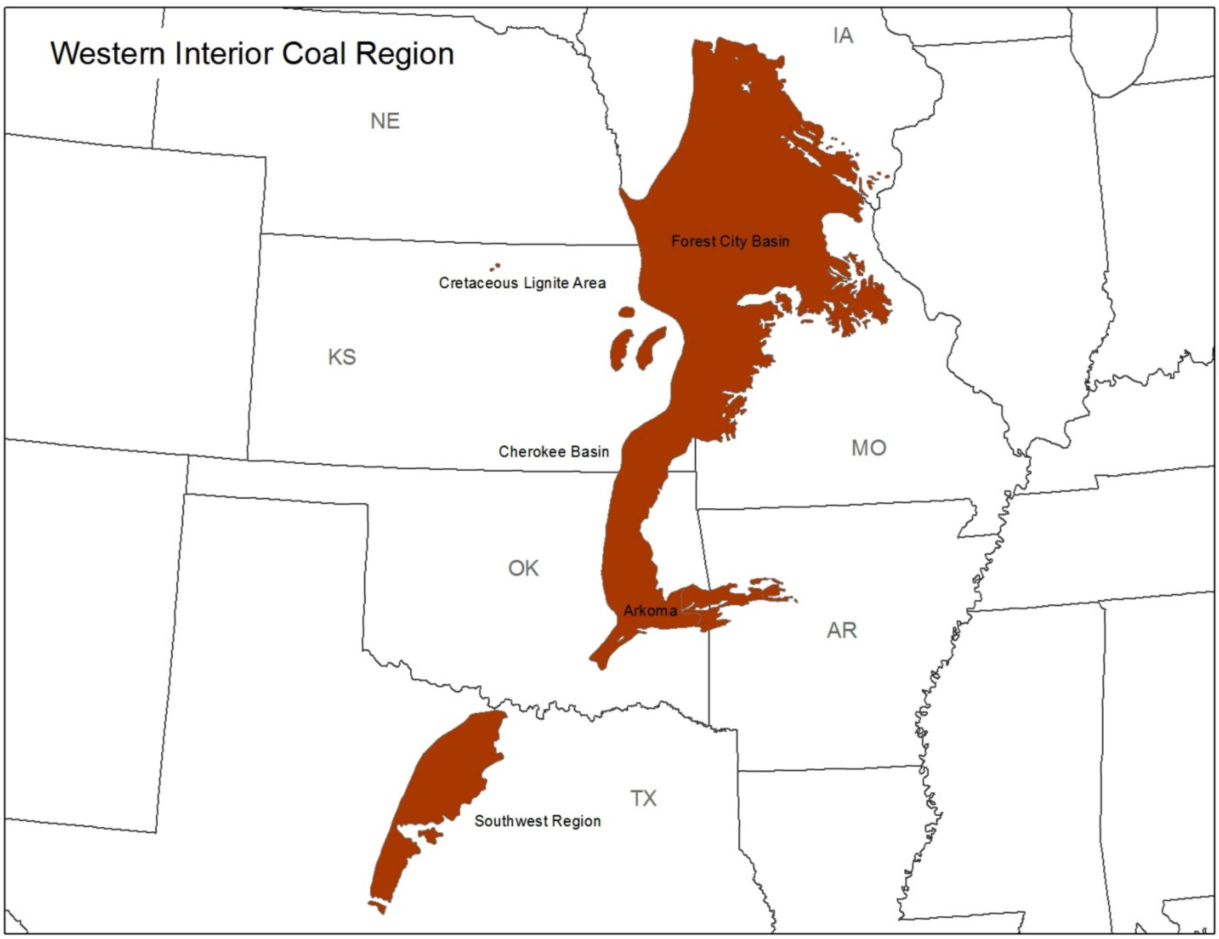
Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011,* U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

3.1.8.7 Western Interior Mining

Location of Coal Resources

The Western Interior region includes the states of Oklahoma, Kansas, Missouri, Iowa, and the west-central region of Arkansas (Figure 3.1-31). Missouri contains 25.7 percent of the estimated demonstrated reserves in the region; however, Oklahoma produces 66 percent of the currently mined reserves as of 2012. Note that while the figure includes the "Southwest Region" in Texas, no coal production in that area has been reported since the enactment of SMCRA, therefore this region in not included in the DEIS analysis.

Figure 3.1-31 Western Interior Coal-Bearing Region



Source: Data -USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Property Ownership

Federal land ownership in this region is limited largely to several national forests in Arkansas and Missouri. The U.S. also holds lands in trust for Indian tribes and individual Indians. Data on the location of coal reserves in relation to federally owned land for this region is lacking, though there is some SMCRA permitting of federally owned coal in Oklahoma.

Types of Coal Resources

The coal in this region is all bituminous, except for coal found in west-central Arkansas, which contains the third highest amount of demonstrated reserves of anthracite in the nation (after Pennsylvania and Virginia). All coal mined in 2012 was bituminous in rank.

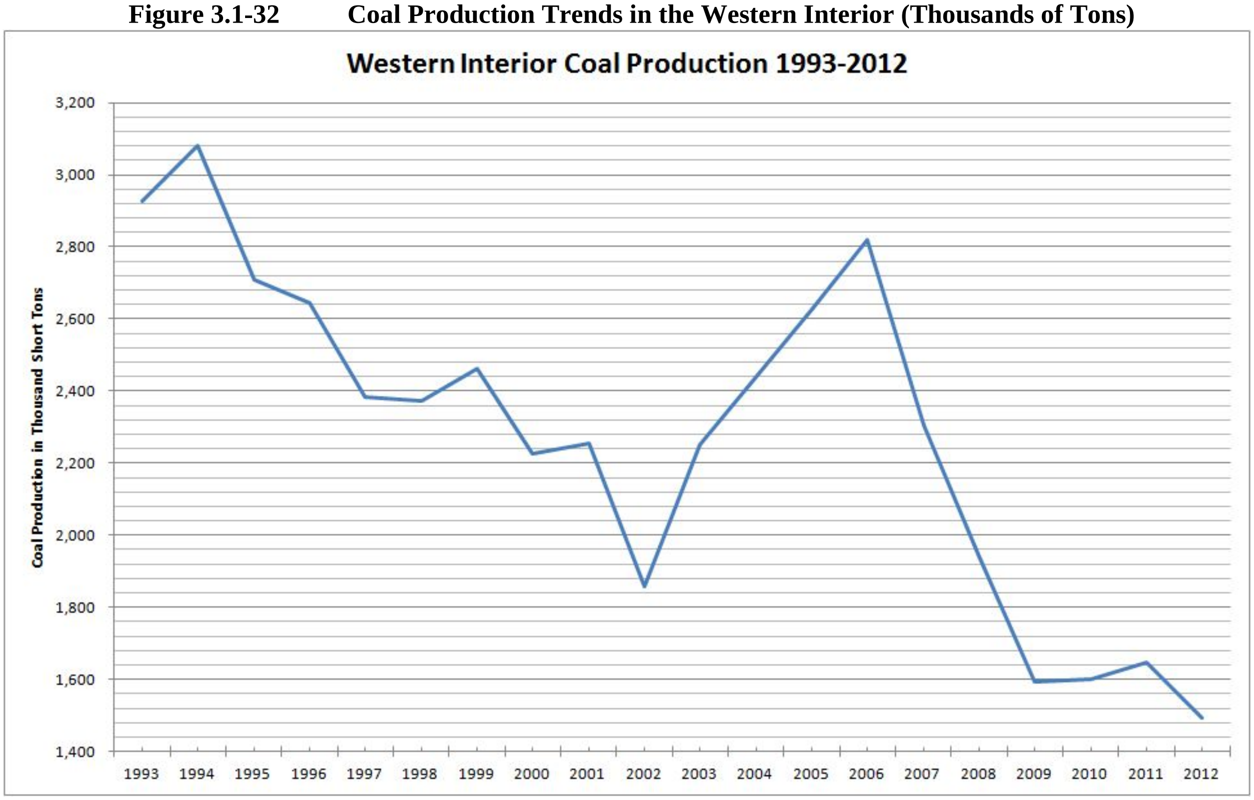
Extraction Methods

Mining methods in the Western Interior region include both area surface mining and underground mining methods. Surface mining accounted for 71.9 percent of production in this region in 2012, producing about 1.1 million tons. Remaining recoverable reserves mineable by surface methods total about 4.5 billion tons. Underground mining produced 0.4 million tons, or 28.1 percent of the production in this region in 2012. Of the three underground mines in the Western Interior region, two produced coal from Oklahoma, the other produced coal from Arkansas. The projected remaining reserves recoverable by underground mining methods in the region are 2.2 billion tons.

Coal Production, Production Trends, and Number of Mines

The Western Interior region consisted of ten surface mines which produced 1,143,856 tons and three underground mines which produced 445,689 tons in 2012 (Figure 3.1-32).

Figure 3.1-32 Coal Production Trends in the Western Interior (Thousands of Tons)



Source: 1993-2011 Data: U.S. EIA, *Table 1, Annual Coal Reports 1993-2011*, U.S. Department of Energy, http://www.eia.gov/coal/annual/archive/; 2012 Data: MSHA. 2012. MSHA Annual Coal Production Data 2012. Provided by OSMRE April 15, 2013

3.2 GEOLOGY

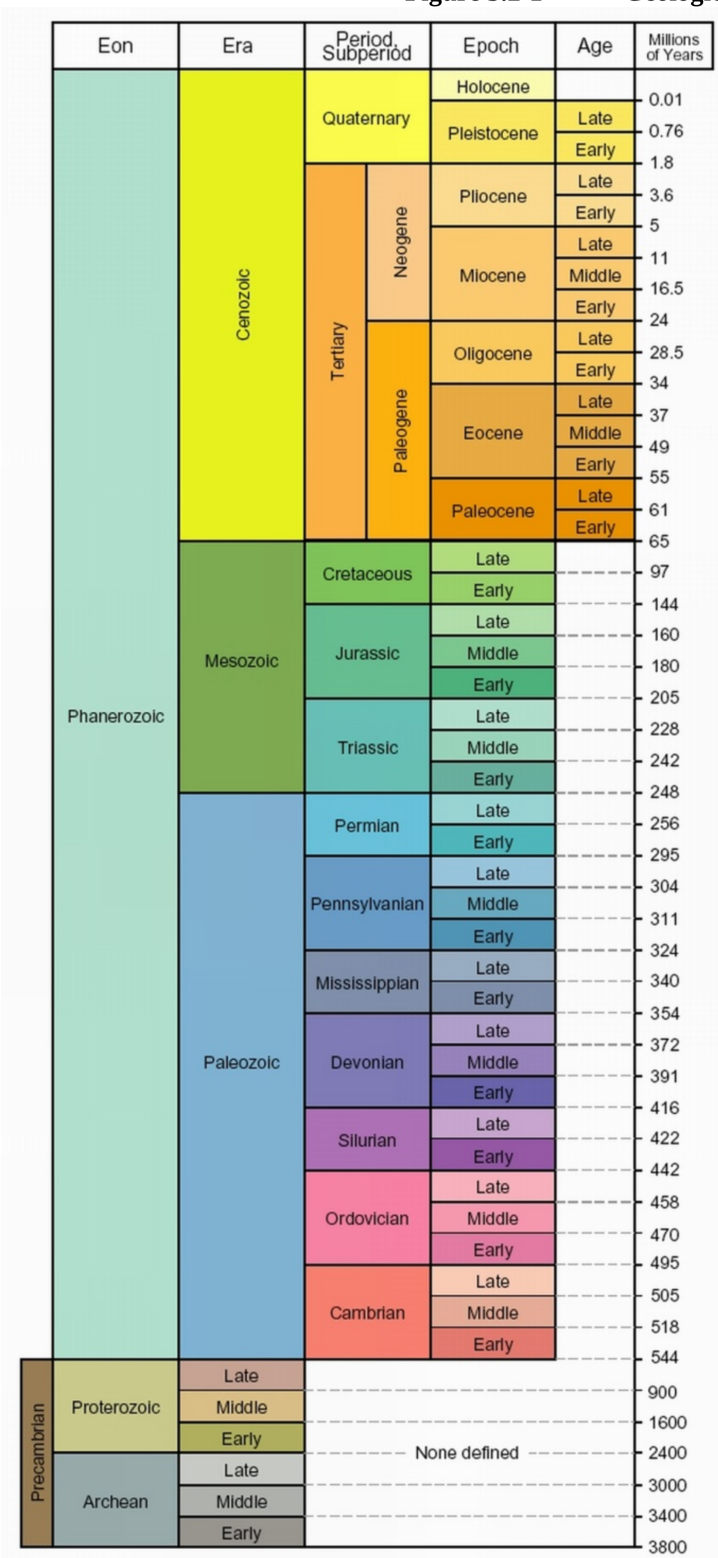
Geologic environments for the coal regions of the U.S. are analyzed relative to each region's depositional environment and geologic history. For purposes of this discussion, the geology is described according to each of seven coal-producing regions identified in Section 3.1. For a map depicting the location and extent of each of these regions see Figure 3.2-1.

The seven coal-producing regions described in this chapter are:

- Appalachian Basin;
- Colorado Plateau;
- Gulf Coast;
- Illinois Basin;
- Northern Rocky Mountains and Great Plains;
- Northwest; and
- Western Interior.

Within each region, discussions are further refined according to states, coal fields, or physiographic provinces. A physiographic province is a geographic region characterized by similarities of geology, landforms, and climate. Each province is notably distinct from surrounding areas. Some of the coal basins encompass such large areas that their geologic descriptions have been generalized. The geologic description of each basin is intended to familiarize the reader with each basin's geologic history as well as to introduce the names of major rock strata and coal-bearing units. A copy of the geologic time scale (See Figure 3.2-1) is provided here as a general reference for the geologic time terms used in the following discussions.

Figure 3.2-1 Geologic Time Scale



Source: The Science Education Resource Center at Carleton College, 2011, *Figure 1: Pre-Miocene- Geologic Time Scale*, Carleton College, http://serc.carleton.edu/research_education/nativelands/nezperce/geology.html

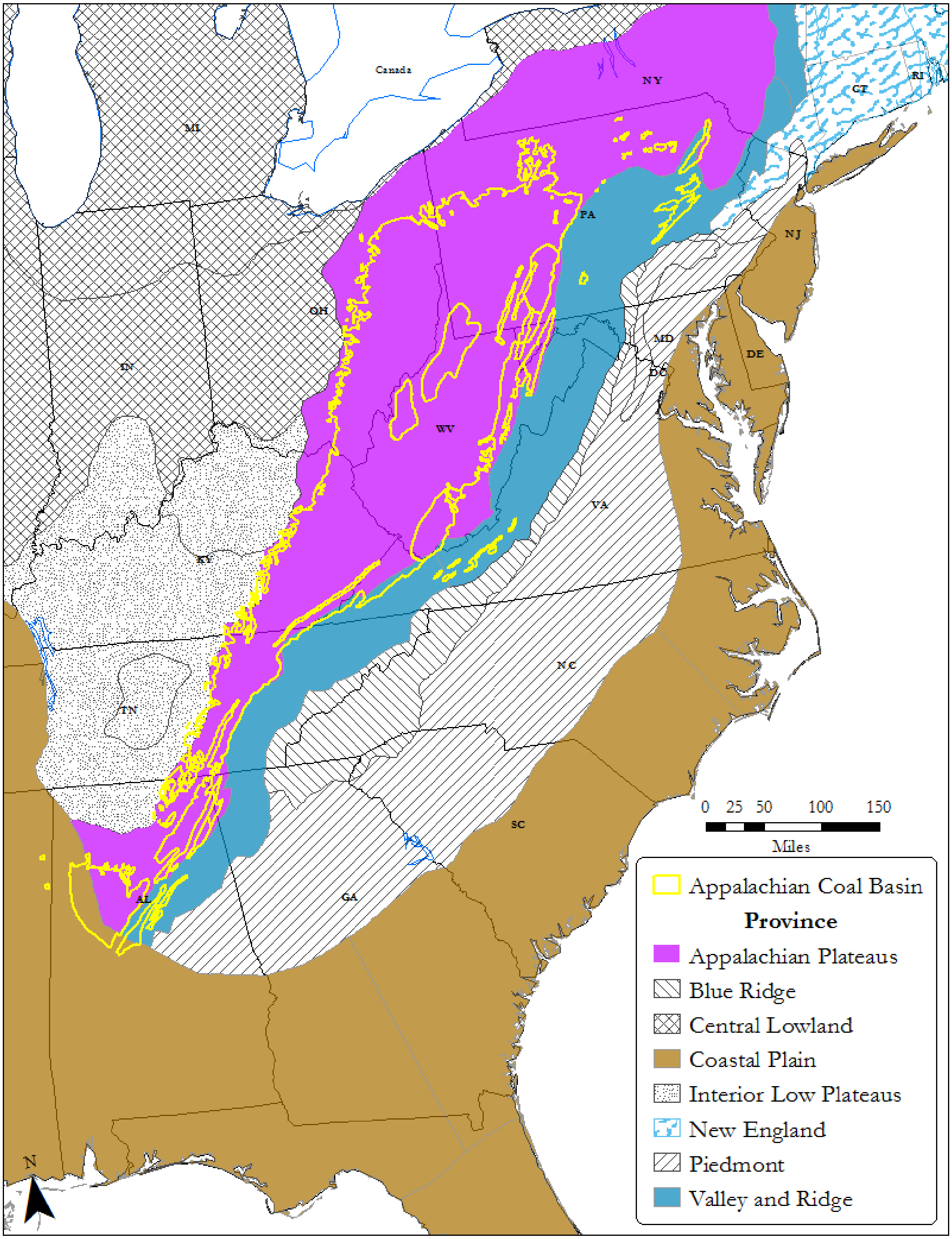
3.2.1 Appalachian Basin Region

The Appalachian Basin region forms a northeast-southwest trending belt, 90 to 370 miles wide, which can be subdivided into four physiographic provinces. From east to west these are: the Piedmont, the Blue Ridge, the Valley and Ridge, and the Appalachian Plateau provinces (See Figure 3.2-2). Coal-bearing strata occur primarily in the Appalachian Plateau and Valley and Ridge provinces.

The Appalachian Basin region (a depositional lowland) encompasses the coal-bearing areas of Pennsylvania, Ohio, Maryland, Georgia, West Virginia, Virginia, eastern Kentucky, Tennessee, and Alabama (See Figure 3.2-2). During the geologic time period known as the Pennsylvanian, (See Figure 3.2-1) streams flowed from minor uplands in the east toward an open marine environment to the west. The Appalachian Basin, located between these two regions, existed in a depositional setting marked by river flood plains, migrating streams, coastal swamps, marshes, peat bogs, sand bars, and lagoons. The shallow swamps were populated by abundant trees and plants that dominated the landscape. As plants died, vegetation accumulated in the widespread swamps and bogs, slowly decomposing to form peat. Periodic river flooding covered the swamps with sands, further compressing the organic debris. As the peat became denser and its moisture content reduced, the process of conversion to lignite (the lowest rank of coal) began. From time to time, the western sea encroached over the land and covered the swamps with marine sands and mud. As the Appalachian Basin subsided repeatedly throughout the Pennsylvanian, this sequence of events was repeated many times, ultimately giving rise to the present-day extensive coal deposits.

Formation of coal deposits ceased when the Appalachian Basin was destroyed as a result of uplift and mountain building in the east. This mountain building occurred as a result of tectonic plate movement during the post-Pennsylvanian, Permian period. Coal, formed earlier in the eastern part of the Basin, was compressed, folded, and faulted to create the harder, less-volatile, and more steeply inclined anthracite coal. In the western part of the basin, deformation was less intense giving rise to the softer, more volatile, and more gently inclined bituminous coal.

Figure 3.2-2 The Physiographic Provinces of the Appalachian Basin Region



Source: Data- USGS, 2004, Physio, U.S. DOI, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

3.2.1.1 West Virginia Geology

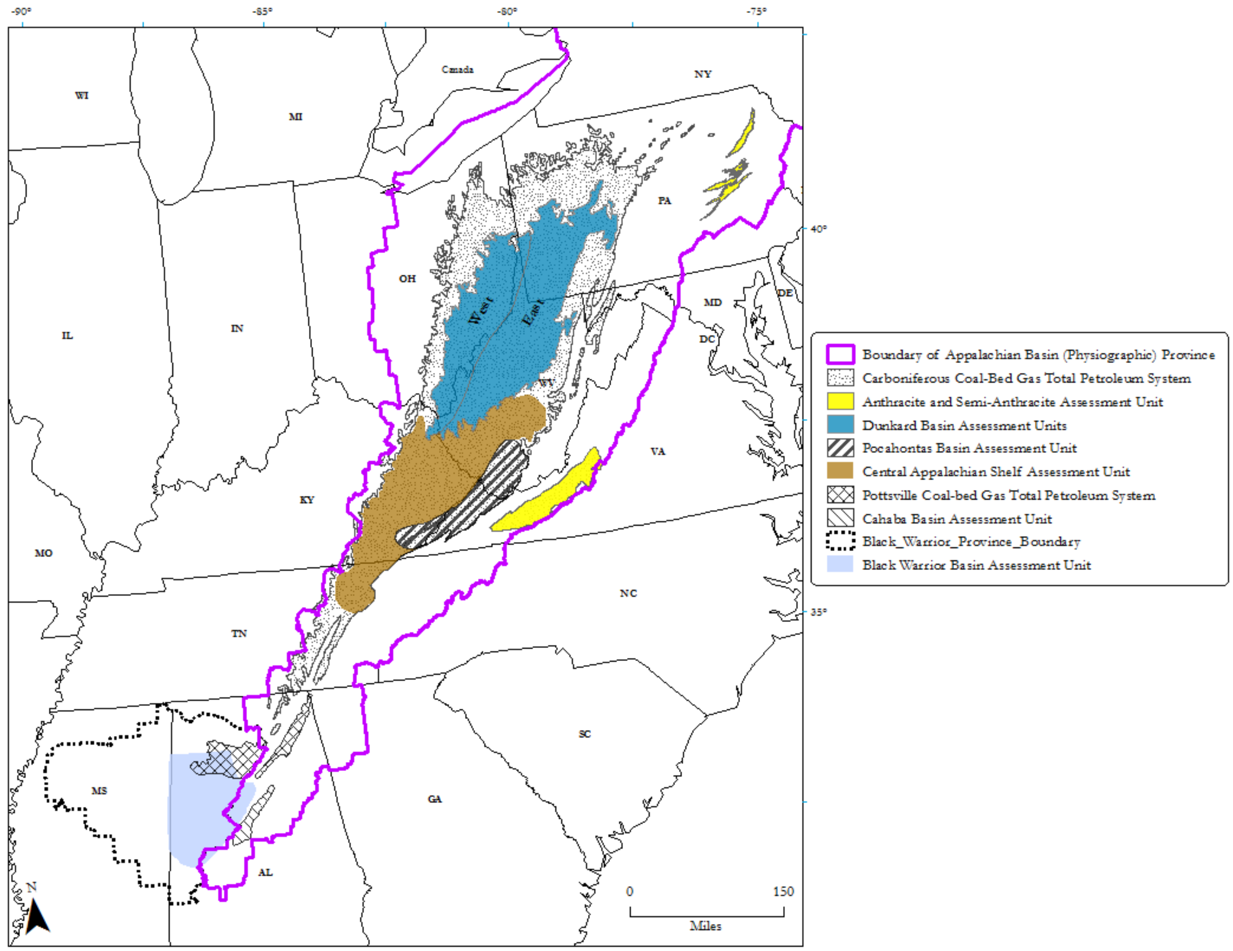
West Virginia is basically composed of two areas: the western two-thirds are relatively flat-lying rocks containing minable coal, and the eastern one-third is comprised of folded and faulted rocks with no minable coal. The former area is the Appalachian Plateau Province, the latter is the Valley and Ridge Province, and they are separated by the Allegheny Front (see Figure 3-2.2).

The Valley and Ridge Province in the east is composed of folded and faulted rocks that range in age from late Precambrian to early Mississippian. This topographically comparatively flat area is composed of complex folded and faulted Cambrian and Ordovician limestones and dolomites as well as a single prominent Ordovician shale (the Martinsburg Shale). The Great Valley ends at North Mountain and from there to the Allegheny Front, a distance of about 50 miles, is a series of northeast-trending mountains and valleys. The rocks in this part of the Valley and Ridge Province range in age from late Ordovician to early Mississippian. The valleys are primarily composed of less-resistant shale and siltstone, while the mountain ridges are mainly more resistant sandstone and limestone. The structural geology of the Valley and Ridge Province is complex with extensive thrust faults and folds that contribute to the repetition of all the rock formations. In addition, three major thrust sheets have displaced the surface and subsurface rocks westward from 30 to 50 miles.

The Appalachian Plateau Province covers the western two-thirds of the state where the rock formations are relatively flat, except for several distinct folds and faults on the eastern side of the province. The oldest rocks are located in these eastern fold sequences and range in age from late Ordovician up through the Mississippian Period. The majority of the Appalachian Plateau Province is comprised of Pennsylvanian and Permian strata, where the majority of the minable coal is located. The rocks exposed in the northern part of the Appalachian Plateau Province are younger than those exposed in the southern part. This is also reflected in the age of the minable coal seams; i.e., younger to the north and older to the south. The boundary between the two provinces, the Allegheny Front Province, is a complex and rather abrupt change in the topography, stratigraphy, and structure. This boundary extends southwestward across the eastern part of the state, passes through Virginia, and reenters southeast West Virginia.

Coal-bearing rocks underlay much of central West Virginia, extending into Ohio, Pennsylvania, and Maryland. One structural fold known as the Hinge Line separates the Dunkard and Pocahontas geologic sub-basins of West Virginia (See Figure 3.2-3). These sub-basins are characterized by differences in the total thickness of their strata, as well as by the distribution of their ancient depositional environments: swamp, lacustrine, marine, and alluvial (Arkle, 1974). The Dunkard and Pocahontas sub-basins coincide approximately with the northern and southern coal fields (younger and older mining districts, respectively) of West Virginia. The various formations of sedimentary rocks exhibit local differences in strata north or south of the Hinge Line in response to different depositional environments. For example, the Allegheny and Conemaugh formations in the Dunkard sub-basin represent a sequence of marine and coastal environments, including deltaic, offshore, and alluvial depositional conditions. In the Pocahontas sub-basin, these formations predominantly include the alluvial facies of sandstones, shales, and channel deposits that generally include only limited coal seams. Additionally, higher sulfur content coal seams occur north of the Hinge Line, while lower sulfur content coal seams occur south of the Hinge Line. A more detailed discussion of coal characteristics is found in Section 3.1.

Figure 3.2-3 Location of Pocahontas and Dunkard Basins in West Virginia



Source: USGS, 2002, *Figure 1: Appalachian Basin and Black Warrior Provinces*, U.S. DOI, http://pubs.usgs.gov/fs/2004/3092/fs2004-3092.html

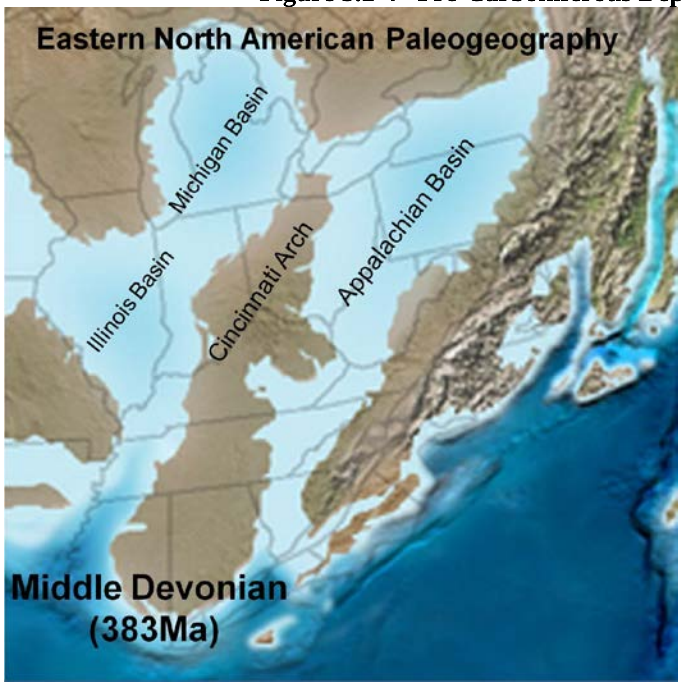
Area and mountaintop-removal mining operations historically have been the most common methods of surface mining in the southern portion of the state. Contour and multiple-seam mining operations occur in both southern and northern West Virginia.

West Virginia coal-bearing formations include from youngest to oldest: the Dunkard Group, the Conemaugh Group, the Kanawha Formation, the New River Formation, and the Pocahontas Formation. Each contains multiple coal beds that are either surface mined or underground mined or both. The more predominantly surface mined coal beds in the state include: the Stockton-Lewiston zone (Upper Kanawha Formation); the Coalburg zone (Upper Kanawha Formation); the Upper Kittanning, the Middle Kittanning, and the Lower Kittanning zones (Allegheny Formation); and the Dunkard Basin Clarion zone (Allegheny Formation) (Fedorko and Blake, 1998).

3.2.1.2 Kentucky Geology

Bituminous coal occurs in Kentucky in two regions: the eastern Kentucky coal field and the western Kentucky coal field. The two fields are separated by a structurally raised area of older rocks known as the Cincinnati Arch (See Figure 3.2-4). Strata of the eastern field, the larger of the two, were deposited in the Appalachian Basin, whereas strata of the western field were deposited in the Illinois Basin. The coal-bearing strata of western Kentucky are associated with the Illinois Basin and discussed further in 3.2.4.

Figure 3.2-4 Pre-Carboniferous Depositional Basins of Kentucky



Source: Dr. Ron Blakey, 2011, *Pre-Carboniferous Depositional Basins of Kentucky*, Northern Arizona University, http://jan.ucc.nau.edu/rcb7/namD385.jpg

Coal is mined from approximately 45 different seams in eastern Kentucky and from about ten seams in western Kentucky (Kentucky Geological Survey, 2006). Eastern coal-bearing rocks underlay approximately 25 percent of the eastern part of the state and form a broad, synclinal basin (Kiesler et al., 1983). Bedrock is essentially flat-lying throughout the trough (Kiesler et al., 1983). Upper Mississippian and Pennsylvanian coal-bearing rocks thicken towards the southeast, reaching their maximum thickness at the basin's southeastern margin. This margin is marked by the Pine Mountain Thrust Fault, a structure which disrupts and offsets the coal beds. Mining methods in eastern Kentucky consist of mountain top mining (steep slope); area surface mining; contour mining; and multiple-seam mining. The Pennsylvanian rocks of the eastern Kentucky coal field consist largely of sandstone, siltstone, and shale. Coal beds and thin marine shale and limestone units are also widespread and occur in most parts of the stratigraphic section. These deposits indicate that during the Pennsylvanian period, Kentucky was near sea level, alternately covered by lakes, extensive swamps, shallow bays, and estuaries.

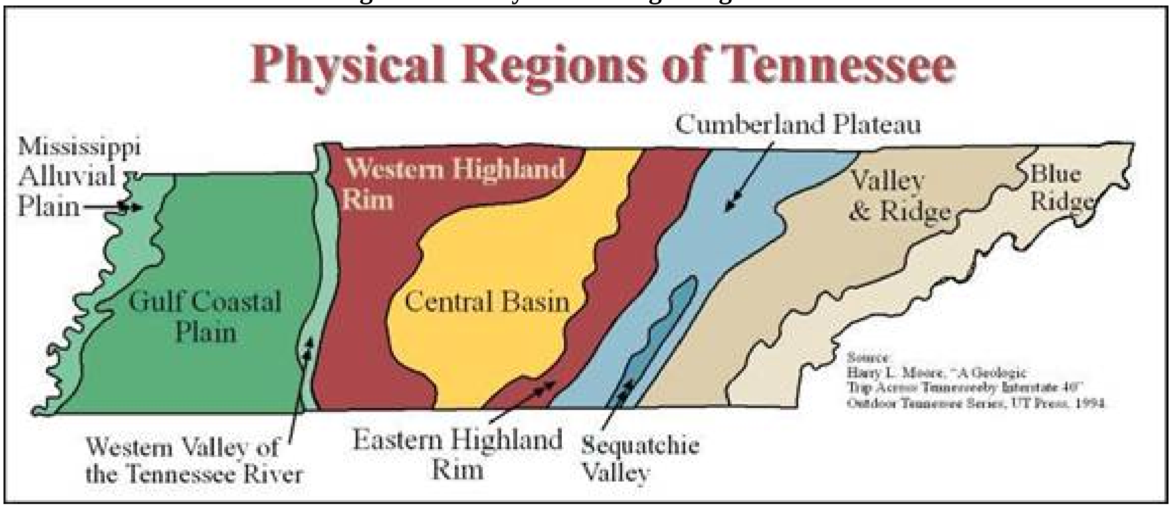
Eastern Kentucky coal-bearing stratigraphic nomenclature (or rock naming convention) and correlation is not consistent with other Appalachian Basin states. For example, northwest of the Pine Mountain thrust fault on the Cumberland overthrust sheet, coal beds equivalent to the Lower Elkhorn coal zone (within the Pikeville Formation) are identified also as the Eagle coal zone, Pond Creek coal zone, and the Blue Gem coal bed. Southeast of the Pine Mountain thrust fault, still in eastern Kentucky, equivalent coals in this same interval are known as the Imboden and Rich Mountain. This same interval of coal is identified as the Blue Gem coal in Tennessee, the Imboden coal bed or Campbell Creek or Pond Creek coal zones in Virginia, and the Eagle coal zone in West Virginia (Ruppert et al., 2010). It is not in this DEIS's scope to standardize nomenclature or attempt to correlate stratigraphy across the coal-bearing region. For that reason, a generalized discussion of eastern Kentucky Pennsylvanian age stratigraphy and coal beds/zones are presented based from the works of Ruppert et al. (2010). In eastern Kentucky, coal-bearing units are the Lower Pennsylvanian-aged lower Breathitt Group (including the Warren Point, Bottom Creek Formation, Sewanee Sandstone, Alvy Creek Formation, Bee Rock Sandstone, and Grundy Formation); the Middle Pennsylvanian-aged middle and upper parts of the Breathitt Group (including the Pikeville, Hyden, Four Corners, and Princess Formations) and the Upper Pennsylvanian aged Conemaugh Group and Monongahela Groups.

In recent years, within the Breathitt Group, the Pikeville and Hyden Formations, (specifically the Upper Elkhorn No. 3, the Lower Elkhorn (or Pond Creek), and the Hazard No. 4 (or Fire Clay) coal zones), have been prominent coal producers in eastern Kentucky.

3.2.1.3 Tennessee Geology

The Tennessee coal fields occur in the east-central portion of the state, forming a northeast-southwest trending outcrop belt from Kentucky to the Alabama border. As with Kentucky, these coal fields form a broad, synclinal basin that is bounded on the west by the Highland Rim escarpment and on the east by the Valley and Ridge Province (See Figure 3.2-5). These coal fields are generally divided between the northern steep-slope areas of the Cumberland Mountains and the southern, flatter Cumberland Plateau, where area mining historically has dominated. Bedrock units primarily have a shallow southeasterly dip and thicken to the southeast near the basin's trough adjacent to the Valley and Ridge Province (Gaydos et al., 1982).

Figure 3.2-5 Physical Geologic Regions of Tennessee



Source: Moore, H.I., 1994, *A Geologic Trip Across Tennessee by Interstate 40*, Outdoor Tennessee Series, UT Press.

The geology and depositional settings for the coal-bearing strata southeast of the Pine Mountain Thrust (eastern Tennessee) are similar to that of Kentucky. Notable geological differences are: (1) the absence of the Princess Formation, the Conemaugh Group and the Monongahela Group; and (2) differences in coal bed/coal zone nomenclature.

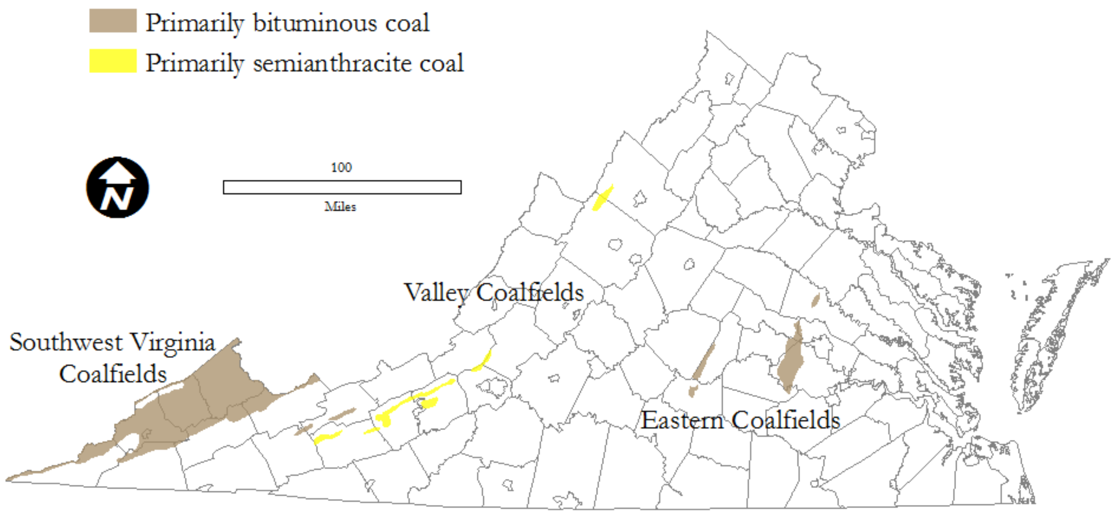
In eastern Tennessee, coal-bearing units are the Lower Pennsylvanian-aged Lower Breathitt Group (including the Warren Point, Bottom Creek Formation, Sewanee Sandstone, Alvy Creek Formation, Bee Rock Sandstone, and Grundy Formation); and the Middle Pennsylvanian-aged Breathitt Group (including the Pikeville, Hyden, and Four Corners Formations).

The reader is referred to the eastern Kentucky coal field discussion for details on geology and stratigraphy.

3.2.1.4 Virginia Geology

Coal occurs in three distinct areas in Virginia: the eastern coal fields; the valley coal fields; and the southwest Virginia coal field (See Figure 3.2-6). Since the 1950s, virtually all of Virginia's coal production has come from the southwest Virginia coal field.

Figure 3.2-6 Coal Fields of Virginia



Source: Virginia Division of Geology and Mineral Resources, 2006a, *Figure 1: Distribution of coal areas* Virginia Department of Mine Minerals and Energy, http://www.dmme.virginia.gov/Dgmr/coal.shtml

The eastern coal fields occur in five Triassic-Jurassic aged basins which were down-faulted into the crystalline rocks of the Piedmont physiographic province. These basins formed when Africa separated from North America to create the Atlantic Ocean. The Culpepper basin in the western Piedmont near the Blue Ridge province is the largest, but numerous smaller basins (including the Richmond, Farmville, and Danville) are scattered throughout the Piedmont (Fichter and Baedke, 2000). The depositional environments within which the coal beds formed include lakes, rivers, alluvial fans, and mudflats.

The valley coal fields comprise eleven long, narrow Early Mississippian-age coal-bearing areas in the Valley and Ridge physiographic province situated in the western part of the state (VA Division of Geology and Mineral Resources, 2006a). Semi-anthracite coals were mined here primarily from 1748 to the early 1900s; however, sporadic operations continue today.

The south west Virginia coal field is located in the Appalachian Plateau Province. The coal field consists of relatively flat-lying rocks bounded on the northwestern and southeastern basin margins by thrust-faulted and uplifted rock units (Rader and Evans, 1993; Harlow and LeCain, 1993). Along the northwestern coal field margin is the Pine Mountain Thrust fault. The southeastern margin is bounded by a series of thrust faults. The Russell Fork fault divides the basin into two regions: (1) the relatively flat-lying rocks northeast of the fault; and (2) the gently folded and faulted rocks located southwest of the fault, which were moved as part of the Pine Mountain thrust sheet (Harlow and LeCain, 1993). The rocks of both regions are nearly flat-lying and have an average northwesterly regional dip of 1.4 percent.

The primary coal-bearing formations in Virginia are, from oldest to youngest, the Pocahontas, Lee, Norton, Wise, and the Harlan Formations (See Figure 3.2-7). These geologic formations make up a stratigraphic interval that varies in thickness from 800 feet up to 5,150 feet. The coal beds are Pennsylvanian in age, low- to high-volatile bituminous in rank, and generally of a very high quality (less than one percent sulfur, less than ten percent ash, and high BTU). Although quality parameters vary locally, volatile matter generally increases from east to west and up section from older to younger coals beds (Wilkes et al., 1992).

Figure 3.2-7 Virginia's Coal-Bearing Formations

System	Formation
Pennsylvanian System	Wise Formation
	Norton Formation
	Lee Formation
	Pocahontas Formation
Mississippian System	Hinton Formation
	Bluefield Formation
	Greenbrier Formation
	Price/Pocono Formation
Devonian System	Chattanooga Formation
Ordovician System	Trenton Formation

Source: Virginiaplaces.org, 2011, *Figure 11: Generalized Stratigraphic Column*, Virginia Department of Mines Minerals and Energy (original source), http://www.virginiaplaces.org/geology/naturalgasresources.html

Southwest Virginia coal field stratigraphic nomenclature and correlation is not consistent with other Appalachian Basin states. Some coal beds such as the Splash Dam, Upper Banner, and Lower Banner have been correlated very consistently within the southwest Virginia coal field and have few local or secondary names. Conversely, the Imboden coal zone, an important historic and regional producer that extends beyond Virginia into Kentucky and West Virginia, has more than 20 local and secondary names in Virginia alone (VA Division of Geology and Mineral Resources, 2006b). In the 1980s, in order to provide more detailed geologic base maps and ensure consistent stratigraphic correlation, Virginia completed the mapping and publication of 7.5 Minute Geologic Quadrangle Maps for the southwest Virginia coal fields. A coal bed's mapped geologic name is required in permitting; however, historic local names are also still commonly used by surface and mineral owners due to the use of these names in deeds, leases, and contracts.

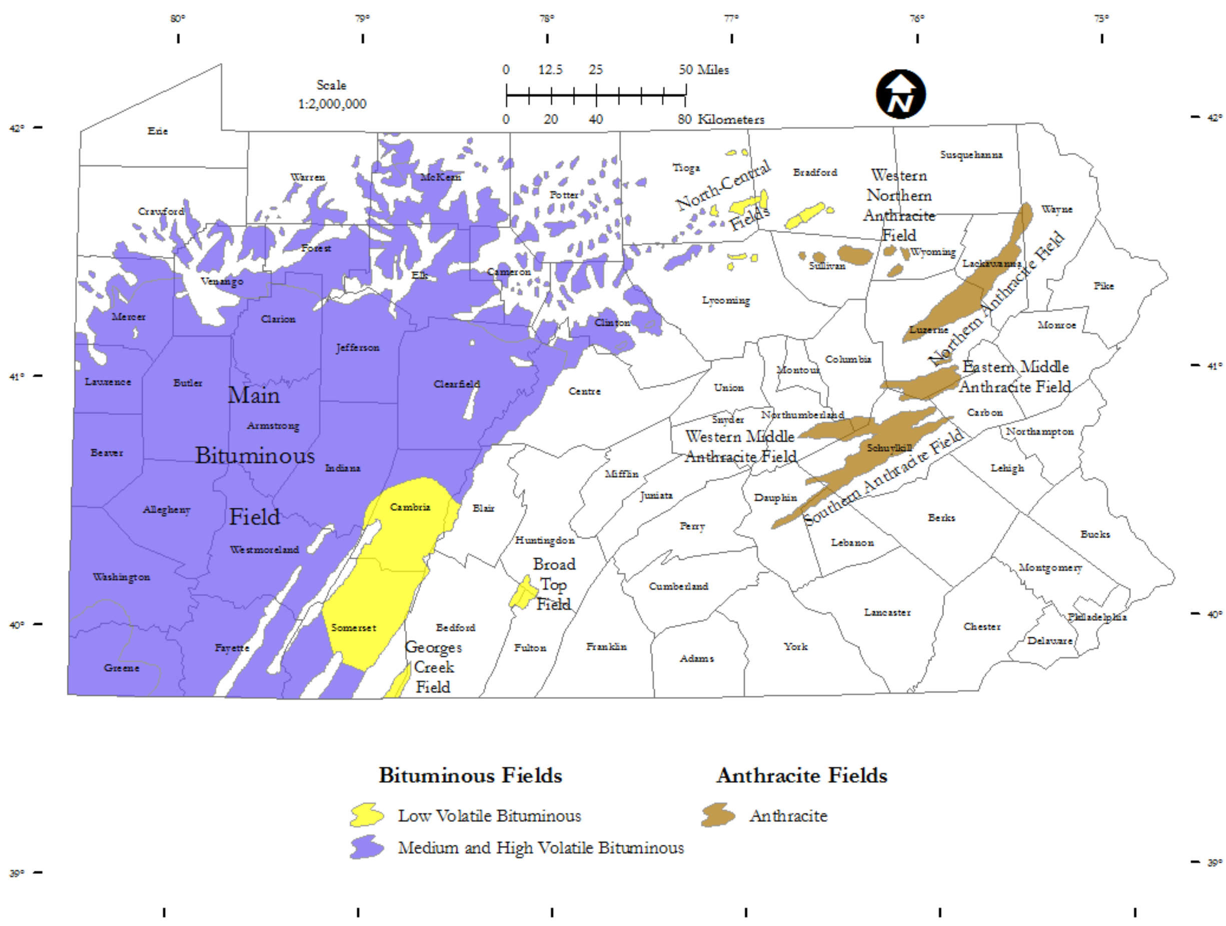
Each coal field contains coal resources with different coal quality and physical properties. Coals range from high-volatile bituminous to natural coke in the Richmond basin area of the eastern coal fields (Wilkes, 1988), medium-volatile bituminous to semi-anthracite in the valley coal fields (Brown et al., 1952), and low- to high-volatile bituminous in the southwest Virginia coal field (Wilkes et al., 1992; VA Division of Geology and Mineral Resources, 2006a).

Mining in the southwest Virginia coal field began in the 1880s. While mountaintop removal (steep slope) and area surface mining operations occur in southwest Virginia, other surface mining methods such as contour and multiple-seam also occur.

3.2.1.5 Pennsylvania Geology

The two Pennsylvanian coal-bearing areas can broadly be discussed as the Anthracite Region located in the east and northeastern part of the state, and the Bituminous Coal Region located in the western part of the state (See Figure 3.2-8). Additional discussion of Pennsylvania coal-bearing sub-basins is found in the earlier subsection on West Virginia geology.

Figure 3.2-8 Distribution of Pennsylvania Coals



Source: PA Department of Conservation and Natural Resources, 2008, *Map 11: Distribution of Pennsylvania Coals*, Commonwealth of Pennsylvania,
http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_016203.pdf

Pennsylvania's Anthracite Region is located in the eastern part of the state in the Valley and Ridge Province of the Appalachian Mountains. Coal-bearing strata are Pennsylvanian-aged. Lithologies consist of shales, weathered limestones, and dolomites which underlie the valleys; the more resistant sandstones and conglomerates support the surrounding ridges. This contrast in rock types results in a series of parallel valleys and ridges for which the province is named. The complex folding and faulting in the province is responsible for the higher temperatures and pressures required to create anthracitic coal.

The Anthracite Region consists of four major coal fields that are situated in synclinal basins surrounded by sandstone ridges. These fields are the northern anthracite field, the eastern middle anthracite field, the western middle anthracite field, and the southern anthracite field.

The primary coal-bearing units in the Anthracite Region, from oldest to youngest, are the Pottsville and Llewellyn Formations. The Pottsville Formation ranges in thickness from a maximum of approximately 1,600 feet to less than 100 feet. The Pottsville Formation is subdivided into three members; from oldest to youngest, these are the Tumbling Run Member, the Schuylkill Member, and the Sharp Mountain Member. The Tumbling Run and Schuylkill Members are absent to the north. The formation contains up to 14 coal beds in some areas, but most are relatively discontinuous. The Lykens Valley Coal, Numbers four through seven, are within the Tumbling Run Member; the Lykens Valley Coal, Numbers one through three, are within the Schuylkill Member; and the Scotty Steel and Little Buck Mountain Coals are within the Sharp Mountain Member of the Pottsville Formation.

The Pottsville Formation in eastern Pennsylvania, consisting predominantly of sandstones and conglomerates, was laid down entirely in non-marine depositional environments (Edmunds et al., 1999).

The Llewellyn Formation, up to 3,500 feet thick, consists of gray, fine to coarse-grained clastic rocks (sandstones, shales, conglomerates) and anthracite coal seams in repetitive sequences. The formation contains up to 40 mineable coal seams. The thickest and most persistent coal beds occur in the lower part of the Llewellyn Formation, particularly the Mammoth Coal zone. The Mammoth Coal zone typically contains 20 feet of coal, and thicknesses of 40 to 60 feet are not unusual. The thickest coal beds tend to be situated in the trough of the syncline. The nomenclature and stratigraphy of the coal-bearing rocks of the Llewellyn Formation are not consistent throughout the state.

The dominant lithologies of the Llewellyn Formation are sandstones and conglomerates. In the north part of the state, the formation contains one known marine bed, the Mill Creek Limestone. Combined with the Cannal and Hillman Limestones (both non-marine), these units constitute an appreciable amount of calcareous material in the uppermost 850 feet of the formation.

The Pennsylvania Bituminous Coal Region is located in the western part of the state in the Appalachian Plateau Province (See Figures 3.2-8 and 3.2-2). The Plateau consists of relatively flat lying strata, largely absent of the complex faulting and intense folding that characterize the Anthracite Region. Given the lack of significant tectonic deformation, the Pennsylvanian-aged peat deposits of the Plateau were never subjected to high temperatures and pressures. Thus, unlike eastern Pennsylvania, the coals of this area are a bituminous grade coal. Coal-bearing rocks of the Bituminous Region include (from the oldest to youngest) the Pottsville, Allegheny, Conemaugh, Monongahela, and Dunkard Groups (See Figure 3.2-9).

The Pottsville Group is variable in thickness. For the most part, it is dominated by sandstone, and the coal beds are discontinuous. Because of the discontinuous nature of these coals, and the fact that they are often thin and split with numerous partings, mining has not been common in the Pottsville Group. The Pottsville Formation can range from 20 feet to at least 250 feet in thickness with the principal coal mined being the Mercer.

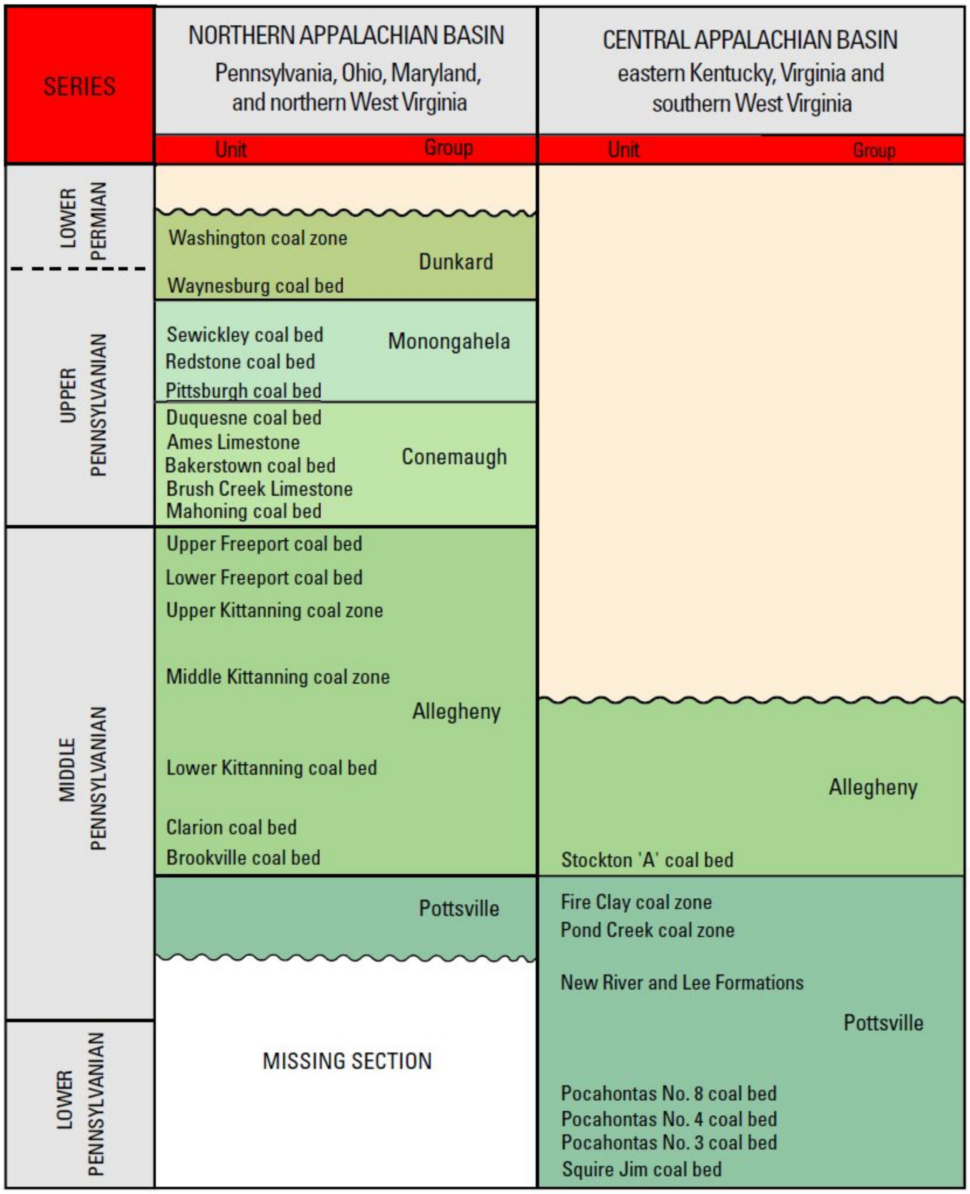
The Allegheny Group is one of two groups that contain the majority of economically mineable coals (See Figure 3.2-9). The Group contains six major coal zones with each zone taking one of three forms: a single, more-or-less continuous sheet; a group of closely related individual lenses; or a multiple-bed complex. The major coal zones are, from oldest to youngest, the Clarion, Lower Kittanning, Middle Kittanning, Upper Kittanning, Lower Freeport, and Upper Freeport.

The Lower Allegheny extends from the base of the Brookville Coal to the base of the Johnstown Limestone (or Upper Kittanning Coal where the limestone is absent). The Upper Allegheny extends from the base of the Johnstown Limestone to the top of the Upper Freeport Coal. The thickness of the Allegheny Group formation ranges from 270 to 330 feet in western Pennsylvania. The group consists of a repeating succession of coal, limestone, and clastic units which range in particle size from claystone to coarse sandstone. The Conemaugh Group contains two formations, the older Glenshaw Formation and the overlying Casselman Formation. The Glenshaw contains several widespread marine units, the most prominent of which are the Brush Creek, Pine Creek, Woods Run, and Ames Limestone. The Glenshaw is thickest in Somerset and southern Cambria Counties, where it reaches 400 to 420 feet and is thinnest near the Ohio border where it is about 280 feet thick. The mineable coals of the Glenshaw Formation, from oldest to youngest, typically are the Mahoning, Brush Creek, and Lower and Upper Bakerstown.

With the exception of the marine shales above the Ames Limestone, the Casselman Formation is made up exclusively of fresh water sedimentary rocks. Coal beds are nearly absent or very thin in the west but increase in quantity eastward. The coal beds of the Casselman Formation, typically include, from oldest to youngest, the Duquesne (or Federal Hill), the Barton (or Elk Lick), Wellersburg, Little Clarksburg (or Franklin), and the Little Pittsburgh.

The Monongahela Group extends from the base of the Pittsburgh Coal to the base of the Waynesburg Coal. It is divided into the Pittsburgh and Uniontown Formations at the base of the Uniontown Coal and is about 270 to 400 feet thick, generally increasing in thickness from the western edge of the state to western Fayette County. The Monongahela Group is entirely non-marine and dominated by limestones, dolomitic limestones, calcareous mudstones, shales, and thin-bedded siltstones and laminites. The only sandstone of significant thickness within the formation lies directly above the Pittsburgh Coal complex. The Pittsburgh Coal is continuous, covering thousands of square miles and is four to ten feet thick. The other major coals found in the Group are the Redstone and Sewickley.

Figure 3.2-9 Generalized Stratigraphic Column of the Pennsylvanian and Lower Permian in the Northern and Central Appalachian Basin Coal Regions



Source: Ruppert and Rice, 2000, *Figure 10: Generalized Stratigraphic Column of the Pennsylvanian and Lower Permian in the Northern and Central Appalachian Basin Coal Regions*, USGS, U.S. DOI, http://pubs.usgs.gov/pp/p1625c/CHAPTER_B/CHAPTER_B.pdf

The Permian-aged Dunkard Group is found only in the most southwestern corner of Pennsylvania in Greene and Washington Counties. It is made up of Waynesburg, Washington and Greene Formations (Berryhill et al., 1971). The Dunkard reaches a maximum thickness of about 1,120 feet in Greene County and the upper surface is the modern day erosional surface. The lower boundary of the Dunkard Group is defined as the base of the Waynesburg Coal, which is the only coal routinely mined in the Dunkard. The Dunkard is generally composed of fine-grained clastics which, in many locations, are calcareous. Thick lacustrine limestones are especially prevalent in the Washington Formation. The only significant sandstone interval lies above the Waynesburg coal.

3.2.1.6 Maryland Geology

The coal-bearing area of Maryland occurs in the westernmost portion of the state (See Figure 3.1-18). The depositional setting and geology of the coal-bearing strata are identical to that of the western Pennsylvanian Bituminous Region. Not surprisingly, the coal-bearing rock formations correlate to those in Pennsylvania. They include (from the oldest to youngest) the Pottsville, Allegheny, Conemaugh, Monongahela, and Dunkard Groups. For this reason, the reader is referred to the western Pennsylvania Bituminous Coal Region discussion provided above for details regarding geology and coal beds.

3.2.1.7 Ohio Geology

Ohio coal-bearing strata are present only in the eastern third of the state (See Figure 3.1-18). The depositional setting and geology for the coals of eastern Ohio is largely similar to that of western Pennsylvania. Not surprisingly, the coal-bearing rock formations are largely the same and are correlative with those in Pennsylvania. They include (from the oldest to youngest) the Pottsville, Allegheny, Conemaugh, Monongahela, and Dunkard Groups. The reader is referred to the western Pennsylvania Bituminous Coal Region discussion above for details regarding geology and coal beds. Additional discussion of Ohio coal-bearing sub-basins is found in the discussion of West Virginia geology.

Formation thicknesses differ somewhat from those found in western Pennsylvania. In eastern Ohio, thicknesses of the Pottsville Group range from 120 feet to approximately 470 feet. The thickness of the Allegheny Group ranges from 190 feet to approximately 260 feet. Thicknesses of the Conemaugh Group range from 350 feet to approximately 500 feet. The Monongahela Group thickness ranges from 200 feet to 500 feet. The Dunkard Group thickness is approximately 520 feet.

3.2.2 Colorado Plateau Coal-Producing Region

The Colorado Plateau region encompasses the coal-bearing areas of western Colorado, Utah, Arizona, and New Mexico (See Figure 3.1-21). The Colorado Plateau region is subdivided into several coal fields including the: Uinta Region; Tongue Mesa Field; Henry Mountains Field; Southwestern Utah Region; San Juan River Region; Pagosa Springs Field; Monero Field; Black Mesa Field; Pinedale Field; Deer Creek Field; Datil Mountain Field; Rio Puerco Field; Tijeras Field; Una del Gato Field; Cerrillos Field; Jornada del Muerto Field; Carthage Field; Sierra Blanca Field; and the Engle Field. For the purposes of this DEIS, discussion will focus on the Black Mesa Field, the San Juan Basin, the Uinta Region, and southwestern Utah since these are the most geologically extensive.

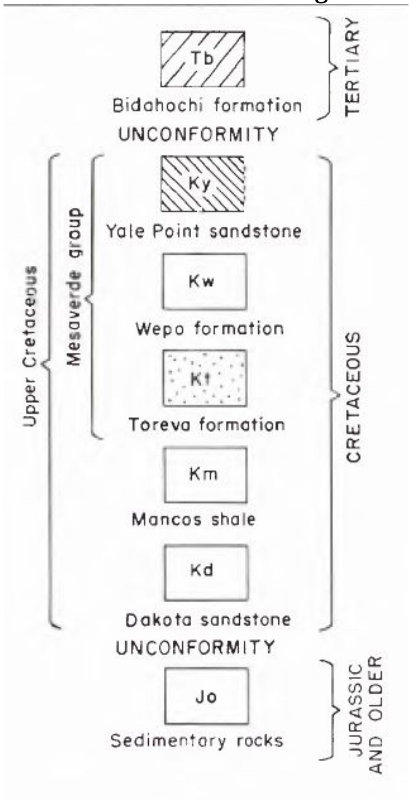
In the Paleozoic Era, the Colorado Plateau region was periodically flooded by extensive inland tropical seas. Sedimentary strata such as limestone, sandstone, siltstone, and shale were laid down in these shallow marine waters in great thicknesses. During times when the seas retreated, fluvial clastics and dune sands were deposited. Slowly, sediments accumulated over a period of 300 million years.

During the younger Mesozoic Era, the depositional environment was dominated by terrestrial sedimentation. Great accumulations of cross-bedded sandstones and eruptions from volcanic mountain ranges to the west buried vast regions beneath ashy debris. The coal beds of the Colorado Plateau were deposited during this time, specifically during the Cretaceous. For much of this period, coal forming units accumulated in coastal-plain wetlands, near-shore marine environments, and fluvial depositional settings.

3.2.2.1 Black Mesa Coal Field Geology

The Black Mesa coal field is located in northeastern Arizona. The general geology of the Black Mesa coal field consists of Cretaceous-aged units including the Dakota Sandstone, the Mancos Shale, and the Mesa Verde Group (See Figure 3.2-10). The Dakota Sandstone contains coal within its middle shale member. The thicker coal units within the Dakota are found in the southwestern part of Black Mesa and can be up to nine feet thick (O'Sullivan, 1958). Within the Mesa Verde Group are the coal-bearing Toreva and Wepo Formations. The Wepo Formation is the major coal-bearing unit of the coal field with eight coal zones measuring from four to 30 feet thick.

Figure 3.2-10 General Geology of the Black Mesa Coal Field



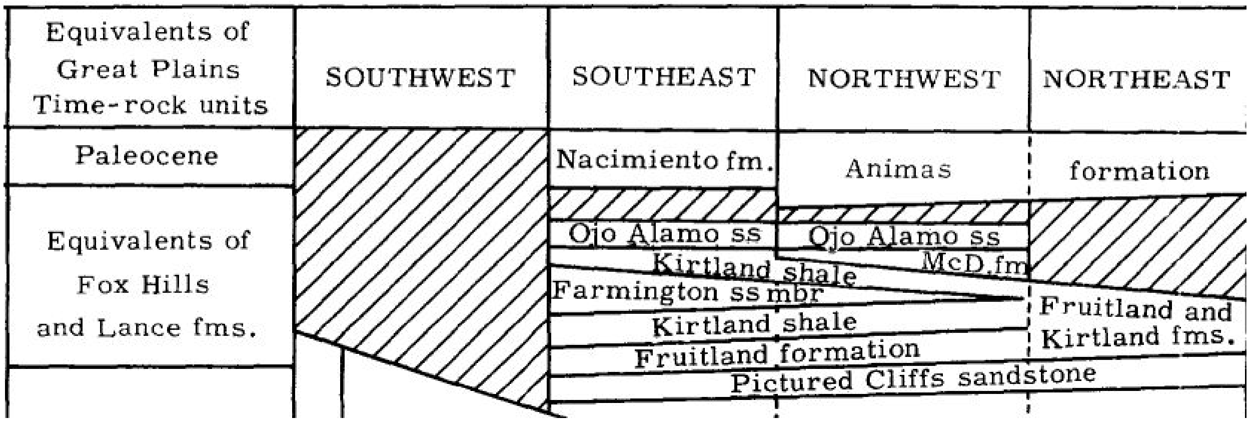
Source: R.B. O'Sullivan, 1958, *Summary of Coal Resources of the Black Mesa Coal Field, Arizona,* New Mexico Geological Society, http://nmgs.nmt.edu/publications/guidebooks/downloads/9/9_p0169_p0171.pdf

3.2.2.2 San Juan Coal Basin Geology

The San Juan Basin is an asymmetrical basin, with a gently dipping southern flank and a steeply dipping northern flank (Stone et al., 1983). It measures roughly 100 miles long in the north-south direction and 90 miles wide. The Fruitland Formation is the primary coal-bearing unit of the San Juan River Region (See Figure 3.2-11).

The Fruitland Formation coal beds are thick, with individual beds up to 80 feet thick. However, only a small percentage of the total number of coal beds is found at depths of 200 feet or less. The formation is composed of interbedded sandstone, siltstone, shale, and coal, with the thickest coalbeds always found in the lower third of the formation.

Figure 3.2-11 Generalized Stratigraphic Column for the San Juan Coal Basin



Source: Caswell Silver, 1951, *Figure 3: Generalized Stratigraphic Column for the San Juan Coal Basin,* New Mexico Geological Society, http://nmgs.nmt.edu/publications/guidebooks/downloads/2/2_p0104_p0118.pdf

3.2.2.3 Uinta Coal Basin Geology

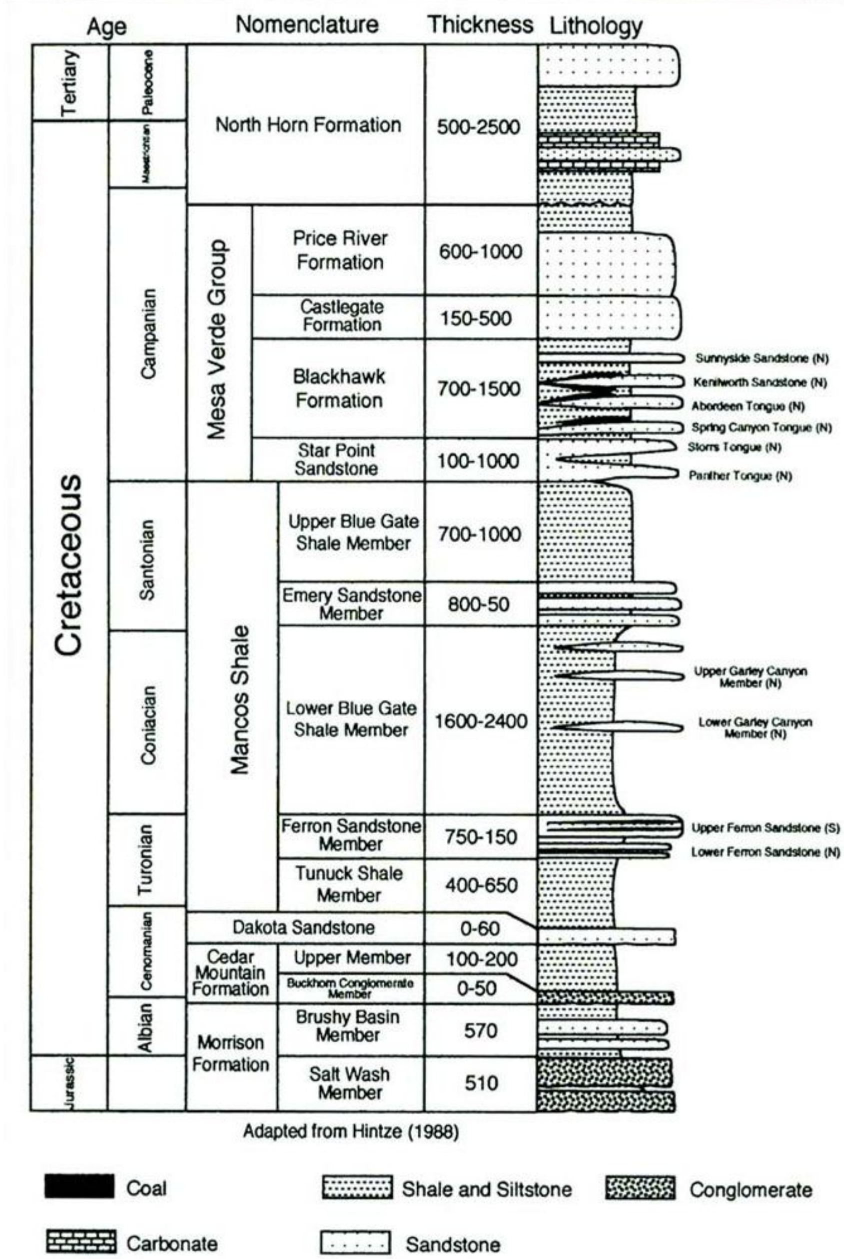
The Uinta Coal Basin, approximately 14,450 square miles in area, is located in eastern Utah and northwestern Colorado (See Figure 3.1-21). Most of the coal mines currently operating in Utah are located in the western end of the Uinta Basin. Three prominent coal fields in the region include the Wasatch coal field, the Book Cliffs coal field, and the Emery coal field.

The coalbeds are present within the Cretaceous strata throughout much of the Uinta Basin (See Figure 3.2-12). The Ferron Sandstone Member of the Mancos Shale and the Blackhawk Formation of the Mesaverde Group are two important coal-bearing units currently being mined.

The Ferron Sandstone Member coalbeds and interbedded sandstone units form a wedge of clastic sediment above the Tunuck Shale Member of the Mancos Shale and below the Lower Blue Gate Shale Member of the Mancos Shale. The coal-bearing rocks are thickest to the west and south margins of the basin, nearer to the upland source of sediments. Total coal thickness in this area ranges from four to 48 feet (averaging 24 feet). Coal beds are named in ascending order of deposition, the A, B, C, D, G, I, J, L, and M.

The Blackhawk Formation consists of coal interbedded with sandstone and a combination of shale and siltstone. It ranges from 450 to 1,500 feet thick in the Book Cliffs coal field. The Blackhawk Formation is underlain by the Star Point Sandstone and overlain by the Castlegate Sandstone. In the Book Cliffs coal field, the main coal zones in the Blackhawk Formation are the Spring Canyon, the Castlegate A, B, C, D, the Kenilworth, the Gilson, the Rock Canyon, and the Sunnyside. In the Wasatch Plateau coal field, the main coal zones are also found in the Blackhawk Formation. The main coal beds are the Accord Lakes, the Axel Anderson, the Blind Canyon, the Wattis (also known as the Upper O’Conner), the Cottonwood, and the Castlegate A.

Figure 3.2-12 Generalized Stratigraphic Column for the Uinta Coal Basin



Source: U.S. EPA, 2004, *Figure A4-2: Generalized Stratigraphic Column for the Uinta Coal Basin*, EPA 816-R-04-003, http://www.epa.gov/ogwdw/uic/pdfs/cbmstudy_attach_uic_attach04_uinta.pdf

3.2.2.4 Henry Mountains Geology

The principal coal resources of the Henry Mountains, located in Wayne and Garfield counties of southeastern Utah, are found within a north to south elongated basin, approximately 50 miles long and two to 18 miles wide (Tabet, 1999).

Coal beds are present within Cretaceous strata including the Ferron Sandstone and Muley Canyon Sandstone members of the Mancos Shale (See Figure 3.2-13). Minor coal beds exist within the Dakota Sandstone but are not considered minable due to its thin and discontinuous occurrence. The Muley Canyon coals are the thickest and most continuous, and are thus the greatest potentially minable coal resource in the area (Doelling, 1972; Tabet, 1999).

Figure 3.2-13 Stratigraphy of the Henry Mountains Coal Field

Stratigraphic Units	Depositional Environment	Thickness (ft)
Tarantual Mesa Sandstone	Continental	270 – 400
Masuk Formation	Coastal plain; major coal	600 – 750
Muley Canyon Sandstone	Nearshore marine	270
Mancos Shale		
Blue Gate Member	Marine	1,400
Ferron Sandstone Member	Nearshore marine/coastal plain; coal	150 – 300
Tununk Member	Marine	525 – 650
Dakota Sandstone	Alluvial to marginal marine; minor coal	1 - 75

Source: Mark Kirschbaum and Laura Biewick, 2008, *Stratigraphy of the Henry Mountains Coal Field*, USGS, U.S. DOI, http://pubs.usgs.gov/pp/p1625b/Reports/Chapters/Chapter_B.pdf

As previously described, the Ferron Sandstone Member coalbeds and interbedded sandstone units form a wedge of clastic sediment above the Tunuck Shale Member of the Mancos Shale and below the Lower Blue Gate Shale Member of the Mancos Shale. The areal distribution of coal within the Henry Mountains Ferron Sandstone is patchy and is best developed in the northern, central and southern parts of the field, in pods approximately one to five miles wide and three to ten miles long. The coal exists in five beds that average one to three feet in thickness and seldom exceed four feet in thickness. The aggregated coal thickness is as much as 16.5 feet. The depth to the Ferron coal varies from exposed cropping coal around the margins of the Henry Mountains to a maximum depth of 2,000 feet in the central part of the basin (Tabet, 1999).

The Muley Canyon Sandstone member overlies the Blue Gate member of the Mancos Shale. The lower part of the Muley Canyon Sandstone consists of massive laminated-to-thin-bedded, very fine to medium-grained sandstone ranging in thickness from 131 to 307 feet. The upper portion is described as more heterogeneous and interbedded with carbonaceous mudstone and coal. Thickness ranges from 92 to 120 feet. The upper portion of the Muley Canyon Sandstone contains the thickest and most persistent coal beds. Unlike the Ferron member, coal within the Muley Canyon Sandstone is distributed throughout most of the Henry Mountains field. The

Muley Canyon Sandstone coal zones generally exist in four to five beds, with as many as ten beds. Thickness of coal ranges from zero to 13.4 feet but generally averages two to five feet. The aggregated coal thickness is as much as 27.5 feet. The depth to the Muley Canyon Sandstone coal varies from 100 feet at the northern and southern extents of the Henry Mountains coal field to a maximum depth of 1,000 feet under Tarantula Mesa (Tabet, 1999).

3.2.2.5 Southwestern Utah Region Geology

The principal coal-bearing units in the Southwestern Utah Region are the Dakota Formation and the Straight Cliff Formation (Kirschbaum and Biewick, 2008) (See Figure 3.2-14). The Dakota Sandstone consists of sandstone interbedded with mudrock and the Smirl Coal bed. The Smirl Coal bed is found from ground level to 1,000 feet below surface in the Alton coal field, which is located in this region. The Smirl Coal bed reaches a maximum thickness of 18 feet.

Figure 3.2-14 Stratigraphic Summary of Upper Cretaceous and Tertiary Strata in the Southwestern Utah Coal Basin

Age	Formation	Thickness (ft)
Miocene	Osiris Tuff	0-600
Eocene and Paleocene	Wasatch Formation	1,350- 1,650
Paleocene	Pine Hollow Formation	0-450
Paleocene and Late Cretaceous	Canaan Peak Formation	0-900
Late Cretaceous	Kaiparowits Formation	600-3,000
	Wahweap Formation	900-2,600
	Straight Cliffs Formation	1,000-2,000
	Tropic Shale	600-900
	Dakota Formation	15-250

Source: Robert Hettinger, 2008, *Figure 6: Stratigraphic Summary of Upper Cretaceous and Tertiary Strata in the Southwestern Utah Coal Basin*, USGS; U.S. DOI, http://pubs.usgs.gov/pp/p1625b/Reports/Chapters/Chapter_J.pdf

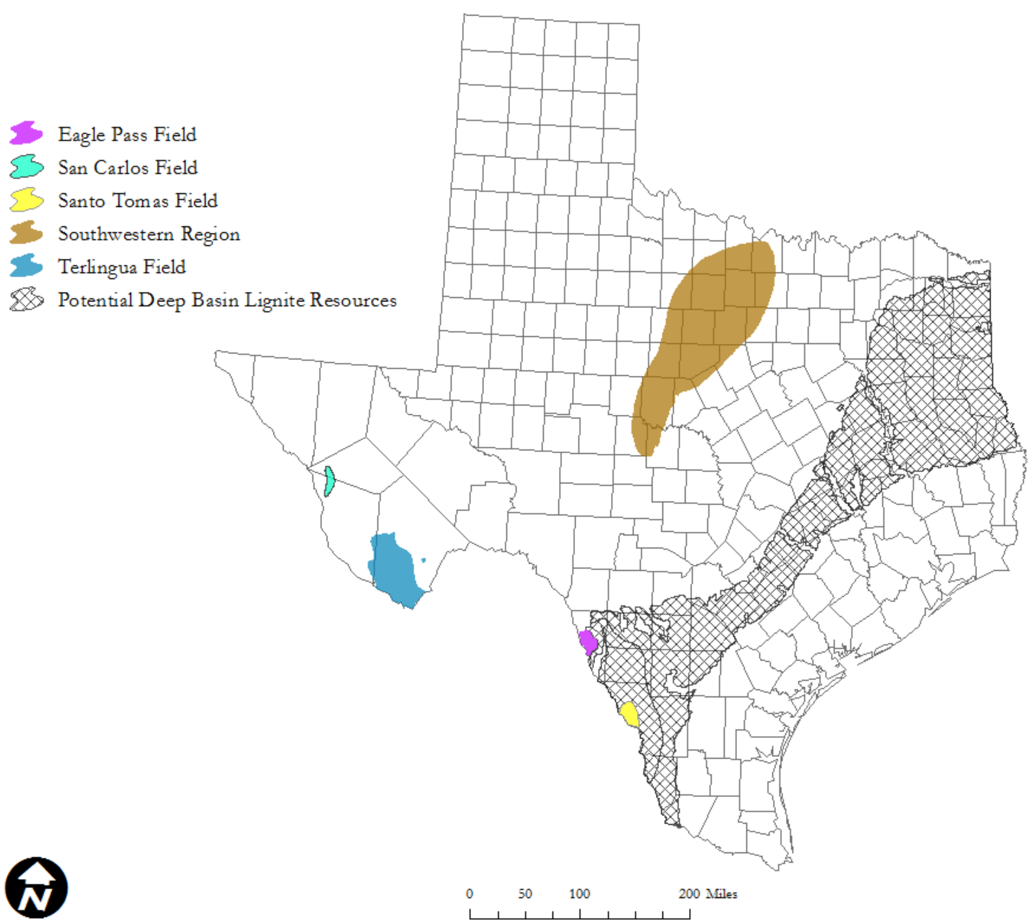
Although the Straight Cliffs Formation is also a prominent coal-bearing unit in southwestern Utah, the unit is not currently being mined. The formation consists of a series of sandstone members which include the John Henry Member, a primarily sandstone with secondary amounts of mudrock and coal. The main coal-bearing units are the Alvey, Rees, Christenson, and lower zones.

3.2.3 Gulf Coast Coal-Producing Region

The Gulf Coast region encompasses the lignite coal-bearing areas of Texas, Arkansas, Louisiana, Mississippi, and parts of Missouri, Alabama, Tennessee, Georgia, and far western Kentucky (See Figure 3.1-23). As of 2010, most coal in the region was produced from Texas, with lesser amounts mined in Louisiana and Mississippi. For this reason, the following discussion will focus on the coal-bearing formations that are mined in Texas, Louisiana, and Mississippi.

In Texas, the lignite bearing formations were deposited during the Late Cretaceous through the Middle Tertiary Periods. These units, which are present as a wide northeast-southwest band across east central Texas, include: the Jackson Group, the Claiborne Group, the Wilcox Group and the Olmos Formation of the Navarro Group (See Figures 3.2-15 and 3.2-16).

Figure 3.2-15 Texas Near-Surface Lignite



Source: Texas Center for Policy Studies, 1995, *Texas Coal Mining Operations*, Texas Environmental Almanac Chapter 7, http://www.texascenter.org/almanac/Energy/ENERGYCH7P3.HTML

Figure 3.2-16 Stratigraphic Occurrence of Texas Lignite

Stratigraphic Occurance of Texas Lignite

		East, Southest, and Central Texas	South Texas
Oligocene	Catahoula Group		
Oligocene	Jackson Group	Whitsett Formation	upper
		Manning Formation*	middle
		Wellborn Formation	lower*
		Caddell Formation	
Eocene Series	Claiborne Group	Yegua Formation*	upper Yegua*
		Cook Mountain Formation	
		Stone City Formation	Laredo Formation
		Sparta Sand	
		Weches Formation	
		Queen City Sand	El Pico Clay
		Reklaw Formation	Bigford Formation
		Carrizo Sand	Carrizo
	Wilcox Group	Calvert Bluff Formation*	
		Simsboro Sand	Lower Wilcox Group*
		Hooper Formation	Indio* Formation
	Midway Group		

*main lignite occurances

Source: WR Kaiser, 1974, *Table 1: Stratigrpahic Occurrence of Texas Lignite*, The University of Texas at Austin, http://www.lib.utexas.edu/books/landscapes/publications/txu-oclc-1552275/txu-oclc-1552275.pdf

Gulf Coast lignites are interpreted as having accumulated in a variety of fluvial, deltaic, and lagoonal depositional environments. Fluvial lignite accumulated in forested, fresh-water swamps (Nichols and Traverse, 1971). Kaiser (1974) states that "[Fluvial lignite] originated as backswamp peats on broad, isolated floodplains separated by stabilized meanderbelts …. [Deltaic] lignite is associated with three sedimentation patterns: alternating distributary channel and interdistributary deposits; repetitive coarsening-upward, delta-front sequences; and stacked coarse-grained meanderbelt deposits. … The thickest, most extensive lignites are associated with delta-plain, interdistributary deposits. … [Lagoonal lignites display a sedimentation pattern] of multi-stacked progradational or coarsening-upward barrier- and strandplain-beach sequences in which the lignites are associated with inland or updip lagoonal muds."

The Jackson Group of east Texas is interpreted as having been formed under two distinct processes of lower delta plain deposition. It has been proposed that thin, discontinuous lignite seams formed in small interdistributary areas, which were frequently covered by sediment during overbank flooding and crevassing. By contrast, thick coal seams, deposited on sand platforms, are laterally continuous and likely represent lignite deposition during periods of delta lobe abandonment.

The east Texas Wilcox Formation may show the characteristics of an alluvial-plain setting. The individual seams are lenticular, where the thickest part of the bed occurs in the center of the seam abruptly decreasing in thickness at the outer margins. Adjacent to the lignite bodies are channel-like barren areas that are filled with either mud or sand. Channels are normally parallel to the individual lignite bodies. Large, irregular, and circular mud-filled areas completely surround some of the lignite seams.

Regardless of the depositional mechanism, it was during these periods that swampy, stagnant conditions prevailed and organic matter was deposited. This organic matter was subsequently buried by sediment and over time compressed into lignite.

The lignite bearing rock in Louisiana was deposited during the Middle Tertiary approximately 36 to 66 million years ago. During this time much of Louisiana existed as an alluvial plain and was characterized by low, marshy land with heavy plant growth. The heavy plant growth then started decomposing within the swampy, marshy areas and was buried by sand and mud sediments from alluvial, deltaic and coastal sediments. The northern part of the state contains lignite beds of the Wilcox Group.

The lignite bearing rocks in Mississippi were also deposited during the Middle Tertiary, approximately 36 to 66 million years ago. The lignite seams currently mined in Mississippi were formed in a fluvial environment in which several sequences of flooding and stream channel migration occurred. It was during these periods that swampy conditions dominated and organic matter was deposited. As discussed previously, over time, this organic material was buried and compressed into lignite. These lignite beds are found in the Wilcox and Claiborne Groups.

Four of the most prominent coal-bearing units in the region are the Jackson Group, the Claiborne Group, the Wilcox Group, and the Olmos Formation of the Navarro Group. Most of the coal currently mined from the Gulf Coast region is from one of these four lithological groups.

3.2.4 Illinois Basin Coal-Producing Region

The Illinois Basin region encompasses the coal-bearing areas of Illinois, Indiana, and western Kentucky (See Figure 3.1-25). The Illinois Basin itself is an oval depression covering approximately 60,000 square miles in the midcontinent area of the United States.

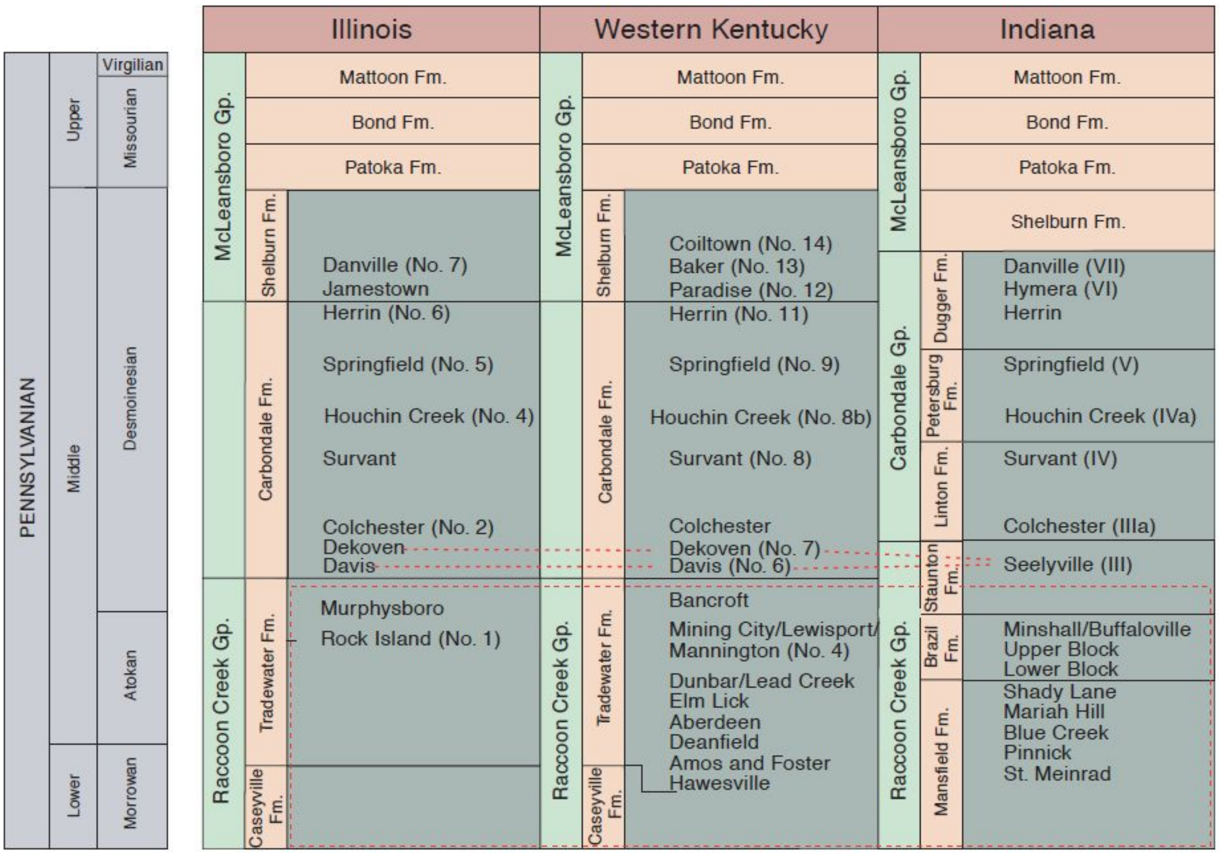
The Illinois Basin was formed as a “failed rift” related to the rupturing of an Early to Middle Cambrian supercontinent. As the continental crust was pulled apart, faulting produced a structural depression in this region. The depression evolved into an embayment that continued to subside from the Late Cambrian into the Permian.

During the Pennsylvanian, the basin filled with a thick succession of sandstone and carbonate deposits. These Pennsylvanian-aged sedimentary rocks, deposited 320 to 280 million years ago, contain the bituminous coal-bearing units which were laid down in freshwater, swamp, and rain forest environments.

No lithologic record is preserved of bedrock strata in the Illinois Basin younger than 225 million years ago. However, during the Late Cretaceous and Early Tertiary, the area immediately above the former rift subsided and filled with sediments of the Mississippi Embayment of the Gulf Coastal Plain (Leighton et al., 1990).

Due to stratigraphic discontinuity and a lack of regional key horizons, it is difficult to correlate Pennsylvanian formations basin wide. Although attempts have been made to resolve these issues (USGS, 2002a), correlation problems still exist. Generally speaking, the Pennsylvanian rocks can be subdivided into the basal Raccoon Creek Group, the overlying Carbondale Group or Formation and the McLeansboro Group. The major economic coals within the Basin are the Springfield and Herrin Coals (in the Carbondale Formation), the Danville (in the McLeansboro in Illinois), and the Baker Coal (in the McLeansboro of Kentucky) (See Figure 3.2-17).

Figure 3.2-17 Generalized Stratigraphy of Coals in the Illinois Basin



Source: J.R. Hatch and R.H. Affolter, 2002, *Figure 1; Stratigraphic chart of the Pennsylvanian System in the Illinois Basin, showing major coal members*, USGS; U.S. DOI, http://pubs.usgs.gov/pp/p1625d/Chapter_C.pdf

In addition to the Springfield, Herrin, Danville, and Baker Coals, many other coals in the Raccoon Creek Group, Carbondale Group or Formation, and the McLeansboro Group have been previously mined. Cumulative production from these other coals, however, has been much less than the production from the four principal coals (Hatch and Affolter, 2002).

3.2.4.1 Illinois Geology

The majority of the Illinois Basin lies within the state of Illinois, occupying an area of approximately 36,800 square miles (See Figure 3.1-27). The Pennsylvanian-aged coal-bearing rocks are divided into the Raccoon Creek Group, Carbondale Formation, and the Shelburn Formation (See Figure 3.2-17). Typically, sandstones are the dominant rock type of these formations, with most of the remainder made up of siltstone, shale and minor amounts of limestone.

In Illinois, the Danville Coal Member is the most prominent coal in the Shelburn Formation of the McLeansboro Group. Other McLeansboro Group coals, stratigraphically above the Danville in Illinois (and Indiana), are not as thick or as extensive as the coals in the underlying Carbondale Formation (Hatch and Affolter, 2002). The Danville has been locally measured at thicknesses reaching six feet, but generally ranging from a few inches to three feet thick (USGS, 2002a). The Danville and Jamestown coal beds in Illinois correlate to the Danville and Jamestown coals beds in Indiana and the Baker and Paradise coal beds in western Kentucky.

The Herrin Coal Member of the Carbondale Formation averages more than six feet thick over extensive areas and locally reaches 15 feet thick in Illinois (USGS, 2002a). The Springfield Coal Member ranges from an average of five feet to a maximum recorded 13 feet thick. In western and west-central Illinois, the Springfield coal exhibits claystone dikes which cut through the coal seam and the overlying strata (Hatch and Affolter, 2002).

3.2.4.2 Indiana Geology

The Indiana coal field is located in the eastern portion of the Illinois Basin and covers an area of approximately 6,500 square miles (See Figure 3.1-27). The Indiana coal field is composed of the bituminous Pennsylvanian-aged Carbondale Group (referred to as a formation in Kentucky and Illinois). The Carbondale Group consists of, from oldest to youngest, the Linton, the Petersburg, and the Dugger Formations (See Figure 3.2-17 above). Shale is the most abundant rock type of the formation with the thick gray units being interpreted as deltaic deposits (Hatch and Affolter, 2002). The Hymera and Danville Coal Members of the Dugger Formation in Indiana are correlative with the Jamestown and Danville Coal Members of the McLeansboro Group in Illinois and with the Paradise and Baker coals of the McLeansboro Group in western Kentucky. The Herrin Coal Member is not well developed in Indiana.

3.2.4.3 Western Kentucky Geology

The western Kentucky coal field covers an area of 6,400 square miles of the southeastern portion of the Illinois Basin (See Figure 3.1-25). The western Kentucky bituminous coal field comprises Pennsylvanian-aged strata that are largely alluvial or deltaic in origin, and their thicknesses are relatively consistent throughout the area (Archer, 2001).

Although the Tradewater Formation of the Raccoon Creek Group contains more than 20 mined coal beds in western Kentucky, discussion is going to focus on the Carbondale and Shelburn Formations as these are the shallower coal-bearing units (See Figure 3.2-17). The Carbondale Formation consists of siltstone, shale, and some local sandstones. It contains some thin discontinuous limestones as well as some of the most heavily mined coal beds in the region. The most prominent of the Carbondale Formation coal beds are the Herrin (No. 11) which lies at the uppermost reaches of the formation, and the Springfield (No. 9). The Herrin (No. 11) coal occurs in two distinct bodies. The thickest of these bodies is in a narrow belt along the southern edge of the western Kentucky coal field where it attains a thickness of ten feet. The second coal body occurs at the north reaches of the coal field where it is less than two and a half feet thick, or absent (Hatch and Affolter, 2002). The Springfield Coal ranges from five to six feet in thickness in the middle of the coal field, but thins to less than four feet toward the east and northeast of the coal field (Hatch and Affolter, 2002).

Also in western Kentucky, the Shelburn Formation (previously known as the Sturgis) is a coal-bearing unit which overlies the Carbondale Formation. Although the principal rock type of the Shelburn Formation is sandstone, the unit also contains interbedded siltstones, shales, limestones, and coal. The Shelburn Formation contains the Baker (No. 13) and Paradise (No.12) coal beds. The Baker Coal exhibits overlying two-foot thick coal riders that are occasionally mined, along with the main seam during surface operations.

3.2.5 Northern Rocky Mountains and Great Plains Coal-Producing Region

The Northern Rocky Mountains and Great Plains region encompasses the coal-bearing areas of Montana, North Dakota, South Dakota, and Wyoming, as well as selected coal-bearing areas in Colorado, Idaho, and Utah. This region is subdivided into many basins, regions or fields (See Figure 3.1-27). The northern Rocky Mountains are subdivided into the Green River Basin Region, the Hams Fork Region, the Jackson Hole Field, the Big Horn Basin Region, and the Wind River Region. The Great Plains are subdivided into the Blackfeet-Valier Region, the North Central Region, the Fort Union Region, the Bull Mountain Field, the Great Falls Field, and the Powder River Basin. This discussion will focus on the Powder River Basin and the Fort Union Region, as most of the coal resources occur in these areas.

3.2.5.1 Powder River Basin Geology

The Powder River Basin is an asymmetrical synclinal basin which trends from southeast to northwest. In Wyoming, the Powder River Basin is bounded by the Black Hills uplift in the northeast, the Hartville uplift in the southeast, the Laramie Mountains in the south, the Casper arch in the southwest, and the Bighorn Mountains in the west. The basin continues northward into Montana where another structural feature, the Cedar Ridge anticline, separates it from the Williston Basin (Bartos and Ogle, 2002).

Although the Powder River Basin contains one of the world’s largest coal deposits, most of the coal is too deeply buried to be recovered economically. Still, the Basin is the largest coal mining region in the U.S. The Powder River Basin constitutes the single largest source of coal in the U.S., contributing about 40 percent to the national total (Luppens et al., 2008).

Some 65 million years ago, the climate of the area was subtropical, with average temperatures of 80°F and 120 inches of rainfall per year. The region had been covered by a shallow sea which slowly retreated as the land surface began to rise. As marine conditions withdrew, lakes and marginal swamps were created. Due to the heavy rain and few rivers to carry the water away, the flat basin floor was a series of swamps and lakes for 25 million years; this was the coal forming period. The swamps were so large that no sediment could get past the outside edges leaving the central portions free to accumulate pure peat. It was this peat that would eventually produce some of the thickest, low ash coals in the world (Wyoming State Geological Survey, 2013).

Principal units of the Powder River Basin are the Fort Union (Paleocene) and Wasatch (Eocene) Formations (See Figure 3.2-18). These strata, which are buried at relatively shallow depths, are interpreted as having been deposited primarily in fluvial, lacustrine, and swampy environments (Seeland, 1992; Ellis et al, 1999). The Fort Union Formation consists of sandstones, siltstones, mudstones, limestones, and coals, including the Wyodak coal zone. Along the eastern margin of the Powder River Basin, the Fort Union Formation dips to the west at an inclination of two to three degrees (Glass, 1997). Near the western margin, the Fort Union Formation dips to the east from 10 to 25 degrees (Glass, 1997).

Figure 3.2-18 Cenozoic Stratigraphic units, Eastern Powder River Basin

ERATHEM	SYSTEM	SERIES	STRATIGRAPHIC UNIT			HYDROGEOLOGIC UNIT
Cenozoic	Quaternary	Holocene and Pleistocene	Alluvium			Alluvial aquifers[1]
	Tertiary	Pliocene	*Not present in study area*			*Not present in study area*
		Miocene				
		Oligocene				
		Eocene	Wasatch Formation			Wasatch aquifer[1]
		Paleocene	Fort Union Formation	Tongue River Member	Tongue River Member[2]	
						Confining unit
					Wyodak-Anderson coal zone and other coal zones and coal beds	Wyodak-Anderson coalbed aquifer and other coalbed aquifers
						Confining unit
					Tongue River Member	Tongue River aquifer
				Lebo Member[3]		Lebo confining layer
				Tullock Member		Tullock aquifer

Source: USGS, 2005c, *Figure 7: Cenozoic Stratigraphic units, Eastern Powder River Basin*, U.S. DOI, http://pubs.usgs.gov/wri/wri024045/htms/report1.htm

Most of the mining in the basin occurs within strata of the Wyodak-Anderson coal zone. This zone is known for its extreme thickness which averages 100 feet thick (University of Wyoming, 2002). Coal beds of the Wyodak-Anderson zone occur at shallow depths along the eastern margin of the Powder River Basin. Near Gillette, Wyoming, several of the individual beds merge to form a single, thick Wyodak coal bed. However, to the south, the east, and the north of Gillette, the Wyodak coal bed splits into several seams (Bartos and Ogle, 2002).

The Wasatch Formation consists of conglomerates, sandstones, siltstones, mudstones, limestones and several coal beds, including the Lake DeSmet. The Lake DeSmet coal beds are thickest in the western and central parts of the Basin, near Lake DeSmet, where they attain a thickness of 250 feet (Glass, 1980; Glass, 1997; University of Wyoming, 2002). The dip of the Wasatch Formation is shallow, generally less than four degrees (Glass, 1997).

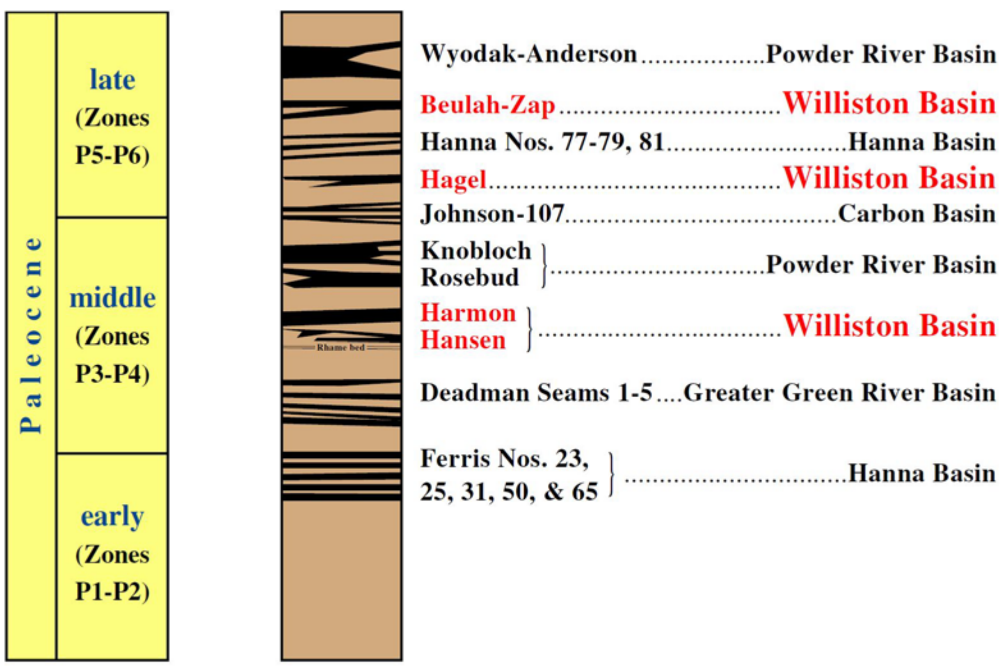
3.2.5.2 Fort Union Region Geology (Williston Basin)

The Fort Union Region in western North Dakota (the Williston Basin) is also a prominent Great Plains coal-bearing area (See Figure 3.1-27). The Williston Basin is a large geologic structural basin, though not a topographic depression, that underlies portions of Montana, North Dakota and South Dakota. The following discussion focuses on the Tertiary-aged Fort Union Formation (or Fort Union Group as it is considered by the North Dakota Geological Survey), as it is the primary coal-producing unit of the region (See Figure 3.2-18).

Strata of the Fort Union Formation are interpreted as having accumulated in the following depositional environments: fluvial and deltaic (the Tongue River and Sentinel Butte Members); tidal (the Ludlow Member); and barrier-shoreface and marine (the Cannonball Member) (Flores et al., 1999).

The Fort Union Formation is composed of, from youngest to oldest, the Sentinel Butte Member, the Tongue River Member, the Cannonball Member, and the Ludlow Member. The formation consists primarily of sandstones, siltstones, and mudstones. It also exhibits lesser amounts of carbonaceous shales, coals, and limestones. The Cannonball Member is the only non-coal-bearing member of the Fort Union Formation. Coal beds/zones include the Harmon and Hansen of the Lower Tongue Member, the Hagel of the Middle Sentinel Butte Member, and the Beulah-Zap of the Upper Sentinel Butte Member (Flores et al., 1999) (See Figures 3.2-18 and 3.2-19). The coal beds generally thicken toward the upper part of the formation with beds reaching thicknesses of 20 to 26 feet.

Figure 3.2-19 Coal Beds of the Williston Basin



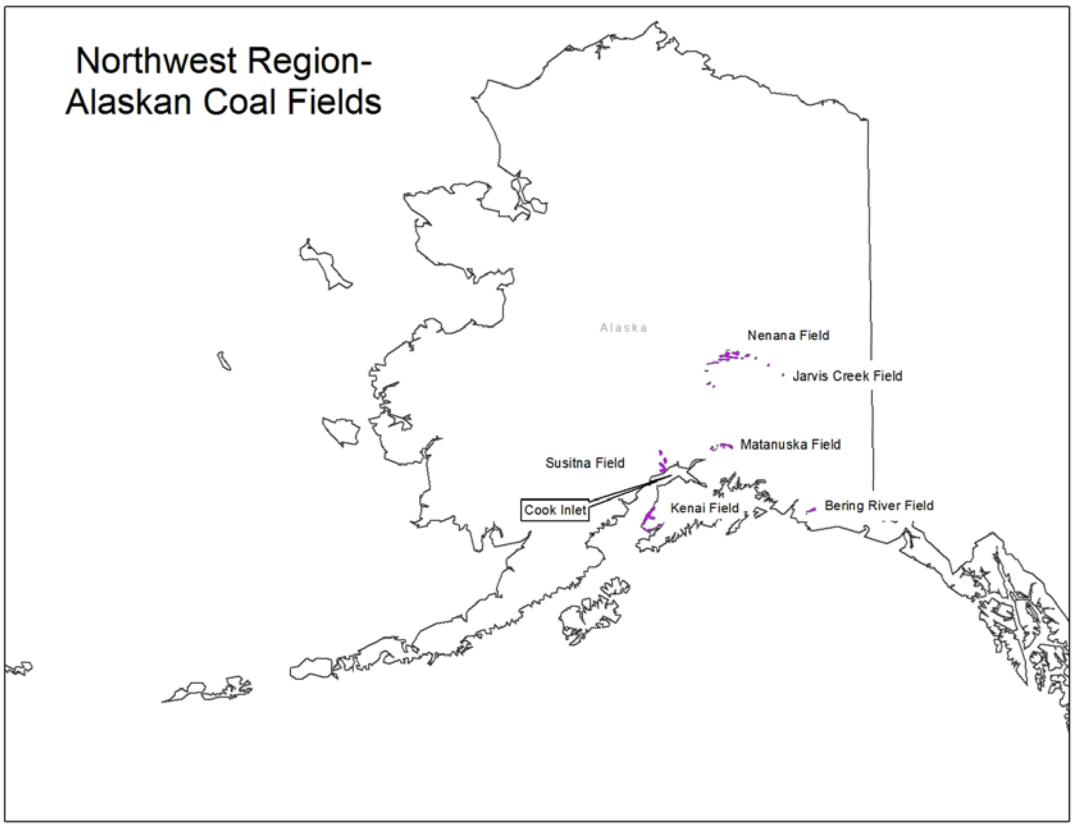
Source: Romeo M. Flores et al., 1999, Figure WF-2: Composite Stratigraphic Section for the Assessment Region Showing the Studied Coal Beds and Zones with Age Relationships Based on Palynology, USGS; U.S. DOI; http://pubs.usgs.gov/pp/p1625a/Chapters/WF.pdf

3.2.6 Northwest Coal-Producing Region

Although the Northwest region includes the states of Oregon, Washington, and Alaska, this discussion will focus on two coal-bearing areas in the state of Alaska that have active mine permits or reasonably foreseeable mining (See Figure 3.2-20) (Nenana and Matanuska). There are no current or proposed coal extraction mine permits in the states of Oregon or Washington or in the other coal basins of Alaska. Presently there is a single existing coal mine extracting coal in Alaska.

The major coal provinces discussed in Alaska are the Nenana Field, the Cook Inlet-Matanuska Valley (See Figure 3.2-20). The Central Alaska-Nenana coal field and the southern Alaska-Cook Inlet coal field account for the majority of the mineable coal resources in the state (Flores et al., 2004).

Figure 3.2-20 Alaskan Coal-Bearing Areas



Source:
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

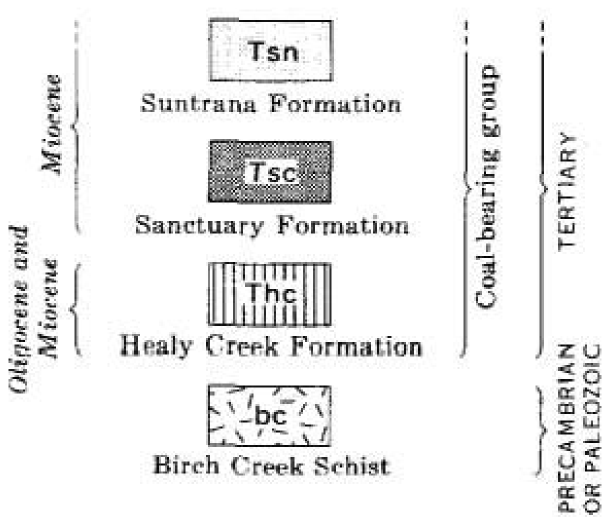
Studies have identified 50 coal fields in Alaska (Wood and Bour, 1988). Alaska coal resources formed in widespread deltaic and continental depositional environments during the Cretaceous and Tertiary. The younger Tertiary coals formed within sedimentary basins which were related to fault systems that controlled basin formation and influenced deposition. The southern Alaska-Cook Inlet, an elongated fault-bounded structural basin, is an example of this type of setting. The basin is situated at the north dipping subduction zone of the Pacific tectonic plate in southern

Alaska. The Cook Inlet coal beds are thought to have been deposited in swamps related to a large fluvial drainage system.

3.2.6.1 Central Alaska-Nenana Coal Field Geology

The Tertiary-aged Nenana coal field is located in the central part of the state with deposits trending east-west along the northern central flank of the Alaskan Range (See Figure 3.2-21). The Nenana coal field accounts for more than half of the coal mined in Alaska and, as of 2015, is the only province currently mined. The Usibelli Group is a non-marine sedimentary unit that contains as many as 30 coal beds and is thought to have formed in fluvial and lacustrine environments. The Suntrana Formation is an important coal-bearing sedimentary unit of the group (See Figure 3.2-21). It consists of interbedded sandstones, siltstones, mudstones, carbonaceous shales and coal. Shallow coal seams generally are encountered at depths less than 100 feet below ground surface and in seam thicknesses that can range up to 32 feet. The Suntrana Formation lies directly on metamorphic basement rock in this area.

Figure 3.2-21 Coal-Bearing Group, Nenana Coal Field, Alaska



Source: Clyde Wahrhaftig et al, 1969, *Figure 2 Coal-Bearing Group, Nenana Coal Field, Alaska*, USGS, U.S. DOI, http://www.dggs.dnr.state.ak.us/webpubs/usgs/b/text/b1274d.PDF

3.2.6.2 Southern Alaska-Cook Inlet Field Geology

There are four Tertiary-aged coal fields identified in the Cook Inlet province, including the Susitna-Beluga, the Kenai, the Broad Pass, and the Matanuska. The Matanuska Coal Field contains more than 20 coal beds with thicknesses ranging from three to 23 feet. These beds occur primarily in the Chickaloon Formation along, with sandstones, siltstones, mudstones, and minor conglomerates.

The Kenai Coal field’s main coal-bearing unit is the Kenai Group (See Figure 3.2-22). Included in the Kenai Group are the Beluga and Sterling Formations. The Beluga Formation consists of sandstones, siltstones, mudstones, carbonaceous shales, coals, and some volcanic ashes. Coal seams can be 12 feet thick in the upper stratigraphic levels (Wilson et al., 2009). The Sterling Formation consists of sandstones, conglomeratic sandstones, siltstones, mudstones, carbonaceous shales, and coal beds. Sterling Formation coal beds have been observed in coastal bluffs at thicknesses of 12 feet (Flores and Stricker, 1992).

Figure 3.2-22 Stratigraphic Column for Cook Inlet Basin Sediments

Age	Era	System	Series		Cook Inlet Basin Stratigraphy	
0	Cenozoic	Quaternary				
1.9						
3.5		Tertiary	Pliocene	U	Sterling Formation	Kenai Group
5.4				L		
11.2			Miocene	U	Beluga Formation	
16				M	Tyonek Formation	
24				L		
28.5			Oligocene	U	Hemlock Formation	
33.5				L		
37			Eocene	U		
49				M		
55				L	West Foreland Formation	
60.5			Paleocene	U		
66 Ma				L		

Source: Geological Society of America, 2000, *Figure 2: Stratigraphic Column for Cook Inlet Basin Sediments*, U.S. General Services Administration Bulletin, http://gsabulletin.gsapubs.org/content/112/9/1414/F2.expansion.html

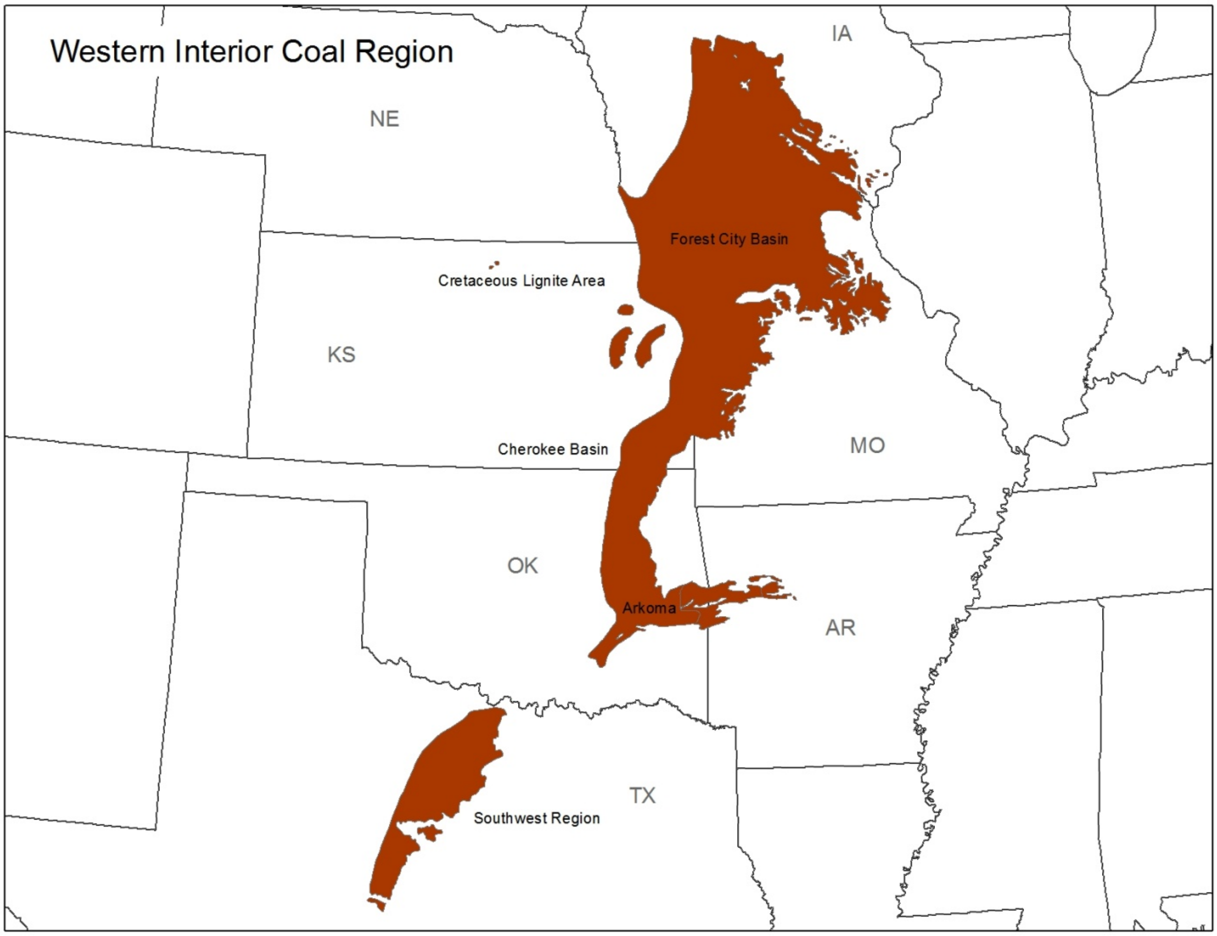
The Broad Pass coal field underlies a narrow trough at the north end of the Cook Inlet and is approximately five miles wide. The predominant coal-bearing unit of this field is correlated with the Sterling Formation of the Kenai Group.

The Susitna-Beluga coal field is also situated north of the Cook Inlet. The predominant coal-bearing unit is the Tyonek Formation, also in the Kenai Group. The Tyonek Formation consists of sandstones, siltstones, mudstones, carbonaceous shales, and coal beds. Sandstones are the most common rock type of the formation. Individual coal beds, as much as 30 feet thick have been documented.

3.2.7 Western Interior Coal-Producing Region

The Western Interior region encompasses the coal-bearing areas of Iowa, Nebraska, Kansas, Oklahoma, Arkansas, Missouri and central Texas (See Figure 3.2-24). The most productive coal fields of the Western Interior region occur in three coal basins: Arkoma, Cherokee, and Forest City. The Arkoma Basin covers about 13,500 square miles in Arkansas and Oklahoma. The Cherokee Basin is part of the Cherokee Platform Province which covers approximately 26,500 square miles in Oklahoma, Kansas, and Missouri. The Forest City Basin covers about 47,000 square miles in Iowa, Kansas, Missouri, and Nebraska. For the purpose of this study, discussion will focus on these basins due to their importance to coal production.

Figure 3.2-23 Western Interior Region



Source: Data- USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

The Arkoma basin was depositionally part of a broad, stable shelf along a passive continental margin during much of its geologic history. The depositional patterns on the shelf varied greatly, with strata accumulating in both marine carbonate and terrestrial clastic environments. There is evidence of a limited source of sediments from the Ouachita fold belt in Arkansas during the deposition of the Pennsylvanian-aged Hartshorne Sandstone, an important coal-bearing formation in the basin. However, the western side of the basin in Oklahoma was apparently quiet and presumably stood at or near sea level throughout that time.

The Cherokee Basin is the central basin of the Western Interior Coal region. It is bounded on the east and southeast by the Ozark Dome, on the west by the Nehama Uplift, and on the north by the Bourbon Arch. The Cherokee Basin was formed by the downward warping of a post-Mississippian peneplain (a regional, flat, erosional surface). The basin was united with the similarly formed Forest City Basin when the low divide separating them was covered by the accumulated deposits of the Cherokee Shale. The Cherokee shale represents the oldest Pennsylvanian-aged formation in Kansas (Lee, 2005).

The Forest City Basin extends from southwestern Iowa and northeastern Kansas to central Missouri. The basin is approximately 240 miles long (north-south) by 195 miles wide (east-west). The basin exists today as a relatively undeformed Pennsylvanian-aged structural basin. A series of northwest-southeast trending folds and faults have been reported in the Missouri portion of the Arkoma Basin.

Sedimentary rocks in the Arkoma Basin range in thickness from 3,000 to 20,000 feet and consist primarily of pre-Mississippian carbonate shelf deposits, organic-rich Mississippian marine shales, and Pennsylvanian fluvial deposits. The Krebs Group, which contains the Hartshorne, McAlester, Savanna, and Boggy Formations, is a prominent coal-bearing unit of the basin. The Lower Hartshorne coal bed is the thickest and the most extensive coal bed in Arkansas and the Arkoma Basin. The Lower Hartshorne has been, and will continue to be, the most economically important coal bed in Arkansas (Arkansas Geological Survey, 2010). The Arkoma Basin contains approximately 40 named coal beds, as well as several unnamed coal beds.

3.2.7.1 Cherokee Basin Geology

The primary coal seams in the Kansas Cherokee Basin are the Riverton Coal of the Krebs Formation and the Weir-Pittsburg and Mulky coals of the Cabaniss Formation. These Pennsylvanian-aged formations consist primarily of shales, some sandstones, and minor amounts of limestone. The Riverton and Weir-Pittsburg coal beds, about three to five feet thick, are the thickest and most widespread of the units. The Mulky Coal can attain thicknesses of two feet. However, the Weir-Pittsburg coal beds and the Mulky Coal both occur at depths of several hundred feet and are mineable only by underground methods.

3.2.7.2 Forest City Basin Geology

In the Forest City Basin, coal-bearing strata are present in the Pennsylvanian-aged Riverton Formation and the Cherokee, Marmaton, and Pleasanton Groups. The coal-bearing units are cyclothems made up of shale, sandstone, limestone, and coal. More than 40 individual beds have been identified, and many have been mined for more than 100 years by both underground and surface methods. Some of the important coal beds which correlate across state boundaries are Riverton, Weir-Pittsburg, Mineral, Scammon, Fleming, Tebo, Croweburg, Bevier, Summit, Mulky, Mystic, and Mulberry. The coal beds are relatively widespread and commonly deep. As a result, many parts of the basin are underlain by multiple, unmined coal beds. The cumulative thickness of the coals may be as much as 25 feet with individual beds as thick as ten feet; however, many of the beds are less than two feet thick.

Depths to the top of the Cherokee Group coals range from surface exposures in the shallower portion of the basin in southeastern Iowa, to about 1,200 to 1,600 feet in the deeper parts of the basin in southwestern Iowa and northeastern Kansas (Bostic et al., 1993). Generally, Pennsylvanian coal rank increases with depth and westward location, where greater depths of sediment burial exist.

3.3 SOILS

This section examines soil resources potentially affected by the alternatives under consideration.

3.3.1 Introduction

Soil is a natural body comprised of solids (minerals and organic matter), liquid, and gases that occurs on the land surface, occupies space, and is characterized by horizons (layers) that are distinguishable from the initial material (bedrock or other parent material) as a result of additions, losses, transfers, and transformations of energy and matter or the ability to support rooted plants in a natural environment (NRCS, 1999). Soil consists of the horizons near the earth's surface that, in contrast to the underlying parent material, have been altered by the interactions of climate, topography, and living organisms over time (NRCS, 1999). The upper limit of soil is the boundary between soil and air, shallow water, live plants, or plant materials that have not begun to decompose (NRCS, 1999). Commonly, soil grades at its lower boundary to unfragmented rock or to earthy materials virtually devoid of animals, roots, or other marks of biological activity (NRCS, 1999). However, the lowest depth of biological activity is difficult to discern and is often gradual. Therefore, for purposes of classification, the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) considers the lower boundary of soil in indistinct situations to be 200 cm (approximately 6.5 feet) (NRCS, 1999). Areas are not considered to have soil if the surface is permanently covered by water too deep for the growth of rooted plants (typically, more than 2.5 meters—approximately 8 feet) (NRCS, 1999).

Factors that contribute to soil development include parent material, climate, topography, biological factors, and time. Parent material is generally bedrock, glacial till, colluvium (material moving in response to gravity), or alluvium (material deposited by rivers and streams) on which a soil forms (U.S. EPA et al., 2003). Climate affects soil composition by freeze/thaw action and by controlling the rate at which physical and chemical weathering take place. Wind and water both remove and deposit soil materials. Soils undergo continual development because of the cumulative effects of all these factors. The time required for soil to form from parent materials ranges from hundreds to tens of thousands of years. Well-drained mine spoils have been observed to begin the process of A-horizon formation in as few as 10 to 20 years after mining.

Physical, chemical, and biological properties of soils determine their productivity and susceptibility to compaction and erosion. The potential for plant growth depends on the ability of the soil to accept, hold, and release nutrients and moisture. Soil provides the environment for root growth and development. It provides habitat for microorganisms that control processes related to plant nutrition, nutrient cycling, and the biological control of pests. The condition of the soil determines the effectiveness of these functions.

In the U.S., soil scientists recognize twelve basic types of soils known as orders. These orders reflect the environment in which soils form, their age, and the ecosystems they support. Of the 12 soil orders, the 11 listed below are present in the coal-producing regions:

- Andisols – dark soils formed from volcanic activity;
- Alfisols – brown forest soils;

- Aridisols – arid region soils;
- Entisols – very young soils that show little weathering;
- Gelisols – frozen soils of tundra areas;
- Histosols – organic soils in marshy or montane areas;
- Inceptisols – young soils;
- Mollisols – dark, rich soils of the plains (mostly grasslands);
- Spodosols – ashy soils of wet, sandy areas;
- Ultisols – highly weathered soils of mostly temperate areas; and
- Vertisols – soils with shrink-swell clays.

Soils are further divided by similar characteristics into suborder, great group, subgroup, family, and soil series. There are more than 19,000 soil series in the U.S. (NRCS, 2011). Throughout this section, certain soil suborders and great groups (italicized) are included with the soil orders to provide a more detailed description of soils within the various regions.

Soil productivity is the ability of a soil to produce vegetation, either in general or in terms of a specific crop. The physical (texture and structure), chemical (organic matter decomposition and nutrient release), and biological (nutrient cycling and nitrogen fixation) properties of soil supply the required air, water, and nutrients the plants require for plant growth (BLM, 2008).

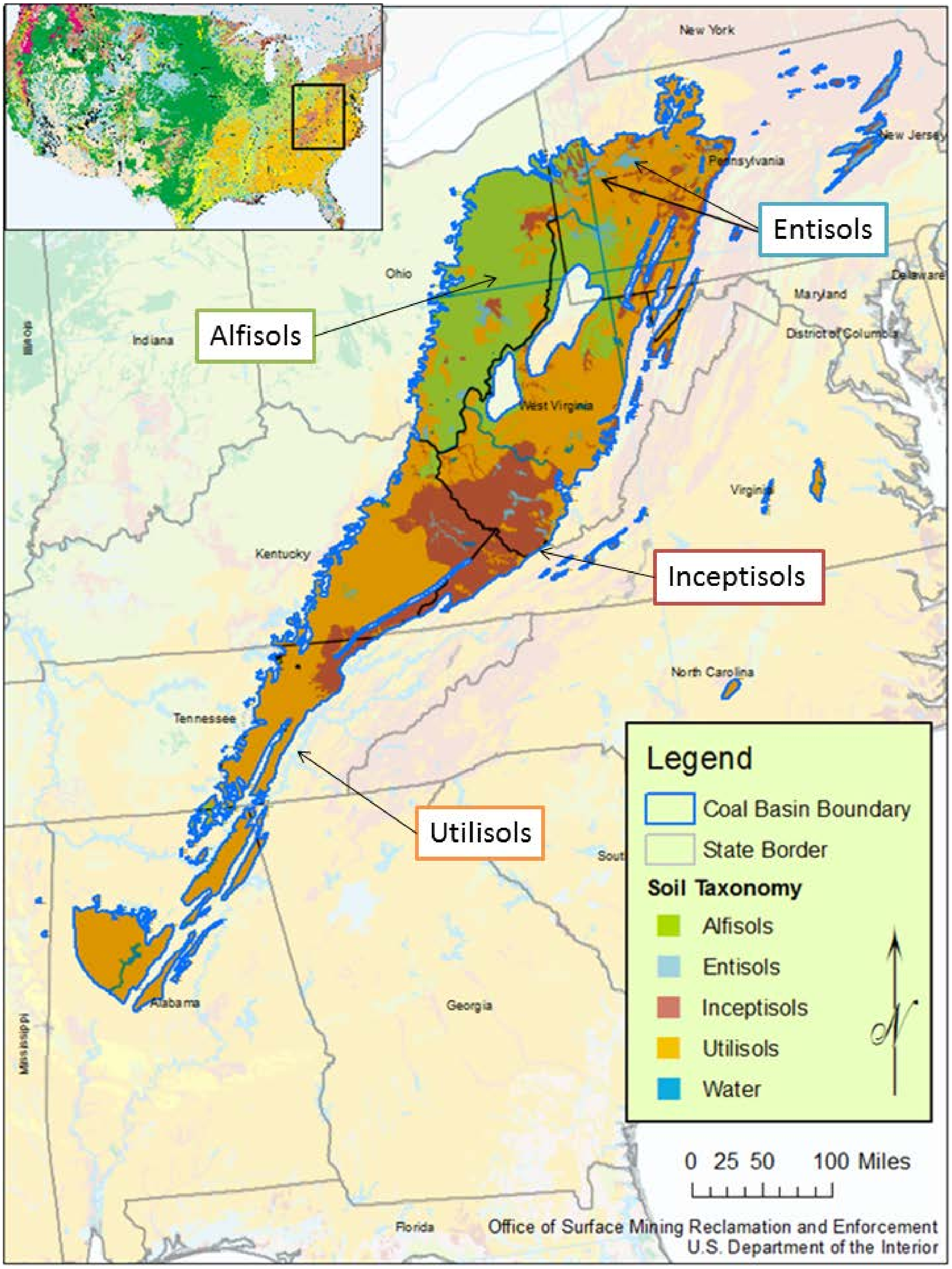
To describe the soil resources potentially affected by the alternatives, this section briefly discusses the dominant soil orders, suborders, and soil associations of the ecoregions (McNab and Avers, 1994) in each coal region. Soil distribution can be very heterogeneous, creating a mosaic of soil types over small areas.

3.3.2 Appalachian Basin Region

3.3.2.1 Description of Soils in Region

The Appalachian Basin region (see Figure 3.3-1) features soils that are predominantly colluvial in nature, i.e., soils that occur on mountain slopes formed on residuum from acidic sandstone, siltstone, and shale. These associations/complexes typically occur on steep side slopes at higher elevations. They form on residuum or creep material from acidic sandstone, siltstone, and shale. These soils are very thin—typically 0-3 inches of topsoil and 1.5-5 feet of subsoil underlain by bedrock. Logging methods may adversely affect topsoil thickness (U.S. EPA et al., 2003).

Figure 3.3-1 Soil Orders of the Appalachian Basin Region



Source: NRCS, 2011, *U.S. General Soil Map (STATSGO2) - Soil Data Mart*, U.S. Department of Agriculture (USDA), downloaded from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

The presence of deeper colluvial and residual weathered deposits on southwest slopes that receive higher precipitation amounts than slopes with other aspects make slopes with a southwest aspect susceptible to landslides.

The most extensive soils in the Appalachian Basin region are Ultisols. Ultisols are generally deep to moderately deep, leached, acidic, and highly weathered. They have a low nutrient content and their ability to retain minerals is moderate to low. Inceptisols are immature soils that occur on steep slopes and in depressions in the region. They form from highly resistant parent material or in alluvial floodplains. Inceptisols are predominantly found on slopes and in depressions in warmer temperature regimes. These soils are generally thin but can be deep in places. They are better able to retain minerals than the Ultisols. Alfisols, which are moderately deep, are also present. Typically, xeric shallow soils are present along the tops of cliffs and rock outcrops, while thin rocky soils accumulate in crevices, on ledges, and along rock margins.

Ecological areas, referred to as ecoregions, in the Appalachian Basin are the Southern Unglaciated Allegheny Plateau, Allegheny Mountains, Northern Cumberland Mountains, and Northern Cumberland Plateau. Soil descriptions of the ecological areas can be summarized as follows (OSMRE, 2008):

- Southern Unglaciated Allegheny Plateau ecological area soils consist mostly of Ultisols (Udalfs, Udults, and Ochrepts). Soil conditions are moist for most of the growing year and the soils have a mixed-clay or primary-clay mineralogy. These fine-loamy or clayey soils are frequently in a reducing environment.
- Soils in the Allegheny Mountains ecological area are predominantly Ultisols, Inceptisols, and Alfisols and are moist for most of the growing year. They are derived from heavily weathered shales, siltstones, sandstone residuum, colluvium, and limestone residuum. Spodosols with frigid temperature regimes and reducing environments occur in isolated pockets at the highest elevations.
- Northern Cumberland Mountains ecological area soils are mainly Ultisols, Inceptisols, and Alfisols. These fine- to coarse–loamy soils are moist for most of the growing year. They are derived from heavily weathered shales, siltstones, sandstone residuum and colluvium, and limestone residuum. Ultisols and Inceptisols (Dystrochrepts, Hapludults, and Fragiudults) on plateaus and upper slopes are fine-loamy to loamy with a siliceous or mixed mineralogy.
- Ultisols dominate side slopes and ridges in the Northern Cumberland Plateau ecological area. Inceptisols are found on slopes and Entisols on floodplains. These medium- to-fine-textured, shallow to deep soils with a siliceous or mixed mineralogy are moist for most of the growing year.

3.3.2.2 Productivity and Reclamation Potential

Throughout much of the Appalachian Basin, reclaimed soils are frequently very thin. Excessive grading caused by the need to restore appropriate slopes as well as additional grading to redistribute soil has resulted in over-compaction. This compaction of soil and root zone media makes revegetation with species other than grasses difficult and has historically inhibited the reestablishment of desired hardwood forests after mining. However, more recent efforts at reestablishing hardwood forests on mined lands in the Appalachian Basin, based on current research indicating that trees grow well in uncompacted mine spoil, have been successful (Burger et al., 2005). In partnership with industry, universities, and the states, OSMRE has developed the Appalachian Region Reforestation Initiative to promote reclamation and reforestation using the Forestry Reclamation Approach. This approach minimizes grading and compaction, thus facilitating successful tree root development and vigorous tree growth, with a high potential for successful forestry postmining land uses.

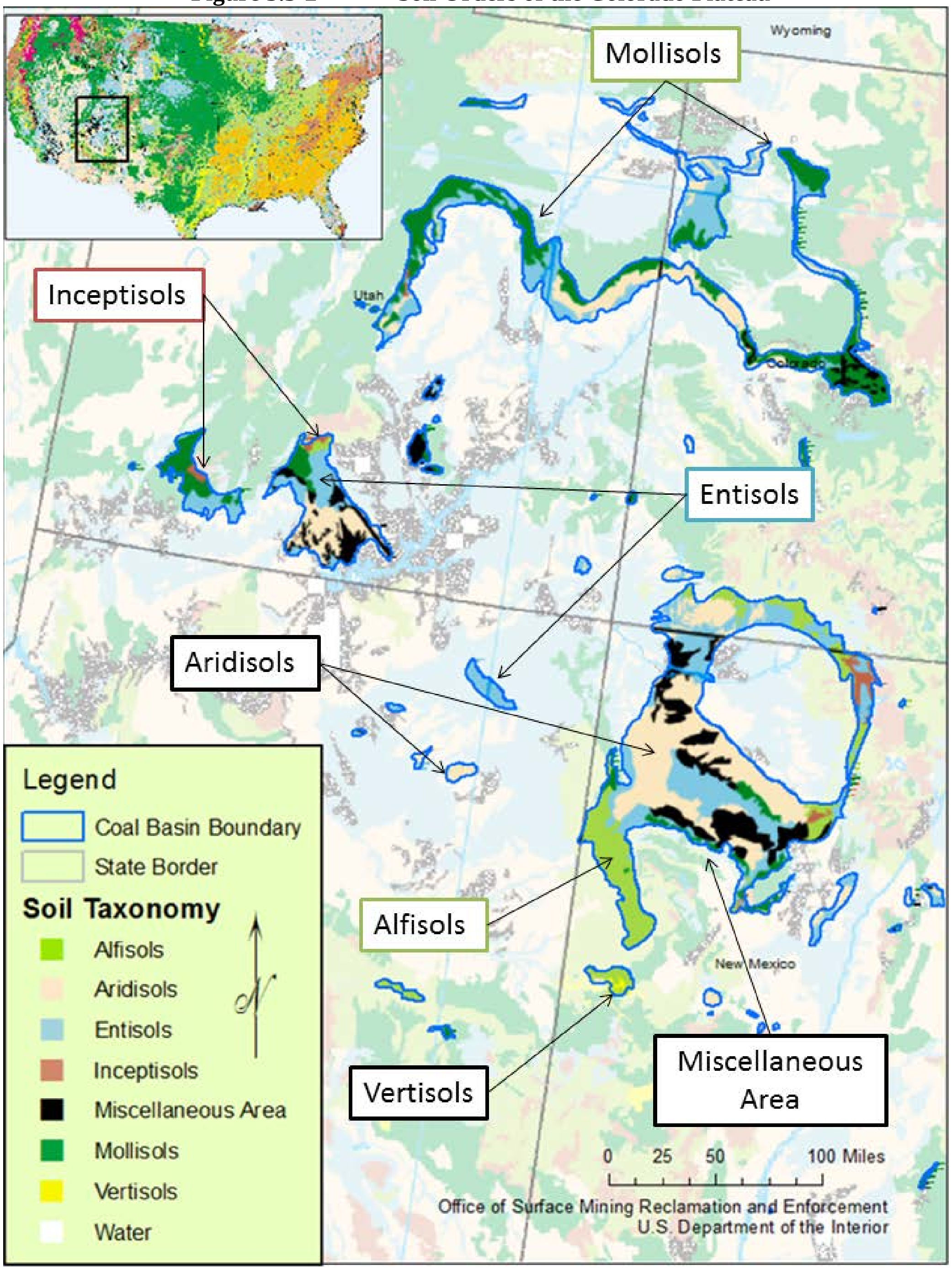
3.3.3 Colorado Plateau Coal-Producing Region

3.3.3.1 Description of Soils in Region

The Colorado Plateau (see Figure 3.3-2) is predominantly composed of Alfisol, Aridisol, Entisol, Inceptisol, and Mollisol soils. Alfisols are predominant in forested areas at high elevations. Aridisols are a common soil series in the western U.S. and are formed in areas that are dry for long periods of time. Entisols of the western U.S. are generally Orthents found on recent erosional surfaces. These soils support rangeland, pasture, and wildlife. Inceptisols in this region occur mostly at high elevations where the vegetation is mostly conifers or mixed conifers. Mollisols form in grasslands and are the dominant soils of the plains and high-elevation plateaus and ridgetops.

Colorado Plateau soils are generally cool soils with dark-colored, organic-rich surface horizons in moderately sloping areas and shallow, poorly developed soils in steeper areas and on rock outcrops. Soils on upper slopes have a thin organic-rich surface horizon and soils on the lower slopes range from shallow to moderately deep. These soils are generally formed in colluvium, with a few formed in residuum derived from shales and sandstone. Some are formed from eolian (wind-deposited) material. Biological crusts, a complex mosaic of blue-green algae, green algae, lichens, mosses, microfungi, and other bacteria (Belnap et al., 2001) are also present. These fragile crusts affect water retention and infiltration and surface runoff and may reduce soil erosion.

Figure 3.3-2 Soil Orders of the Colorado Plateau



Source: NRCS, 2011, *U.S. General Soil Map (STATSGO2) - Soil Data Mart*, USDA, downloaded from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

Ecological areas in the Colorado Plateau region are the Navajo Canyonlands, Tavaputs Plateau, and Southern Parks and Ranges. Soil descriptions of the ecological areas can be summarized as follows (OSMRE, 2008):

- Soils in the Navajo Canyonlands ecological area are mostly Aridisols with some Inceptisols, Alfisols, and Entisols. Soils are fine- to coarse-loamy, generally dry, and shallow, especially along slopes. Entisols can be rocky or gravelly.
- The Tavaputs Plateau ecological area soils include Entisols and Aridisols with moderate moisture, cold soil temperature regimes, and arid soil moisture regimes (dry for at least half the year). Entisols are generally fine-loamy, but can be clayey. Most soils contain calcium. Many soils (Entisols, Aridisols, and the less common Inceptisols) are shallow-rocky or loamy-skeletal with cold temperature regimes.
- Soils in the Southern Parks and Ranges ecological area are Alfisols and Mollisols. Fine, kaolinitic, and fine-loamy Alfisols are present, along with fine-grained Mollisols.

The NRCS identifies more than 580 soil associations in the ecological regions in the Colorado Plateau region. While not technically a soil, rock outcrops are part of the soil mapping scheme. These outcrops are extensive throughout the Colorado Plateau.

3.3.3.2 Productivity and Reclamation Potential

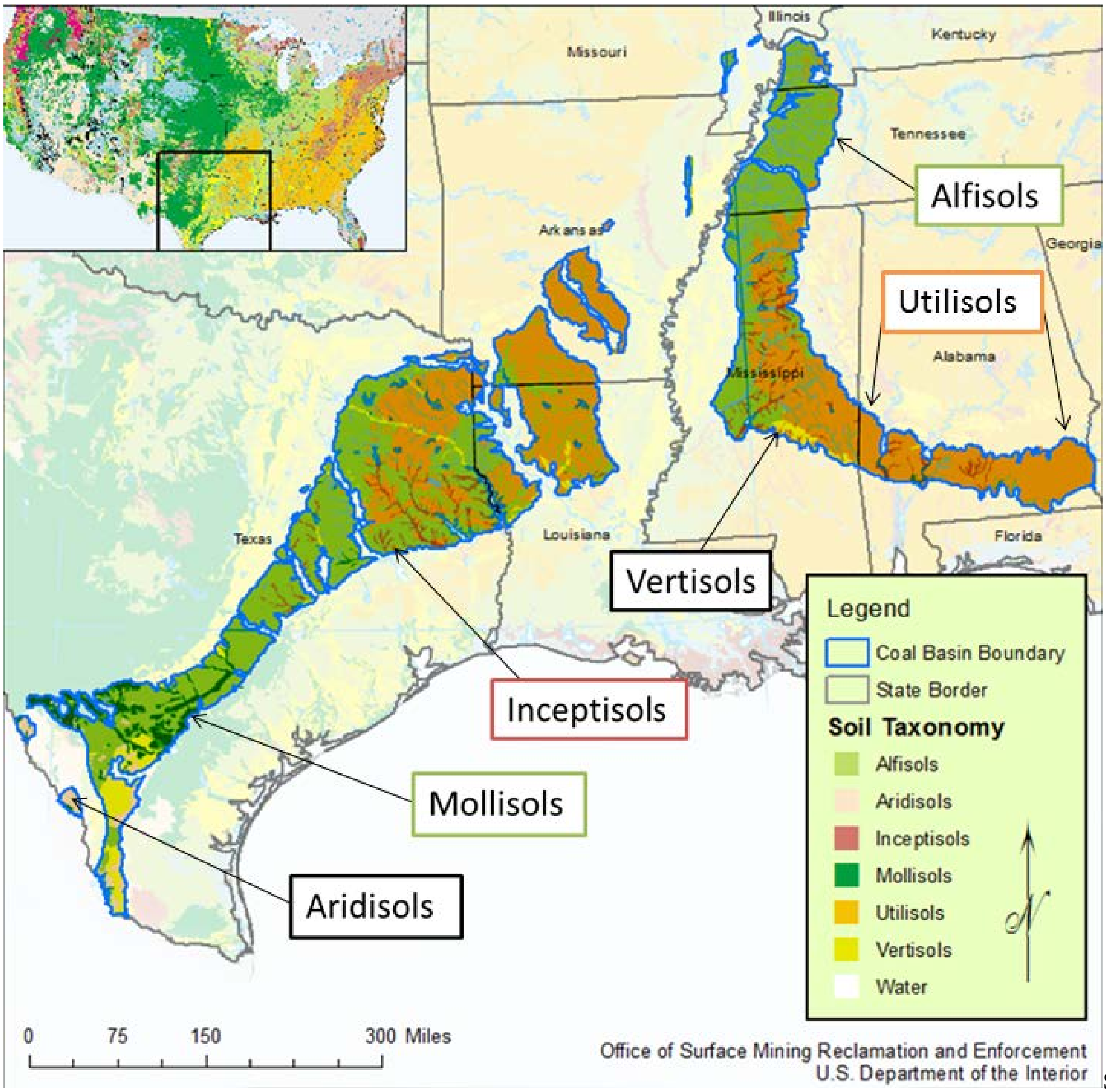
Most of the Colorado Plateau is arid to semiarid, although some areas are forested. Precipitation is a limiting factor when revegetating mined land. Elevated soil salinity levels can limit productivity. To establish vegetation, soil substitutes and supplements are commonly used, particularly in areas with shallow or rocky soils. Seed mixes of native and non-native species are tailored to the individual environment. Seeding is done during seasons with the best chance for precipitation.

3.3.4 Gulf Coast Coal-Producing Region

3.3.4.1 Description of Soils in Region

The Gulf Coast region (see Figure 3.3-3) consists of lignite fields that spread from southern Texas northeastward into northern Louisiana and southern and south-central Arkansas. A separate lignite field stretches north from the Mississippi Embayment area into parts of far western Tennessee and Kentucky and east into southern Alabama. Although lignite is present in all of these states, it is only mined in Texas, Louisiana, and Mississippi. For this reason, the following discussion focuses on the lignite-mining portions of these three states.

Figure 3.3-3 Soil Orders of the Gulf Coast



Source: NRCS, 2011, *U.S. General Soil Map (STATSGO2) - Soil Data Mart*, USDA, downloaded from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

Soils in the Gulf Coast region are predominantly Alfisols, Inceptisols, Mollisols, Ultisols, and Vertisols. Alfisols occur in dry areas of the southern Great Plains, mostly in Texas. They support savanna and grassland vegetation. Entisols in the Gulf Coast region are present along the coast and on floodplains, fans, and small streams. Inceptisols, Mollisols, and Vertisols occur in temperate subhumid or semiarid regions. Ultisols occur in wet environments and support cropland and forests.

Gulf Coast region soils range from dry (as in south Texas) to wet (as in eastern Texas, Louisiana and Mississippi) and most soils are on flat to gently rolling plains dissected by streams. Soils in the major coal areas of eastern Texas are generally well-developed clayey or loamy soils. They tend to have high shrink-swell properties. Soils further east in the more humid environment of Louisiana and Mississippi are rich organic Entisols, Vertisols, and Ultisols.

Ecological areas in the Gulf Coast region are the Rio Grande Plain; Oak Woods and Prairies; Coastal Plains and Flatwoods – Western Gulf; Mid-Coastal Plains – Western; Coastal Plains – Middle Section; and Lower Coastal Plains and Flatwoods. Soil descriptions of the ecological areas are as follows (OSMRE, 2008):

- Rio Grande Plain ecological area soils consist of Usterts, Torrerts, and Ustalfs. Pellusterts, including Calciustolls and Calciorthids are found on plains over clayey marine sediments. Torrerts, Haplustolls, Calciustolls, Paleustalfs, and Haplustalfs are found on plains. Soils have a hyperthermic temperature regime, an ustic or aridic moisture regime, and mixed mineralogy. Soils are mostly deep, fine- to coarse-textured, well-drained, and have limited soil moisture for use by vegetation during the growing season.
- In the Oak Woods and Prairies ecological area, soils are predominantly Ustalfs. Paleustalfs and Albaqualfs are found on uplands and other areas with thick sandy surfaces. Pelluderts, Pellusterts, and Hapludolls are found on floodplains and clayey terraces along major rivers. These soils have a thermic temperature regime, an ustic moisture regime, and montmorillonitic mineralogy. Soils are deep, medium-textured, and generally have a slowly-permeable, clayey subsoil. Moisture may be limiting for plant growth during parts of the year.
- Soils of the Coastal Plains and Flatwoods – Western Gulf ecological area are mostly siliceous fine clays and fine silty clay Alfisols with lesser amounts of coarser siliceous Entisols and Ultisols. Ultisols (Udults, Paleudults, Hapludults) and Alfisols (Hapludalfs, Paleudalfs, and Albaqualfs) occur on uplands. Entisols (Fluvaquents, Udifluvents) and the less common Inceptisols occur along major streams. Soils are mostly derived from weathered sandstone and shale and of siliceous or mixed mineralogy. Soils are deep, coarsely-textured, moist, and mostly well-drained.
- The Mid-Coastal Plains – Western ecological area soils are predominantly Ultisols. Alfisols and some Ultisols are found on uplands. Entisols, Inceptisols, and Alfisols are found on bottomlands along major streams. Soils are generally fine-grained, but some coarser soils are present. Siliceous mineralogy is prevalent with lesser amounts of clayey and kaolinitic soil series.
- Coastal Plains – Middle Section soils are mostly Ultisols characterized by fine to fine-loamy siliceous material with lesser amounts of coarser Entisols, Inceptisols and wetter Alfisols. Ultisols are on level to strongly sloping uplands and occur on less sloping, moderately well-drained areas. Small but significant areas of Alfisols and Entisols are present in localized areas and bottomlands. Ultisols are found in low-elevation wetlands. Soils are deep and loamy, clayey, or sandy with poor to good drainage.
- Soils of the Lower Coastal Plains and Flatwoods ecological area are predominantly Ultisols with fine to fine-loamy clays with a thermic temperature regime and a moist moisture regime. Soil texture ranges from fine-silty to fine-loamy to sandy. Mineralogy ranges from quartzitic to arkosic to clayey to micaceous. Soils are deep, moderately-permeable, and well-drained.

3.3.4.2 Productivity and Reclamation Potential

Productivity and reclamation potential vary throughout the Gulf Coast region. Soils in the lignite areas of Louisiana and Mississippi typically possess high productivity and reclamation potential. However, in the immediate area of current coal production, soils have more substantial limitations, which commonly result in the use of topsoil substitutes. Climate and water availability can influence productivity. Soils in Texas are more variable with productivity and reclamation potential ranging from poor in the dry south to fair in the wetter east. All current coal-producing areas contain certain soil types with one or more of the following limitations: (1) poor parent materials (residuum), (2) less than ideal soil texture, (3) extreme weathering, and (4) acidic soil chemistry.

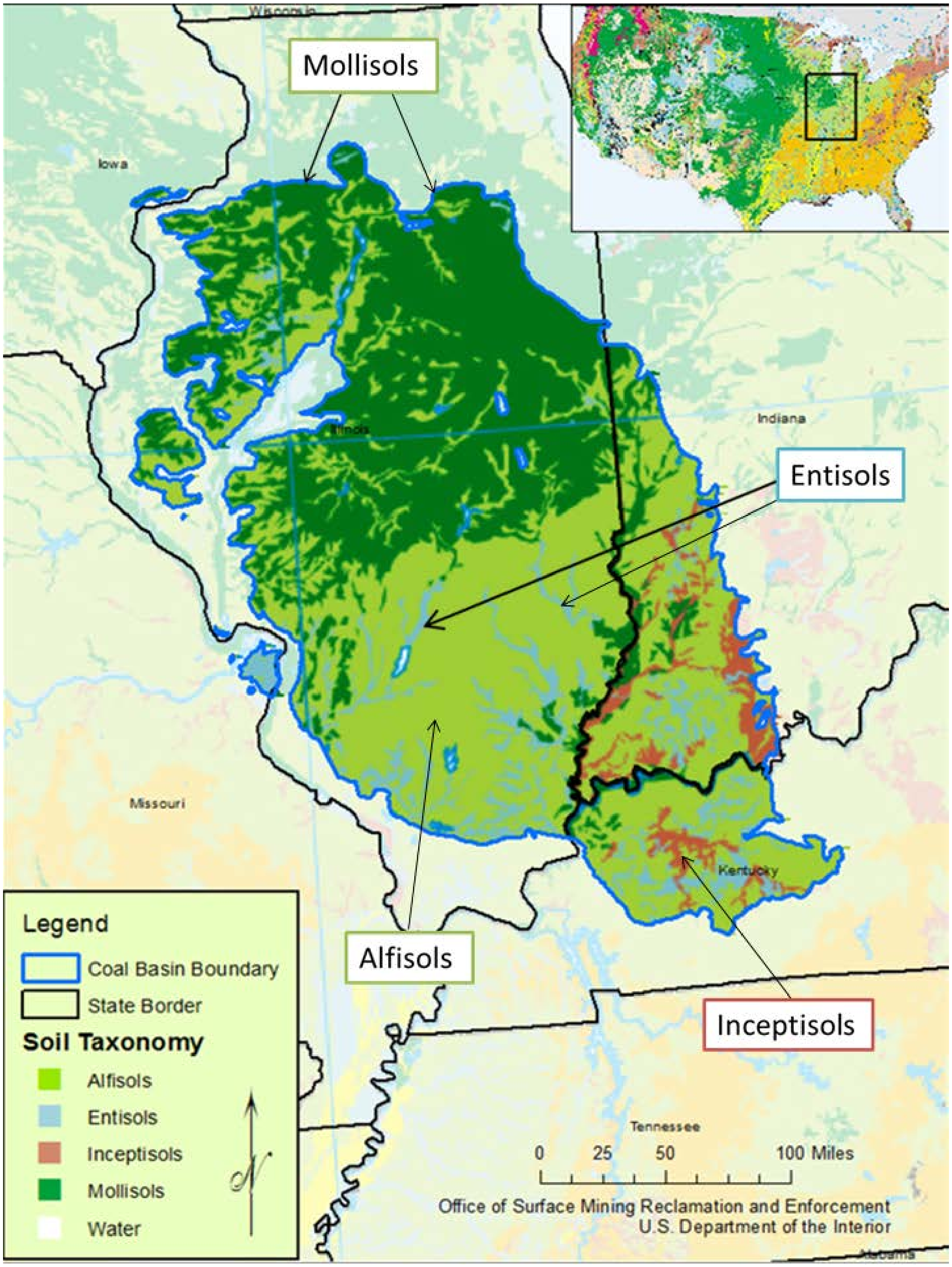
Operators commonly use topsoil substitutes in the Gulf Coast region to achieve an increase in productivity over the highly eroded and weathered native soils. The NRCS has developed mapping units for many mined areas in Texas that have been reclaimed using soil substitute materials. Although limited in acreage, two postmining soil substitute mapping units within the state have been classified as prime farmland soils (Bigbrown and Grayrock) (Bearden, E.D., 1997; NRCS, 2013).

3.3.5 Illinois Basin Coal-Producing Region

3.3.5.1 Description of Soils in Region

The Illinois Basin (see Figure 3.3-4) contains the southern two-thirds of Illinois, southwestern Indiana, and part of western Kentucky. Soils in the Illinois Basin are Mollisols, Alfisols, Inceptisols, and Entisols. Mollisols, predominant in the northern half of the region, reflect their prairie origins and are mostly freely-draining. Originally dominated by tallgrass prairie, these soils are now used primarily as cropland and pasture/hayland, with some grazing land. A high percentage of these soils are designated as prime farmland. Alfisols predominate in the southern half of the basin and are present over much of the area near the Mississippi and Ohio Rivers. Entisols occur in the vicinity of rivers and streams in the Illinois Basin coal region. These soils support vegetation that tolerates permanent or periodic saturation.

Figure 3.3-4 Soil Orders of the Illinois Basin



Source:
U.S. General Soil Map (STATSGO2) - Soil Data Mart, USDA, downloaded from:
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

Soils in key ecological areas can be described as follows (OSMRE, 2008):

- Central Till Plains soils are mostly Ultisols and Alfisols, but Inceptisols and Mollisols are also present. Soils tend to have relatively thick upper horizons that are darkened by decomposed organic matter. They are very productive for agricultural crops and are predominantly designated as prime farmland soil types. Located on floodplains and till plains, these soils are commonly poorly-drained, with fine-silty to coarse-silty textures.
- Interior Low Plateau - Shawnee Hills soils formed from loess, residuum, and alluvium. The area is dominated by Ultisols and Alfisols with Inceptisol inclusions. These fine-silty and fine-loamy soils are generally well-drained to moderately well-drained.

3.3.5.2 Productivity and Reclamation Potential

Soils in the Illinois Basin coal region are highly productive, supporting primarily agricultural land uses of cropland and pastureland. The thickness, texture, and high organic content of these soils afford good handling characteristics and promote rapid revegetation after disturbance. This region's flat to rolling topography and overall lack of steep slopes also contribute to excellent reclamation potential. Prime farmland soils reclaimed after mining have experienced 100 percent restoration of agricultural productivity.

Proper soil handling and replacement techniques are essential in the reclamation of these prime farmland soils to avoid compaction and a reduction in agricultural crop productivity. The region's less fertile native soil types generally are reclaimed to non-agricultural postmining land uses, frequently fish and wildlife or forestry. When compaction is avoided, these soils can readily support excellent forestry and wildlife postmining land uses.

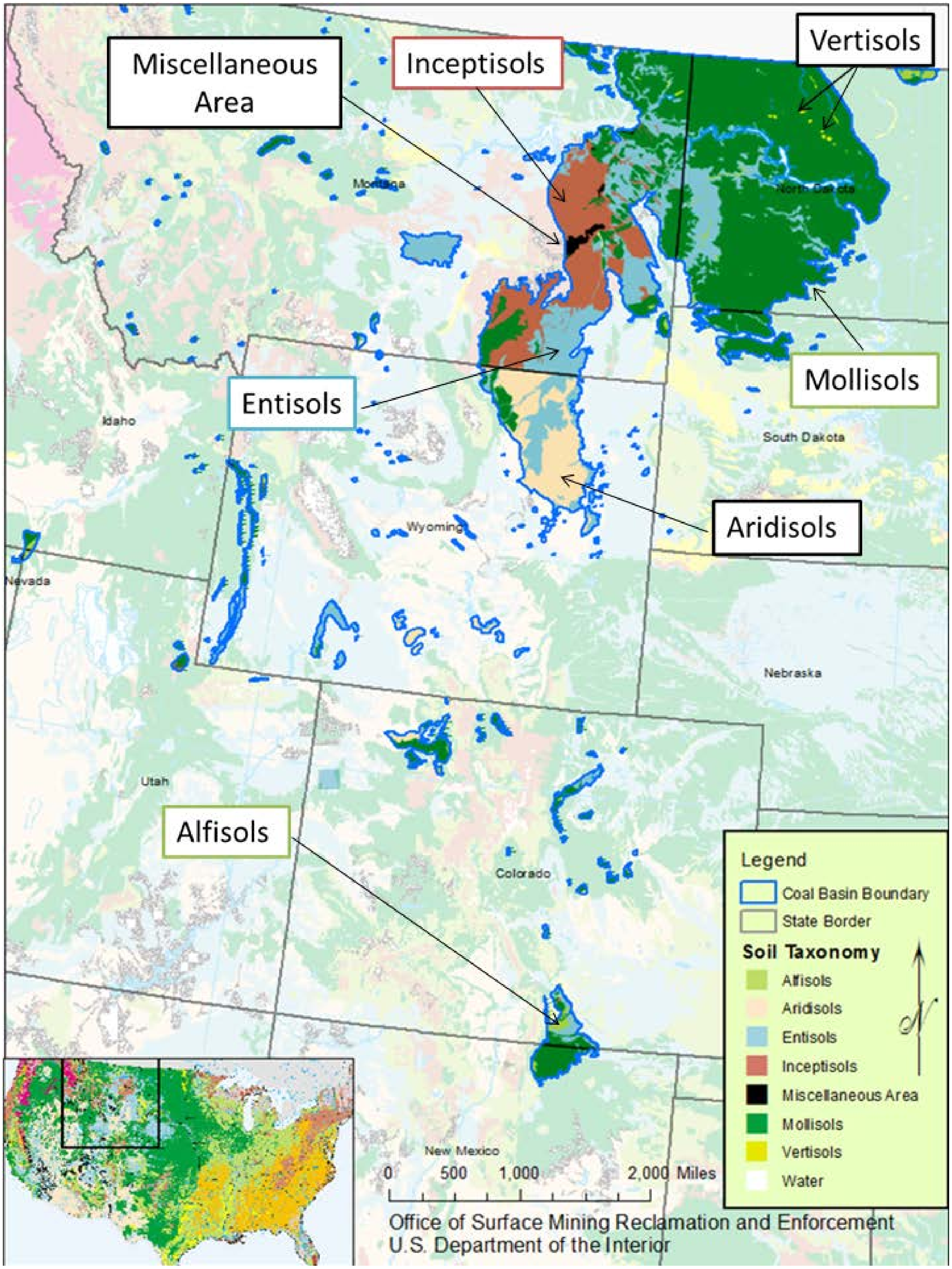
3.3.6 Northern Rocky Mountains and Great Plains Coal-Producing Region

3.3.6.1 Description of Soils in Region

Soils in the Northern Rocky Mountains and Great Plains region (see Figure 3.3-5) have generally developed from residual material (residuum) and alluvium in a climate of cold winters, warm summers, and low precipitation. The upland soils are derived from both residual material (flat-lying, interbedded sandstone, siltstone, and shale) and stream alluvium. Valley soils have developed from unconsolidated stream sediments, including silt, sand, and gravel (BLM, 2003b). Exposed bedrock is present on steep slopes.

The most extensive soils are Entisols, which occur mainly on sloping topography. The physical and chemical characteristics of Entisol soils largely depend on the soil parent materials and the bedrock on which they occur. These soils generally are low in plant nutrients and commonly have clay textures.

Figure 3.3-5 Soil Orders of the Northern Rocky Mountains and Great Plains



Source:
NRCS, 2011, *U.S. General Soil Map (STATSGO2) - Soil Data Mart*, USDA, downloaded from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

The coal-rich Powder River Basin has large areas of gently sloping to nearly flat topography with Aridisol soils. These soils have low to moderate organic matter content and plant nutrients in the surface horizons. They also have moderate to strong structural development within the surface and subsoil horizons. This results in a more fertile rooting zone, particularly when soil textures are loamy rather than sandy or clayey.

Mollisol soils occur mainly in western North Dakota. These fertile soils contain high levels of organic matter and nutrients. They are commonly classified as prime farmland.

Soils in rolling to steep mountainous terrain are generally formed from residuum and transported material from bedrock. Soils are shallow to deep, well-drained, and moderately-permeable (Lowham et al., 1985). Runoff potential is moderately low to high and erodibility is low to moderate. The most abundant soils are found on alpine slopes and meadows and are generally classified as Cryoboalfs (Gaggiani et al., 1987).

Plains soils are derived from transported and residual materials. They generally contain organic material, are fine-grained, and are more alkaline than mountain soils (Lowry et al., 1983). The low to moderate permeability of these soils can result in moderate to high surface runoff from precipitation events (Lowry et al., 1983). Additionally, soils on the Plains are subject to wind erosion. Biological crusts, a complex mosaic of blue-green algae, green algae, lichens, mosses, microfungi, and other bacteria (Belnap et al., 2001) are also present in the Northern Rocky Mountains and Great Plains region. These fragile crusts affect water retention and infiltration and surface runoff and may reduce soil erosion.

Fluvial soil types are found on gently sloping to flat drainage bottoms in the Powder River Basin. Fluvial soils vary considerably in fertility, depending on the source of alluvium. When low in salts and sodium, these soils tend to be very fertile and are the most productive in the Basin (BLM, 1984).

3.3.6.2 Productivity and Reclamation Potential

Reclamation potential varies, depending on soil type, depth, and slope. On the Great Plains, precipitation is the main factor in determining reclamation success, especially for native species. The North Dakota lignite area receives greater precipitation than the Powder River Basin. Reclamation of these soils is successful when best management practices are applied, including use of the appropriate seeding mixture (native and non-native species) and soil substitutes and supplements. Reclamation potential in mountainous areas is generally poor because of the soil type, limited depth of soil, slope, and dry conditions, except in mountain meadows.

3.3.7 Northwest Coal-Producing Region

3.3.7.1 Description of Soils in Region

The coal fields of Alaska are located within three ecoregions: the Interior Forested Lowlands and Uplands Province, the Alaska Range Province, and the Cook Inlet Province. Soils are extremely diverse, ranging from areas containing little to no soil in rugged terrain to deep glacial deposits in lowland areas. Soils containing permafrost and peat also are found within this area.

The Cook Inlet Province is underlain by deep glacial deposits. Upper soil horizons are formed from loess and from windblown volcanic ash. This Province contains peat deposits, but is generally free from permafrost. The dominant soils are Haplocryands, Sphagnic Borofibrists, Terric Borosaprists, Typic Borohemists, Andic Haplocryods, and Andic Humicryods (Gallant et al., 1995).

The dominant soils within the Alaska Range Province are Typic Haplocryands and Typic Vitricryands. Glacial deposits are the predominant soil parent material, with some soils forming in deposits of ash and cinder. The soils are highly erodible. Steep slopes and mountain peaks have little or no soil cover (Gallant et al., 1995).

Upland soils within the Forested Lowland and Upland Province formed from loess and colluvial material. Some upland soils formed from residual rock parent material. Lowland soils formed from loess and alluvium. They tend to be shallow and underlain by permafrost. The dominant soils within this ecoregion are Histic Pergelic, Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, Pergelic Cryochrepts, Typic Cryochretps, Typic Cryorthents, and Pergelic Cryumbrepts (Gallant et al., 1995).

3.3.7.2 Productivity and Reclamation Potential

Productivity and reclamation potential of soils in the coal fields of Alaska are low because of the harsh climate.

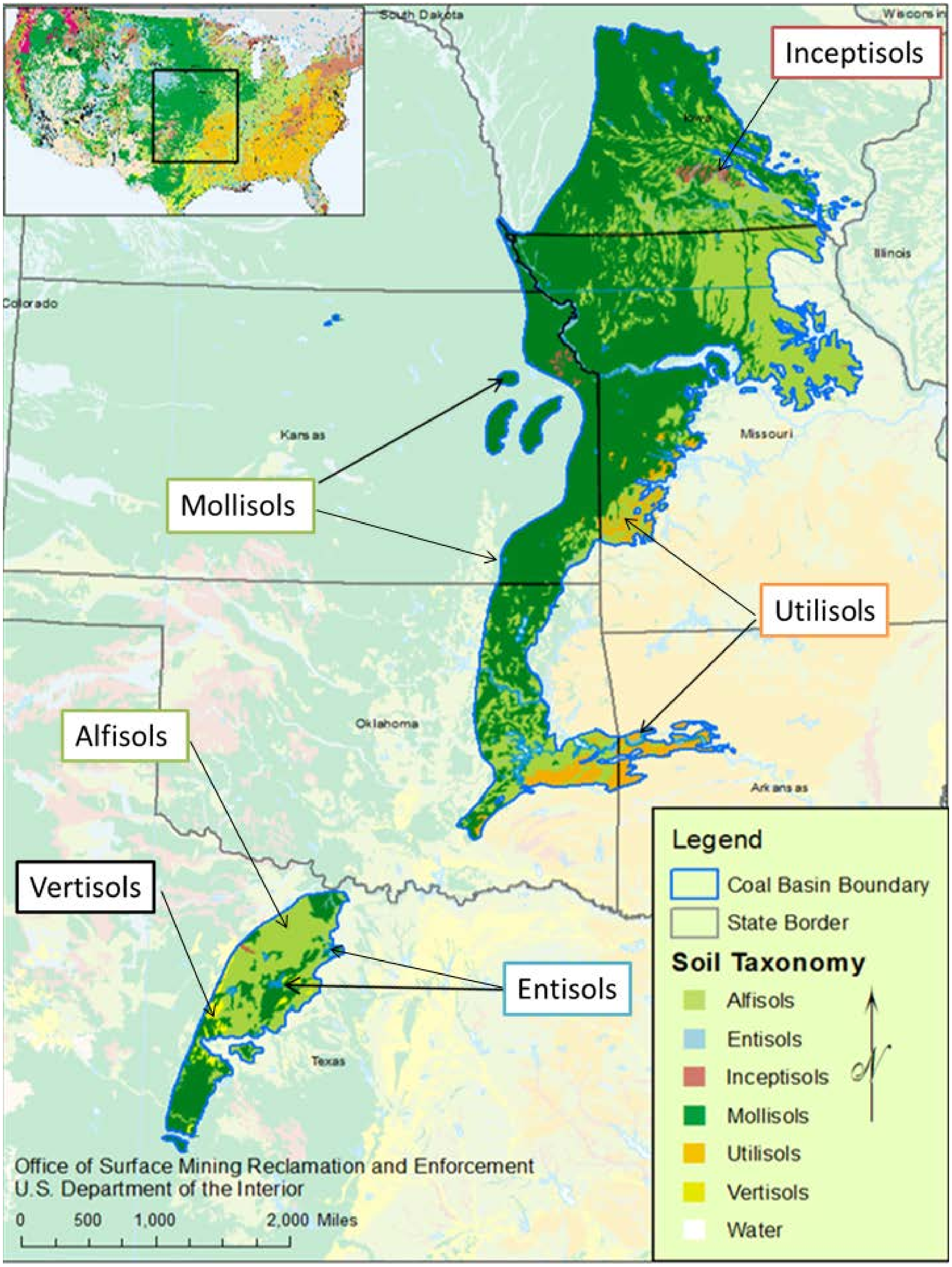
3.3.8 Western Interior Coal-Producing Region

3.3.8.1 Description of Soils in Region

The Western Interior coal region includes the bituminous coal reserves of central and southern Iowa, northwestern and central Missouri, southeastern Nebraska, eastern Kansas, eastern Oklahoma, and west-central Arkansas. The limited bituminous coal reserves in north-central Texas are not included in this discussion because these reserves are not currently mined (see Figure 3.3-6).

Soils in the Western Interior coal region are predominantly Mollisols, which have a favorable texture and high levels of organic matter. Alfisols are present, especially in Oklahoma and Arkansas, with minor amounts of Entisols occurring near rivers. Mollisols are the dominant soils of the Plains. They form in grasslands and are used mainly as cropland and pasture/haylands. Alfisols in this region occur in areas with moderate rainfall and support grassland and forest vegetation. Entisols are generally sandy. They are among the most productive rangeland soils, especially along rivers, and are used as rangeland or pasture. These soils may be subject to wind erosion.

Figure 3.3-6 Soil Orders of the Western Interior



Source:
NRCS, 2011, *U.S. General Soil Map (STATSGO2) - Soil Data Mart*, USDA, downloaded from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053629

3.3.8.2 Productivity and Reclamation Potential

In the Western Interior coal region, soils are generally productive and support a range of agricultural land uses (primarily cropland and pasture/haylands). The overall lack of steep slopes on the Plains improves reclamation potential.

3.4 TOPOGRAPHY

3.4.1 Introduction

Topography refers to the general configuration of the surface of the land. In common usage it is the landscape and it can be described generally by terms such as mountainous, hilly, undulating, upland, lowland, plain, etc. Topography includes the concepts of relief (high vs. low areas) and compass orientation of natural or manmade features (American Geological Institute, 1997). Topography is intimately related with the science of geomorphology which attempts to explain the origin and evolution of topographic features.

3.4.2 Regional Topography

The earth's surface can be subdivided into natural regions that display internal uniformity. A physiological province is a geographic area that exhibits such a similarity among its topographic features, and is distinct from those of surrounding areas. Each physiographic province is a broad region with a uniformity of character regarding the geomorphology, relief, and environment. In most instances the type and boundaries of any physiographic province are determined by the nature and structure of the underlying rocks. However, any one physiographic province may contain within its borders more than one type of topographic feature. That is, a single province may contain both ridges and valleys, or basins and mountains, or high plateaus and low level areas, etc., so long as the province is distinct from surrounding areas.

Major physiographic provinces may further be subdivided into either sub-provinces or sections based on additional geographic distinctions or changes in topographic characteristics within the major province. As an example, the Gulf Coast Physiographic Province contains the East Gulf Coastal Plain Section and the West Gulf Coastal Plain Section, a differentiation based on geographic location (See Figure 3.4-9). The Illinois Basin Province contains the two sub-provinces of the Central Lowlands and the Interior Low Plateaus, the former having been glaciated and the southern limit of glaciation marking the boundary between the two (See Fig. 3.4-10).

The next sections will describe in further detail the geomorphology of the following seven U.S. coal-bearing regions:

- Appalachian Basin.
- Colorado Plateau.
- Gulf Coast.
- Illinois Basin.

- Northern Rocky Mountains and the Great Plains.
- Northwest (including Alaska).
- Western Interior.

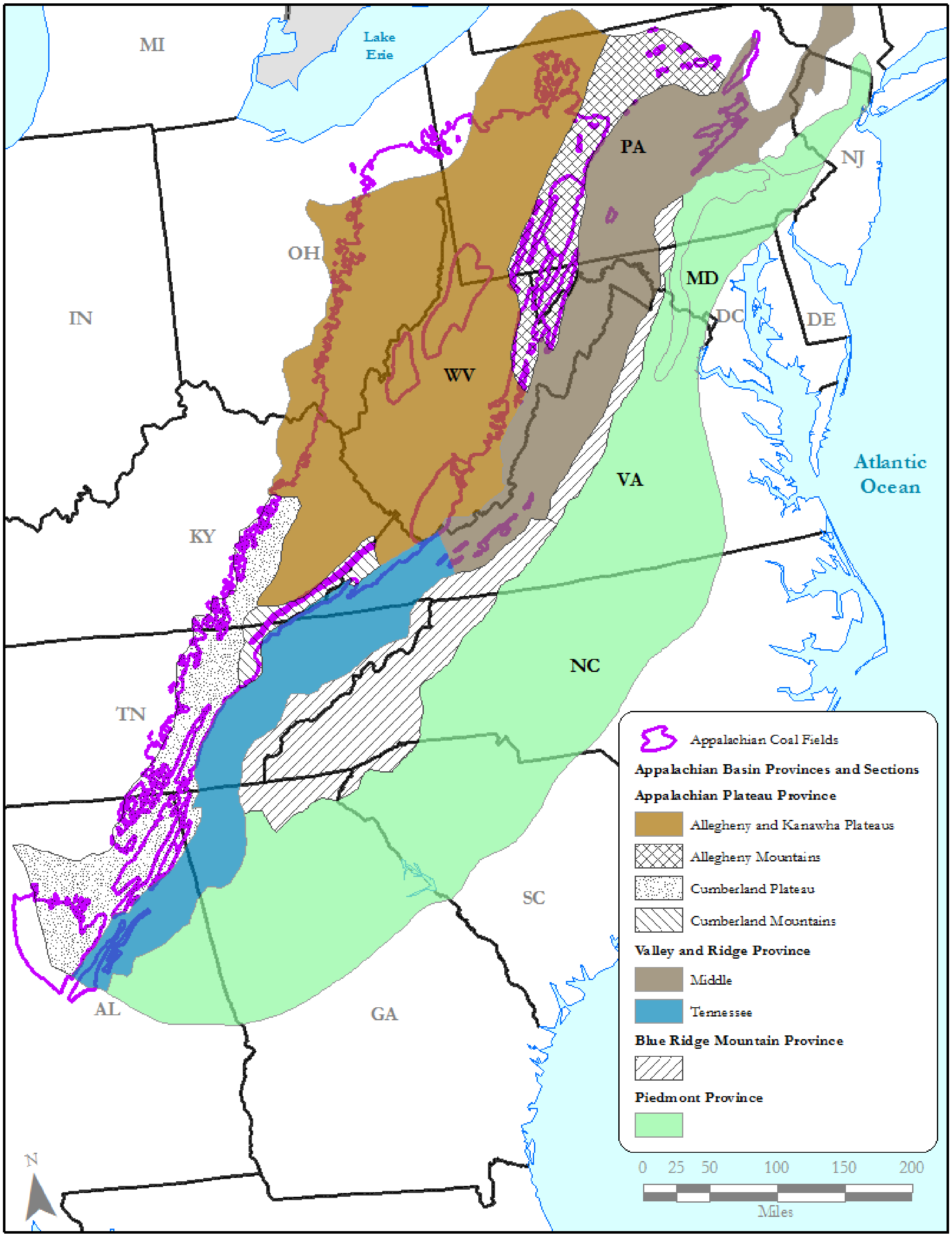
3.4.2.1 Appalachian Basin Region

During the Paleozoic sediments were laid down in a broad, northeast-southwest trending lowland along the eastern portion of the U.S. This area of accumulating strata is termed, in common parlance, the Appalachian Basin. Here the term basin is used in the physiographic sense to indicate a low area within which sedimentary deposits accumulate. Over time, and under pressure from overlying strata, these deposits became lithified or converted to rock. It is within the swamps and lagoons of the Appalachian Basin that carbon-rich deposits amassed, eventually forming the strata of the Appalachian coal beds. Due to multiple episodes of tectonic plate collisions and mountain-building from the early Paleozoic to early Mesozoic (i.e., from about 450 to 220 million years ago) the region was raised into what is now termed the Appalachian Highlands. Folding, faulting and uplift of these lithified strata was followed by periods of erosion and weathering. These Earth forces created the distinctive topography that characterizes the Appalachian physiographic provinces we witness today (See Figures 3.4-1, and 3.2-2). Currently, uplifted and rejuvenated streams continue to cut downward through the ancient bedrock.

The Piedmont and Blue Ridge Provinces do not concern us as these areas are composed of crystalline (igneous and metamorphic) rocks and contain no known deposits of coal. Conversely, the Valley and Ridge Province, and the Appalachian Plateau Province contain significant thicknesses of sedimentary rocks (sandstones, siltstones, shales, conglomerates and limestones) within which are included numerous beds of coal. The coal accumulated most significantly during a period of time termed the Pennsylvanian, however lesser widespread deposits were formed at other times. Coals in these two physiographic provinces are of both the bituminous (medium rank) and anthracite (high rank) types.

The difference in the topography between the Appalachian Plateau and Valley and Ridge provinces is determined primarily by the structure of the underlying bedrock. The Plateau is underlain by sedimentary strata that are either horizontal or gently folded. Consequently, the topography is typified by relatively flat, concordant (equal elevation) upland surfaces, carved by stream erosion into steep-sided, relatively narrow river valleys. By contrast, the strata of the Valley and Ridge Province have been folded and faulted into complex structures producing a topography of long linear ridges and broad valleys.

Figure 3.4-1 Physiographic Provinces and Sections of the Appalachian Basin Region



Source:
USGS, 2004, *Physio*, U.S. DOI, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

Figure 3.4-2 View of the Allegheny Mountains

Source: OSMRE, 2015a. Photograph Archive. U.S. Department of the Interior.

The Appalachian Plateau marks the western part of the Appalachian Highlands, stretching from New York to Georgia and Alabama. The surface of the Plateau is highest in the east and slopes gently to the northwest where it merges into the Interior Plains. The province is divided into several physiographic sections, which include the Allegheny Mountains, Cumberland Mountains, and the Kanawha Plateau and Cumberland Plateau (See Figure 3.4-1). Most of the lateral extent of the Appalachian bituminous coal seams is located within the Kanawha and the Cumberland Plateaus; lesser deposits occur in the Allegheny and Cumberland Mountains.

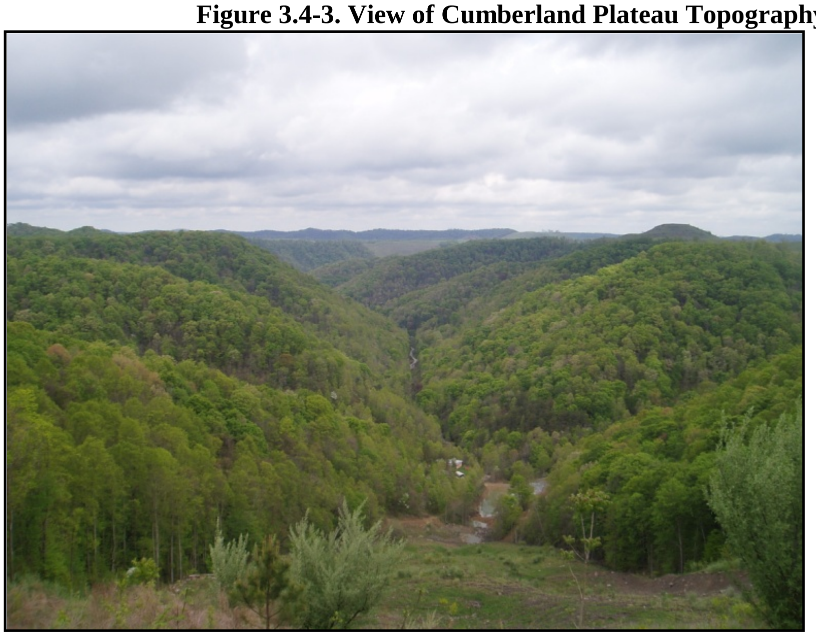
The “plateau” and “mountain” sections of the Appalachian Plateau differ from each other primarily according to local relief. The Allegheny Mountains run for about 400 miles from north-central Pennsylvania, through western Maryland and eastern West Virginia, to southwestern Virginia (See Figure 3.4-2). They rise to approximately 4,860 feet above mean sea level (MSL) in northeastern West Virginia. Local relief ranges from approximately 1,000 to 2,000 feet. In the east, the mountains are dominated by a high, steep escarpment known as the Allegheny Front. In the west, they grade down into the closely associated Allegheny Plateau. The Allegheny Mountain Section differs from the Allegheny Plateau in that dissection is so advanced that the topography no longer resembles a plateau, even a dissected one. This section also differs in that mild folding and erosion on anticlines and synclines have produced linear ridges. As a result, the section includes trellis as well as dendritic (radial branching) drainage patterns.

The Allegheny Plateau is a large dissected plateau area in western and central New York, northern and western Pennsylvania, northern and western West Virginia, and eastern Ohio. It is divided into the glaciated Allegheny Plateau and the unglaciated Allegheny Plateau (where bituminous coal seams are located). In the unglaciated Allegheny Plateau in southeastern Ohio and westernmost West Virginia, relief is typically in the range of 200 to 400 feet. Locally, the highest elevations in this area are often in the range of 900 to 1,500 feet. Along the plateau's eastern border however, at the Allegheny Front, elevations may reach well over 4,000 feet above MSL, with relief of up to 2,000 feet. Generally the section’s stratigraphy includes more shale than the Allegheny Mountains (where sandstone is more common); consequently its slopes tend to be smoother. The general drainage pattern in this section is dendritic.

The Cumberland Mountains section represents the southern counterpart of the Allegheny Mountains (See Figure 3.4-1). It occupies a strip about 150 miles long and 25 miles wide in Virginia, Kentucky, and Tennessee. Its geology is dominated by the Cumberland thrust block which is 125 miles long and 25 miles wide. The Cumberland Mountains are higher than the adjacent Cumberland Plateau to the west because the thrust brought resistant rock to the surface at a relatively high elevation. Peak elevations range from 2,000 to 2,600 feet above MSL and local relief varies from 100 to 200 feet. Similar to the Allegheny Mountains, this section contains trellis as well as dendritic drainage patterns.

The Cumberland Plateau constitutes the southernmost part of the Appalachian Plateau Province (See Figures 3.4-1 and 3.4-3). It includes parts of eastern Kentucky and Tennessee, and a small portion of northern Alabama and northwest Georgia. Elevations range from 1,270 to 2,000 feet above MSL and local relief averages 200 feet but can reach 1,000 feet along the eastern edge where the land transitions to the Ridge and Valley Province (Gaydos, 1982; Hollyday, 1983). The general drainage pattern is dendritic. The terms "Allegheny Plateau" and "Cumberland Plateau" stem from historical usage rather than geological difference. There is no strict dividing line between the two. Two major rivers share the names of the plateaus, with the Allegheny River rising in the Allegheny Plateau and the Cumberland River rising in the Cumberland Plateau.

Figure 3.4-3. View of Cumberland Plateau Topography in Eastern Kentucky

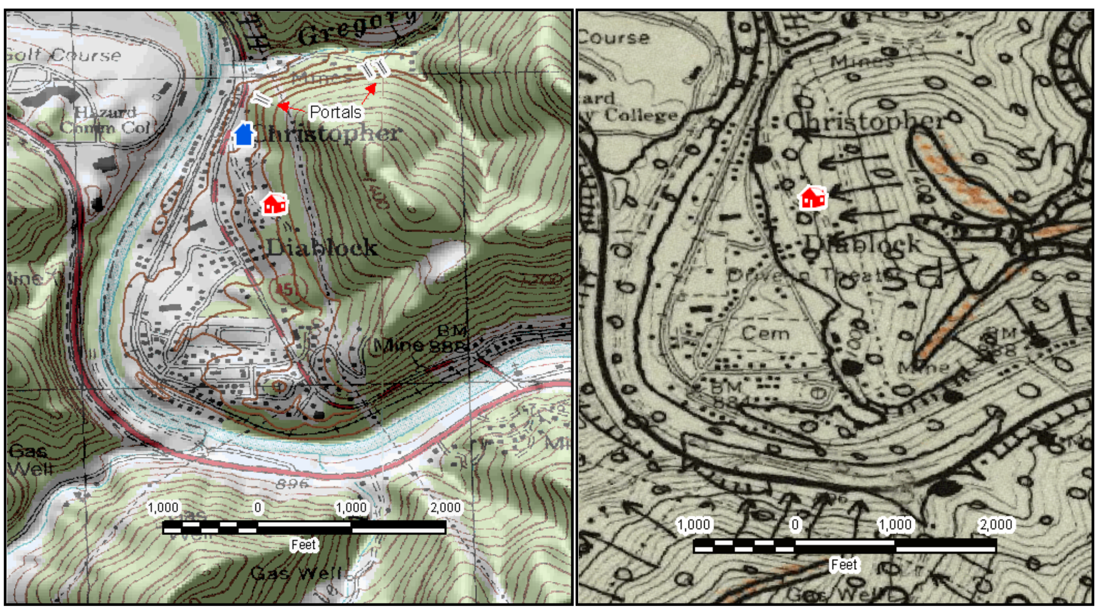


Source: OSMRE, 2015a. Photograph Archive. U.S. Department of the Interior.

Owing to steep slopes, an abundance of weak mudstones (claystone, shale, and siltstone) in the geologic section, and a temperate-to-humid climate, the Appalachian Plateau is an actively erosional landscape prone to mass movement processes, including rock falls, slope wash, soil creep, landslides, mudflows, and debris flows (See Figure 3.4-4). The active nature of the slopes in these mountains and hills is well documented on soil maps of the U.S. Natural Resources Conservation Service; in regional slope-instability mapping by Lessing et al. (1976) and Outerbridge (1979, 1982); and in numerous geotechnical investigations of natural landslides and other types of major mass movements. Gray and Gardner (1977) provide the following summary of how unstable slopes can form from the accumulation of rock and debris:

> Weathering of rock and formation of soil is most active in the upper portions of the hillside where slopes are steep and rock occurs at the surface or at shallow depths. The soil particles derived from weathering of the near surface rock are transported downhill through mass wasting processes such as sheet wash and creep. A short distance down the slope, the transported soil begins to encounter conditions where downhill movement is retarded and soil accumulation occurs. Areas of accumulation usually occur where the slope angle decreases and/or where the volume of soil entering the area is greater that the capacity of mass wasting processes to remove it. Two basic zones of accumulation can be identified: the first involves accumulation on flatter slopes above ledges and on benches; the second involves accumulation within swales and small gullies on the hillside.

Figure 3.4-4 OSMRE Landslide Investigation in Perry County, Kentucky



Source: Michael, P. et al., 2010, *Figure 11*, U.S. Department of the Interior. (Modified from U.S. EPA, 2005)
http://www.techtransfer.osmre.gov/ARsite/Publications/0610-Michael-PA.pdf

Left: site topography; Right: 1979 USGS survey of landslides and related features surrounding the site. Area covered with small circles represents colluvial slopes with landslides. Arrows delineate zones of debris flows and debris avalanches. Orange shading represents rock and soil susceptible to landslides.

Loose rock debris can accumulate at ledges, in swales, or at the toe of slopes. Ledges and benches form where more resistant rocks, such as sandstones and limestones, jut out of the slope farther than the surrounding, more easily eroded softer shales. Swales are smooth, broad indentations or concavities in a slope which form due to concentrations of weak or fractured rock. Another zone of accumulation occurs at the base or toe of a slope where the rate of colluvium introduction exceeds the rate of its erosion by fluvial processes. (Rock fragments pile up faster than streams can carry them away.)

It is important to note that even where thick accumulations of colluvium are naturally stable, their modification via human construction practices can destabilize them. Common forms of human-induced destabilization include:

- over-steepening of a slope by removal of colluvial material (See Figure 3.4-5);
- overloading the slope with fill; and
- increasing pore-water pressure in the colluvial material through disruption or redirection of natural drainage.

Figure 3.4-5 Destruction of a Residential Structure by a Landslide Caused by Human Activities (Excavation) into a Slope, Eastern Kentucky.

Source: Office of Surface Mining, n.d., *Landslide in Eastern Kentucky*, U.S. Department of the Interior

The common occurrence of potentially unstable slopes in the Appalachian Plateau and its effect on the long-term stability of excess spoil fills has long been recognized within the mining industry and among government regulators. Emphasis is placed on the identification of "landslide topography" to avoid construction on unstable foundation slopes. Four key elements related to Appalachian Plateau topography that affect the stability of excess spoil fills are summarized below. More detailed discussions are available in OSMRE (2002) and, Michael and Superfesky (2007):

Steep fill foundation slopes: Fill failures are a relatively uncommon occurrence in the Appalachian Plateau; those that have been reported have foundation slopes in excess of twenty percent. Contributing to failure potential is the use of weak, non-durable rock in the construction of excess spoil fills. West Virginia, Kentucky and Virginia have implemented fill minimization provisions. These provisions require that: operations be conducted such that more spoil material be placed within the mined area and, less material be placed in excess spoil fills. Following this procedure avoids the placement of fill material in the proximity of intermittent and perennial streams. One potential outcome of these provisions is that the toe, or bottom of the fill, is often located at higher elevations in the hollows (i.e. to prevent or limit burial of streams), which, as a consequence, result in the toe resting on steeper foundation slopes. This aforementioned scenario can negatively impact the stability of the fills if proper design and construction techniques are not followed. The effect of steep foundation slopes must be off-set by proper foundation preparation and placement of underdrains that can efficiently convey seepage out of the valley fill.

Potentially low shear strength of fill foundation materials: As discussed above, layers of colluvium are pervasive on the hill sides and tend to thicken downslope towards base level. However, deep soils can occur locally in higher elevations where weak rock types (e.g., mud rocks like shale and claystone) are exposed. Several studies have emphasized that the identification of soil-like material in the foundation of a proposed excess spoil fill — and the use of accurate foundation shear strength properties — is essential for a realistic valley fill stability analysis.

Ground water discharge into excess spoil fills: Sedimentary strata in the Appalachian Plateau, including aquifers, are near-horizontal in inclination; consequently, numerous water-bearing beds intersect — or crop out — into excess spoil fills. The rock strata also tend to be densely fractured near the surface due to valley stress relief. Thus ground water can flow parallel to valley side slopes as well as horizontally through aquifers. As a result, numerous excess spoil fills are constructed on top of seeps and springs, especially in locations where bounding sedimentary strata dip into the fill. The construction of fill underdrains capable of discharging subsurface drainage that has entered the fill is critical.

Figure 3.4-6 shows an example of an excess spoil durable rock fill that failed due to an inadequate underdrain (as well as placement on a steep, soil-like foundation). Underdrains in durable rock fills rely solely on the natural segregation of end-dumped durable rock material. The larger, heavier durable rock is theoretically supposed to roll downslope and form a natural underdrain. In reality, the spoil material often does not adequately segregate. Consequently, naturally occurring springs and seeps in the hillside, as well as those that may occur within the fill foundation, can be buried with non-durable rock material. This can lead to greater water infiltration into the fill material and longer contact time with toxic materials in the spoil; this in turn may result in contaminated discharges.

Figure 3.4-6 Failed Excess Spoil Fill (Specifically a Durable Rock Fill) in Eastern Kentucky

Source: Peter Michael, et al., 2010, *Figure 3 Durable rock fill in eastern Kentucky*, U.S. Department of the Interior. http://www.techtransfer.osmre.gov/ARsite/Publications/0610-Michael-PA.pdf

Erosion potential of surface drainage and timely reclamation: In the Appalachian Plateau the combination of steep slopes and abundant precipitation results in significant kinetic energy even in headwater streams. This condition necessitates that drainage be carefully controlled to minimize unchecked runoff. Such uncontrolled flow may result in: (a) dangerous sediment-laden floods or mudflows; (b) clogging of exposed parts of fill underdrain structures; and (c) heavy sedimentation and pollution of off-permit downstream waters. Effective drainage control is especially important while the excess spoil fill is still under construction as well as during the process of final grading and revegetation. Contemporaneous reclamation can lessen the severity of erosion and surface drainage that may lead to off-site damage. A worst case example of a severe, life-threatening flood from a durable rock fill into a residential area is the Lyburn incident in West Virginia in 2002 (OSMRE, 2002) (See Figure 3.4-7).

Figure 3.4-7 Property Damage in Residential Area from Storm Runoff Erosion over an Unreclaimed Excess Spoil Fill

Source: Peter Michael, et al., 2010, *Figure 5 property damages downstream of the fill*, U.S. Department of the Interior. http://www.techtransfer.osmre.gov/ARsite/Publications/0610-Michael-PA.pdf

The character of the Valley and Ridge Province (Figure 3.4-1) is well-described by Hunt (1967):

> The Valley and Ridge Province extends the entire length of the Appalachian Highlands. It is divided into three sections: a very narrow one, only 25 miles wide, with much shale at the north along the Hudson River; a second, 75 miles wide, with varied kinds of rocks in Pennsylvania, Maryland and northern Virginia; and a third, about 50 miles wide, which is like the second but more faulted, extending from southern Virginia to the south end of the highlands in Alabama.
>
> The Valley and Ridge Province is world famous for its fold mountains . . . which are made up of Paleozoic sedimentary formations 40,000 feet in thickness. The sediments that formed these rocks were derived from a mountain mass that lay to the east. . .. The composition of the formations changes away from the source of the sediments. Sandstone and shale formations tend to grade westward into shale and limestone. The well-known limestone caverns of Virginia are developed in Paleozoic limestone formations in the valley west of the Blue Ridge . . .
>
> Toward the end of Paleozoic time . . . deposits like those on the Coastal Plain spread westward across the top of the older marine formations. This coastal plain contained swamps . . . [of] . . . tree-like ferns . . .. The accumulation of this woody material in the swamps produced the coal beds that are found in the

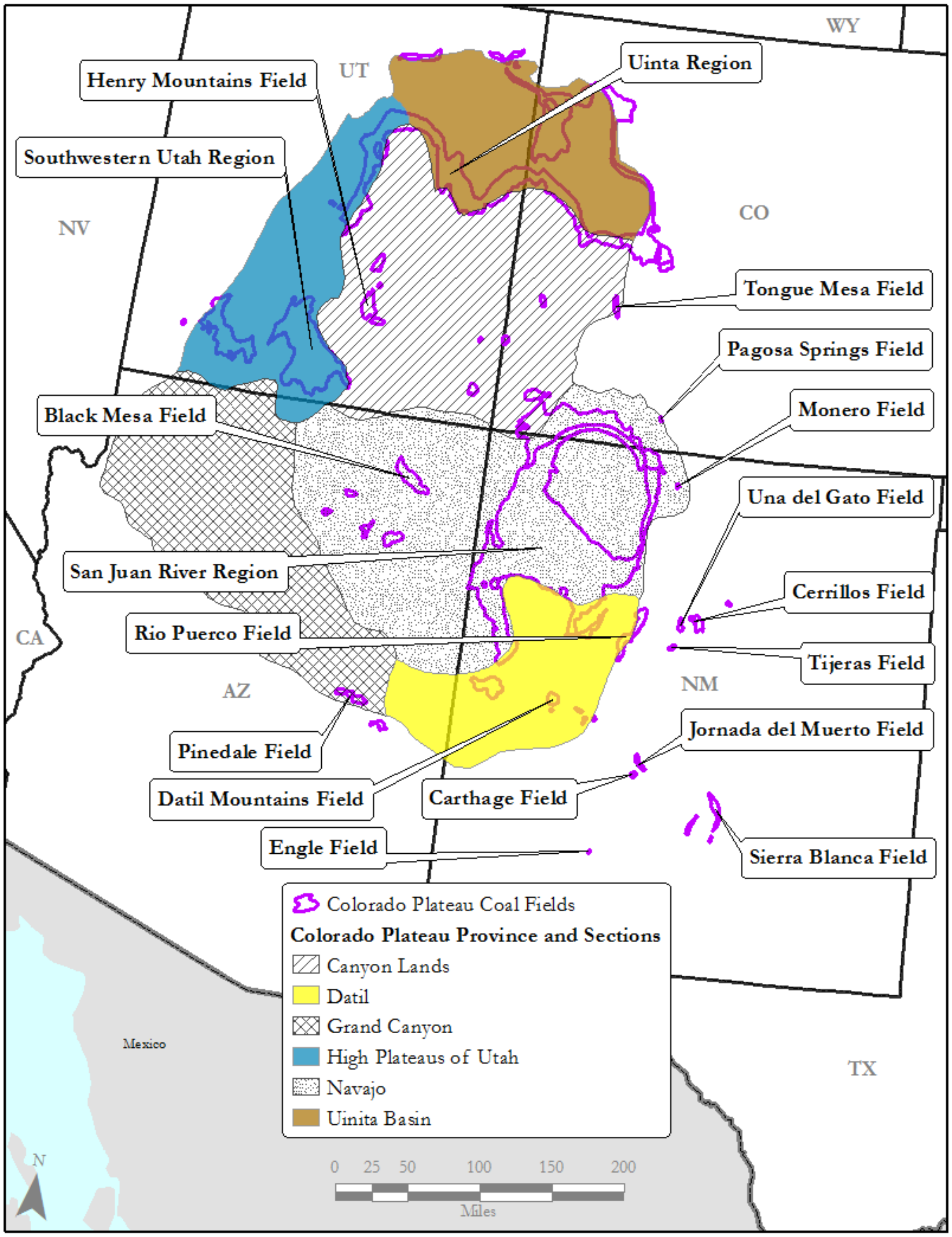
anthracite fields in the Valley and Ridge Province and the bituminous coal fields of the Appalachian Plateaus farther west.

The effects of weathering and erosion on sedimentary rocks over eons of time produced the distinctive physiography to the Valley and Ridge Province. The erosion of erodible bedrock and shale provided the bedrock underlying the valleys. The sandstones and conglomerates, by contrast, are harder and appreciably more durable so they form the linear ridges that now dominate the uplands. Seen from the air, the mountains are long, linear, sinuous ridges that, in places exhibit tight s-shaped curves. This singular pattern of the hard strata is a result of post-depositional folding that largely occurred toward the end of the Paleozoic.

3.4.2.2 Colorado Plateau Region

The majority of the Colorado Plateau coal-bearing region is contained within the physiographic provinces of the same name. The province is a high-elevation region consisting of plateaus and isolated mountains that encompass parts of Utah, New Mexico, Colorado, and Arizona (See Figures 3.4-8). It is bounded on the east by the Rocky Mountains, on the north by the Uinta Mountains, and on the south by the Mogollon Rim. The most common elevation on the plateau is 5,500 to 6,000 feet MSL (OSMRE, 2008). The landscape is dominated by deep canyons, elevated plains, low plateaus, buttes, mesas, and badlands, and is largely underlain by horizontal strata of sedimentary rocks. Large scale mass wasting has changed many of the landforms in this region (Orme, 2002). The Colorado Plateau includes the Uinta Basin of northeastern Utah and the Piceance Basin of northwestern Colorado. Identified mineable coal resources exist along southern rim of these basins as well as within the north-south trending faulted anticline separating the basins, known as the Douglas Creek Arch. Along the edge of the basin, topography is characterized by a series of nearly parallel north and northeasterly trending ridges and valleys with steep bluffs. The overall aspect of the basin is northeasterly. At lower elevations to the north of the basin rim, broad open plains exist interrupted by moderately hilly land and mesas (U.S. BLM, 1985).

Figure 3.4-8 Physiographic Provinces and Sections of the Colorado Plateau



Source:
USGS, 2004, *Physio*, U.S. DOI, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

The central coal fields of Utah include the Wasatch Plateau (in the northeast corner of the High Plateau Section) and Tavaputs Plateau (located in the southern Uinta Basin). The Wasatch Plateau is characterized by a gently rolling dissected plateau with deeply cut ravines and alluvial valleys. The Tavaputs Plateau is characterized by rugged terrain and deeply incised canyons. The southern Utah coal fields, including the Kaiparowits, Alton, Kolob-Harmony, and Henry Mountain coal fields, exist in portions of the High Plateau and Canyon Lands physiographic sections (See Figures 3.4-8). The plateaus form a series of broad and erosion-resistant bedrock terraces or benches that have been dissected by deep canyons. Elevations above MSL range from 4,000 feet near the Utah-Arizona border to 11,000 feet in the Henry Mountains (U.S. DOI, 1979).

The Black Mesa coal fields of northeastern Arizona and the portions of the San Juan River coal fields of northwestern New Mexico exist within the Navajo physiographic section. Geomorphic processes active in this area have resulted in significant plateau dissection and deep canyon formations. Volcanic mountains and intrusions also exist, but block-fault structural mountain ranges do not. Major landforms are canyon lands, plateaus, plains, and hills. Elevation ranges from 4,000 to 8,000 feet MSL. The San Juan Basin coal field, located in northwestern New Mexico and southwestern Colorado is located at a higher elevation and in a wetter climate. Landforms in the area of this coal field include mountains, plains, plateaus, and hills, with steeper landforms toward the inner core of the basin. Elevations range from 6,000 to over 14,000 feet MSL (OSMRE, 2008).

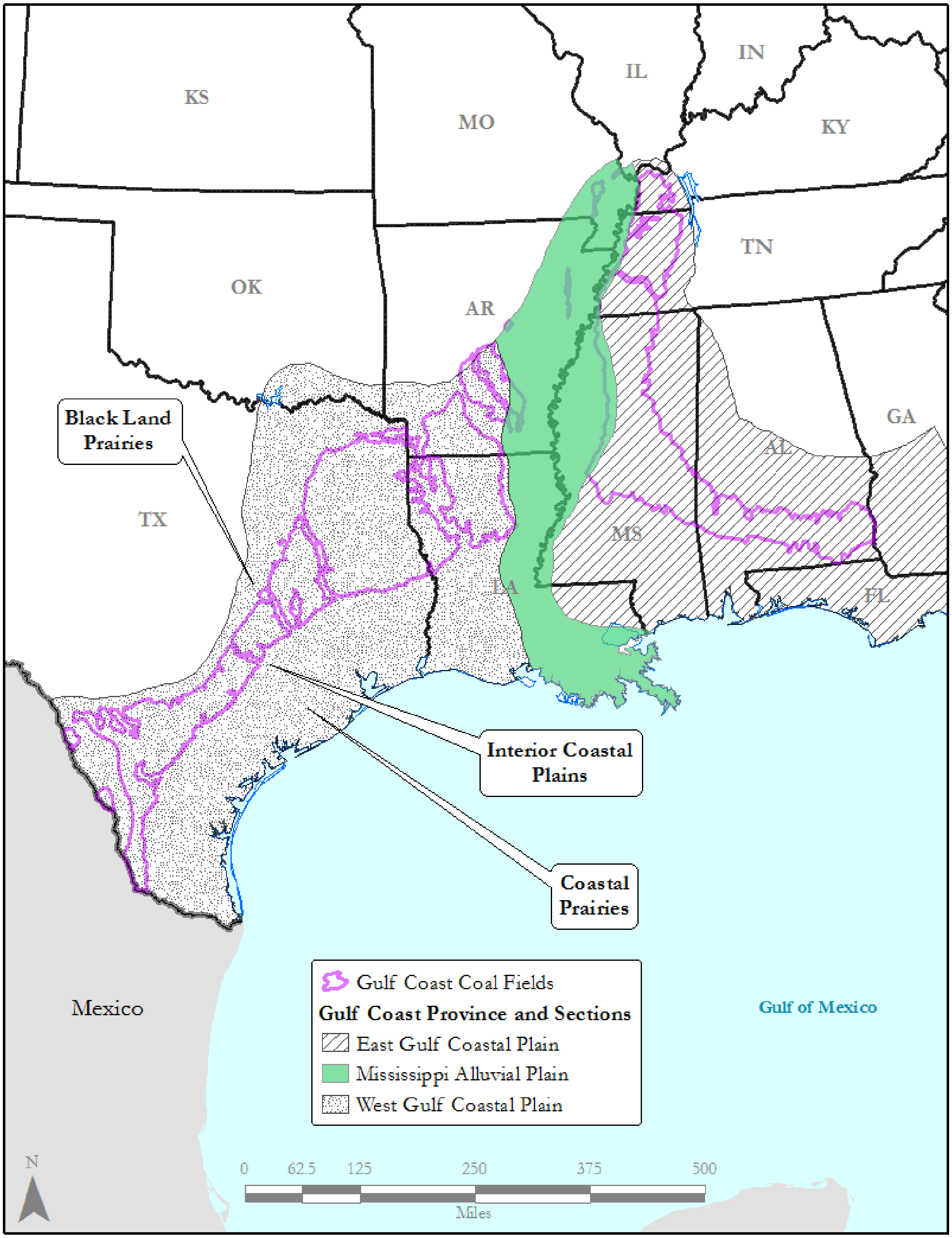
3.4.2.3 Gulf Coast Region

The Gulf Coast region is part of the Coastal Plains geomorphic province (See Figures 3.4-9). Mining in the Gulf Coast region is limited to the east Gulf Coastal Plain and the West Gulf Coastal Plain Physiographic Sections. The western Gulf Coastal Plain, covering portions of Texas, Louisiana, and Arkansas, comprises the Coastal Prairies, Interior Coastal Plains, and the Blackland Prairies (these subdivisions, parallel to the Gulf Coast in Texas and Louisana, are not delineated in Figure 3.4-9). The Coastal Prairies extend inland from the Gulf of Mexico to an elevation of approximately 300 feet above MSL.

The primary topography of this area is nearly flat prairie, sloping approximately one foot per mile toward the Gulf. The Interior Coastal Plains reaches an elevation of approximately 300 to 800 feet above MSL. The primary topographic features are parallel ridges (cuestas) and valleys. The Blackland Prairies extend from approximately 450 to 1,000 feet MSL and comprises mostly low, rolling terrain (Bureau of Economic Geology, 1996). Elevations in the coal mining areas range from 80 to 1,350 feet MSL with local relief approximately between zero and 500 feet (Orme, 2002).

The east Gulf Coastal Plain extends from Florida to the Parishes of Louisiana over most of Mississippi, some of western Tennessee and Kentucky, the southwestern two thirds of Alabama, and the western panhandle of Florida (Ruth, 2006). Topography of the east Coastal Plains is widely varied, with areas of rounded, eroded hills, cuestas, and nearly featureless plains (Neilson, 2007).

Figure 3.4-9 Physiographic Provinces and Sections of the Gulf Coast



Source: USGS, 2004, *Physio*, U.S. DOI, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

3.4.2.4 Illinois Basin Region

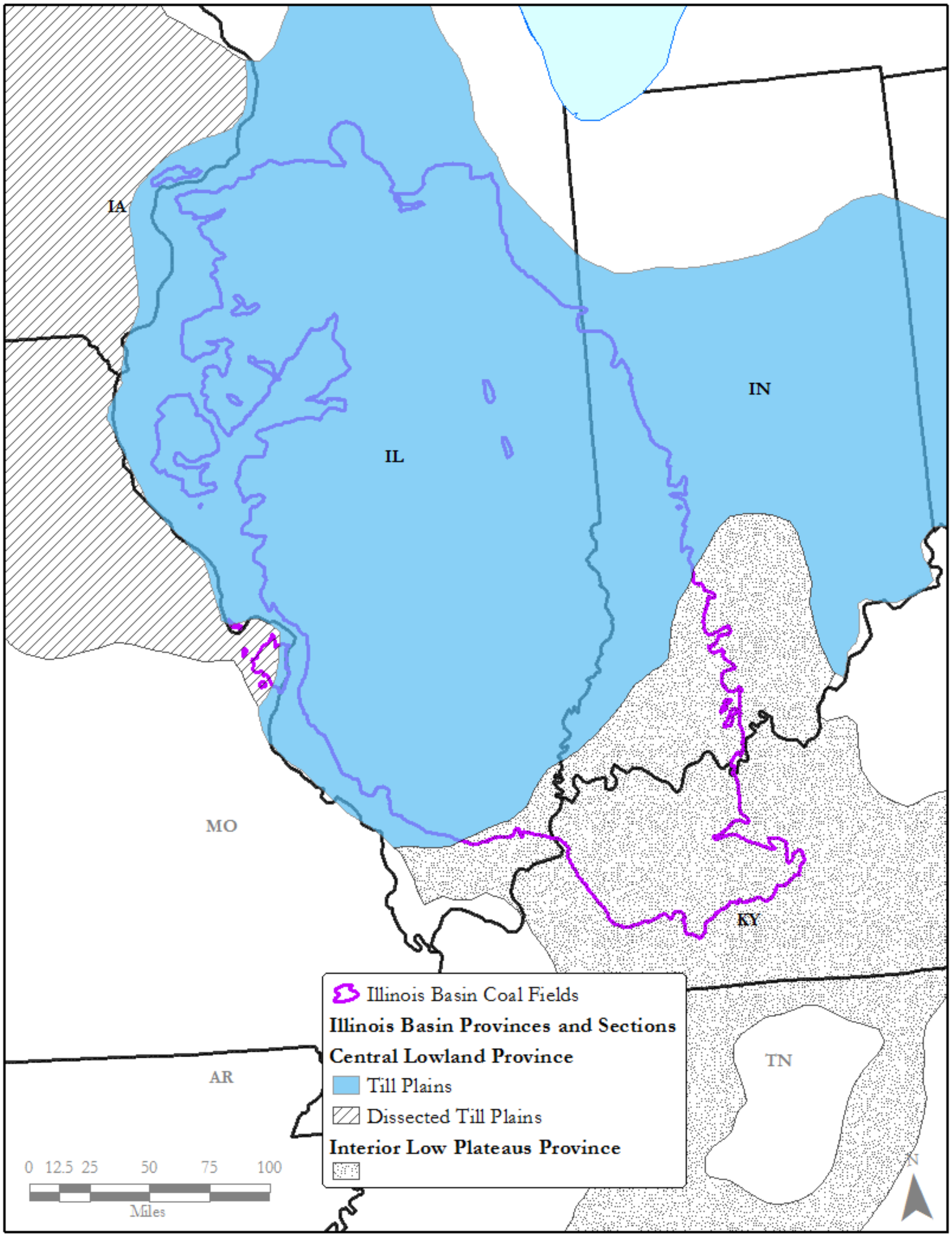
The Illinois Basin is a northwest-southeast trending geologic basin which is bounded on all sides by structural arches. The Basin is located within the Central Lowlands and Interior Low Plateaus physiographic provinces; its margins are delineated by the outer limits of the coal fields (See Figure 3.4-10).

The majority of the Illinois Basin physiography is characterized by gently rolling plains with surface elevations in the coal mining areas ranging from 325 to 1000 feet above MSL. In places relief is up to one hundred feet. Vogel (1981) describes the topography as follows:

> Most of the area in Illinois and Indiana lies within the Central Lowlands physiographic province, while the portion in Kentucky and extreme southern Illinois and Indiana is in the Interior Low Plateaus. The boundary between these two physiographic provinces marks the southern limit of glaciations.
>
> The Central Lowlands, in the vicinity of the coal fields, consists of broad level uplands between steep sided valleys with broad floodplains. This area is covered with glacial till and loess deposits that, toward the Mississippi River, reach 30 feet in thickness.
>
> The Interior Low Plateaus consist of a slightly westward sloping plateau that is deeply entrenched with meandering rivers. This area has more relief than that to the north, but is still gently rolling. The low, gently rolling topography of the Illinois Basin Coal region has allowed extensive area-type surface mining and an easily developed road, rail, and river barge transportation system (Vogel, 1981).

Geomorphic processes include fluvial erosion, transport and deposit, minor mass wasting, and in Kentucky, karst solution. Pre-law surface mined lands may exhibit hummocky or ridge-swale topography. Broad flood plains exist in the region and glacial till and loess deposits can reach up to 30 feet in thickness (Orme, 2002).

Figure 3.4-10 Physiographic Provinces and Sections of the Illinois Basin



Source:
USGS, 2004, *Physio*, U.S. Department of the Interior, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

3.4.2.5 Northern Rocky Mountains and Great Plains Region

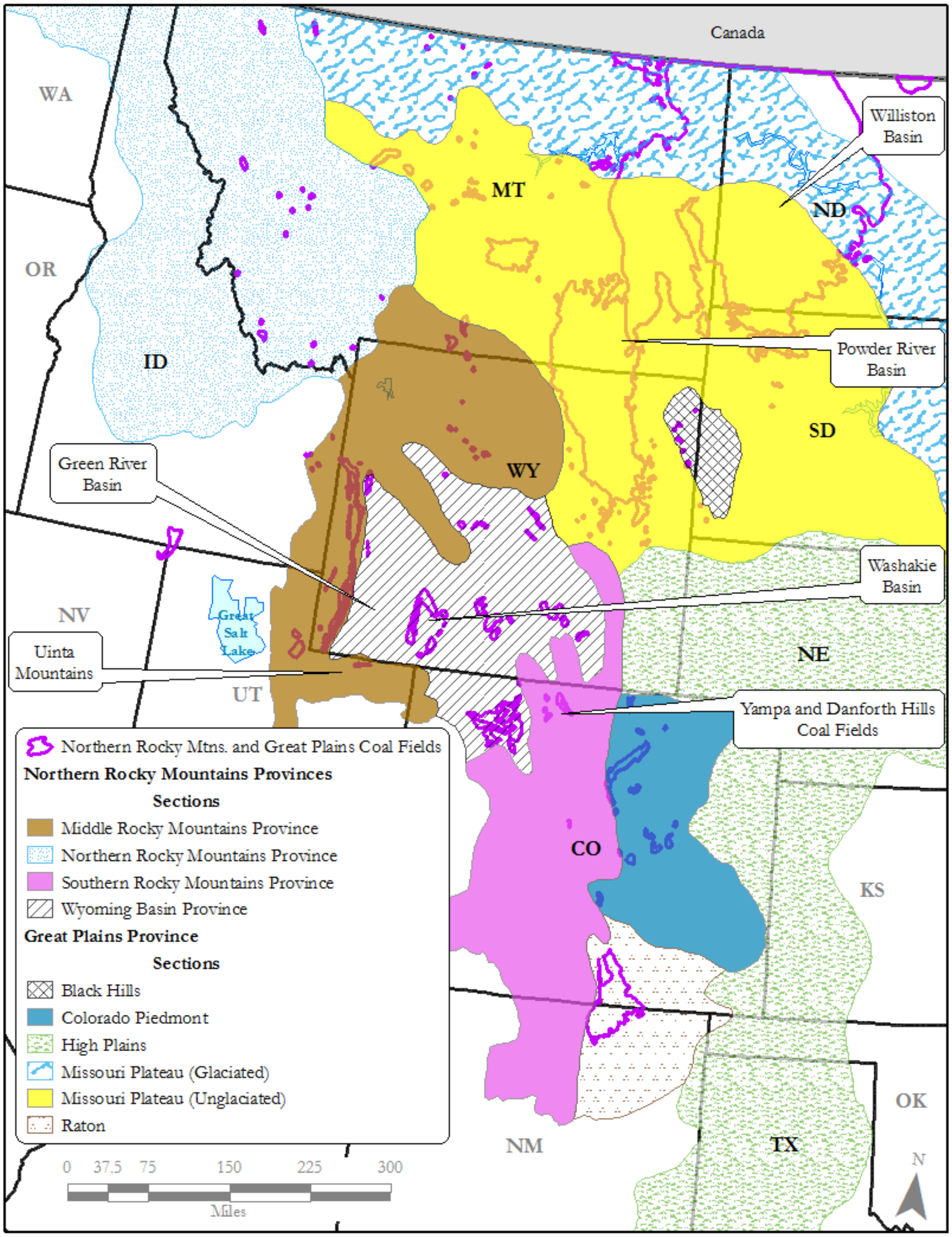
The Northern Rocky Mountains and Great Plains coal region exists within the Middle Rocky Mountain, Wyoming Basin and Great Plains physiographic provinces (see Figure 3.4-11). Southwestern Wyoming is an area of low mountains and semiarid basins. Total relief is about 3,500 feet. The Middle Rocky Mountains and Wyoming Basin physiographic provinces are divided geographically from west to east into the Overthrust Belt, Green River Basin, Rock Springs Uplift, Great Divide Basin, Washakie Basin, and Hanna Basin. [Not all of the aforementioned features are indicated in Figure 3.5-5.] The Overthrust Belt is characterized by north-south trending mountains and valleys formed from linear folds and faults.

Elevations range from about 6,800 to 7,400 above MSL. The Rock Springs uplift is composed of a central basin surrounded by ridges and mountains that dip into the surrounding basins. Elevations range from about 6,400 to over 8,600 feet MSL. The Washakie Basin is characterized by low rolling hills, high rock rims on the north and southwest, and broad shallow valleys. Elevations range from about 6,000 feet to about 8,000 feet MSL. The Hanna basin is characterized by high plains that are topographically broken around the margin by low ridges composed of resistant sandstone. Elevations range from 7,000 to 8,000 feet above MSL (U.S. BLM, 1980).

The coal fields of northwest Colorado (including the Danforth Hills and Yampa fields) are located in the Wyoming Basin and Southern Rocky Mountains physiographic provinces (see Figure 3.4-11). The Dansforth Hills field is characterized by steep south facing escarpments and gentler north-facing dip slopes whereas the Yampa fields demonstrate low mountain ranges, rolling hills and broad valleys. Elevation ranges from about 6,200 to 8,700 feet above MSL.

In northeast Montana and southwest North Dakota, the Missouri Plateau is divided into the southern unglaciated and the northern glaciated sections of the greater Great Plains province (See Figure 3.4-11). Previously glaciated areas demonstrate modified bedrock topography and glacial drift erosional remnants on upland and valley fill in major drainages. The topography is characterized by wide flat alluvial valleys, rolling prairies, and low to moderate hills with local relief of 20 to 560 feet. The unglaciated Missouri Plateau is comprised of eroded bedrock surfaces with gently rolling uplands, scattered buttes, and highly dissected badlands. Relief is comparable to the glaciated Missouri Plateau. Elevation for the area ranges from 1,600 feet to 3,600 feet above MSL.

Figure 3.4-11 Physiographic Provinces and Sections of the Northern Rocky Mountains and Great Plains



Source:
USGS, 2004, Physio, U.S. DOI, **http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml**

The Powder River Basin (PRB) is a high plains environment that is bounded by the Black Hills on the east; the Big Horn Mountains on the west; the Hartville Uplift, Casper-Arch, and Laramie Mountains on the south; and the Yellowstone River on the north, including northeast portions of Wyoming and southeast portions of Montana. The basin consists of a dissected rolling upland plain with low relief, broken by low buttes, mesas, hills, ridges, buttes and plateaus capped by "clinker" or sandstone. Elevations in the PRB coal resource area range from approximately 5,000 to 6,000 feet above MSL.

Located mostly in the Missouri Plains of North Dakota and Montana (Great Plains Province), the Williston Basin is a north-south trending oval-shaped region. Measuring approximately 300 miles wide by 500 miles long, the Basin provides an excellent example of a lack of conformance between an area's surface physiography and its contrasting underlying structure. Topographically, the Basin is best characterized as being generally flat with only a gently rolling land surface. Locally, however, a topographic relief of several hundred feet has been created near the Missouri and Yellowstone Rivers, a result of erosion of the relatively soft sandstones, coals, and shales. The subsurface, in contrast, is marked by a structural down-warping of the strata to form an actual geological basin wherein all stratigraphic units are inclined toward the center. Strata of the Williston Basin are of Late Cretaceous and Early Tertiary age.

According to the USGS (Thamke, et. al.):

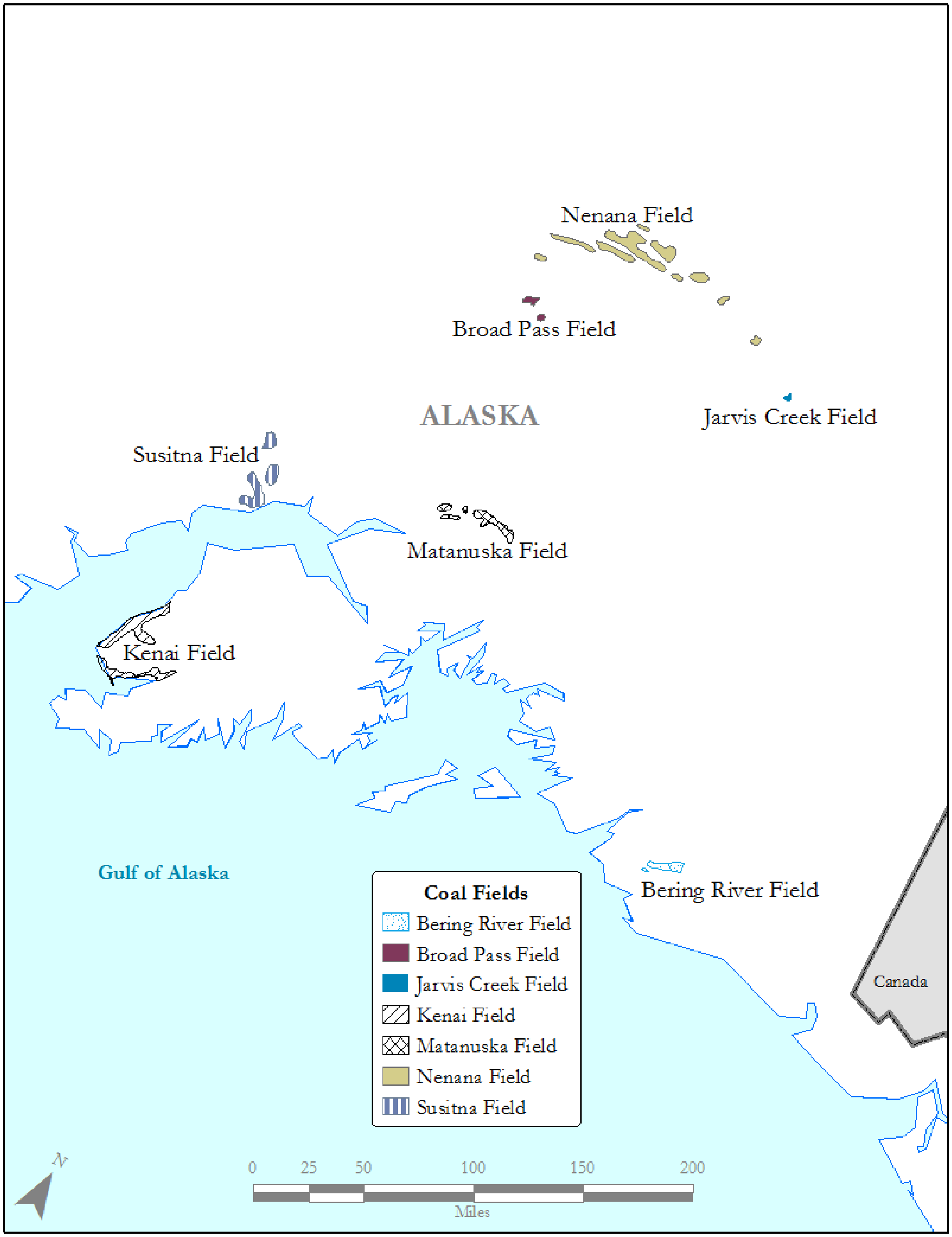
> The area is semiarid, with mean precipitation ranging from 12 to 20 inches per year (in/yr) and available precipitation (difference between monthly precipitation and potential evapotranspiration) ranging from 0 to 5 in/yr (Reilly and others, 2008). Pasture and hayland is the predominant land-cover category (70 percent) in the study area (Multi-Resolution Land Characteristics Consortium, 2011).

3.4.2.6 Northwest Region

The Northwest Coal region includes potentially mineable resources of interior Alaska. The description of the affected environment will be limited to Alaska because there is little active mining in Oregon and Washington. The Northern Alaska coal fields are also not discussed due to the questionable potential for their development and production at this time.

The primary coal resources of Alaska are associated with the Nenana and Matanuska coal fields of the interior (See Figure 3.4-12). The interior coal fields exist primarily within the northern foothills of the Alaska Range. The terrain includes steep bluffs and gently rolling plateau topography with deep stream valleys and steep slopes. At lower elevation, the topography transitions to irregular hummocky terrain. Elevations range from 1,200 to 4,400 feet above MSL (U.S. BLM, 1981; OSMRE, 1983).

Figure 3.4-12 Alaskan Coal Fields



Source:
USGS, 2011a, *Coal Fields*, U.S. Department of the Interior,
http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

3.4.2.7 Western Interior Region

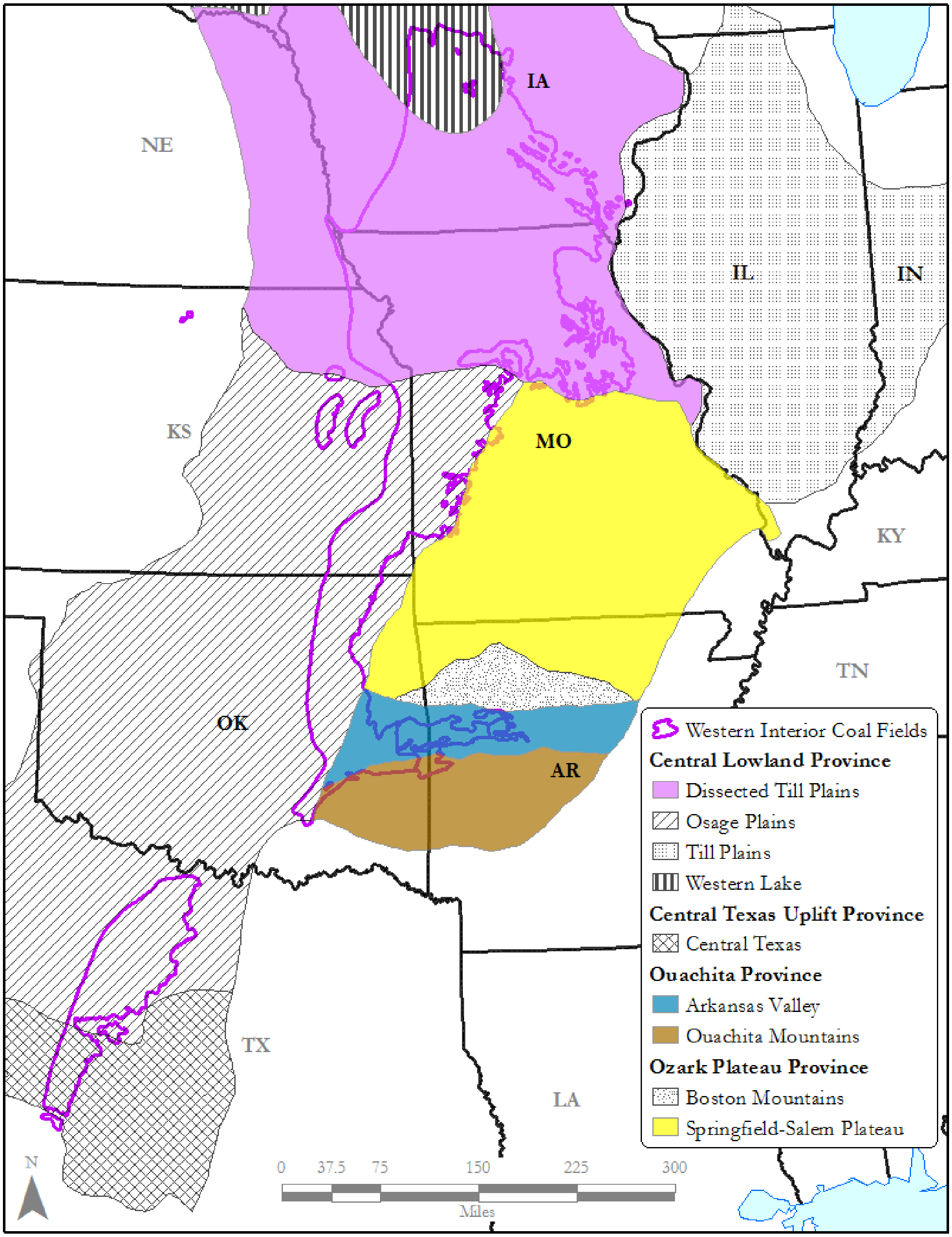
The Western Interior coal-bearing region includes Arkansas, Iowa, Kansas, Oklahoma, and Missouri (See Figure 3.4-13). The general topography of the region is very flat plain with elevations ranging from 500 to 1200 above MSL with very little local relief. The northern portion of the Western Interior region occupies the Central Lowlands physiographic province including the Osage Plains, and Dissected Till Plains Sections (See Figure 3.4-13). The portion lying primarily in Kansas and Oklahoma falls within the Osage Plains, while the Missouri and Iowa portions fall within the dissected Till Plains. The small area of the Western Interior coal region that extends into western Arkansas and parts of eastern Oklahoma falls in the Ozark Plateau physiographic province.

The Dissected Till Plains section has been glaciated and therefore is of low relief, ranging from 100 to 300 feet. The glacial till of this area is covered in the more eastern parts with up to 30 feet of loess.

The Osage Plains section lies south of the glacial limit so it has greater relief than the glaciated area of the Central Lowlands to the north. Most of the Osage area consists of upland plains with deeply entrenched rivers, some with valleys a few hundred feet deep.

The Ozark Plateaus physiographic province resembles the Appalachian Plateau Province, but elevations and relief average lower than in the Appalachians. A maximum elevation of 2,000 feet is reached in the southern part of this province (Vogel, 1981).

Figure 3.4-13 Physiographic Provinces and Sections of the Western Interior



Source:
USGS, 2004, *Physio*, U.S. DOI, http://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml

3.5 WATER RESOURCES

3.5.1 Introduction

Water resource considerations vary greatly across the coal-producing regions covered by this DEIS. This section presents background information on the affected environment for both the physical (flow of water) and the chemical (water quality) aspects of water resources. The discussion is organized into two major topics:

- **General Hydrology**: The General Hydrology section provides national-level information as context for understanding the affected environment descriptions of the seven coal regions.

- **Regional Hydrology**: The Regional Hydrology section describes groundwater and surface water systems for the seven coal regions, and characterizes associated water usage.

3.5.2 General Hydrology

The following discussion provides background information needed to understand the regional hydrological descriptions presented in the Regional Hydrology section below. The general description of hydrology is organized in four parts:

- The Climatic and Precipitation discussion section provides basic climatic information related to climatic differences and similarities between the seven coal resource regions.

- The Groundwater discussion section provides a brief introduction to the national importance and use of groundwater.

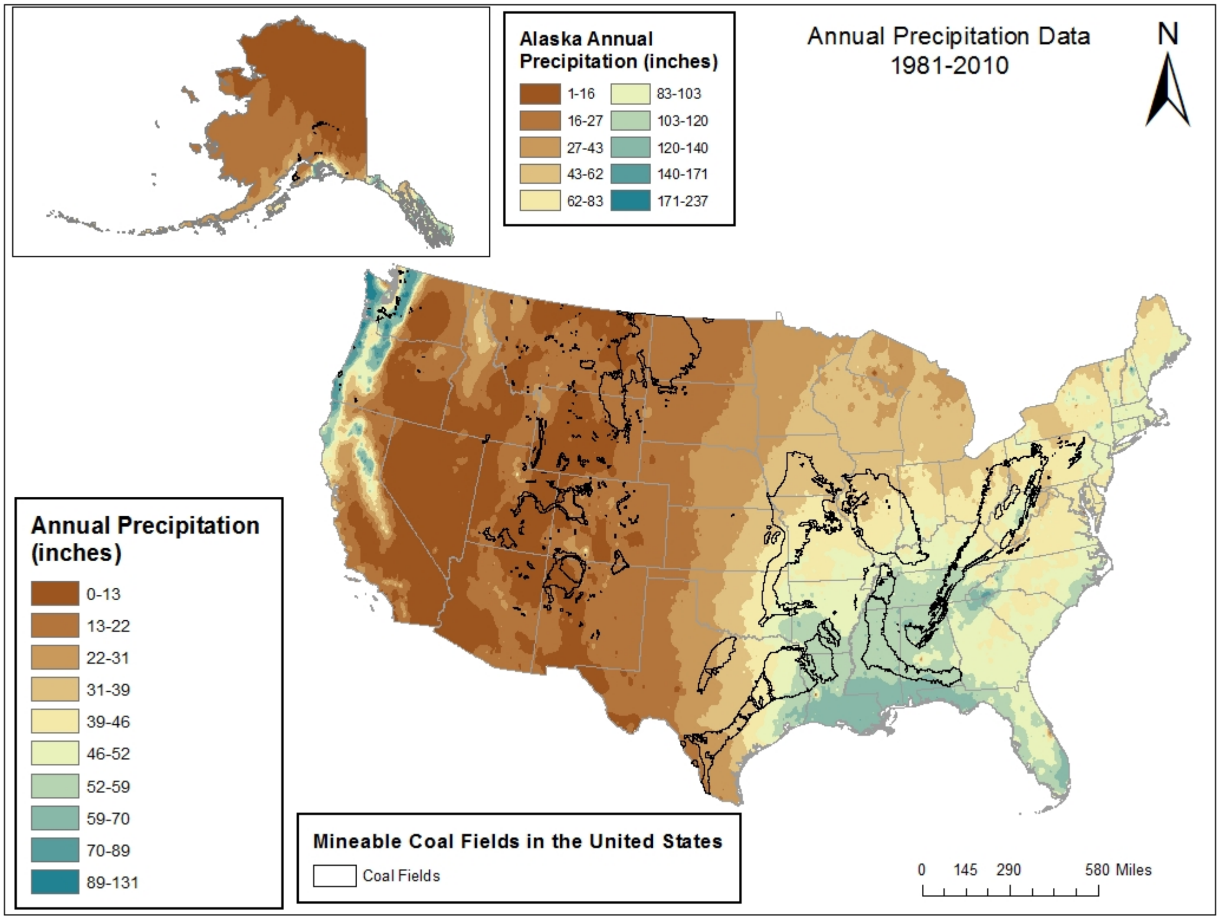
- The Surface Water discussion section covers four topics: stream types; stream morphology; water quantity; and, water quality. This introductory information is related to information about surface water in the Regional Hydrology section.

- The Water Usage discussion section provides a national overview of how surface and groundwater is used to support a variety of domestic and industrial needs. This section also discusses how water usage by the mining industry compares to water usage by other domestic and industrial users. More detailed water usage information is also provided in the Regional Hydrology section.

3.5.2.1 Climate and Precipitation

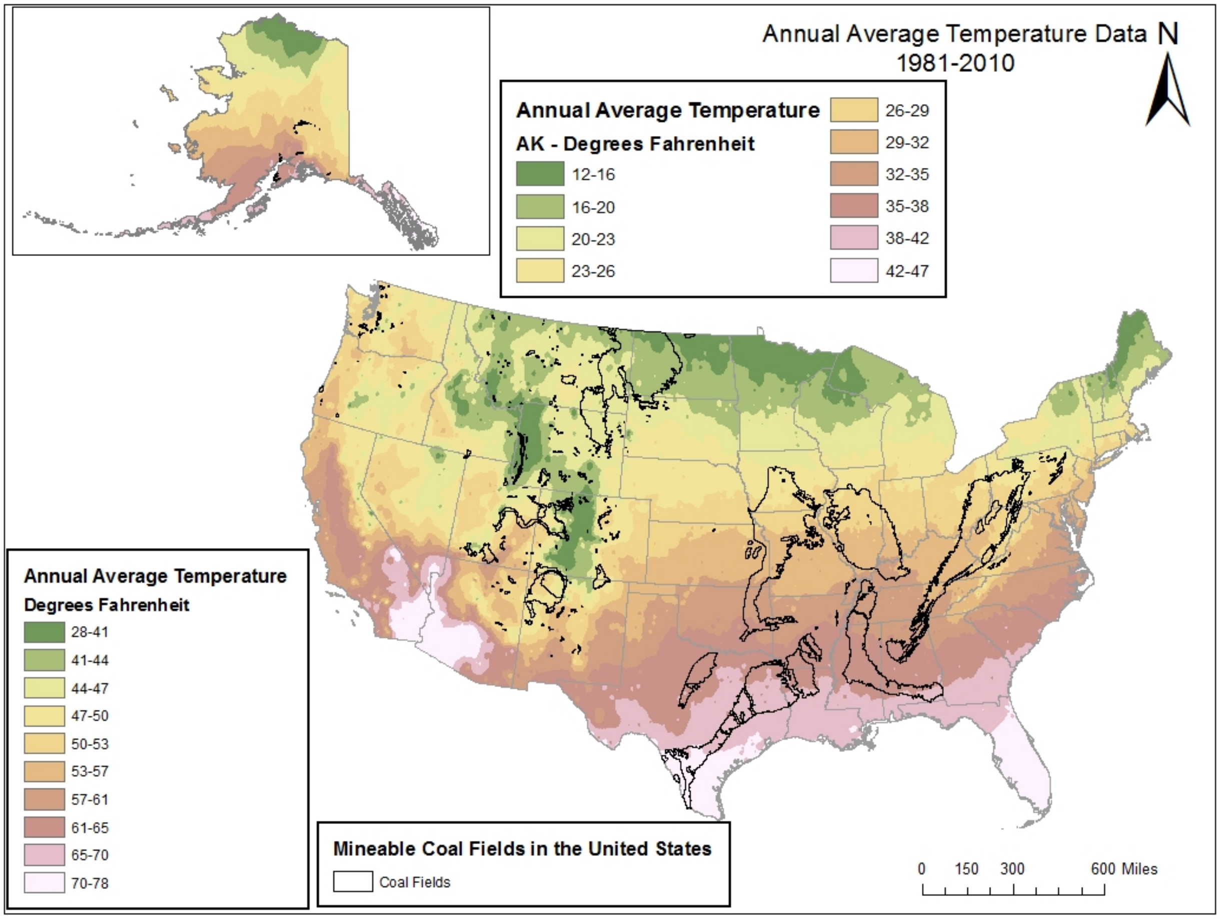
Climatic conditions vary greatly across the seven coal-producing areas, ranging from semi-arid to humid conditions. This variability affects stream type and flow characteristics. This section presents two maps of the continental U.S. depicting the annual precipitation and annual average temperature (Figures 3.5-1 and 3.5-2). Specific climate conditions for each of the seven coal resource regions are discussed below.

Figure 3.5-1 Annual Precipitation 1981 to 2010



Source:
USGS, 2001c, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeolNOAA, 2010. 1981-2010 *Climate Normals- precipitation*, U.S. Department of Commerce. http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html

Figure 3.5-2 Annual Average Temperature 1981 to 2010



Source:
USGS, 2001c, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol
NOAA, 2010. 1981-2010 *Climate Normals- Temperature*, U.S. Department of Commerce.
http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html

Appalachian Basin Region

The Appalachian Basin has a humid climate with abundant rainfall. Precipitation averages about 45 inches annually (Figure 3.5-1). Rainfall is greatest in the mountain areas. Precipitation is generally greatest during the spring and summer and least during the fall and winter. October is usually the driest month. Thunderstorms occur 40 to 50 days per year on average and are more frequent during June and July. These storms sometimes produce intense local rainfall and cause flooding in the narrow valley bottoms. Intense storms rarely encompass large areas but are frequent over small areas. The ten-year, 24-hour rainfall average is approximately four inches (Ehlke, et al., 1982). The mean annual rainfall ranges from 52 inches to 56 inches, with winter being the wettest season and March as the wettest month, on average. The driest months are commonly in the fall, with October being the driest month overall. It is common to have periods of no precipitation lasting longer than two to three weeks (Harkins et al., 1980).

Colorado Plateau Region

Climate classification predominantly depends on altitude with lower elevations in the east being classified as sub-humid and higher elevations in the west as semi-arid (Colorado Climate Center, 2010; Western Regional Climate Center, 2013). The climate in the four corners area of New Mexico, Arizona, Utah, and Colorado is characterized as semiarid to arid. The driest and wettest months on average are June and December, respectively. Most of the rainfall that occurs as intense thunderstorms occurs during the late summer (Colorado Climate Center, 2010). The climate changes to the north in the higher terrain areas of eastern Utah and western Colorado. Areas at higher altitudes have greater precipitation and lower temperatures than those at lower altitudes. Average annual precipitation on the Colorado Plateau, based on analysis of daily records from 97 long-term weather stations, ranges from 5.4 to 26.3 inches per year, with a median precipitation of 11.8 inches per year (USGS, 2005d). In higher altitudes for this area, the precipitation usually ranges between 25 to 35 inches per year. During summer and early fall, precipitation comes from intense, short duration, localized convective storms.

Gulf Coast Region

Generally, a maritime climate prevails along the Gulf Coast of Texas. Average annual precipitation in the coastal mining area of Texas exceeds 56 inches with some areas incurring higher amounts. There are two basic seasons: a hot summer that may last from April through October and winter that starts in November and usually lasts until March. Monthly average temperatures range from 48°F in January to 88°F in August (City-Data.com, 2010; Texas Water Development Board, 2012). Proceeding towards Oklahoma and Arkansas, the climate is characterized by a mild spring, a hot and humid summer, a mild autumn, and a mild winter. On average, July and August are the warmest months with December and January being the coldest. Average daily maximum temperatures in Oklahoma and Arkansas range from 50 degrees in January to 95 degrees in July and August.

Normal annual precipitation for the Gulf Coast coal-producing region ranges from about 36 inches in the northwestern to about 50 inches in the southeastern part of this area. In an average year, about 32 percent of the annual participation falls in the spring with 27 percent, 22 percent, and 19 percent falling in the summer, autumn, and winter, respectively. April, May, and June are the wettest months and are characterized by short-duration thunderstorms of varying intensity that make up most of the rainfall for the year. Twenty-four hour rainfall totals of up to ten inches have been recorded. In the winter, snowfall averages close to six inches per year occurring mainly in January and February (Marcher, et al., 1987).

Illinois Basin Region

In the Illinois Basin, precipitation is mainly produced by low-pressure westerly systems entraining southerly winds bearing moist, warm air from the Gulf of Mexico. Occasionally, high pressure cells from the north also create rain, snow, and sleet conditions. Average annual precipitation ranges from approximately 39 to 50 inches. Precipitation occurs about 120 days per year. Monthly precipitation averages from August through October are 20 percent to 35 percent less than monthly averages for the remainder of the year. Intense storms usually cover large areas.

Northern Rocky Mountains and Great Plains Region

The climate in this area is significantly affected by the mountains along the Pacific coast and the Rocky Mountains. Annual precipitation in the mountains exceeds 25 inches while the plains receive approximately 10 to 16 inches. Most precipitation occurs as snowfall from November through April with greater than 100 inches of snow in the mountains and 30 to 75 inches in the plains. Much of the snow in the plains is sublimated. Precipitation during the summer months primarily occurs as light showers with occasional intense thunderstorms.

Northwest Region

Currently, the producing coal region of concern in the Northwest Coal region includes only the State of Alaska, particularly interior Alaska. The continental climate of interior Alaska has a wide range of air temperatures between summer and winter and large fluctuations around the seasonal means. The only active coal mining operation in Alaska is in the Tanana Valley. The mean annual temperatures in the Tanana Valley average 26.4˚F at the Fairbanks International Airport with the warmest month, July, averaging 61.3°F, and the coldest month January averaging -10.3˚F (1917 to 2000 averages). However, these averages do not present an accurate picture of either the extreme summer or winter air temperatures. For example, in the Tanana Valley, periods of extreme cold ranging in the vicinity of -40°F to -49˚F are not uncommon at any time from late November through February. In contrast, daily maximum temperatures occasionally reach 90˚F to 98.6˚F in June and July, often with only modest night cooling because of persistent daylight (Bonanza Creek LTER, 2011).

Annual precipitation in interior Alaska is low and decreases from west to east, with a 50-year average for Fairbanks of 11.3 inches and a range from 5.6 inches in 1957 to 18.8 inches in 1990. Most summer and winter precipitation is generated from major frontal systems that cross the State, but convective storms add significantly to the summer precipitation. Precipitation events in early summer (May, June, and early July) are typically light and showery, with high spatial variability. The relatively dry summer conditions are replaced by the fall rain events which can be heavy and sustained. On average, precipitation increases through the summer.

Western Interior Region

The general climate of the Western Interior region is continental affected primarily by alternative masses of warm moist air from the Gulf of Mexico and cold, comparatively dry air from the northern polar regions. Hence, there are large variations in precipitation and temperature. Average annual precipitation ranges from approximately 34 inches in the western area, increasing to greater than 40 inches towards the east. About 70 percent of precipitation occurs in the growing season from April through October. Rainfall occurs either in intense thunderstorms of short duration or longer storms that cover greater areal extent. The ten-year 24-hour storm average is approximately five inches. The average temperature is about 56 °F in the Western Interior region. July is generally usually the warmest month with an average daily maximum of 91 °F and an average daily temperature of 69 °F. January is the coldest month with the average daily maximum and minimum of 40 °F and 21°F, respectively (NOAA, 2011; National Weather Service, 2012).

3.5.2.2 Groundwater Usage Overview

Groundwater is among the Nation's most important natural resources. As defined in the federal regulations (30 CFR 701.5), groundwater is "subsurface water that fills available openings in rock or soil materials to the extent that they are considered water saturated." A USGS report (USGS, 2000b) states that groundwater "… provides drinking water to urban and rural communities, supports irrigation and industry, sustains the flow of streams and rivers, and maintains riparian and wetland ecosystems. In many areas of the Nation, the future sustainability of groundwater resources is at risk from overuse and contamination. Because groundwater systems typically respond slowly to human actions, a long-term perspective is needed to manage this valuable resource."

Nationwide, fresh groundwater withdrawals of 79.6 billion gallons per day (bg/d) in 2005 were about five percent less than in 2000. Of this 79.6 bg/d, about 67.2 percent were for irrigation, 18.3 percent for public supply, 4.7 percent for domestic supply, 3.9 percent for industrial use, 2.4 percent for aquaculture, 1.6 percent for livestock, 1.3 percent for mining, and 0.6 percent for thermoelectric use. More than half (43.35bg/d) occurred in six states: California, Texas, Nebraska, Arkansas, Florida, and Idaho (Kenny, et al., 2009). Of these six major groundwater user states, only Texas is considered a significant coal producer. Appendix J includes tables listing the source and amount of groundwater withdrawals for all counties within the U.S. that produced coal in 2005. These tables can be used to compare the magnitude of mining-related withdrawals to other industries.

3.5.2.3 Surface Water Overview

Surface water is that portion of precipitation that exceeds the infiltration capacity of the soil and becomes overland flow. It travels down gradient to a point of convergence (stream) or is captured in a surface depression. Surface water can also include a portion of precipitation that has infiltrated into the soil or geologic matrix during or immediately after a precipitation event, and traveled as subsurface flow ultimately discharging into a stream or lake (interflow) or to the ground surface at topographic lows (through flow). Watersheds and their surrounding ecosystems are linked by the flow of water. In a watershed context, landscape hydrologic connectivity refers to the maintenance of natural hydraulic connections of surface and subsurface flow between source, headwater, or contributing areas and downstream/down-gradient receiving waters. As headwater streams occur upstream from, and may ultimately discharge into higher order perennial streams, they connect landscape processes through their influence on the supply, transport, and fate of water and solutes in the watershed (Alexander, et al., 2007; Leibowitz, et al., 2008).

Stream Types

"Stream" is a general term for a body of flowing water. In hydrology, the term is generally applied to the water flowing in a natural channel, as distinct from a canal. Stream reaches are "dynamic zones within stream networks" (Fritz, et al., 2006) meaning that the points-of-origin of streams are not static but can vary depending on factors such as precipitation, evapotranspiration, and land use (Paybins, 2003). Streams in natural channels may be classified as follows (Meinzer, 1923):

- Relation to time:
    - **Perennial**: A stream that flows continuously.
    - **Intermittent or seasonal**: A stream that flows only at certain times of the year when it receives water from springs, precipitation, or from some surface source such as melting snow.
    - **Ephemeral**: A stream that flows only in direct response to precipitation or snowmelt, and whose channel is at all times above the water table.
- Relation to space:
    - **Continuous**: A stream that does not have interruptions in space.
    - **Interrupted**: A stream that contains alternating reaches that are perennial, intermittent, or ephemeral.
- Relation to groundwater:
    - **Gaining**: A stream or reach of a stream that receives groundwater contributions.
    - **Losing**: A stream or reach of a stream that contributes water to groundwater.
    - **Insulated**: A stream or reach of a stream that neither contributes water to groundwater nor receives water from it. It is separated from groundwater by an impermeable bed.
    - **Perched**: A stream whose stream bed is above the water table and separated from underlying groundwater by an impermeable geologic unit in the unsaturated zone.

Table 3.5-1 contains a summary of the lengths and percentages of intermittent and perennial streams for each coal resource region. This table was generated using the USGS National Hydrography Dataset (NHD). The NHD is a comprehensive set of digital spatial data that represents the surface water of the U.S. using common features such as lakes, ponds, streams, rivers, canals, stream gages, and dams (USGS, 2011b).

Table 3.5-1
Summary of NHD Intermittent and Perennial Stream Lengths for the Coal Resource Regions

Region	Stream Type	Length (miles)	Percent of Total Length
Appalachian Basin	Intermittent	69,798	55.0
	Perennial	56,929	45.0
	Total	126,727	
Colorado Plateau	Intermittent	43,482	93.9
	Perennial	2,811	6.1
	Total	46,293	
Gulf Coast	Intermittent	175,925	79.0
	Perennial	46,695	21.0
	Total	222,620	
Illinois Basin	Intermittent	70,645	74.6
	Perennial	24,073	25.4
	Total	94,718	
Northern Rocky Mountains and Great Plains	Intermittent	147,003	94.4
	Perennial	8,645	5.6
	Total	155,648	
Northwest	Intermittent	3,554	55.0
	Perennial	2,912	45.0
	Total	6,466	
Western Interior	Intermittent	91,932	58.3
	Perennial	65,673	41.7
	Total	157,605	

Source: USGS, 2011b, National Hydrography Dataset.
Length values are rounded to the nearest hundreds. Percent of total length values are rounded to the nearest tenths. (http://nhd.usgs.gov/documentation.html).

As seen in Table 3.5-1, all of the regions have intermittent stream lengths greater than perennial stream lengths, but the values vary markedly. For more arid regions such as the Colorado Plateau and the Northern Rocky Mountains and Great Plains, the lengths of intermittent streams are far greater than perennial streams. For the Illinois and Gulf Coast Basins where rainfall amounts can be notably variable, the intermittent stream lengths are greater but not as significantly as in the more arid regions. The Appalachian, Northwest, and Western Interior regions have the least difference in length of intermittent versus perennial streams.

Using the NHD, the EPA has estimated that 59 percent of the streams in the U.S. (excluding Alaska) are ephemeral or intermittent (Levick, et al., 2008). The NHD also identifies start reaches as those that have no other streams flowing into them (at the 1:100,000 scale). These reaches can thus be considered headwater or first-order streams (Levick, et al., 2008; Nadeau and Rains, 2007).

One of the most common methods used to classify streams is known as the Strahler method (Strahler, 1952). Using this method, streams are numbered progressively from the headwaters or drainage basin divide to a downstream location. Headwater streams with no tributaries are designated as first-order. When two first-order streams join to create a confluence, a second-order stream is designated. When two second-order streams create a confluence a third-order stream is designated, and so on downstream. Leopold, et al. (1964) used the Strahler method to estimate the total stream length in the U.S. (Table 3.5-2). Extrapolating from maps of 1:24,000 to 1:62,500 scale, the authors estimated that there are 3,250,000 miles of streams in the U.S.. Since Leopold, et al. (1964) used a 1:24,000 scale map as their basis, the stream lengths presented in Table 3.5-2 are likely under-representative of the actual stream lengths as many ephemeral streams and some intermittent ones are likely not shown on large scale maps.

Table 3.5-2
Number and Length of Streams in the U.S.

Order	Number	Average Stream Length (mi)	Total Stream Length (mi)
1	1,570,000	1	1,570,000
2	350,000	2.3	810,000
3	80,000	5.3	420,000
4	18,000	12	220,000
5	4,200	28	116,000
6	950	64	61,000
7	200	147	30,000
8	41	338	14,000
9	8	777	6,200
10	1	1,800	1,800

Source: Adapted from Leopold et al., 1964.

Stream Morphology

This DEIS describes stream morphology using the Rosgen (1994) classification system. While all Rosgen types can be identified in all regions, discussion is limited to a generalized Rosgen Level 1 description of the characteristic stream type(s) that are likely to be impacted by surface and underground mining in their respective coal region. Further, classifications for the most part are identified as a function of the physiographic and topographic relief conditions present. The intent is to highlight the relative occurrence of Rosgen stream types across coal regions, not describe all stream types present.

The variety of stream forms or morphologies that exist in the environment are an expression of driving forces (water, gravity) and resisting forces (as influenced by lithology, vegetation, sediment load, and sediment size). The dominance of erosion or deposition is determined by the relative magnitude of the elements affecting the driving and resisting forces, and thus determines stream form and how actively streams change their morphology (Lane, 1955).

Broad morphological characterization is accomplished using descriptions of relief, local lithology, plan form, valley configuration, channel profile, and dominant substrate. The Rosgen classification system described in the seminal published work, *A Classification of Natural Rivers* (Rosgen, 1994), is widely recognized among land use and water resource managers. The Rosgen system synthesizes the results of previous works in stream morphology (Lane, 1957; Leopold & Wolman, 1957; Schumm, 1963; Culbertson, et al., 1967; Khan, 1971) with additional extensive research to create a stream taxonomy that can be used to objectively describe streams observed in all coal regions. Table 3.5-3 presents the nine fundamental Rosgen stream types. For a detailed discussion of the Rosgen Classification system, the reader is directed to *Applied River Morphology* (Rosgen, 1996). A generalized Level 1 discussion of the dominant stream types is presented below. The Level 1 classification within the Rosgen system describes generalized categories of streams using broad descriptions of longitudinal profiles, valley and channel cross-sections, and plan view patterns (Rosgen, 1994).

Streams that are observed in headwater basins of high relief are steep (four to ten percent) to very steep (>ten percent), have high erosion and transport potential, and are recognized as “A” and “Aa+” type streams (Table 3.5-3). These streams are very stable when they exist in resistant bedrock or boulder colluviums, but can incise weak sedimentary rock and finer-grained unconsolidated alluvium. Slopes exceeding ten percent are considered erosional and are susceptible to mass wasting processes such as debris flows. Stream-bed features include alternating steps and pools, cascades and waterfalls. Steps are vertical drops formed by boulders, bedrock, or downed trees and pools are deep flat areas in the stream created by scour (North Carolina State University, 1999). Generally, these single-channel streams are linear in plain view with little sinuosity and are characterized by limited valley floodplain width. Sinuosity is defined as the ratio of the stream channel length to valley length. Streams that have limited floodplains are described as entrenched. The degree of entrenchment is measured as a ratio of the floodplain width to the bankfull channel width.

Moving within the drainage basin from steep headwater areas downstream to areas of moderate relief and gradient, “A” type streams transition to “B” types (Figure 3.5-3). “B” type streams are moderately steep to gently sloped (two percent to four percent). They are also laterally constrained by narrow valley slopes and consequently have narrow floodplains. They are straight, single-channel streams with little sinuosity and exhibit stream bed features such as rapids and alternating riffles and pools. Riffles are sections of streams comprised of gravel-size or larger bed sediment and are shallow and swift at low flows (North Carolina State University, 1999). Similar to “B” type streams; “G” type streams are also moderately steep to gently sloped (two percent to four percent) but are more entrenched and have lower bankfull channel width to bankfull channel depth (W/D) ratios (<12). Measurements of W/D ratios are useful to describe relative differences in channel cross-section and also provide a visual assessment of channel stability. For example, “G” types are recognized as unstable with grade control problems and high bank erosion.

Sinuous streams are stream type “C.” These streams have low channel gradients (less than two percent), and occur within narrow to wide alluvial valleys in landscapes of low relief. These streams are wide and shallow as demonstrated by their high W/D ratios (greater than 12). “C” type streams exhibit enhanced lateral migration or “meandering” due to a lack of lateral constraints, erodible bed and bank materials, and active channel aggradation and degradation processes. A meander is a bend or curve in the stream channel. Typical stream features include riffles, pools, and point bars. Point bars are crescent shaped depositional features with coarse material located on the inside of a bend in the stream (North Carolina State University, 1999).

Table 3.5-3
Rosgen's Nine Fundamental Stream Types

Stream Type	General Description	Entrenchment Ratio[1]	W/D Ratio[2]	Sinuosity[3]	Slope	Landform/Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0 to 1.1	>.10	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0 to 1.2	.04 to .10	High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks.	1.4 to 2.2	>12	>1.2	.02 to .039	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate w/scour pools.
C	Low gradient, meandering, point-bar, riffle/pool, alluvial channels with broad, well defined floodplains.	>2.2	>12	>1.2	<.02	Broad valleys w/terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks.	n/a	>40	n/a	<.04	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment, w/abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well vegetated floodplains and associated wetlands. Very gentle relief with	>2.2	Highly variable	Highly variable	<.005	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition w/well-vegetated bars that are laterally stable with

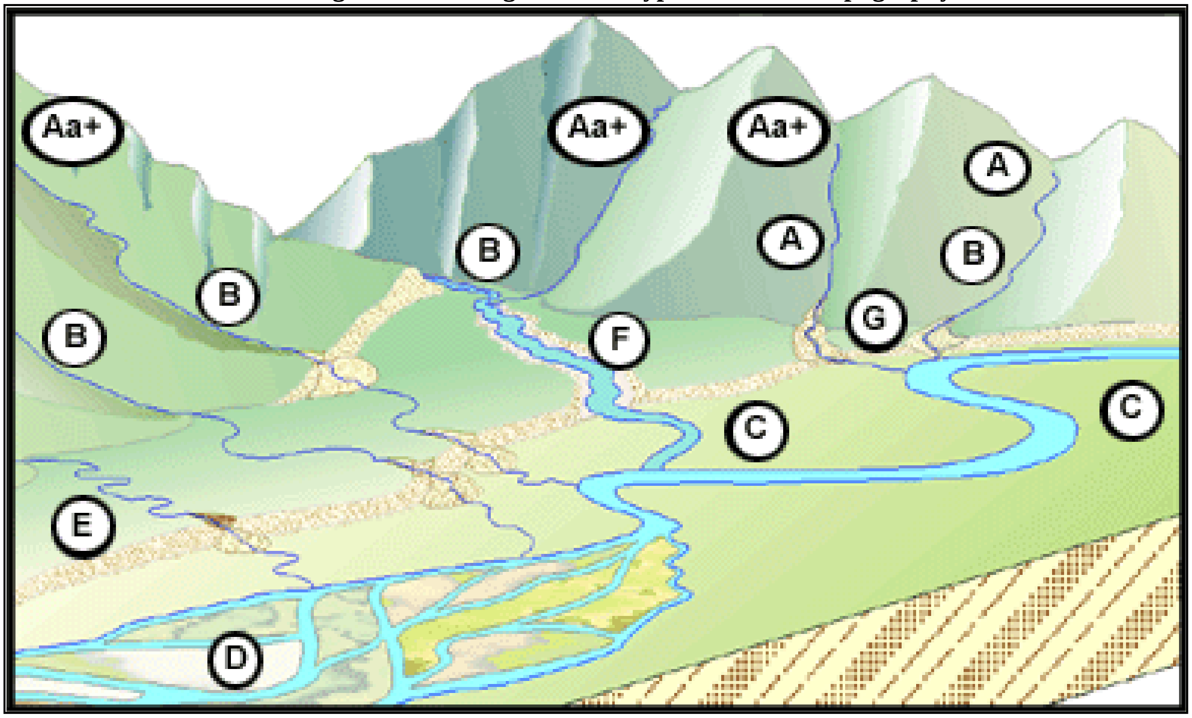
Stream Type	General Description	Entrenchment Ratio[1]	W/D Ratio[2]	Sinuosity[3]	Slope	Landform/Soils/Features
	highly variable sinuosities and width/depth ratios. Very stable stream banks.					broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, meandering riffle/ pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio.	>2.2	<12	>1.5	<.02	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios.
F	Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio.	<1.4	>12	>1.2	<.02	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology.
G	Entrenched "gully" step/pool and low width/depth ratio on moderate gradients.	<1.4	<12	>1.2	.02 to .039	Gullies, step/pool morphology w/moderate slopes and low width/depth ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials, i.e., fans or deltas. Unstable, with grade control problems and high bank erosion rates.

[1] Entrenchment ratio - ratio of the floodplain width to the bankfull channel width
[2] Width to depth (W/D) ratio - ratio of the bankfull channel width to bankfull channel depth
[3] Sinuosity - ratio of the ratio stream channel length to valley length
Source: Rosgen, 1996.

The Rosgen "E" and "F" stream types are similar to "C" stream types in that they exist within landscapes of low relief. These stream types are differentiated from the "C" types by their relative degree of entrenchment and W/D ratios. Relative to "C" types, "E" stream types have lower W/D ratios indicating they are narrower and deeper. "F" types have lower entrenchment ratios (more entrenched), indicating a lack of floodplain.

Streams can also exhibit multiple-channel or "braided" forms. These streams are recognized as "D" types and occur on lands of very low relief with very low gradients. They are shallow in depth, contain abundant sediment supplies, and are highly active with respect to lateral adjustments. The individual channels are separated by depositional bars. The stream-type occurs in landforms comprised of depositional alluvium such as glacial wash and alluvial fans.

Figure 3.5-3 Rosgen stream types relative to topography



Source: U.S. EPA, 2013f. Watershed Academy Web, Fundamentals of Rosgen Stream Classification System. Excerpts from Rosgen, D.L., 1996, *Applied River Morphology*.
http://cfpub.epa.gov/watertrain/moduleFrame.cfm?module_id=27&parent_object_id=1189&object_id=1189

All nine fundamental Rosgen stream types can be further sub-classified using numeric designation (one to six). These numeric designations correspond with the textural class of the dominant channel material. The numeric scale starts with (1) being bedrock and (2) the coarsest of material being boulders. It progresses incrementally to (6) being the finest of material silt/clay. For example, a sinuous single channel of low gradient that exhibits high W/D ratio, high entrenchment ratios (low entrenchment), with cobble channel material would be a "C3" type, while a similar stream with sand channel material would be a "C5" type (Rosgen, 1996).

Management Interpretations

The sensitivity of streams to imposed changes such as increases in flow, human disturbance, and the introduction or loss of riparian vegetation varies by stream type. Stream-type sensitivity is shown in Table 3.5-4, as are values for recovery potential, sediment supply, stream bank erosion potential, and vegetative controlling influence. The predictions were derived from rangeland management studies but are applicable to other kinds of disturbances such as silviculture and surface mining (Rosgen, 1994; Rosgen, 1996).

Table 3.5-4
Management Interpretations by Rosgen Stream Type

Stream Type	Sensitivity to Disturbance[1]	Recovery Potential[2]	Sediment Supply[3]	Streambank Erosion Potential	Vegetation Controlling Influence[4]
A1	very low	excellent	very low	very low	negligible
A2	very low	excellent	very low	very low	negligible
A3	very high	very poor	very high	very high	negligible
A4	extreme	very poor	very high	very high	negligible
A5	extreme	very poor	very high	very high	negligible
A6	high	poor	high	high	negligible
B1	very low	excellent	very low	very low	negligible
B2	very low	excellent	very low	very low	negligible
B3	low	excellent	low	low	moderate
B4	moderate	excellent	moderate	low	moderate
B5	moderate	excellent	moderate	moderate	moderate
B6	moderate	excellent	moderate	low	moderate
C1	low	very good	very low	low	moderate
C2	low	very good	low	low	moderate
C3	moderate	good	moderate	moderate	very high
C4	very high	good	high	very high	very high
C5	very high	fair	very high	very high	very high
C6	very high	good	high	high	very high
D3	very high	poor	very high	very high	moderate
D4	very high	poor	very high	very high	moderate
D5	very high	poor	very high	very high	moderate
D6	high	poor	high	high	moderate
DA4	moderate	good	very low	low	very high
DA5	moderate	good	low	low	very high
DA6	moderate	good	very low	very low	very high
E3	high	good	low	moderate	very high
E4	very high	good	moderate	high	very high
E5	very high	good	moderate	high	very high
E6	very high	good	low	moderate	very high
F1	low	fair	low	moderate	low
F2	low	fair	moderate	moderate	low
F3	moderate	poor	very high	very high	moderate
F4	extreme	poor	very high	very high	moderate
F5	very high	poor	very high	very high	moderate
F6	very high	fair	high	very high	moderate
G1	low	good	low	low	low
G2	moderate	fair	moderate	moderate	low
G3	very high	poor	very high	very high	high
G4	extreme	very poor	very high	very high	high
G5	extreme	very poor	very high	very high	high
G6	very high	poor	high	high	high

[1] Includes increases in streamflow magnitude and timing and/or sediment increases.
[2] Assumes natural recovery once cause of instability is corrected.
[3] Includes suspended and bedload from channel derived sources and/or from stream adjacent slopes.
[4] Vegetation that influences width/depth ratio-stability.

Sources: Rosgen 1994; Rosgen, 1996

Water Quantity and Stream Regime

While streams in the U.S. vary greatly, stream characteristics can be described as a function of the climatic and topographic environment as well as of watershed geology and land cover. Snelder, et al., (2005) proposes that climatic and topographic characteristics of a watershed are the dominant causes of variation in hydrological processes at macro (approximately 400 to 40,000 square miles) and meso (approximately 40 to 400 square miles) spatial scales, and can be used to define distinctive flow regime classes and delineate patterns in flow regimes at these spatial scales.

For example, streams whose watersheds are located in high precipitation areas are expected to have the most consistent flows and most frequent floods. Streams that are located in the rain-shadows or regions of low precipitation are expected to have the extended periods of low flow and flow variation is expected to be higher. Variability in temperature further drives the seasonal response to precipitation. In cool regions, precipitation as snow is stored in winter and released as snowmelt in spring and summer. In warm regions, snow storage is less and runoff regimes will more closely follow the temporal distribution of precipitation (Poff and Ward, 1989; Snelder, et al., 2005).

Snelder, et al., (2005) also discusses how topography influences stream characteristics. Mountainous environments receive higher precipitation than lowland areas and can be expected to have lower flow variability, more sustained base flows, and higher low flows. In regions that receive significant precipitation in the form of snow, snowpack storage dampens the watershed response to precipitation and delays the watershed's release of water until summer. Mountain environments are expected to have low flood frequency and marked summer peak flows (Duncan, 1992; Snelder, et al., 2005). Regions of lower relief and elevation are characterized by limited snow storage that typically melts by mid-to-late spring. Thus, these areas may have two low flow periods, summer and winter. Flow variability and the magnitude and frequency of high flows, relative to median flow, is expected to be higher in areas of low relief as compared to mountain regions because there is less storage of precipitation and attenuation of watershed response to precipitation. Low flows in areas of low relief are expected to be small, relative to median flow, compared to mountain regions for the same reason. Areas of very low relief are least affected by the storage of precipitation as snow, and thus the flow regime is expected to follow seasonal patterns in precipitation and evapotranspiration regimes (Duncan, 1992; Snelder, et al., 2005).

Surface-water quality is described regionally using a three-step approach. First, select designated uses defined by each state within each coal resource area are provided. This information provides the reader with an idea of the types of designated uses that must be protected regardless of the alternative selected. Secondly, the regional discussion summarizes the integrated water quality report assessments for each state. The water quality assessment summary provides a snapshot of the ratio of surface waters attaining their designated use (referred to as "good waters") to those not attaining their designated use (referred to as "impaired waters"). The summary includes the total miles of streams in each of the "good," "impaired," and "threatened" categories as well as information on the number of stream miles assessed versus total stream miles. Readers can compare and contrast these tables between states and coal resource regions to assess surface water quality conditions. Thirdly, readers who seek a more detailed discussion of surface water quality conditions than provided in the summary tables can consult hyperlinks to access the Clean Water Act (CWA) integrated reports for each of the states. Collectively, these three pieces of information provide a general understanding of the existing water quality for each region.

3.5.2.4 Water Usage Overview

Water supply resources include both groundwater and surface water. Groundwater is typically withdrawn via wells from deep aquifers or from shallow aquifers typically found in areas adjacent to rivers and streams. Surface water supply resources include direct withdrawals from reservoirs, rivers, lakes, and streams. Water is typically supplied by public and private utilities. Users may also provide their own water (self-supply) from wells for agricultural and residential use. Water supply resources and suppliers vary in each region.

The pattern of total water usage and distribution varies between each region. Areas differ with respect to the mix of public supply, domestic, commercial/industrial, agricultural, mining, and thermoelectric uses. The use categories are defined below (Templin, et al., 1997).

- A public water supply use is a public or private water system that provides water to at least 25 people or has a minimum of 15 service connections. Public water suppliers provide water to domestic, commercial, and industrial users, to facilities generating thermoelectric power, for public use, and occasionally for mining and irrigation.
- Domestic water use includes water used for household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, car washing, and watering lawns and gardens. For the purposes of this discussion, domestic water use includes private self-supply only.
- Commercial water use includes water used by commercial facilities such as hotels, motels, restaurants, office buildings, government and military facilities, hospitals, educational institutions, and retail sales stores.
- Industrial water use includes water used to manufacture products such as steel, chemical, and paper, as well as water used in petroleum and metals refining. It does not include power generation for sale to other users, mining of minerals, or the extraction of crude petroleum and gases, which are included in other water-use categories.
- Mining water use includes water used for the extraction and on-site processing of naturally occurring minerals including coal, ores, petroleum, and natural gas. The mining category includes product incorporation during dust control, tailings disposal, slurry conveyance, and drying; wastewater treatment; deliveries of reclaimed wastewater; return flow; and dewatering.
- Irrigation includes water applied to crops grown on commercial farms. Irrigation water use is by far the largest use of water diverted from streams or withdrawn from aquifers in the western U.S. (Solley, 1997). Total annual irrigation water use can vary depending on many factors, including climate, foreign trade, commodity prices, production costs, cost efficiency of irrigation, and changes in irrigation technology.
- Livestock water use includes water used to raise cattle, sheep, goats, hogs, and poultry, and horses.

- Aquaculture includes water used for farming of organisms that live in water, such as fish, including fish hatcheries, shrimp, and other shellfish.
- Thermoelectric power generation includes water used in the generation of electric power when the following fuel types are used: fossil, nuclear, biomass, solid waste, or geothermal energy.

For the purpose of the DEIS, commercial and industrial use are treated as a single category. Likewise, irrigation, livestock, and aquaculture uses are combined as agricultural use.

A portion of the total domestic and agricultural water used is self-supplied. Self-supplied water, primarily withdrawn from private groundwater wells, is typically used for household and farming/irrigation applications. Private wells are most common in rural areas not served by municipal water supplies. There are over 15.6 million users of private water supply wells (wells that serve one to five homes) in the U.S. (U.S. Census Bureau, 2008). Unlike municipal water supply, which is monitored for water quality and typically treated prior to distribution, self-supplied water is unregulated by the EPA, and well owners take full responsibility for water quality, availability, and maintenance of their wells. Because private wells may not be routinely monitored or treated under Safe Drinking Water Act regulations, they may be more vulnerable to water quality and supply changes related to mining than a public water supply system. However, under SMCRA, operators are required to mitigate certain water supply impacts related to coal mining operations by replacing the impacted water supply (SMCRA Sections 717 (b) and 720 (a)(2)).

Table 3.5-5 provides a percentage breakdown of the USGS reported 2005 water use by usage category for each of the seven coal resource areas (USGS, 2010b). The water usage information is compiled by the USGS every five years. The USGS published the 2010 USGS water-usage data report in November 2014. OSMRE plans to update the final version of the EIS with 2010 water usage data.

Table 3.5-5
Total Water Usage by Category and Region

Category	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Thermo-electric	77.6%	2.2%	42.4%	86%	7.7%	0.5%	72%
Public Supply	9.5%	5.4%	9.6%	5.8%	5.1%	21%	18.3%
Domestic	1%	0.4%	0.8%	0.5%	0.3%	1.9%	0.4%
Agriculture	2.7%	91.4%	41.9%	2.8%	86%	73.9%	7.4%
Industrial and Commercial	8.7%	0.4%	5%	4.4%	0.7%	2.3%	1.5%
Mining	0.6%	0.2%	0.3%	0.6%	0.4%	0.4%	0.4%

Source: USGS, 2010b

3.5.3 Regional Hydrology

The U.S. coal regions feature diverse hydrological resources. As a foundation for analysis of impacts in Chapter 4, the following regional discussions provide a broad overview of regional water resources.

3.5.3.1 Appalachian Basin Coal-Producing Region

Groundwater

The eastern extent of the Appalachian Plateaus physiographic province is bound by the Cumberland Front Escarpment in Kentucky and Tennessee. The coal region extends north of the escarpment into the western parts of Virginia, West Virginia and Maryland and into western and northern Pennsylvania. The coal region extends south into northeastern Alabama and northwestern Georgia for a short distance. The western boundary of the Appalachian Basin Coal region follows the extent of Mississippian and Pennsylvanian age rocks, with mineable coal in the Pennsylvanian rocks.

Primary Aquifers

Aquifers in the Appalachian Basin Coal region are either surficial aquifer systems in unconsolidated deposits, or occur in the deeper consolidated rocks. Sand and gravel surficial aquifers overlie the consolidated rock aquifers in much of northeastern Ohio and along the Ohio River and its tributaries. Aquifers in consolidated rocks consist of sedimentary bedrock ranging in age from Mississippian through Permian.

Unconsolidated Aquifers

The unconsolidated surficial aquifer systems consist of sand and gravel deposits of glacial and alluvial origin that filled in bedrock valleys. The alluvial material occurs primarily along existing streams and consists mostly of reworked glacial deposits. Wells completed in the sand and gravel deposits, which have a high hydraulic conductivity, typically have a high associated yield. The reworked glacial material forming unconsolidated aquifer is most common in southward-flowing streams, such as the Allegheny and the Ohio Rivers, which have their headwaters in glaciated areas. Alluvium in the valleys of northward-flowing streams typically consists of material that has been weathered and eroded from exposed consolidated sedimentary rocks. The alluvium along the northward-flowing rivers, such as the Kanawha in West Virginia and the Monongahela in Pennsylvania, generally is finer grained than that along the southward-flowing rivers and often yields less water to wells compared to southward-flowing rivers. Well yields in sand and gravel deposits commonly range from 100 to 500 gallons per minute but can exceed 2,000 gallons per minute. Well yields in the finer grained aquifers commonly range from 25 to 50 gallons per minute (Lloyd and Lyke, 1995).

Primary Bedrock Aquifers

Aquifers in the Pennsylvanian age deposits in the Appalachian Basin Coal region mostly consist of sandstone and limestone, separated by coal and shale deposits. The aquifers in the Pennsylvanian age rocks are grouped into Upper Pennsylvanian aquifers and Middle and Lower

Pennsylvanian aquifers. Coal beds and seams also can yield water because they are commonly fractured along joint systems (cleat) that store and transmit water.

The Upper Pennsylvanian aquifers are primarily in the Pennsylvanian Monongahela and Conemaugh Groups, but may be hydraulically connected to sandstones of the Dunkard Group. In southeastern Ohio and northeastern Kentucky, Upper Pennsylvanian rocks are primarily interbedded sandstone, siltstone, and shale with minor coal, grading to shale and siltstone. Together, the Monongehela and the Conemaugh Groups average about 1,000 feet in thickness. Well yields in Upper Pennsylvanian rocks range from 20 to 430 gallons per minute. Individual sandstone beds in Upper Pennsylvanian rocks generally are of limited areal extent, and isolated from other sandstone beds. The discontinuous occurrence and the general fine-grained texture of the unfractured rocks and sparse fracture openings may combine to impede the flow of groundwater. Perched water tables above clay layers underlying coal beds in the upland areas support springs along valley walls (Trapp and Horn, 1997; Lloyd and Lyke, 1995).

Middle and Lower Pennsylvanian aquifers contain the most widespread source of groundwater in the Appalachian Basin. Shale with interbedded sandstone is the dominant lithology of Middle and Lower Pennsylvanian rocks in the northern part of the coal region, whereas sandstone is dominant in the south. In Alabama, the southernmost part of the Appalachian Basin, in Alabama, most of the productive aquifers are associated with solution channels in karst limestone. Wells completed in the Bangor Limestone yield as much as 200 gallons per minute, and springs issuing from the Bangor have reported flows of as much as 4,000 gallons per minute. The Tuscumbia Limestone, combined with the hydraulically connected Fort Payne Chert, yields as much as 2,300 gallons per minute to wells. The Monteagle Limestone generally yields only small volumes of water. Rocks of the Middle and Lower Pennsylvanian aquifers include the Allegheny Formation and the Pottsville Group in Ohio, the Breathitt and the Lee Formations in Kentucky, and several equivalent formations in Tennessee. The Allegheny Formation and the Pottsville Group are primarily interbedded sandstone, siltstone, and shale but contain economically important beds of coal. An average of about 40 percent of the total thickness of the Pottsville Group is sandstone. In Kentucky, the Breathitt Formation is primarily interbedded sandstone, siltstone, and shale, whereas the Lee Formation is predominantly sandstone with some conglomerate. Beds of sandstone in the Breathitt Formation are typically from 30 to 120 feet thick and compose about 50 percent of the total thickness of the formation. About 80 percent of the total thickness of the Lee Formation consists of beds of sandstone and conglomerate. Middle and Lower Pennsylvanian rocks in Tennessee are predominately interbedded conglomerate and sandstone with some siltstone, shale, and coal beds. Some of the Middle and Lower Pennsylvanian sandstone and conglomerate beds are regionally extensive and contain well-developed fracture systems. The primary water-yielding units are sandstone and conglomerate beds in the Crab Orchard Mountains Group; some conglomerate beds in this group locally are 200 feet thick, whereas sandstone beds in the group range from 100 to 300 feet thick and are locally conglomeratic. Well yields from Middle and Lower Pennsylvanian aquifers only range from one to 25 gallons per minute in Ohio but range from five to 50 gallons per minute in Tennessee. Low-permeability layers of underclay beneath coal beds may limit downward movement of the water and create perched water-table conditions above the main water table. The perched water discharges as baseflow to streams, or as at the surface as springs (Lloyd and Lyke, 1995; Miller, 1990).

Figure 3.5-4 illustrates the general extent of the various aquifer types in the Appalachian Basin.

Groundwater Quality

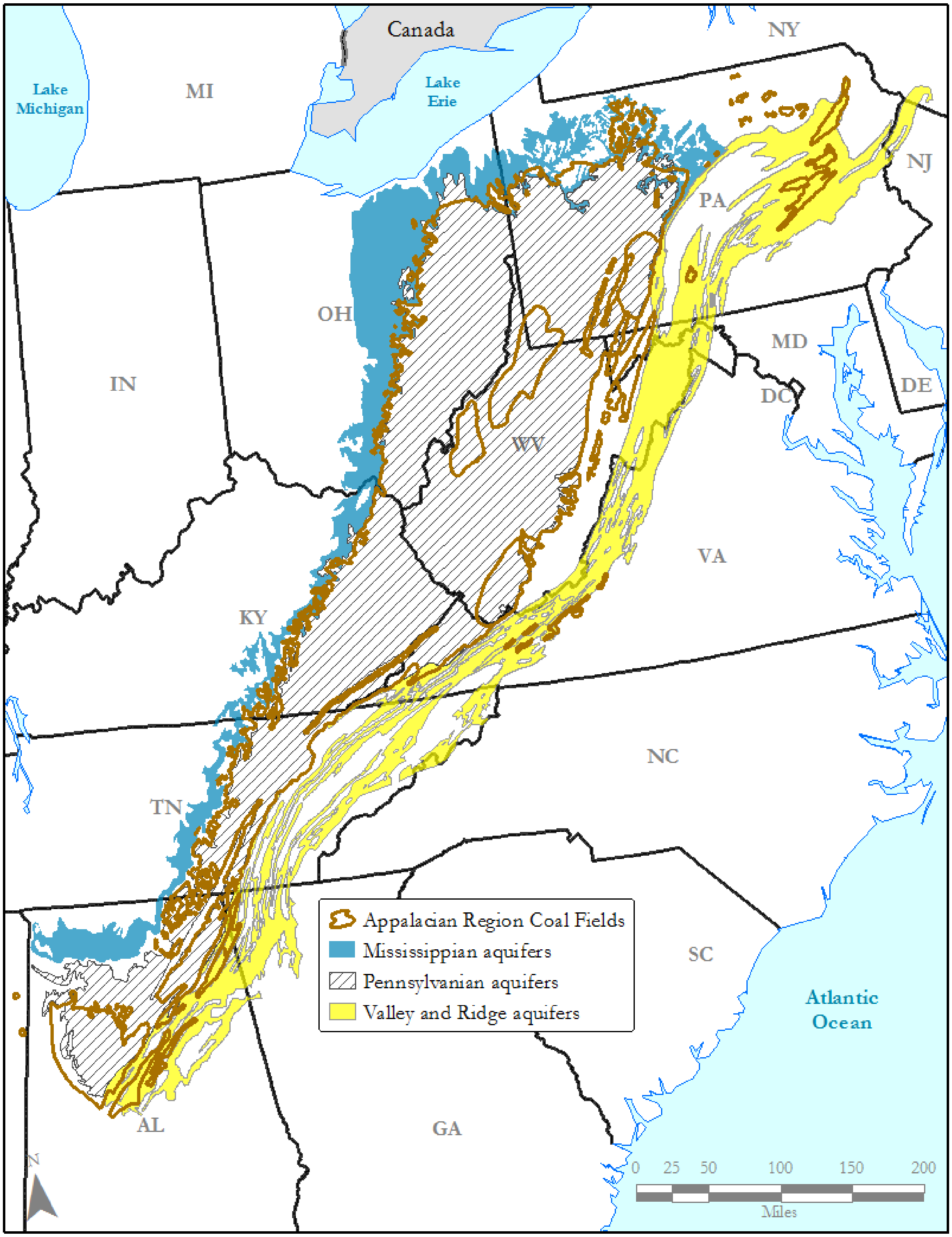
Groundwater from the aquifers in the Appalachian Basin is typically suitable for most intended uses, with chlorination usually being the only treatment required to make the water suitable for drinking. However, locally, elevated concentrations of iron or sulfate may be present and water from the surficial aquifer system and the aquifers in consolidated rocks may be contaminated by saltwater present at shallow depths or by human activity (i.e., disposal of waste water from the development of the coal, oil, and gas resources of the area) (Lloyd and Lyke, 1995).

Water from the surficial aquifer system in the Ohio portion of the region is predominantly a calcium bicarbonate type. According to the USGS Groundwater Atlas for Illinois, Indiana, Kentucky, Ohio and Tennessee, the surficial aquifers in Ohio water generally have larger median concentrations of dissolved solids (413 mg/L), chloride (31 mg/L), and sulfate (76 mg/L) and is harder (337 mg/L CaCO3) than water from the aquifers in consolidated rocks in the same area. Iron concentrations also tend to be more elevated in water from the surficial aquifer system than from water in consolidated rock aquifers and generally increase with depth (Lloyd and Lyke, 1995).

Surficial aquifer groundwater quality for the Maryland, Pennsylvania, Virginia and West Virginia area is defined by the USGS Groundwater Atlas of the United States, HA 730-L (Trapp and Horn, 1997) as: "suitable for municipal supplies and most other purposes. Most of the water in the upper parts of the aquifers is not highly mineralized." Trapp and Horn (1997) lists median values for dissolved solids at 250 mg/L; hardness (caused primarily by calcium and magnesium ions) at 140 mg/L; pH at 7.2; chloride at 29 mg/L; sulfate at 29 mg/L; and iron concentration at 100 μg/L.

Lloyd and Lyke (1995) state that "the principal factors governing the chemical quality of groundwater in the aquifers in consolidated rocks are aquifer mineralogy and residence time (the amount of time the water has been in contact with the rocks). Water from sandstone aquifers containing few soluble minerals generally is soft, whereas hard water is obtained from limestone or shale containing more of the soluble minerals calcite and dolomite. Water in the deeper parts of the aquifers tends to be more mineralized than water from shallow depths because the deeply circulating water generally has followed longer flow paths and has been in contact with aquifer minerals for a longer period of time. Generally, water from wells located in recharge areas on ridges is less mineralized than elsewhere because of a shorter residence time in the aquifer. Water from wells located in valleys where discharge occurs is more mineralized than elsewhere."

Figure 3.5-4 Appalachian Basin Region Aquifers



Source:
USGS, 2003, Principal Aquifers of the United States.
http://water.usgs.gov/ogw/aquifer/map.html

Water from the Pennsylvanian aquifers in Ohio generally is either a calcium magnesium bicarbonate type or a calcium sodium bicarbonate type. Thin shale beds are present between the sandstone and limestone aquifers in these rocks. The shale contains calcite and siderite (an iron carbonate mineral). These minerals, along with the calcite and minor dolomite in the limestone beds, are the source of the calcium and magnesium. In Kentucky, water from wells completed in the Middle and Lower Pennsylvanian aquifers commonly is a calcium sodium bicarbonate type. Water from the aquifers in Mississippian rocks in Kentucky is a slightly alkaline, calcium bicarbonate type. Excessive hardness and elevated concentrations of iron, chloride, and sulfate are locally present in water from the Pennsylvanian aquifers. Groundwater quality varies with depth in the coal-producing Cumberland Plateau area of Virginia. Generally, the first 100 feet of depth below stream elevation, the groundwater is of poor quality, mainly due to sulfur and iron contamination. Naturally saline waters occur at depths greater than 300 feet in Virginia. Therefore, the best quality waters are usually found between 150 and 300 feet in this area. Data from Pennsylvanian aquifers in Tennessee indicate that water quality ranges from soft to hard and contains small concentrations of dissolved solids. In contrast, water from Mississippian aquifers, which are mostly limestone, generally is a calcium bicarbonate type and is harder and more mineralized than water from Middle and Lower Pennsylvanian aquifers. In Pennsylvania and West Virginia, the aquifer water is typically a calcium sodium bicarbonate type. Dissolved-solids concentrations are small and average only about 230 milligrams per liter. Hardness averages about 95 milligrams per liter. Water from predominately shale aquifers in Pennsylvania is reported to be hard, whereas that from predominately sandstone aquifers is reported to be soft. The median iron concentration is about 0.1 milligram per liter, but concentrations as high as 38 milligrams per liter have been reported. In Alabama, water quality is variable; although suitable for most intended uses, concentrations of sulfate and iron are elevated in places. Large concentrations of hydrogen sulfide, derived from sulfate, can impart a "rotten-egg" odor to the water. The quality of the water in Alabama generally deteriorates with depth as it becomes more mineralized (Miller, 1990; Trapp and Horn, 1997; Lloyd and Lyke, 1995).

Groundwater is an important source of freshwater in the Appalachian Plateaus province. Ohio's surficial aquifers "are the major source of groundwater because they have the largest well yields of any aquifers in the Appalachian Plateaus province and because many of Ohio's urban areas are located near major streams whose valleys are filled with sand and gravel deposits of the surficial aquifer system" (Lloyd and Lyke, 1995).

Surficial aquifers are more prevalent in Ohio and northwestern and northeastern Pennsylvania than elsewhere in the Appalachian Plateaus province. Lloyd and Lyke (1995) observe that "Despite their generally lower yields, the aquifers in consolidated rocks are also important sources of water. Upper Pennsylvanian aquifers provide domestic supplies, and Mississippian aquifers provide domestic and small public supplies. Middle and Lower Pennsylvanian aquifers are used primarily for domestic, stock, and small public and industrial supplies throughout the Appalachian Plateaus Province."

Surface Water

The coal fields of the Appalachian Basin region exist principally within the Ohio River, Tennessee River, and Alabama River drainage basins. Larger tributary basins of the Ohio River basin include the Allegheny, Monongahela, and Susquehanna of Pennsylvania (46,110 square miles of total contributing area); the Upper Ohio, Muskingum, Kanawha, Middle Ohio, and Big Sandy River basins of Ohio, Virginia and West Virginia (48,130 square miles of total contributing area); and the Kentucky and Cumberland River basins of Virginia and Tennessee (28,200 square miles of total contributing area).

Larger tributary basins of the Tennessee River basin include the Upper and Middle Kentucky River basins of Tennessee and Alabama (32,660 square miles of total contributing area); and the Alabama and Mobile River basins (44,600 square miles of total contributing area) of the larger Alabama River of Alabama (Seaber, et al., 1994).

Stream Morphology

Appalachian Mountain Stream of "A" Type
Source: OSMRE, 2015a

Streams within the Appalachian Basin coal resource area exist within the Appalachian Plateaus physiographic province, which includes the Allegheny Mountains, Cumberland Mountain, and Cumberland Plateau and Kanawha (or unglaciated Allegheny Plateau) physiographic sections as described in Section 3.4 (Topography). As their names convey, the Allegheny and Cumberland Mountains physiographic provinces are areas of high relief. The Cumberland Plateau and Kanawha physiographic sections also have high relief and are highly dissected, although to a lesser degree. Characteristic stream types in this coal region include ephemeral, intermittent and perennial headwater Rosgen "A," "Aa+," and "B" types. These streams are steep to very steep, straight, single channel streams that are laterally confined. Stream substrates include combinations of exposed bedrock and coarse sediment (including boulders, cobbles, and gravel). In-stream features include cascading step pools, waterfalls, and alternating rapids, riffles, and pools.

At lower elevation and gentler gradients, relatively wide and shallow perennial type "C" streams exist in mountain valleys. These streams are characterized by moderate sinuosity in broad valleys and well developed floodplains. Typical in-stream features include alternating riffles and pools. The degree of lateral migration or meandering of the channels varies according to the erodibility of bank materials and abundance of riparian vegetation. When channel and bank substrate is primarily comprised of course material such as boulders, cobble, and gravel, sediment supply for these stream types is generally very low.

Surface Water Quantity / Stream Regime

Studies have shown that forested watersheds typically have little surface runoff and subsurface processes (such as interflow) dominate (Sloan and Moore, 1984). Water that infiltrates into the forest soils is slowly released, thereby sustaining stream flow (Chang, 2003). Ten to 20 percent of annual precipitation is intercepted by the forest canopy (Chang, 2003) and approximately one percent to five percent of the annual precipitation is absorbed by forest detritus (Helvey and Patric, 1965). The portion of the infiltrated flow that does not proceed as interflow primarily moves through stress-relief fractures in the weathered and unweathered underlying geological strata and is discharged through seeps. A portion of the flow migrates through deeper strata.

Streamflow in the Appalachian coal region generally follows a pattern that varies seasonally with precipitation and evapotranspiration. Beginning in late October, streamflow generally increases and maintains a high runoff rate through May. This is due to enhanced precipitation (rain and snowmelt) and a corresponding decrease in evapotranspiration. Increases in regional evapotranspiration begin in May, reducing the amount of available runoff; low flow season begins in August and continues through October (Kiesler, et al., 1983; Quinones, et al., 1983). During the summer months of July and August monthly stream flow may be augmented by thunderstorm activity (Harkins et al., 1980).

In addition to climatic influences described above, principal basin characteristics such as the size of the contributing area, physiography, and geologic character of the region significantly influence how runoff is expressed as stream flow. Other important drainage basin characteristics include land use, vegetation, and existing soil types. Hufschmidt and others (1981) has noted that as the recurrence interval of a precipitation event becomes greater (less frequent), other basin characteristics such as land use, vegetation, and soil type become less influential. In some areas of the Appalachian coal region predictive equations may have been developed to estimate mean annual and monthly flows (Herb, et al., 1981); flood magnitude and frequency (McCabe, 1962; Hannum, 1976; Quinones, et al., 1983; Randolph and Gamble, 1976; Gamble, 1983); and average minimum discharge (Flippo, 1982; Herb, et al., 1981) using principal drainage basin characteristics. Drainage basin characteristic of significance in predicting low flow are contributing area, annual precipitation, geology, and channel slope. The magnitude of peak flow predictions are correlated to contributing area, mean annual precipitation, and potential evapotranspiration.

The Appalachian coal region topography is generally one of high relief that is conducive to producing severe floods. The region is characterized by steep slopes with narrow valleys. When this topography is coupled with intense storms, floods of short duration and large magnitude are common. In areas of unglaciated physiography, valley configuration demonstrating narrow flood plains and steep slopes leads to rapid accumulation of storm runoff during periods of rainfall. In previously glaciated areas, broad flood plains and flat slopes produce a less rapid accumulation of runoff and a longer duration of flood flow (Engelke, et al., 1981; Quinones, et al., 1983; Harkins et al., 1980).

Studies suggest the flow in streams draining coal-bearing rock is poorly sustained. Low flow diminishes rapidly and base flows are poorly sustained during dry periods due to poor recharge and storage conditions. Studies in Kentucky have determined that in contributing areas less than 100 square miles, stream flow approaches zero during low flow in the season from June to October (Quinones, et al., 1983). In areas of the Cumberland Plateau, low-flow data suggest that Pennsylvania sandstones, shales, and coals demonstrate significantly lower flow than Pre-Pennsylvanian limestones and dolomites. It is unclear whether this finding is attributable to their storage potential or enhanced mining activity associated with the Pennsylvania geology (Hufschmidt et al., 1981). Findings by Harkins and Others (1980) suggest that low-flow discharge in drainage basins existing in Pre-Pennsylvanian geology is higher than in drainage basins existing in Pennsylvanian geology. Kiesler, et al. (1983) observed higher low-flow discharges in drainage basins existing primarily in the Lee Formation than drainage basins existing primarily in the Breathitt Formation. Both are Pennsylvanian in origin but the Lee Formation consist of sandstone, conglomerate, shale, siltstone, coal, and underclay; in contrast, the Breathitt Formation consist of siltstone, sandstone, shale, coal, underclay, ironstone, and limestone. Low flows are higher in glaciated regions due to their groundwater storage potential than in unglaciated relatively impermeable sandstones, shales, coals and limestone (Engelke et al., 1981).

Surface Water Quality

Table 3.5-6 shows that states within the Appalachian Basin have more than 80 state-defined designated use categories that are used to classify and protect their surface waters. Pennsylvania and Maryland have the most individual designated use classifications, while Alabama and Kentucky have the least.

The water quality assessments used as the basis for the integrated reports provide insight into the aquatic health of the region's surface waters. Table 3.5-7 shows that 96 percent of the waters assessed in Ohio are categorized as impaired waters. In contrast, Pennsylvania had the lowest percentage of stream impairment at 19 percent. In terms of number of stream miles impaired, Ohio had the most at 50,771.2 miles, and Alabama had the least at 3,060.8 miles. In addition, the table shows that 81 percent of the assessed streams in Pennsylvania are characterized as good waters compared to only four percent of assessed streams in Ohio. In terms of the number of stream miles attaining a good water designation Pennsylvania contains the highest number (69,686.2 miles), and Maryland has the least (2,534.2 miles). Tennessee was the only state to report streams in the "threatened waters" category. They reported 38.9 miles of threatened waters in 2010.

Overall, the Appalachian Basin region contains over 420,393.9 miles of streams, of which, 233,719.2 miles of steams have been assessed. Approximately 116,198.5 of the 233,719.2 stream miles are attaining their designated use, while 117,471.8 are deemed impaired. This means approximately 50 percent of the streams assessed in the Appalachian coal region are attaining their designated use, while approximately 50 percent are impaired.

It is important to note that this portion of the DEIS examines general water-quality conditions for each of the coal regions. The discussion includes all causes of stream impairment and is not limited to mining-related impairments.

Table 3.5-6
Selected State-Defined Designated Use – Appalachian Basin Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water							
Alabama	**Kentucky**	**Maryland**	**Ohio**	**Pennsylvania**	**Tennessee**	**Virginia**	**West Virginia**
Outstanding Alabama Water	Warm water aquatic habitat	**Use I (basic water use)**	**Aquatic Life**	**Aquatic Life**	Domestic Water Supply	**General Uses**	**Aquatic Life**
Public Water Supply	Cold water aquatic habitat	Swimming	Warmwater	Cold Water	Industrial Water Supply	Recreational uses	Trout waters
Swimming and Other Whole Body Water-Contact Sports	Primary contact recreation	Boating	Limited warmwater	Warm Water Fishes	Fish and Aquatic Life	The propagation of growth of a balanced, indigenous population of aquatic life	Wetlands
Shellfish Harvesting	Secondary contact recreation	Fishing	Exceptional warmwater	Migratory Fishes	Trout Stream	Wildlife	**Water Supply**
Fish and Wildlife	Domestic water supply	Water Contact	Modified warmwater	Trout Stocking	Naturally Reproducing Trout Stream	Production feedible and marketable natural resources	Public water
Limited Warmwater Fishery	Outstanding state resource water	Protection of aquatic life and wildlife	Seasonal Salmonid		Recreation		Water contact recreation
Agricultural and Industrial Water Supply		Agricultural supply	Coldwater	**Water Supply**	Livestock Watering and Wildlife	**Subcategories**	Irrigation
		Industrial water supply	Limited resource water	Potable Water Supply	Irrigation	Migratory Fish Spawning and Nursery	Livestock watering
				Industrial Water Supply	Navigation	Shallow-water Submerged Aquatic Vegetation	Wildlife
		Use I-P	**Water Supply**	Livestock Water Supply		Open Water Aquatic Life	Water transport
		All Use I plus Public Water Supply	Public	Wildlife Water Supply		Deep Water Quatic Life	
			Agricultural	Irrigation		Deep Channel Seasonal Refuge	**Other**
		Use II	Industrial				Cooling water
		All Use I plus shellfishe harvesting		**Recreation**			Power production
			Recreation	Boating			Industrial
		Use III	Bathing waters	Fishing			
		All Use I plus public water supply	Primary contact	Water Contact Sports			
			Secondary Contact	Esthetics			
		Use IV					
		All Use I plus recreational trout waters		**Special Protection**			
				High Quality Waters			
		Use IV-P		Exceptional Value Waters			
		All Use IV plus public water supply					
				Other			
				Navigation			

Source: U.S. EPA, 2013i

Table 3.5-7
Summary of State CWA Water Quality Assessments – Appalachian Basin Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)									
	Alabama (2010)	Kentucky (2010)	Maryland (2002)	Pennsylvania (2006)	Ohio (2010)	Tennessee (2010)	Virginia (2010)	West Virginia (2010)	Summation for Appalachian Region
Good Waters	7,852.6	3,896.4	2,534.2	69,686.2	1,711.8	17,675.4	5,627.1	7,214.8	116,198.5
Threatened Waters	NA	NA	NA	NA	NA	38.9	NA	NA	38.9
Impaired Waters	3,060.8	6,877.5	3,796.4	16,347.3	50,771.2	12,914.6	12,101.3	11,602.7	117,471.8
Total Assessed Waters	10,913.4	10,773.9	6,330.6	86,033.5	52,493.0	30,628.9	17,728.4	18,817.5	233,719.2
Total Waters	77,242.0	49,105.0	8,789.0	83,260.0	58,230.0	61,075.0	50,414.9	32,278.0	420,393.9
Percent of Waters Assessed	14.1	21.9	72.0	103.3	90.1	50.1	35.2	58.3	55.5
*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.									
** NA = Not Avaliable									

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports – Appalachian Basin Coal-Producing Region

The following links provide additional detail on water quality in the Appalachian Basin states.

State	Hyperlinks
Alabama	http://www.adem.alabama.gov/programs/water/waterquality.cnt
Kentucky	http://water.ky.gov/waterquality/Pages/IntegratedReport.aspx
Maryland	http://www.mde.state.md.us/programs/Water/TMDL/Integrated303dReports/Pages/Final_approved_2010_ir.aspx
Ohio	http://epa.ohio.gov/dsw/document_index/305b.aspx
Pennsylvania	http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556/integrated_water_quality_report_-_2010/682562
Tennessee	http://www.tennessee.gov/environment/water/water-quality_publications.shtml
Virginia	http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs.aspx

State	Hyperlinks
West Virginia	http://www.dep.wv.gov/WWE/watershed/IR/Pages/303d_305b.aspx

Water Usage

Based on 2005 USGS data, water resources in this region are used as follows: 77.6 percent thermoelectric, 9.5 percent public supply, 8.7 percent industrial/commercial, 2.7 percent agricultural, and one percent or less domestic and mining. The total water usage for the year 2005 was 27,512 million gallons per day (MGD) (USGS, 2010b).

Thermoelectric facilities use the highest percentage of groundwater withdrawals, at 50 percent. Approximately 21 percent of groundwater is withdrawn by public supply utilities and 11 percent is used for domestic purposes. Industrial/commercial uses account for approximately eight percent, agriculture 5.5 percent, and mining three percent.

Approximately 80 percent of surface water withdrawals are associated with thermoelectric facilities. Approximately 8.5 percent each are used for public supply and industrial/commercial demand. Agricultural uses 2.4 percent. Less than one percent of surface water withdrawals are used for mining and domestic purposes.

Regional drinking water withdrawals are represented by the public supply and domestic withdrawal data. According to 2005 USGS data, 73 percent of total drinking water withdrawals are from surface water sources. Of the public water supply withdrawals, 80 percent are from surface water. Additionally, since 1985, domestic (private) water withdrawals have remained largely unchanged; whereas, public water supply withdrawals have increased 17 percent, indicating that overall regional drinking water demand is increasing.

A review of USGS water use data for the years 1985 to 2000 indicates that the total share of the population supplied by a public water supplier is increasing while the proportion of the population that is self-supplied is decreasing (Table 3.5-8) (USGS, 2013a). However, 2005 data (the most recent available information) show a domestic self-supply population of 3.4 million, 19 percent of the total regional population (USGS, 2010b). This self-supply population relies primarily on private wells for their water supply. Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply.

Table 3.5-8
Summary of Domestic Water Supply by Population (thousands/percent of total) – Appalachian Basin

Year	Self-Supply Population	Public Supply Population
2005	3,445 (19%)	14,753 (81%)
2000	NA	NA
1995	4,129 (23%)	13,723 (67%)
1990	4,130 (24%)	13,261 (66%)
1985	5,061 (28%)	12,751 (62%)

Source: USGS 2010a, USGS 2010b

3.5.3.2 Colorado Plateau Coal-Producing Region

Groundwater

The Colorado Plateau aquifers underlie an area of approximately 110,000 square miles in western Colorado, northwestern New Mexico, northeastern Arizona, and eastern Utah. The Colorado Plateau coal region is approximately coincident with the Colorado Plateaus Physiographic Province. The distribution of aquifers in the Colorado Plateau is controlled in part by the structural deformation and erosion that has occurred since deposition of the sediments composing the aquifers. Information for groundwater characterization of the Colorado Plateau Coal region was largely derived from USGS summary reports developed to support Environmental Assessments and Impact Study Reports (Wynn et al., 2001; Kuhn et al., 1983; Lines, 1985; Eakin et al., 1976; Hren et al., 1987; Roybal et al., 1983; Roybal et al., 1984).

In general, the aquifers in the Colorado Plateau Coal region are composed of permeable, moderately to well-consolidated sedimentary rocks. The rocks within and adjacent to coal development are Cretaceous and Tertiary in age, and vary greatly in thickness, lithology, and hydraulic characteristics. The stratigraphic relations of the rocks are complicated in places, and the stratigraphic nomenclature consequently is diverse. Many water-yielding units have been identified in these rocks, and most publications pertaining to the hydrogeology of the area describe only a few of the units or pertain to only part of the region. The many water-yielding units in the area are generally grouped into three principal aquifers relative to coal mining activities: the Uinta-Animas aquifer, the Mesaverde aquifer, and the Dakota-Glen Canyon aquifer system (Robson and Banta, 1995).

Unconsolidated Aquifers

In the more mountainous areas of the Colorado Plateau Coal region, much of the alluvium in the stream valleys is too thin, narrow, and discontinuous to be considered a major aquifer, even though some of the larger mountain alluvial deposits (such as those near the Sevier River in central Utah and in the Uinta Basin of northeastern Utah) contain locally important surficial aquifers (Robson and Banta, 1995). Groundwater springs are an important source of water in Arizona and Utah coal resource areas. Springs are used for public water supplies and irrigation; provide water for livestock and wildlife; and provide the major source of baseflow to perennial streams (Lines, 1985). Although not part of the major aquifer systems described later in this section, springs in mountain areas of Utah and drainages of arid northern Arizona are a vulnerable and carefully protected resource.

Primary Bedrock Aquifers

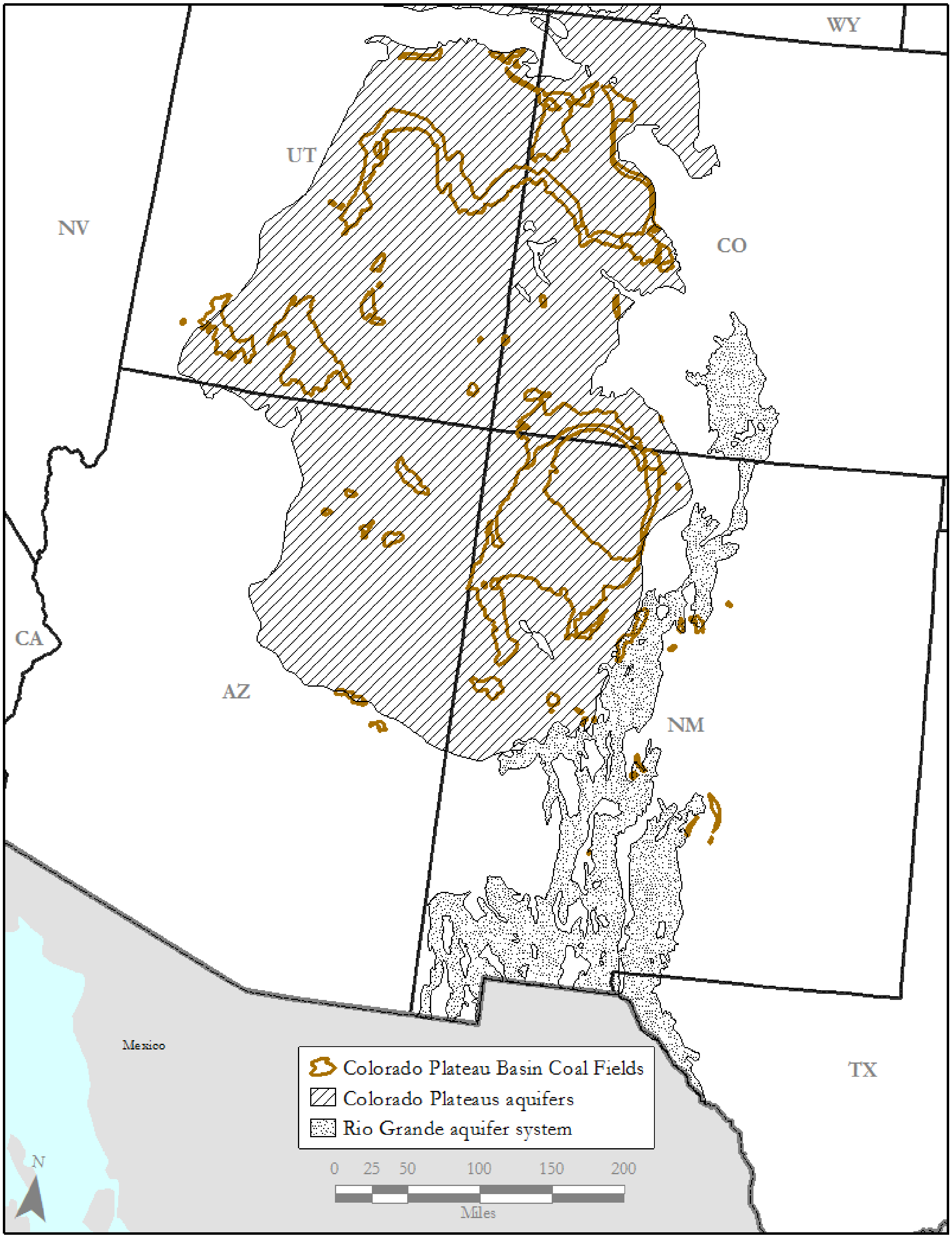
The Uinta-Animas aquifer primarily is composed of Lower Tertiary rocks in the Uinta Basin of northeastern Utah, the Piceance Basin of northwestern Colorado, and the San Juan Basin of northwestern New Mexico. Aquifers in each basin are present in different parts of the stratigraphic section. Some formations are considered to be an aquifer in more than one basin; however, some formations vary so much in their hydraulic characteristics that they are considered to be an aquifer in one basin and a confining unit in another. Water-yielding units in the Uinta-Animas aquifer in the Uinta Basin commonly are separated from each other and from the underlying Mesaverde aquifer by units of low permeability composed of claystone, shale, marlstone, or limestone. The Uinta-Animas aquifer in the Piceance Basin consists of silty sandstone, siltstone, and marlstone. The Uinta-Animas aquifer in the San Juan Basin generally consists of permeable, coarse, arkosic sandstone inter-layered with mudstone. The thickness of the Uinta-Animas aquifer generally increases toward the central part of each basin. The Uinta Basin aquifer ranges in thickness from zero feet at the southern margin of the aquifer to as much as 9,000 feet in the north-central part of the aquifer. In the Piceance Basin, the Uinta-Animas aquifer is as much as 2,000 feet thick in the central part of the basin. In the northeastern part of the San Juan Basin, the maximum thickness of the Uinta-Animas aquifer is about 3,500 feet (Robson and Banta, 1995).

The Mesaverde aquifer comprises water-yielding units in the Upper Cretaceous Mesaverde Group, and some adjacent Tertiary and Upper Cretaceous formations. The Mesaverde aquifer is at or near land surface in extensive areas of the Colorado Plateaus and underlies the Uinta-Animas aquifer. The aquifer is of regional importance in the Piceance, Uinta, Black Mesa, and San Juan Basins. Some of the rocks forming the Mesaverde aquifer contain coal beds, particularly in Black Mesa Basin. The rocks composing the Mesaverde aquifer are conglomerate, sandstone, siltstone, mudstone, claystone, carbonaceous shale, limestone, and coal. Because these rocks primarily were deposited in environments that changed as sea level changed during the Late Cretaceous, lithology varies vertically and laterally, and inter-tonguing is common among the various formations and strata making up the aquifer (Robson and Banta, 1995).

The Dakota-Glen Canyon aquifer system is generally divided into four primary aquifers: Dakota Aquifer, Morrison Aquifer, Entrada Aquifer, and Glen Canyon Aquifer. Sandstone, conglomerate, and conglomeratic sandstone are the major water-yielding materials in these aquifers. Mudstone, claystone, siltstone, shale, and limestone generally form the confining units separating these aquifers (Robson and Banta, 1995). In the northern Arizona Black Mesa Basin, the Glen Canyon aquifer is regionally significant for municipal and industrial supply. From 1971 to 2005, approximately 4,000 acre-feet per year was pumped for industrial use from the Glen Canyon aquifer, which is locally referred to as the Navajo aquifer system. In 2005, the Black Mesa coal slurry transportation system was discontinued, reducing industrial supply withdrawal to approximately 1,500 acre-feet per year. Municipal groundwater withdrawals have steadily increased in the Black Mesa Basin and currently account for approximately 3,000 acre-feet per year (Macy, 2010). Other significant groundwater withdrawals in Navajo County are to the south of Black Mesa Basin, and beyond the coal resource areas.

Figure 3.5-5 illustrates the general extent of the various aquifer types in the Colorado Plateau Coal-Producing region.

Figure 3.5-5 Colorado Plateau Region Aquifers



Source: USGS, 2003, Principal Aquifers of the United States.
http://water.usgs.gov/ogw/aquifer/map.html

Groundwater Quality

Groundwater chemistry in the Colorado Plateau Quaternary aquifers (unconsolidated) is naturally variable and generally high in mineral content. Calcium, sodium, bicarbonate, and sulfate are the predominant major ions in water from the Quaternary aquifers. Concentrations of total dissolved solids are typically less than 3,500 mg/L, and average approximately 600 mg/L (Wynn et al., 2001; Kuhn et al., 1983; Lines, 1985; Eakin et al., 1976; Hren et al., 1987; Roybal et al., 1983; Roybal et al., 1984).

Groundwater chemistry in the Tertiary aquifers varies throughout the Colorado Plateau, but the principal chemical constituents are generally sodium, calcium, sulfate, and bicarbonate. Concentrations of total dissolved solids in the Tertiary Wasatch, Green River, and Fort Union Formations are typically low, and range from 160 to 1,200 mg/L, with a median concentration of approximately 400 mg/L (Wynn et al., 2001; Kuhn et al., 1983; Lines, 1985; Eakin et al., 1976; Hren et al., 1987; Roybal et al., 1983; Roybal et al., 1984).

Cretaceous aquifers of the Colorado Plateau coal resource area are extensive. Elevated chloride concentrations typically indicate marine depositional conditions. Water in coal and shale deposits tends to be saline, with minor concentrations of sulfate, indicating a chemical reducing environment. Principal constituents of the Cretaceous Mesa Verde Group and Kaiparowits Formation are typically sodium, magnesium, sulfate, and bicarbonate. Completed wells commonly exceed the fluoride drinking water standard. Concentrations of total dissolved solids range from 300 to 8,300 mg/L, with an average concentration of approximately 1,400 mg/L (Wynn et al., 2001; Kuhn et al., 1983; Lines, 1985; Eakin et al., 1976; Hren et al., 1987; Roybal et al., 1983; Roybal et al., 1984).

Surface Water

The coal fields of the Colorado Plateau exist principally in the Upper and Lower Colorado River Basins and the Rio Grande River Basin. Larger Upper Colorado River tributaries of northwest Colorado and the Utah coal fields include the White-Yampa, Dolores, Gunnison, Dirty-Devil, Colorado Headwaters, and Lower Green River drainage basins. When combined, these drainage basins total 66,910 square miles of contributing area. Lower Colorado River tributaries include the San Juan River of southwestern Colorado, northwestern New Mexico, and southwestern Utah, draining 24,600 square miles. The Little Colorado River of Arizona drains approximately 26,900 square miles. The Rio Grande River drains approximately 28,900 square miles from Upper Rio Grande headwaters in Colorado to the Elephant Butte Dam near Truth or Consequences, New Mexico (Seaber, et al., 1994).

Stream Morphology

Streams within the Colorado Plateau coal region exist within the Colorado Plateau physiographic province, including the Navajo (Arizona and New Mexico) and High Plateaus and Uinta Basin (Utah and Colorado) physiographic sections. These physiographic provinces are areas of moderate to high relief, including highly dissected mountains and plateaus with deep canyons that transition to alluvial valleys at lower elevation.

Characteristic stream forms in areas of very high to moderate relief include ephemeral and intermittent Rosgen “A,” “B,” and “G” types. In mountainous areas that receive significant amounts of snow precipitation, streams of these types exist as perennial headwater streams. These streams are steep to very steep straight single channel streams that are laterally confined by geologic control. Stream substrates include combinations of exposed bedrock, colluviums such as boulders, cobble and gravel, and cohesive silt/clay. In-stream features may include cascading step pools, waterfalls; and at lower elevation, alternating rapids, riffles, and pools. When formed in residual soils derived from highly weathered sedimentary rock or grussic granite, "A" types may be expressed as a highly incised gully. In valley slopes less than four percent but greater than two percent, these gully streams are recognized as "G" types. "G" types develop in terminal alluvial fans generating high bank erosion rates that contribute significant bedloads and suspended sediment.

Braided stream in Colorado Plateau of "D" Type
Source: OSMRE, 2015a

At lower elevation and relief, Rosgen "C," "F," and "D" types are characteristic. In the arid southwest, these streams frequently occur as intermittent and ephemeral streams. Relatively wide and shallow single-channel "C" types exist in valleys of gentle gradients. These streams are characterized by moderate sinuosity in broad valleys with developed floodplains. In-stream features include alternating depositional point bar features with sections of riffles and pools. The degree of lateral migration or meandering of the channel varies according to the erodibility of bank materials and relative abundance of riparian vegetation. Sediment supply in these streams is high. In the late 19th century, ephemeral stream channels throughout the American Southwest began to incise into alluvial valleys, creating deep continuous channels that are collectively referred to as "arroyos." Arroyos are defined by Elliot, et al. (1999) as large-scale, continuous, and persistent erosional features created when stream channels incise into their alluvial valleys (Levick et al., 2008). Arroyos correspond with "F" type streams. These streams are highly incised, deeply entrenched channels in alluvium. Unique to "F" types is the complete lack of floodplain.

Rosgen "D" type streams are wide, shallow, multi-channel, braided steams formed in broad depositional valleys of very low gradient. These streams have low sinuosity and have very high width-to-depth ratios. They are sediment transport–limited, with abundant sediment supply. Through excessive deposition longitudinal and transverse bars develop forming the characteristic braided form. Formed in non-cohesive sandy alluvium, these streams experience high bank erosion and widening. In the arid southwest, ephemeral streams of these types are regionally recognized as "washes."

Surface Water Quantity / Stream Regime

Streams within the Colorado Plateau coal region demonstrate large variations in annual and seasonal flow. Excluding anthropogenic causes (e.g., diversions, reservoir impounding and significant in-stream withdrawals) these variations in streamflow are attributable to the natural geologic, physiographic, and climatic variability characteristic of the region. Regions of high elevation (mean basin elevation > 8,000 feet) that receive 15 inches or more of annual precipitation are distinguished from areas of low elevation (mean basin elevation < 8,000 feet) that receive less than 15 inches of annual precipitation. In regions of high elevation, snowmelt is the dominant source of streamflow, while in the lower elevations thunderstorms are the dominant source. Streams originating in mountainous regions demonstrate greater average annual flow per square mile than streams originating in lower-elevation semiarid regions. Consequently, streams originating in the mountains will tend to sustain perennial flows while streams originating in areas of lower elevation tend to be ephemeral flowing only a few days each year. Runoff resulting from snowmelt occurs from April through July and thunderstorms in the lower elevations occur in the summer months. Craig and Rankl (1978) found that on small drainages (less than 11 square miles) at lower elevation, high intensity thunderstorms cause larger runoff events and snowmelt contributions are not significant. The average flow of streams that originate in the mountains usually increases downstream. The exception occurs when the streams flow through a low-altitude area, where infiltration and evapotranspiration may be greater than inflow, exhibiting high transmission losses. During periods of little or no precipitation, streamflow is sustained primarily by groundwater discharge. Larger streams are affected by diversions and reservoirs during periods of low flow (Wynn et al., 2001; Lines, 1985; Eakin et al., 1976; Hren et al., 1987; Roybal et al., 1983; Roybal et al., 1984).

Surface Water Quality

Table 3.5-9 shows that states within the Colorado Plateau region have approximately 50 state or tribe-defined designated use categories to classify and protect surface waters. The water quality assessments used for the integrated reports provide insight into the aquatic health of the region's surface waters. Excluding Colorado, states and tribal lands within this region have a low percentage of their surface waters assessed. Table 3.5-10 shows that three of the four states have less than 13 percent of their waters assessed, while Colorado has 55.5 percent of its waters assessed. Based on available data, 56 percent of the waters assessed in New Mexico are not achieving their designated use ("impaired waters"), while Colorado had the lowest percentage of stream impairment at 18 percent. Colorado had the most stream miles impaired at 11,135.5 miles, and Arizona had the least at 1,016 miles. In terms of number of stream miles achieving their designated use, Colorado contains the highest number (48,503.4 miles) and Arizona has the least (1,747.7 miles).

Overall, the Colorado Plateau region is comparable to Appalachian Basin in the number of stream miles. The Appalachian Coal region contains 420,393 miles of stream and the Colorado Plateau region contains 394,435 miles of streams. Unlike the Appalachian Basin region, however, only 20.1 percent of streams in the Colorado Plateau region have been assessed. Approximately 59,708.5 of the 79,284.0 stream miles that have been assessed (75 percent) are achieving their designated use, while 19,576.5,920 (25 percent) are considered impaired. Impairment is associated with all pollution sources, and is not limited to mining-related impairments.

Table 3.5-9
Selected State-Defined Designated Use – Colorado Plateau Coal-Producing Region

Selected State/Tribe-Defined Designated Uses for Surface Water					
Arizona	**Colorado**	**New Mexico**	**Utah**	**Navajo Nation**	**Hopi Tribe****
Agriculture	Agriculture	**Municipal and Domestic Water**	**Agriculture**	Domestic Water Supply	Cold Water Habitat
Aquatic Life Cold Water - Class 1	Aquatic Life Cold Water - Class 1	Fish and Aquatic Biota	Fisheries	Fish Consumption	Warm Water Habitat
Aquatic Life Cold Water - Class 2	Aquatic Life Cold Water - Class 2	Recreation	Industry	Primary Human Contact	Ephemeral
Aquatic Life Warm Water - Class 1	Aquatic Life Warm Water -Class 1	Agricultural uses	Drinking water	Secondary Human Contact	Primary Contact
Aquatic Life Warm Water - Class 1	Aquatic Life Warm Water -Class 1	Industrial Water	Recreation	Agricultural Water Supply	Primary Contact Cenemonial
Domestic Water Source	Domestic Water Source		Scenic value	Aquatic and Wildlife Habitat	Full Body Contact
Recreation Primary Contact	Recreation Primary Contact		Aquatic life other than fish	Livestock Watering	Partial Body Contact
Recreation Secondary Contact	Recreation Secondary Contact		Wildlife		Agricultural Irrigation
			Fish conumption		Fish Consumption
					Ground-Water Recharage
					Industrial Water Supply
					Domestic Water Source
** The Hopi Tribe completed draft water quality standards in 2008 that are currently under review by EPA					

Source: U.S. EPA, 2013i

Table 3.5-10
Summary of State CWA Water Quality Assessments – Colorado Plateau Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)					
	Arizona (2008)	**Colorado (2010)**	**New Mexico (2010)**	**Utah (2010)**	**Summation for Colorado Plateau Region**
Good Waters	1,747.7	48,503.4	2,456.2	7,001.2	59,708.5
Threatened Waters	NA	NA	NA	NA	
Impaired Waters	1,016.6	11,135.5	3,805.9	3,618.5	19,576.5
Total Assessed Waters	2,764.4	59,638.8	6,262.1	10,619.6	79,284.9
Total Waters	90,375.0	107,403.0	110,741.0	85,916.0	394,435.0
Percent of Waters Assessed	3.1	55.5	5.7	12.4	20.1
*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information. ** NA = Not Avaliable					

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports – Colorado Plateau Coal Region

The following links provide additional detail on water quality in the Colorado Plateau region.

State	Hyperlink
Arizona	http://www.azdeq.gov/environ/water/assessment/assess2012_2014.html
Colorado	https://www.colorado.gov/pacific/cdphe/wqcc-reports-and-plans
New Mexico	http://www.nmenv.state.nm.us/nav_water.html
Utah	http://www.waterquality.utah.gov/WQAssess/currentIR.htm

Water Usage

Based on 2005 USGS data, water resources in this region are predominantly used for agriculture (91 percent), with five percent for public supply, two percent for thermoelectric use, and less than one percent each for domestic, industrial/commercial, and mining. The total water usage for the year 2005 was 9,950 MGD (USGS, 2010b).

Approximately 70 percent of groundwater withdrawals are associated with agricultural operations. Another 22 percent of groundwater is withdrawn by public water suppliers. Only two percent of groundwater is withdrawn by domestic self-suppliers. The primary aquifer system and source of groundwater in this region are the Colorado Plateaus aquifers. The most productive water yielding aquifers within this system are the Uinta-Animas aquifer, the Mesaverde aquifer, the Dakota-Glen Canyon aquifer system, and the Coconino-De Chelly aquifer (Robson and Banta, 1995). Water recharge to aquifers in this region generally occurs in upland areas, which receive more precipitation than the lower elevation areas (USGS, 2010b).

Within the Colorado Plateau Basin, a widespread water table decline has not been identified, but isolated areas of 40-foot water table declines have been identified (Reilly, et al., 2008). This would indicate that, for the most part, stress on the aquifer is confined to isolated areas and is not widespread.

Public water suppliers obtain only 1.8 percent of their withdrawals from surface water. Surface water is generally not used for private domestic purposes in the region (USGS, 2010b).

A review of USGS water use data for the years 1985 to 2005 indicates that the total share of the population supplied by a public water supplier is increasing. In contrast, the self-supply population is relatively unchanged, but has decreased as a share of total population (see Table 3.5-11). In 2005, there was an estimated regional domestic self-supply population of about 0.4 million, 13 percent of the total regional population (USGS, 2010b). This self-supply population relies primarily on private wells for their water supply. Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply.

Table 3.5-11
Summary of Domestic Water Supply by Population (thousands/percent of total) – Colorado Plateau

Year	Self-Supply Population	Public Supply Population
2005	408 (13%)	2,710 (87%)
2000	NA	NA
1995	396 (16%)	2,056 (84%)
1990	373 (17%)	1,792 (83%)
1985	406 (20%)	1,629 (80%)

Source: USGS 2010a, USGS 2010b

3.5.3.3 Gulf Coast Coal-Producing Region

Groundwater

The Gulf Coast coal region consists of lignite fields that spread eastward from southern Texas through the coal-producing areas of Louisiana and Mississippi. Extending into southern Alabama, the field significantly diminishes in central Georgia and the Florida panhandle. The lignite field also extends northward up the Mississippi River embayment area to include much of eastern Arkansas, southeastern Missouri, and parts of westernmost Kentucky and Tennessee. Although lignite is present in all of the states included in this region, it is only mined in Texas, Louisiana, and Mississippi. For this reason, the following discussion focuses on the lignite-mining portions of these three states.

The Gulf coastal area extending from Texas eastward into Florida and north along the Atlantic coast comprises the Coastal Plain physiographic province. In Texas, the lignite fields of economic importance are located in the West Gulf Coastal Plain (Interior Coastal Plains) section of this province, which is characterized by relatively parallel ridges and valleys with geologic strata, consisting predominantly of unconsolidated sands and muds, dipping towards the Gulf of Mexico (Bureau of Economic Geology, 1996). The West Gulf Coastal Plain continues into northwestern Louisiana where unconsolidated deposits consist mainly of sand, gravel, silt, and mud deposits with discreet lenses of lignite that are relatively flat-lying with localized variably-dipping beds (Paleontological Research Institution, 2013; Hayes and Kennedy, 1903). In Mississippi, lignite is mined in the North Central Hills section, which is characterized by ridges and valleys (Stewart, 2003). Deposits in this region consist mainly of sand, clay, and silt with discontinuous lignite layers (USGS, 2010c; Warwick, et al., 1997).

Primary Aquifers

Significant aquifers within the mined areas of Texas, Louisiana, and Mississippi are comprised of unconsolidated deposits of deltaic, fluvial, or marine origin. In Texas, the major aquifer within the lignite region belongs to the upper Paleocene Wilcox Group and the lower Eocene Carrizo Formation of the Claiborne Group (Tertiary Period). This aquifer is contained within the Texas coastal uplands aquifer system along with several minor aquifers and confining layers (Ryder, 1996). The most widespread groundwater structure underlying Louisiana and Mississippi is the Mississippi embayment aquifer system (Renken, 1998).

Unconsolidated Aquifers

Texas Coastal Uplands Aquifer System

The Texas coastal uplands aquifer system underlies all or parts of 60 counties (about 48,000 square miles) in south and southeastern Texas. This system contains both aquifers and confining layers and is located stratigraphically in proximity to the major lignite-producing intervals of the Jackson, Claiborne, and Wilcox Groups (Ryder, 1996).

There are four major aquifers and two confining layers constituting the Texas coastal uplands aquifer system. In descending order, the aquifers include the Upper Claiborne, Middle Claiborne, Lower Claiborne-Upper Wilcox, and Middle Wilcox. The two confining layers, the Middle Claiborne and the Lower Claiborne, are located above and below the Middle Claiborne aquifer, respectively (Ryder, 1996).

Of the four aquifers listed above, the Lower Claiborne-Upper Wilcox (Carrizo-Wilcox aquifer) is the most widely used aquifer in Texas (Ryder, 1996). Its distribution is widespread, extending from southern Texas northeastward into Arkansas and Louisiana. The Carrizo-Wilcox provides water in all or parts of 60 counties in Texas and is a major source of water in northwestern Louisiana and southern Arkansas (Ashworth and Hopkins, 1995). The thickness of the freshwater sands in the Carrizo-Wilcox is variable, with a maximum thickness of nearly 3,000 feet (Ryder, 1996). In addition to its hydrologic significance, the Carrizo-Wilcox is located stratigraphically in proximity to economically important lignite seams.

Well yields from the Carrizo-Wilcox typically range from 500 to 3,000 gallons per minute with irrigation and municipal withdrawals accounting for the majority of usage, especially in Texas (Ashworth and Hopkins, 1995). Recharge occurs predominantly via infiltration of precipitation through overlying material or direct infiltration at outcrop areas. Conditions in the aquifer range from unconfined in outcrop regions, to confined in down-dip areas when the unit is overlain by low-permeability material (Ryder, 1996).

As a result of heavy usage for irrigation and municipal purposes, many areas of Texas are experiencing significant declines in water levels in the Carrizo-Wilcox aquifer. Over the past 70 years, levels have dropped as much as 500 feet in some areas. Dewatering to facilitate lignite mining has also resulted in lower water levels in the vicinity of some active operations (Ashworth and Hopkins, 1995).

Mississippi Embayment Aquifer System

The Mississippi embayment aquifer system is an important source of fresh water in parts of Arkansas, Mississippi, and Louisiana. Within this system, there are six distinct aquifers comprised mostly of weakly consolidated to unconsolidated sand, silts, and clays. The upper four aquifers (Upper Claiborne, Middle Claiborne, Lower Claiborne-Upper Wilcox, and Middle Wilcox) are comparable to the four major aquifers discussed above in the Texas coastal uplands aquifer system. Likewise, the upper two confining layers, the Middle Claiborne and the Lower Claiborne (located stratigraphically above and below the Middle Claiborne aquifer, respectively), are comparable to those located in Texas. Below the Middle Wilcox aquifer, the Mississippi embayment system contains two additional aquifers and one confining layer as compared to the

Texas coastal uplands. In descending order, these units include the Lower Wilcox aquifer, the Midway confining layer, and the McNairy-Nacatoch aquifer (Renken, 1998).

Sediments comprising the embayment system are thinnest along the margins of the basin and progressively thicken to more than 6,000 feet towards the axis. The greatest thickness occurs in south-central Louisiana and southwestern Mississippi. Several of the upper aquifers (Upper and Middle Claiborne and Lower Claiborne-Upper Wilcox) become less permeable and progressively thin southwards until the units disappear, while some of the confining layers become more permeable and thin northwards. In some areas, the aquifer system is hydraulically connected to the Mississippi River Valley alluvial aquifer (Renken, 1998).

The Middle Claiborne is the most heavily used aquifer within the Mississippi embayment system. Well yields in Louisiana and Mississippi typically range from 100 to 300 gallons per minute with higher yields reported in Arkansas (300 to 1,000 gallons per minute). In parts of extreme northern Mississippi and eastern Arkansas, the Lower Claiborne confining layer is absent, allowing the Middle Claiborne and Lower Claiborne-Upper Wilcox aquifers to merge, producing well yields up to 2,000 gallons per minute (Renken, 1998). The combined unit is locally referred to as the Memphis aquifer.

Recharge to the Mississippi embayment system occurs predominantly via infiltration of precipitation through overlying material or direct infiltration at outcrop areas. Groundwater flow is generally from recharge areas at higher elevations to lower, more flat-lying regions of the Mississippi Alluvial Plain. Water levels in the Middle Claiborne have declined as much as 100 feet due to large withdrawals in southern Arkansas and northern Louisiana (Renken, 1998).

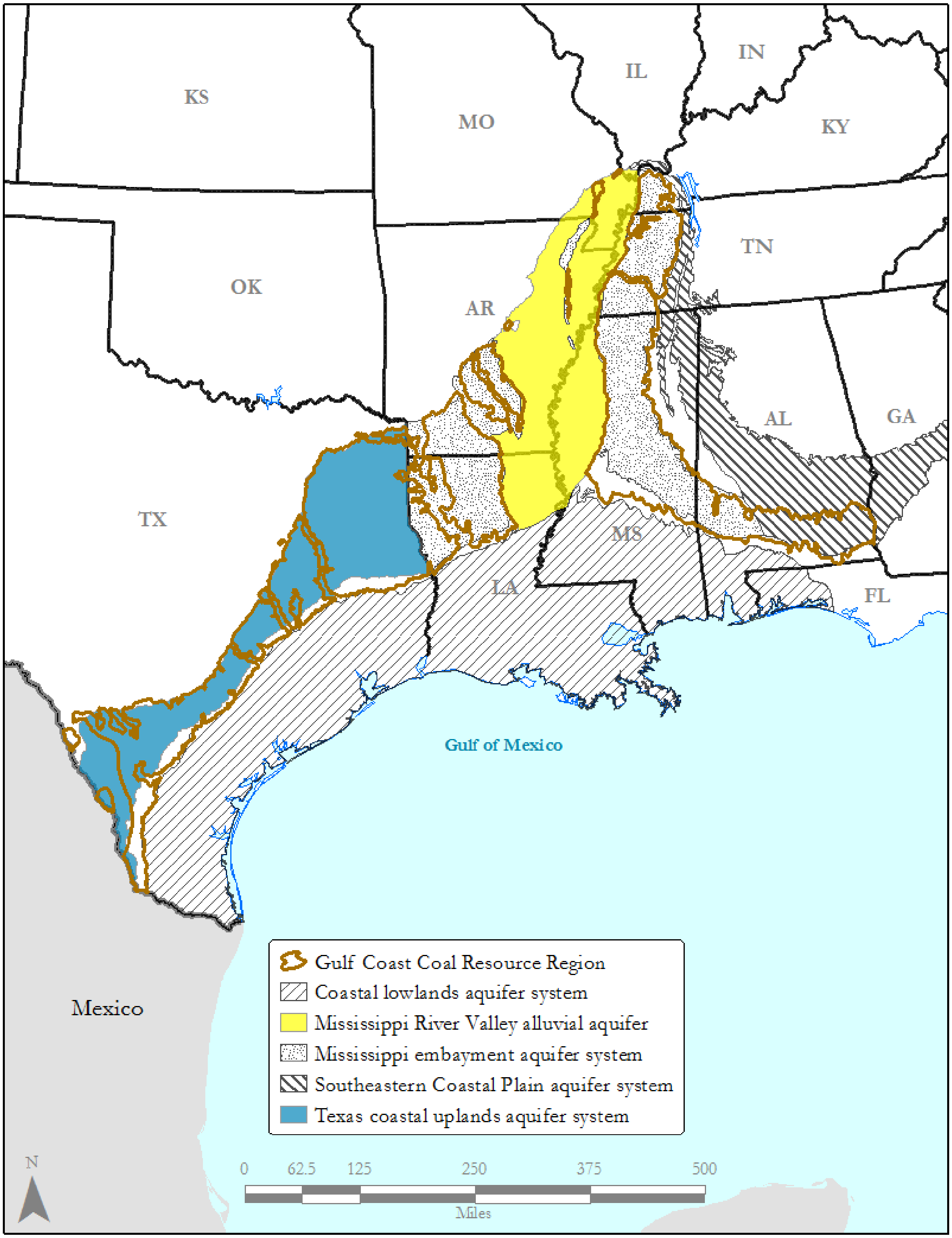
Figure 3.5-6 illustrates the general extent of the various aquifer types in the Gulf Coast Coal-Producing region.

Groundwater Quality

Water quality in the widely used Carrizo-Wilcox aquifer typically ranges from fresh to slightly saline with many areas exhibiting dissolved solid concentrations less than 500 milligrams per liter (Ryder, 1996). Although the water is typically harder at recharge zones, the dissolved solid concentrations are lower relative to those in downdip regions. The aquifer may contain hydrogen sulfide and methane in limited areas, and elevated levels of iron are common in the northeastern region. In southwestern Texas, the aquifer may be contaminated with oil field brines as a result of local activities associated with petroleum-related exploration and processing (Ashworth and Hopkins, 1995).

Water within the Middle Claiborne aquifer is also relatively fresh in over half of its areal extent, with dissolved solids measuring less than 500 milligrams per liter. The dissolved solid concentration increases in east-central Louisiana where the aquifer is present in the vicinity of the Mississippi River. The water quality also degrades with depth, with dissolved solids increasing to 10,000 milligrams per liter or more (Renken, 1998).

Figure 3.5-6 Gulf Coast Region Aquifers



Source: USGS, 2003, Principal Aquifers of the United States.
http://water.usgs.gov/ogw/aquifer/map.html

Surface Water

The lower Mississippi River, Red River, and Brazos River comprise the major drainage basins within the lignite fields of the Gulf Coast coal region. The largest of these three, the lower Mississippi River basin, drains 101,324 square miles from the confluence of the Mississippi and Ohio Rivers in Illinois to the Gulf of Mexico (Turnipseed and Storm, 2003). The Red River drains 93,200 square miles mostly in Texas and Oklahoma, with lesser acreage in Arkansas and Louisiana (Kammerer, 1990). The Red River is a major tributary to the Mississippi River and joins the Mississippi along the east-central border of Louisiana. The Brazos River drains 45,600 square miles predominantly in Texas, with minor contributions from New Mexico (Kammerer, 1990). The Brazos River discharges into the Gulf of Mexico at Freeport, Texas.

Stream Morphology

Streams within the Gulf Coast coal region exist within the Coastal Plain physiographic province. In Texas, the lignite fields of economic importance are located mostly in the West Gulf Coastal Plain (Interior Coastal Plains) section of this province and are characterized by relatively parallel ridges and valleys, with geologic strata consisting predominantly of unconsolidated sands and muds, dipping towards the Gulf of Mexico. The West Gulf Coastal Plain continues into northwestern Louisiana where unconsolidated deposits consist mainly of sand, gravel, silt, and mud deposits. Discreet lenses of lignite are relatively flat-lying with localized variably-dipping beds. Elevations in the coal mining areas range from 80 to 1,350 feet, with local relief approximately zero to 500 feet (Orme, 2002).

Topography of the East Coastal Plains is widely varied, with areas of rounded, eroded hills, cuestas, and nearly featureless plains (Neilson, 2007). In Mississippi, lignite is mined in the North Central Hills section, characterized by moderately dissected uplands and wide flat areas in major stream drainages. Deposits in this region consist mainly of sand, clay, and silt with discontinuous lignite layers.

Other than in the steeper headwater areas, the characteristic stream form in the Gulf Coast region consist of intermittent and perennial streams of Rosgen “C” type. These streams exist in areas of low relief within well-developed floodplains. They are generally described as wide and shallow, exhibiting high width/depth ratios (>12). Typical in-stream features include alternating riffles and pools, runs, glides and characteristic point bars within the active channel. They are representative of the classic sinuous meandering stream where the degree of lateral migration achieved through aggradation and degradation processes varies according to the erodibility of bank materials, abundance of riparian vegetation, upstream watershed conditions, and flow and sediment regime.

Streams of Rosgen type “E” and “F” also persist and are distinguished from Rosgen “C” types by their relative degree of entrenchment, width-to-depth ratio and sinuosity. Streams of Rosgen “E” type demonstrate higher sinuosity and lower width to depth ratios (narrow and deep) than the “C” type. Rosgen “F” types are distinguished by their moderately to highly entrenched (incised) steam profile, with little to no developed floodplain. Ephemeral streams are also widespread across the Gulf Coast coal region.

Surface Water Quantity / Stream Regime

In this part of the country, the majority of precipitation occurs in the form of rain as moisture moves in from the Gulf of Mexico. The southern coastal parts of Texas, Louisiana, and Mississippi generally experience greater rainfall amounts than the more inland areas. On average, precipitation amounts are greater in Louisiana and Mississippi as compared to Texas, with Louisiana ranking as the second wettest state in the country and Mississippi ranking third (Baker, 2012). Rainfall occurs year-round and can be extreme as hurricanes move inland from the Gulf of Mexico. Historically, more Atlantic hurricanes occur in the fall (NOAA, 2009).

Streams located in areas with sufficient topographic relief generally have headwaters in upland areas with relatively steep slopes and gradients that become more gentle as the streams flow downward into wider, flat drainage areas of major streams. As a result, flash floods occurring in the headwaters will generally have peak flows that occur rapidly and then slow as the stream gradient decreases.

In the upland areas of Mississippi, including the active lignite mining area, many of the streams have been modified (dredging, dam construction, etc.) to help alleviate the effects of flooding (Wilson and Turnipseed, 1989). These modifications have resulted in channel and bank instability in many of the streams (Wilson and Turnipseed, 1989). In addition, streams have also been channelized for agricultural purposes. To better understand and enable flood estimations, the USGS conducted a flood study and estimated flood magnitudes for recurrence intervals from two to 500 years for 330 gaged sites in Mississippi (Landers and Wilson, 1991). Most of the streams located in the upland area eventually drain into the Mississippi River.

Flooding is also relatively common along the Red River and many of its tributaries in the lignite mining areas of northwestern Louisiana and eastern Texas. Both historical and more recent flood events have been documented as a result of heavy rainfall from thunderstorms and tropical systems that have moved inland from the Gulf of Mexico (LakeBistineau.com, 2011).

Much of the lignite mining region in southeastern Texas is drained by the Brazos River. This river is the longest in the state, encompassing about 16 percent of the land area (Wurbs, et al., 1993). Although precipitation generally occurs throughout the year, droughts do occur. Texas ranks 35th in precipitation for the continental U. S. (Baker, 2012). Peak discharges for waterways within the Brazos river drainage basin generally occur in late spring or early fall (Raines, 1998).

The Brazos is a meandering river with many associated oxbow lakes (Wurbs, et al., 1993). The river has many monitoring gages as well as reservoirs for water storage (Wurbs, et al., 1993). Reservoirs are also common along many of its tributaries (Raines, 1998). Within the Brazos River basin, severe flooding has occurred, resulting in the loss of life and personal property (Phillips, 2006; Raines, 1998). Minor flooding along the river and its tributaries is common and generally occurs annually. As a result, the USGS conducted an extensive study and developed regionally specific regression equations for estimating peak flow frequency for varied recurrence intervals (Raines, 1998). These equations were developed for natural streams, defined as "…a stream for which the annual peak discharges are not affected by reservoirs, regulation, diversions, urbanization, or any other human-related activity" (Raines, 1998). USGS also developed extreme peak discharge curves to estimate extreme flood potential. These tools supply valuable insight for water-resource planning and management (Raines, 1998).

Surface Water Quality

Table 3.5-12 lists the designated use to classify and protect the surface waters in the Gulf Coast region. State water quality assessments provide insight into the health of the region's surface waters. The states within the Gulf Coast region have a low percentage of their surface waters assessed. Table 3.5-13 shows that Louisiana has the highest percentage of streams assessed at 14.3 percent while Mississippi has the least at 4.6 percent. About 76 percent of the waters assessed in Louisiana are not achieving their designated use ("impaired waters"). Texas had the lowest percentage of stream impairment at 43 percent. Texas had the most stream miles impaired (10,320.7) and Mississippi had the least (2,182.8). In terms of number of stream miles achieving their designated use, Texas contains the most (13,225.7 miles) and Louisiana has the least (2,305.2 miles).

Overall, the Gulf Coast region contains 341,525 miles of streams of which only 36,883.3 have been assessed. Approximately 17,201.5 of the 36,883.3 stream miles that have been assessed (47 percent) are achieving their designated use, while 19,681.8 (53 percent) are considered impaired. This reflects the impact of all pollution sources and is not limited to mining-related impairments.

Table 3.5-12
Selected State-Defined Designated Use – Gulf Coast Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water		
Louisiana	**Mississippi**	**Texas**
Argriculture	Public Water Supply	Recreation - Contact
Drinking Water Supply	Recreation	Recreation - Noncontact
Fish and wildlife propagation	Shellfish Harvesting	Domestic water supply - Aquifer protection
Outstanding natural resource waters	Fish and Wildlife	Domestic water supply - Public water supply
Oyster propagation	Ephemeral	Aquatic Life
Primary contact recreation		Navigation
Secondary contact recreation		Agricultural water supply
		Industrial water supply
		Seagrass propagation
		Wetland water quality

Source: U.S. EPA, 2013i

Table 3.5-13
Summary of State CWA Water Quality Assessments – Gulf Coast Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)

	Louisiana (2010)	Mississippi (2010)	Texas (2010)	Summation for Gulf Coast Region
Good Waters	2,305.2	1,670.6	13,225.7	17,201.5
Threatened Waters	NA	NA	NA	
Impaired Waters	7,178.3	2,182.8	10,320.7	19,681.8
Total Assessed Waters	9,483.5	3,853.4	23,546.4	36,883.3
Total Waters	66,294.0	84,003.0	191,228.0	341,525.0
Percent of Waters Assessed	14.3	4.6	12.3	10.8

*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.

** NA = Not Avaliable

Source: U.S. EPA, 2012c

<u>Hyperlinks to Integrated CWA Reports – Gulf Coast Coal Region</u>

The following links provide additional detail on water quality in the Gulf Coast region.

State	Hyperlink
Louisiana	http://www.deq.louisiana.gov/portal/DIVISIONS/WaterPermits/WaterQualityStandardsAssessment/WaterQualityInventorySection305b/2010WaterQualityIntegratedReport.aspx
Mississippi	http://www.deq.state.ms.us/MDEQ.nsf/page/FS_SurfaceWaterQualityAssessments?OpenDocument
Texas	http://www.tceq.texas.gov/waterquality/assessment/305_303.html

Water Usage

Based on 2005 USGS data, water resources in this region are used for approximately equal parts agriculture and thermoelectric (41.9 and 42.4 percent respectively), 9.6 percent public supply, five percent industrial/commercial, less than one percent domestic, and 0.3 percent for mining. The total water usage for the year 2005 was 34,504 MGD (USGS, 2010b).

Agricultural operations use about 82 percent of groundwater withdrawn in this region. Approximately 13 percent of groundwater withdrawn is used. Only two percent of the groundwater is withdrawn for domestic purposes (i.e. private residential wells).

Thermoelectric facilities account for about 71 percent of surface water withdrawals. Approximately 14 percent of surface water withdrawn is used by agriculture. Eight percent is used by public supply and no surface water in the region is utilized for private domestic purposes.

According to 2005 USGS data, 43 percent of total drinking water withdrawals are from surface water sources. Public water utilities obtain 46 percent of their withdrawals from surface water sources. Since 1985, domestic (private, self-supplied) withdrawals have increased 85 percent, and public water supply withdrawals have increased 26 percent, indicating that regional drinking water demand is increasing (USGS, 2010b).

A review of USGS water use data for the years 1985 to 2000 indicates that the split between public and private supplies has remained relatively unchanged (see Table 3.5-14). In 2005, there was an estimated regional domestic self-supply population of nearly 2.5 million, 13 percent of the total regional population. This self-supply population relies primarily on private wells for water. Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply.

Table 3.5-14
Summary of Domestic Water Supply Population (thousands/percent of total) – Gulf Coast Coal-Producing Region

Year	Self-Supply Population	Public Supply Population
2005	2,553 (13%)	17,580 (87%)
2000	NA	NA
1995	2,039 (12%)	15,576 (88%)
1990	1,935 (12%)	14,585 (88%)
1985	2,027 (12%)	14,318 (88%)

Source: USGS 2010a, USGS 2010b

3.5.3.4 Illinois Basin Coal-Producing Region

Groundwater

The Illinois Basin is a spoon-shaped structural depression underlying most of Illinois, parts of southwestern Indiana, and parts of western Kentucky. The basin measures nearly 53,000 square miles and trends north/northwest to south/southeast. At its greatest depth, the basin contains nearly 15,000 feet of sedimentary rocks (Lloyd and Lyke, 1995).

The majority of the Illinois Basin is located in the Central Lowland physiographic province. This province consists of areas that have experienced extensive glaciation during the Pleistocene Epoch resulting in the surficial landscape seen today. The Central Lowland is "…characterized by a low-relief surface formed by glacial till, outwash plains, and glacial-lake plains. Long, low, arcuate ridges, which were formed by recessional moraines and generally are concave to the north, are common features on these plains. The glacial deposits composing the ridges and plains have completely buried the pre-glacial topographic features" (Lloyd and Lyke, 1995).

The remaining portion of the Illinois Basin includes extreme southern Illinois and parts of southern Indiana and northwestern Kentucky and is part of the Shawnee Hills Section of the Interior Low Plateau province. "This Section is part of the Interior Low Plateaus geomorphic province. Extensive sandstone bluffs, cuestas, rise up to 100 feet (30 meters) above the terrain in front of them and dip gently down the back slope. Other landforms include steep-sided ridges and hills, gentler hills and broader valleys, karst terrain, gently rolling lowland plains, and bottom lands along major rivers, with associated terraces and meander scars. A notable but very minor landform is anthropogenic lands that have been strip-mined exhibit hummocky or ridge-swale topography" (USFS, 1994).

The surficial, unconsolidated deposits in the Illinois Basin consist of clays, silts, sands and gravels reflecting the glacial history of this region. Consolidated bedrock above the Precambrian basement rock consists mostly of Paleozoic sedimentary units of shale, siltstone, limestone, sandstone, dolomite, and coal deposited during the Cambrian to Pennsylvanian Period. The primary bituminous coal reserves are found within the Pennsylvanian rock which underlies the unconsolidated sediments (Zuehls, et al., 1981; Zuehls, et al., 1984).

Where not cited specifically, the majority of the information contained below was obtained from USGS Water-Resources Investigations Open-File Reports 81-403 (Zuehls, et al., 1981), 81-498 (Wangsness, et al., 1981), 82-638 (Quinones, et al., 1983), and 83-544 (Zuehls, et al., 1984).

Primary Aquifers

The most productive aquifers within the Illinois Basin consist of sand and gravel deposits of alluvial and glacial origin. Those found along major waterways or within buried valleys can provide significant volumes of water. The upper Paleozoic strata can also be a source of potable water; however, the yields are much lower and highly variable. Deeper aquifers generally contain groundwater that is not suitable for consumption.

Unconsolidated Aquifers

Unconsolidated sands and gravels are the most productive aquifers in the Illinois Basin. Within the glaciated section of the Basin, these deposits are generally located in glacial drift deposits, in buried valleys, as lenses in till or lacustrine deposits, and along streams and rivers. In the coal fields of western Kentucky, these deposits are present in valleys along the Ohio River and its tributaries. Recharge is generally from direct infiltration of precipitation or seepage from streams.

Wells completed in the Basin's unconsolidated aquifers can produce water at highly variable rates ranging from a few to hundreds of gallons per minute. This wide range is due to the variability in the thickness, areal extent, composition, and occurrence of the sand and gravel layers. In parts of southern Illinois, the glacial deposits are often thin and limited in extent, resulting in domestic users relying more on bedrock sources for portable water. In contrast, the thickness of sand and gravel in the buried Mahomet Bedrock Valley in north-central Illinois can exceed 100 feet, with potential rates of 500+ gallons per minute. The inconsistencies within the unconsolidated layers also result in discreet and variable groundwater flow in the various layers.

Primary Bedrock Aquifers

The most widely used bedrock source for potable groundwater in the Illinois Basin is the Pennsylvania-age strata immediately underlying the unconsolidated layers discussed above. Sandstone and limestone make up the more prolific Pennsylvanian aquifers, although some areas rely on local coal seams for small quantities of water. The sandstone and limestone units are often found in alternating layers with shale and siltstone. "Sheet-like and channel-fill sandstones at the bases of the sedimentary sequences are some of the most productive aquifers in Pennsylvanian rocks. However, a zone of fractures, joints, and bedding plains commonly occurs in the upper parts of exposed Pennsylvanian rocks, and these openings yield water to wells regardless of rock type" (Lloyd and Lyke, 1995).

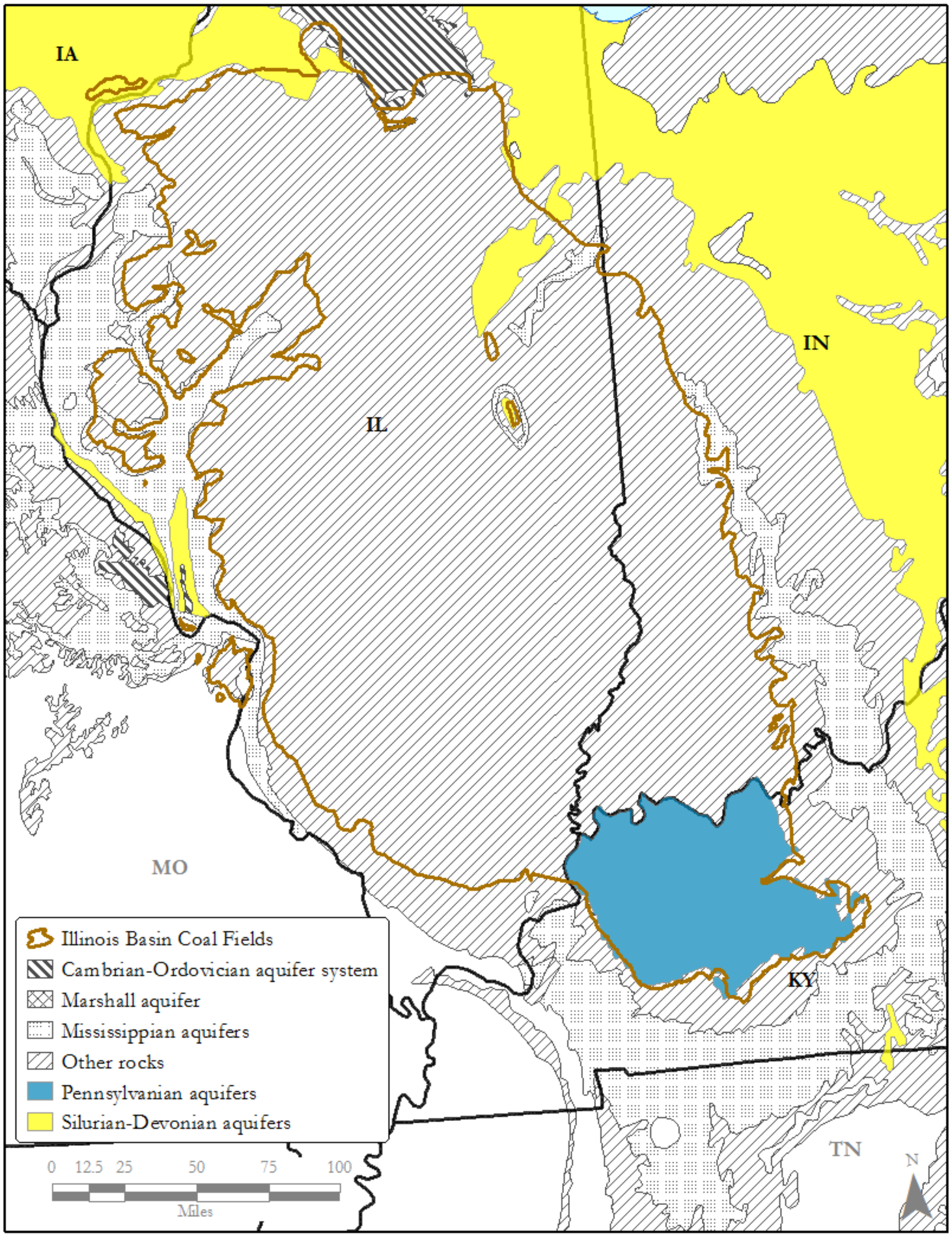
The Pennsylvanian aquifers are present throughout the Illinois Basin, except in limited areas along the western border and in east-central Illinois and southern Indiana where these units have been eroded, exposing Mississippian strata at the ground surface. Although wells have been reported to yield from one to 100 gallons per minute, the average is generally ten gallons per minute (Lloyd and Lyke, 1995).

Due to the presence of low-permeability layers interbedded with the Pennsylvanian water-bearing units, most of the aquifers in this region are under confined conditions. In some areas, artesian conditions may be present resulting in free-flowing wells and the presence of seeps and springs. Groundwater moves along bedding planes and fractures and through solution-enhanced openings within the matrix. The aquifers are recharged from precipitation infiltrating through the overlying material.

In addition to the Pennsylvanian-age bedrock, small quantities of groundwater may be obtained from Mississippian-age limestone and sandstone. These rocks underlie the Pennsylvanian strata in most of the basin, except where erosion has removed the Pennsylvania rock and exposed the underlying Mississippian units. Like the Pennsylvanian strata, Mississippian aquifers consist mainly of limestones (predominantly in the lower portion of the Mississippi strata) and sandstones (predominantly in the upper portion of the Mississippi strata). Because of gradational changes from limestone to shale that occur in an eastwardly direction across Illinois, eastern Illinois and western Indiana have fewer aquifers within the lower Mississippi strata than in the western part of Illinois (Lloyd and Lyke, 1995).

Recharge to the Mississippian-age aquifers is from precipitation infiltrating through the overlying unconsolidated material and Pennsylvanian rocks or direct infiltration at outcrops. Similar to the overlying Pennsylvanian aquifers, aquifers of Mississippian age are reported as having yields from one to 100 gallons per minute with an average of ten gallons per minute. Greater yields are possible when wells are completed in fractured aquifers and those with solution-enhanced cavities. As a result of the great depth to these aquifers in most of the Illinois Basin and the decreasing water quality with depth, Mississippian aquifers accounted for only three percent in Illinois and one percent in Indiana of the total groundwater withdrawn in 1985 (Lloyd and Lyke, 1995). Figure 3.5-7 illustrates the general extent of the aquifers making up the Illinois Basin aquifer system.

Figure 3.5-7 Illinois Basin Region Aquifers



Source: USGS, 2003, Principal Aquifers of the United States.
http://water.usgs.gov/ogw/aquifer/map.html

Groundwater Quality

Water quality in the sand and gravel aquifers is generally suitable for most purposes although some treatment may be required. On average, the water is hard with a neutral pH owing to the presence of bicarbonates. The groundwater may contain elevated levels of iron (greater than 0.3 milligrams per liter) and generally has a median dissolved solid concentration near 500 milligrams per liter. Chloride and sulfate values are generally present at acceptable levels (below 250 milligrams per liter) (Lloyd and Lyke, 1995).

Lloyd and Lyke (1995) state that "The quality of water obtained from the upper parts of the Pennsylvanian aquifers generally is similar throughout the area. However, pronounced water-quality changes occur with depth. Because the water-yielding sandstones and limestones are thin and are interlayered with thin, low-permeability deposits, such as shale and coal, the water withdrawn from these aquifers tends to be a composite water type, which reflects interaction of the groundwater with several rock types that contain different minerals." Groundwater in the upper sections is moderately hard with an average concentration of 500 milligrams per liter dissolved solids. Dissolved solids increase with depth, owing to higher concentrations of sodium, chloride, fluoride, and bicarbonate (Lloyd and Lyke, 1995; Wangsness, et al., 1983). In some areas, wells constructed to depths of 300 feet or more provide only highly mineralized or saline water (Wangsness, et al., 1983). The depth to poor quality water decreases towards the central portion of the basin. "Near the southern limit of the area, only the upper ten percent of the Pennsylvanian rocks contain freshwater" (Lloyd and Lyke, 1995).

Water quality is also an issue in the deeper Mississippian aquifers. In areas where these aquifers are shallow and beneath unconsolidated sands and gravels or thin layers of Pennsylvanian strata, the water quality is generally acceptable for most purposes. However, as the rock layers become more substantial and deeply buried under thick units of Pennsylvanian rocks, the water quality declines due to a lack of freshwater circulation. This is the case in the central portion of the Illinois Basin, which contains the thickest Pennsylvanian and Mississippian strata (Lloyd and Lyke, 1995).

Surface Water

The Illinois Basin coal region consists of bituminous reserves underlying most of Illinois, parts of southwestern Indiana, and parts of western Kentucky. These coal fields are located predominantly in the Central Lowland physiographic province and in the Upper Mississippi and Ohio River Basins. The Upper Mississippi River basin drains 189,000 square miles from its source in Itasca, Minnesota to the confluence of the Mississippi and Ohio Rivers in southern Illinois (Upper Mississippi River Basin Association, 2011). The Ohio River basin drains 203,000 square miles along its route from Pennsylvania to southern Illinois (Kammerer, 1990).

Stream Morphology

Streams within the Illinois Basin coal resource area exist within the Central Lowlands and Interior Low Plateaus provinces, which includes the Till Plains and Highland Rim physiographic sections. The surficial geology and dominant landforms significantly influence the types of streams present.

The dominant stream forms in this coal region include intermittent and perennial streams of Rosgen "C" type. These streams exist in areas of low relief within well-developed floodplains. They are generally described as wide and shallow, exhibiting high width/depth ratios (>12). Typical in-stream features include alternating riffles and pools, runs, glides, and characteristic point-bars within the active channel. They are representative of the classic sinuous meandering stream. Streams of Rosgen type "E" and "F" also persist and are distinguished from Rosgen "C" types by their relative degree of entrenchment, width-to-depth ratio, and sinuosity. Streams of Rosgen "E" type demonstrate higher sinuosity and lower width-to-depth ratios (narrow and deep) than the "C" type. Rosgen "F" types are distinguished by their moderately to highly entrenched (incised) steam profile, with little to no developed floodplain. Ephemeral streams are also widespread across the Illinois Basin.

<u>Surface Water Quantity / Stream Regime</u>

The Illinois Basin region experiences severe weather, including drought conditions (< 13 inches) approximately once every five years. The area also experiences a high frequency of intense, short-duration, warm-season rainstorms. About 50 percent to 70 percent of the annual precipitation is produced by thunderstorms and generally occurs from April through September. Likewise, streamflow in the area generally follows a seasonal pattern. The yearly cycle begins in October, the month of lowest precipitation and lowest streamflow. November has a period of increased streamflow which is maintained through the spring months and into May. Precipitation increases and evapotranspiration decreases, helping maintain stream flow through the winter months before the spring rains cause an increased level of runoff. The low-flow season follows in early June and usually extends into early October. Approximately 75 percent of flooding occurs between January and April (McCabe, 1962).

Mean annual streamflow is dependent upon drainage basin characteristics, including drainage area; soil index and mean annual precipitation; percentage of forest covered area; percentage of area covered by lakes and ponds; mean elevation of drainage area; mean channel slope; and distance of channel from the topographic divide (Sieber, 1970). Regionally specific regression equations used to predict average discharge, peak flow, and channel slope have been developed and demonstrate adequate predictive power. In areas with significant topographic relief, flash floods often occur in headwater streams during spring months. Floods peak slowly at sites with gentle stream gradient and relief, and peak quickly on small streams with steeper stream gradients. Low flows occur after many days of no precipitation or snowmelt and are principally sustained by subsurface contributions in the form of springs and seeps. Many lakes have been constructed in the region to attenuate high streamflows and provide flood control (Zuehls, et al., 1981).

<u>Surface Water Quality</u>

Table 3.5-15 lists the state-defined designated use categories used to classify and protect the surface waters in the Illinois Basin region. The water quality assessments used for the integrated reports help characterize the aquatic health of the region's surface waters. Table 3.5-16 shows that Indiana has the highest percentage of streams assessed at 67.5 percent, while Illinois has the least at 21.8 percent. About 64 percent of the waters assessed in Kentucky are impaired, while approximately 69 percent of streams in Indiana and 60 percent of streams assessed in Illinois are impaired. Indiana had the most impaired stream miles at 16,654.3 miles, and Kentucky had the least at 6,877.5 miles. Overall, Indiana contains the highest number of stream miles achieving use designations (7,415.7 miles) while Kentucky has the least (3,896.4 miles).

Overall, the Illinois Basin contains 156,172 miles of streams of which only 50,412.9 have been assessed. Approximately 17,539.4 of the 50,412.9 stream miles that have been assessed are achieving their designated use while 32,873.4 are considered impaired. Stated differently, 35 percent of the streams assessed in the region are achieving their designated use while 65 percent are impaired. This assessment includes all causes of stream impairment and is not limited to mining-related impairments

Table 3.5-15
Selected State-Defined Designated Use – Illinois Basin Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water		
Indiana	**Illinois**	**Kentucky**
Contact Recreation	Aquatic Life	Warm water aquatic habitat
Warm water aquatic community	Fish Consumption	Cold water aquatic habitat
Public Water Supply	Indigenous Aquatic Life	Primary contact recreation
Industrial Water Supply	Primary Contact	Secondary contact recreation
Agricultural	Public and Food Processing Water Supply	Domestic water supply
Unusual aquatic habitat	Secondary Contact	Outstanding state resource water
Limited Use	Aesthetic Quality	

Source: U.S. EPA, 2013i

Table 3.5-16
Summary of State CWA Water Quality Assessments – Illinois Basin Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)				
	Illinois (2008)	Indiana (2010)	Kentucky (2010)	Summation for Illinois Basin Region
Good Waters	6,227.3	7,415.7	3,896.4	17,539.4
Threatened Waters	NA	NA	NA	
Impaired Waters	9,341.6	16,654.3	6,877.5	32,873.4
Total Assessed Waters	15,568.9	24,070.1	10,773.9	50,412.9
Total Waters	71,394.0	35,673.0	49,105.0	156,172.0
Percent of Waters Assessed	21.8	67.5	21.9	32.3

*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.
** NA = Not Avaliable

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports – Illinois Basin Coal Region

The following links provide additional detail on water quality in the Illinois Basin region.

State	Hyperlink
Illinois	http://www.epa.state.il.us/water/water-quality/
Indiana	http://www.in.gov/idem/nps/2639.htm
Kentucky	http://water.ky.gov/waterquality/Pages/IntegratedReport.aspx

Water Usage

Approximately 86 percent of the water resources in this region are used for thermoelectric applications, six percent for public supply, four percent for industrial/commercial, three percent for agriculture, and one percent or less for domestic wells and mining. The total water usage for the year 2005 was 17,529 MGD (USGS, 2010b).

Agricultural operations use about 43 percent of groundwater withdrawn in the region. Approximately 31 percent of groundwater withdrawals go to public supply utilities. Only 0.1 percent of groundwater withdrawals are associated with private, self-supply wells (USGS, 2010b).

Approximately 91 percent of surface water withdrawn is used by thermoelectric facilities. Public suppliers withdraw about four percent of surface water. No surface water is used by private self-suppliers of domestic water (USGS, 2010b).

According to 2005 USGS data, 64 percent of total drinking water withdrawals are from surface water sources. Public water supply operations obtain 69 percent of their water from surface sources. Since 1985, domestic water withdrawals have decreased 12 percent, and public water supply withdrawals have increased 79 percent, indicating that regional drinking water demand is increasing on net (USGS, 2010b).

In 2005, the domestic self-supply population was nearly 1.1 million, 14 percent of the total regional population. This self-supply population relies primarily on private wells (nearly all domestic water is supplied from groundwater) (USGS, 2010b). Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply (Table 3.5-17).

Table 3.5-17
Summary of Domestic Water Supply by Population (thousands/percent of total) – Illinois Basin Coal-Producing Region

Year	Self-Supply Population	Public Supply Population
2005	1,058 (14%)	6,424 (86%)
2000	1,268 (17%)	5,399 (74%)
1995	1,364 (19%)	5,720 (81%)
1990	1,275 (18%)	5,686 (82%)
1985	1,302 (18%)	5,799 (82%)

Source: USGS 2010a, USGS 2010b

3.5.3.5 Northern Rocky Mountains and Great Plains Coal-Producing Region

Groundwater

The majority of the mineable coal in the Northern Rocky Mountains and Great Plains Coal region is within the Tertiary and Cretaceous age deposits of the Powder River Basin, Williston Basin, Bull Mountain Basin, and the Green River Basin. Information for groundwater characterization of the Northern Rocky Mountains and Great Plains Coal region was largely derived from USGS summary reports developed to support Environmental Assessments and Impact Study Reports (Crosby and Klausing, 1983; Slagle et al., 1986; Lowry et al., 1986; Lowham et al., 1985).

Primary Aquifers

The Powder River Basin is largely located in northeast Wyoming and extends into southeastern Montana. According to Lewis and Hotchkiss (1981), the shallow aquifer system of the Powder River Basin is comprised of five hydrogeologic units above the regionally persistent Upper Cretaceous shale aquitard. The Williston Basin is a geologic structural basin extending north-south approximately 475 miles, and 300 miles east-west. The Williston Basin is present over the western two-thirds of North Dakota, northeastern Montana, and into Saskatchewan, Canada. The Bull Mountain Basin is located north of Billings, Montana, in south-central Montana in an asymmetrical syncline with beds that dip generally less than five degrees. The Bull Mountain Basin covers an area of approximately 750 square miles. The Green River coal area covers approximately 15,400 square miles mostly in southwestern Wyoming with some area extending into northwestern Colorado. The mineable coal beds of these four primary basins are predominantly in the Tertiary Fort Union Formation.

Unconsolidated Aquifers

Unconsolidated-deposit aquifers are composed of sand and gravel deposited as alluvium along streams as thin, narrow bands. The material is from alpine mountain glacial outwash transported and deposited by streams as alluvium during the Quaternary Period. In some valleys, the basin-fill alluvial deposits contain glacial outwash and other types of deposits that resulted from alpine glaciations. Clayey lake-bed deposits form confining units in some basins. The thickness of the unconsolidated-deposit aquifers is unknown in most basins because no wells totally penetrate the aquifers, but may be as much as 900 feet in some basins. Basin-fill deposits typically are coarse grained near basin margins and finer-grained toward basin centers. Sand and gravel making up alluvial deposits and glacial outwash generally are extremely permeable, whereas fine-grained lake deposits and poorly sorted till have minimal permeability and commonly form local confining units (Whitehead, 1996).

Primary Bedrock Aquifers

The Upper Tertiary aquifers are mostly comprised of unconsolidated to semi-consolidated Pliocene age and Eocene age sand and gravel, commonly interbedded with deposits of clay and silt. The upper Tertiary aquifers consist of broad, extensive alluvium deposited as overlapping and coalescing alluvial fans by streams entering the basins from the surrounding mountains. The source of the alluvium was mostly derived from the Middle Rocky Mountains. The upper Tertiary aquifers are part of the High Plains aquifer system, which is as much as 1,000 feet thick in southeastern Wyoming. The hydraulic conductivity of the upper Tertiary aquifers is variable due to the sorting and grain size distribution of the deposits composing the aquifers. Highest hydraulically conductive aquifers consist primarily of sand and gravel, and hydraulic conductivity decreases as clay content increases (Whitehead, 1996).

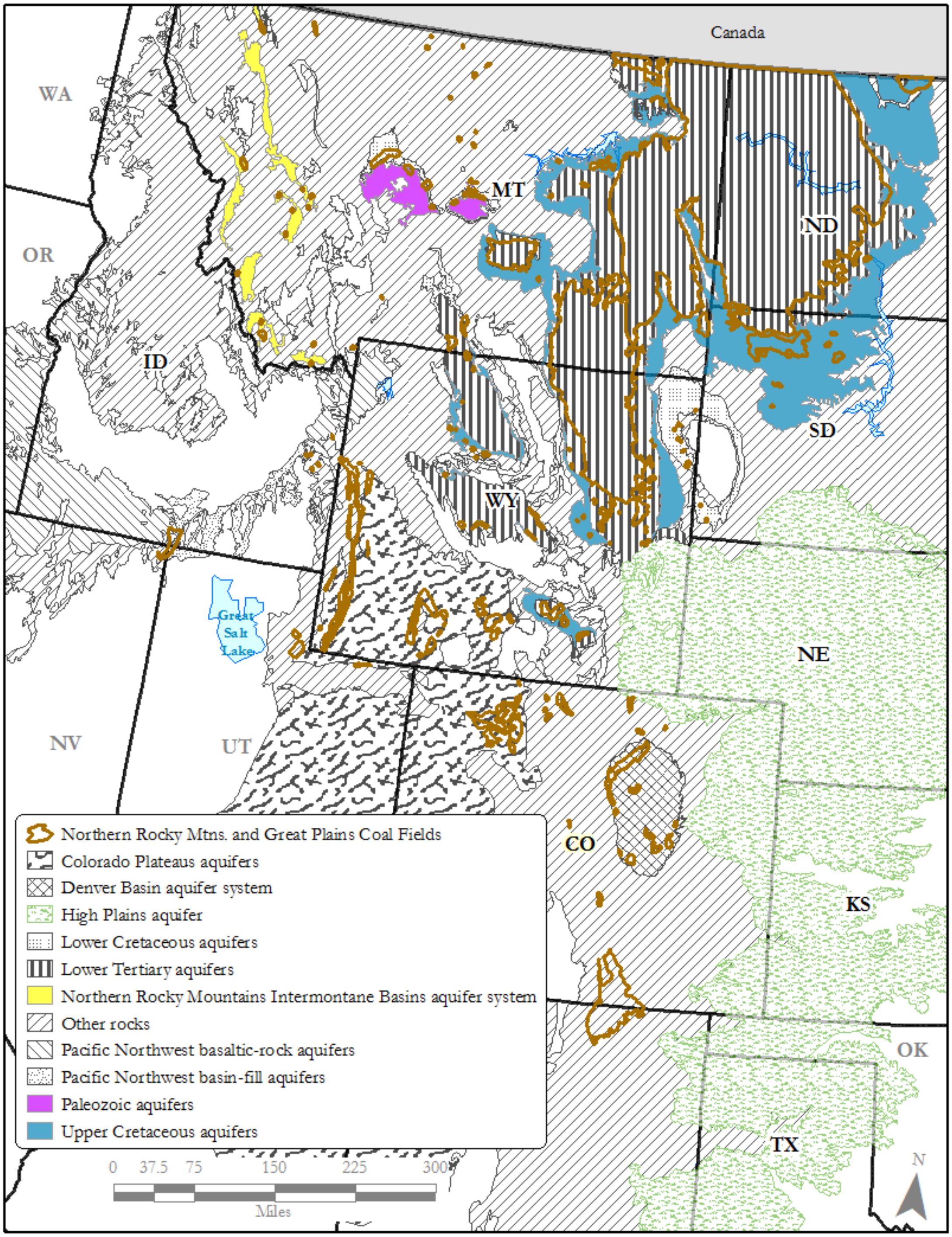
Lower Tertiary aquifers consist primarily of semi-consolidated to consolidated sandstone beds. Water-yielding sandstones are interbedded with shale, mudstone, siltstone, lignite, and coal. Some coal beds yield water, particularly if the coal is fractured or contains clinker zones of partially burned coal. Most of the lower Tertiary rocks were deposited in continental environments, but some of the shale and limestone beds were deposited in a marine environment and form confining units. Lower Tertiary aquifers in eastern Montana, western North Dakota, and northeastern Wyoming consist mostly of sandstone beds in the Fort Union Formation. The lower Tertiary aquifers in this area are down-warped into the Williston and the Powder River Basins and consist of parts of the uppermost consolidated-rock formations in these basins. Lower Tertiary rocks generally are less than 1,000 feet thick in the Williston Basin, but not all these rocks yield water. The rocks composing the lower Tertiary aquifers contain more shale in their eastern parts than elsewhere, and the transmissivity of the aquifers, therefore, decreases to the east. The hydraulic conductivity of the lower Tertiary aquifers is variable and dependent on the amount of interconnected pore space in the sandstone beds composing the aquifers. Thick coal seams, which are interbedded with sandstone or with fine-grained sediments, also can have joints and bedding planes that store and transmit water (Whitehead, 1996).

The upper Cretaceous aquifers are mostly comprised of consolidated sandstone beds. The sandstone is interbedded with shale, siltstone, and occasional thin, lenticular beds of coal. Upper Cretaceous aquifers crop out mostly around the edges of the Williston and the Powder River Basins, but are exposed in smaller areas along the margins of the Green River, the Great Divide, the Hanna, the Wind River, and the Bighorn Basins. The aquifers are down-warped and faulted to depths of several thousand feet in these basins but contain mostly saline water in their deeper parts. The principal water-yielding formations are the Hell Creek Formation and the Fox Hills Sandstone. In western Wyoming, some water is obtained from the Lance Formation, and some from the deeper Mesaverde Formation. The upper Cretaceous Pierre Shale is a major confining unit and separates deeper aquifers (Whitehead, 1996).

Formations of consolidated sandstone compose the lower Cretaceous aquifers. Lower Cretaceous aquifers are exposed at the land surface mostly as exposed bands in uplifted areas. Recharge predominantly occurs at surface outcrop areas. In Montana, North Dakota, and Wyoming, the Muddy Sandstone and equivalent water-yielding rocks overlie the Skull Creek Shale and are equivalent to the Newcastle Sandstone. Sandstones equivalent to the Inyan Kara Group in North Dakota are part of the Kootenai Formation in central and western Montana. The Cloverly Formation in Wyoming, which is equivalent to the Dakota Sandstone, is an important aquifer. The sandstones of the Dakota aquifer receive some recharge at high altitudes and some by upward leakage from deeper aquifers. The water in the aquifer is under high artesian pressure. During development of the Dakota aquifer in the late 19th century, many wells completed in the aquifer flowed at the land surface. The rate of flow of some wells was as much as 4,000 gallons per minute. Much of the water was not put to productive use because these wells were allowed to flow continuously causing water levels to decline 700 feet in some places (Whitehead, 1996).

Figure 3.5-1 illustrates the general extent of the aquifers making up the Northern Rocky Mountains and Great Plains aquifer systems associated with coal resource areas.

Figure 3.5-1 Northern Rocky Mountains and Great Plains Region Aquifers



Source: USGS, 2003, Principal Aquifers of the United States.
http://water.usgs.gov/ogw/aquifer/map.html

Groundwater Quality

Groundwater chemistry in the Quaternary aquifers is naturally variable and generally high in mineral content. Calcium, sodium, bicarbonate, and sulfate are the predominant major ions in water from the Quaternary aquifers. Concentrations of total dissolved solids commonly increase with depth, and ranges from 106 to 16,500 mg/L, with a median value of approximately 1,500 mg/L (Crosby and Klausing, 1983; Slagle et al., 1986; Lowry et al., 1986; Lowham et al., 1985).

Groundwater chemistry in the Tertiary aquifers is naturally variable and generally high in mineral content, with magnesium, sodium, bicarbonate, and sulfates the most common major ions. Waters from the lower Tertiary aquifers generally were more mineralized. Concentrations of total dissolved solids range from 123 to 11,700 mg/L, with a median concentration of 1,300 mg/L (Crosby and Klausing, 1983; Slagle et al., 1986; Lowry et al., 1986; Lowham et al., 1985).

Cretaceous aquifers of the coal resource areas are extensive, but contain freshwater only where they crop out and are covered by younger rocks (Whitehead, 1996). Groundwater chemistry in the Cretaceous aquifers is naturally variable and generally high in mineral content, with sodium, chloride, bicarbonate, and sulfates the most common major ions. Concentrations of total dissolved solids range from 126 to 13,000 mg/L, with a median concentration of approximately 2,200 mg/L (Crosby and Klausing, 1983; Slagle et al., 1986; Lowry et al., 1986; Lowham et al., 1985).

Surface Water

The coal fields of the Northern Rocky Mountains and Great Plains exist principally in the Upper Colorado and Missouri River Basins. In the southwest corner of Wyoming, the Green River Basin, Rock Springs Uplift, and Washakie Basin contribute to the Upper Green River drainage basin and the Great Divide closed drainage basin. The Yampa coal fields of northwest Colorado contribute to the White-Yampa River drainage basin. The combined drainage area of the Upper Green, Great Divide and White-Yampa River drainage basins is 33,700 square miles. Both the Upper Green and the White-Yampa River drainage basins contribute to the Upper Colorado. The Great Divide closed basin of Wyoming has a contributing area of 3,870 square miles (Seaber, et al., 1994).

To the north, coal resource areas including the Powder River Basin of Wyoming and Montana, North Dakota coal fields, and the Wyoming Hanna Basin coal field contribute to the Missouri River Basin. Larger Missouri River Basin tributaries include the North Platte, Powder-Tongue, Big Horn, Little Missouri, Lower Yellowstone, Cheyenne, Oahe, and Poplar River drainage basins. The combined drainage area of these tributary basins is 176,300 square miles (Seaber, et al., 1994).

Stream Morphology

Streams within the Northern Rocky Mountains and Great Plains coal region exist principally within the Wyoming Basin and Great Plains, and to a lesser extent the Middle Rocky Mountain physiographic provinces, including the Missouri Plateau physiographic section of the Great Plains (as described in Section 3.4). The topography is diverse and includes rolling plains with wide alluvial valleys, dissected plateaus and mountains of high relief.

Characteristic stream forms in areas of very high to moderate relief include ephemeral and intermittent Rosgen "A," "B," and "G" types. In mountainous areas that receive significant amounts of snow, streams of these types may exist as perennial headwater streams. These streams are steep to very steep straight single channel streams that are laterally confined by geologic control. Stream substrates include combinations of exposed bedrock, colluviums (such as boulders, cobble and gravel) and cohesive silt/clay. In-stream features may include cascading step pools, waterfalls, and at lower elevation alternating rapids, riffles, and pools. When formed in residual soils derived from highly weathered sedimentary rock or grussic granite, "A" types may be expressed as a highly incised gully. In valley slopes less than four percent but greater than two percent these gully streams are recognized as "G" types. "G" types develop in terminal alluvial fans generating high bank erosion rates that contribute significant bedloads and suspended sediment.

At lower elevation and relief, the characteristic stream forms include ephemeral and intermittent streams of Rosgen "C" type. Perennial streams of this type exist in the region, but to a much lesser extent. These streams exist in areas of low relief within well-developed floodplains. They are generally described as wide and shallow exhibiting high width/depth ratios (>12). Typical in-stream features include alternating riffles and pools, and characteristic point bars within the active channel. They are representative of the classic sinuous meandering stream. Streams of Rosgen type "E" and "F" also persist and are distinguished from Rosgen "C" types by their relative degree of entrenchment, width-to-depth ratio and sinuosity. Streams of Rosgen "E" type demonstrate higher sinuosity and lower width-to-depth ratios (narrow and deep) than the "C" type. Rosgen "F" types are distinguished by their moderately to highly entrenched (incised) steam profile, with little to no developed floodplain.

A "C" type meandering stream in the Powder River Basin

Source: OSMRE, 2015a

<u>Surface Water Quantity / Stream Regime</u>

Similar to Colorado Plateau, streamflow in the Rocky Mountains and Great Plains coal region can be highly variable and is dependent upon elevation, prevailing source of runoff, and relative contribution of baseflow from groundwater sources.

Runoff from mountains is a function of climatic factors (precipitation, temperature, wind, evaporation, and solar radiation) and the physical characteristic of the basin (elevation and drainage area). Flows from mountains are highly variable depending on snowpack, rate of increase in temperature, and distribution and quantity of spring rains. Extreme long term variability is observed when annual rates are compared to long term averages and can vary from 13 percent to 250 percent of the long term average. Extremely large flows or flooding can occur when deep snow pack, warm air, and rain occur simultaneously. Streams near mountains exhibit perennial flow, with most of the flow generated from snow melt.

Moving into the plains of lower elevation, streams are primarily ephemeral and intermittent with reaches of groundwater contribution depending on local aquifer systems. The average annual runoff from streams in the plains is a function of the quantity and intensity of precipitation events, drainage area, evaporation, and evapotranspiration, and permeability of surface material. For comparison, the average annual runoff per square mile from mountainous areas exceeds 200 acre-feet versus ten acre-feet per square mile in the plains. The average annual runoff for small drainage basins in the plains is less variable than in near-mountain streams. Flow is generally proportional to drainage area and increases downstream. Flow duration curves for smaller tributaries in the plains demonstrate similar form, where the slope of the plotted data is fairly steep, including the lower end of the curve indicating ephemeral regime and a lack of baseflow.

Mountain streams will typically peak in June as a function of spring snowmelt, while plains streams may experience their peak in the spring months of March through April (snowmelt derived) or in the summer months of May through September (rainfall derived). Most of the annual peak flows in the plains are derived from snowmelt, but the larger peak flows experienced on the plains are from rainfall events. Flood hydrographs of streams near mountain headwater drainages demonstrate a gradual rise and gradual receding of flow with daily fluctuations due to the diurnal temperature fluctuation. Conversely, plains streams demonstrate steeply rising and receding flow response and overall shorter flood duration than their mountain counterparts. In general, the relative magnitude of floods varies inversely with the drainage area; the larger the area, the smaller the proportion of the area affected by extreme runoff events. The potential for damage from flooding is greater near the mountains than on the plains. Precipitation is highly spatially variable, so while there may be flooding every year, it is rare to have flooding on all major streams within any given year.

Man-made alteration of runoff (e.g., irrigation, stock ponds) can significantly impact stream flows through evaporation and consumptive use. Flows can be augmented through discharge from Coal Bed Methane development and aquifer pumping associated with coal mining (Lowham et al., 1985; Crosby and Klausing, 1983; Slagle et al., 1986; Lowry et al., 1986; Kuhn et al., 1983).

Surface Water Quality

Table 3.5-18 shows that states within the Northern Rocky Mountains and Great Plains Coal region have approximately 30 state-defined designated use categories that are used to classify and protect their surface waters. The water quality assessments used as the basis for the integrated reports provide insight into the aquatic health of the region's surface waters. Table 3.5-19 shows that 85 percent of the waters assessed in Montana are not achieving their designated use ("impaired waters") while North Dakota had the lowest percentage of stream impairment at about seven percent. In terms of number of stream miles impaired, Montana had the most at 17,263.3 miles while Wyoming had the least at 1,432.3 miles. About 87 percent of the assessed streams in North Dakota are achieving their designated use ("good waters") compared to only 15 percent of assessed streams in Montana. Colorado contains the highest number of stream miles achieving designated use (48,503.4 miles) while Montana has the least (3,022.5 miles). North Dakota was the only state to report waters in the "threatened waters" category (4,341.6 miles).

Overall, the Northern Rock Mountains and Great Plains Coal region contains over 447,527 miles of streams, of which 152,043.8 miles have been assessed. Approximately 114,313.6 of the 152,043.8 stream miles are achieving their designated use (75 percent) while 33,535.7 are considered impaired (25 percent). This assessment considers all causes of stream impairment and is not limited to mining-related impairments.

Table 3.5-18
Selected State-Defined Designated Use –
Northern Rocky Mountains and Great Plains Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water			
Colorado	**Montana**	**North Dakota**	**Wyoming**
Agriculture	Agricultural	**Municipal and Domestic Water**	**Agriculture**
Aquatic Life Cold Water - Class 1	Aquatic Life	Fish and Aquatic Biota	Fisheries
Aquatic Life Cold Water - Class 2	Cold Water Fishery	Recreation	Industry
Aquatic Life Warm Water - Class 1	Warm Water Fishery	Agricultural uses	Drinking water
Aquatic Life Warm Water - Class 1	Industrial	Industrial Water	Recreation
Domestic Water Source	Drinking Water		Scenic value
Recreation Primary Contact	Primary Contact Recreation		Aquatic life other than fish
Recreation Secondary Contact			Wildlife
			Fish conumption

Source: U.S. EPA, 2013i

Table 3.5-19
Summary of State CWA Water Quality Assessments –
Northern Rocky Mountains and Great Plains Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)

	Montana (2012)	North Dakota (2012)	Colorado (2010)	Wyoming (2012)	Summation for Northern Rocky Mnts Region
Good Waters	3,022.5	47,090.8	48,503.4	15,696.9	114,313.6
Threatened Waters	NA	4,341.6	NA	392.9	
Impaired Waters	17,263.3	3,713.8	11,135.4	1,423.2	33,535.7
Total Assessed Waters	20,285.8	54,606.2	59,638.8	17,513.0	152,043.8
Total Waters	176,750.0	54,607.0	107,403.0	108,767.0	447,527.0
Percent of Waters Assessed	11.5	100.0	55.5	16.1	34.0

*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.

** NA = Not Avaliable

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports - Northern Rocky Mountains and Great Plains Coal Region

The following links provide additional detail on water quality in the Northern Rocky Mountains and Great Plains region.

State	Hyperlink
Montana	http://cwaic.mt.gov/wq_reps.aspx?yr=2010qryId=76990
North Dakota	http://www.ndhealth.gov/WQ/SW/A_Publications.htm
Colorado	https://www.colorado.gov/pacific/cdphe/wqcc-reports-and-plans
Wyoming	http://deq.state.wy.us/wqd/watershed/#Assess

Water Usage

Based on 2005 USGS data, water resources in this region are used for primarily for agriculture (86 percent), with five percent for public supply, and one percent or less for domestic and industrial/commercial. There is no reported water usage for mining or thermoelectric. The total freshwater usage for the year 2005 was 18,128 MGD (USGS, 2010b).

Approximately 69 percent of groundwater withdrawn is used by agriculture. Approximately 19 percent of groundwater withdrawals are associated with public supply utilities, and only four percent of the groundwater is withdrawn from private wells for domestic use. Within the Northern Rocky Mountains and Great Plains region, a widespread water table decline has not been identified, but isolated areas of 40-foot water table declines have been identified in Wyoming (Reilly, et al., 2008). This would indicate that, for the most part, stress on the aquifer is confined to isolated areas and is not widespread.

Approximately 87 percent of the surface water withdrawn is used agriculture. Thermoelectric facilities use approximately eight percent of the surface water withdrawals and approximately four percent is withdrawn by public water supply utilities. Only a small fraction of surface water is used for private water supplies.

According to 2005 USGS data, 74 percent of total drinking water withdrawals are from surface water sources. Seventy-eight percent of public water supply withdrawals are from surface water. Additionally, since 1985, domestic water withdrawals have increased 92 percent, and public water supply withdrawals have increased seven percent, indicating that overall regional drinking water demand is increasing (USGS, 2010b).

In 2005, there was an estimated domestic self-supply population of nearly 0.5 million, about ten percent of the total regional population (See Table 3.5-20). This self-supply population relies primarily on private wells for their water supply (USGS, 2010b). Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply.

Table 3.5-20
Summary of Domestic Water Supply of Population (thousands/percent of total) – Northern Rocky Mountains and Great Plains Coal-Producing Region

Year	Self-Supply Population	Public Supply Population
2005	544 (10%)	4,798 (90%)
2000	683 (14%)	4,223 (85%)
1995	604 (13%)	3,887 (87%)
1990	492 (12%)	3,538 (88%)
1985	553 (14%)	3,540 (86%)

Source: USGS 2010a, USGS 2010b

3.5.3.6 Northwestern Coal-Producing Region

Groundwater

The Northwest Coal region includes potentially mineable resources in Oregon, Washington, and Alaska. The description of the affected environment is limited to Alaska, because there is neither active mining nor evidence of continued production in Oregon and Washington. The Northern Alaska coal fields are also not discussed due to the questionable potential for their development and production at this time. The Usibelli Coal Mine, near Healy Alaska, is the only coal operation with active production; therefore, the potentially affected groundwater environment specific to this coal operation is described.

Primary Aquifers

The Usibelli Coal Mine produces coal from three seams in the Miocene age Suntrana Formation in interior Alaska. The coal reserves are within a repeated sequence of coarse sandstone grading upward to finer sandstone, with increasing amounts of silt and clay (Merritt, 1985). The area is defined by a broad synclinal structure, which roughly corresponds to the Hoseanna Creek drainage basin. Throughout the Hoseanna Creek Basin, the coal seams tend to function as aquifers, confined below by impermeable clay and above by tight, fine-grained sandstone (Miller and Whitehead, 1999). Specifically, the Moose coal seam is the only significant aquifer with appreciable extent, and is the lowest aquifer affected by mining (Ray and Vohden, 1992). Groundwater flow in the Moose coal seam aquifer is controlled by fractures within the coal, and bound by faulting in the Suntrana Formation (Ray and Vohden, 1992). Groundwater also is present in shallow alluvium in surrounding drainages with surficial gravel deposits. However, the alluvial gravel deposits in the area do not contain significant quantity of water for sustainable development due to the discontinuous nature of the deposits and variable thickness (Miller and Whitehead, 1999).

The water, classified by the dominant dissolved ions it contains, is a calcium bicarbonate type. Dissolved solids concentrations in the water are typically less than 400 milligrams per liter. In general, most dissolved trace metals from samples within the permit area were either not detectable or detected at concentrations near the method detection limits. Detected dissolved metals concentrations include barium (0.092 to 0.574 mg/L), iron (0.13 to 3.26 mg/L), manganese (0.181 to 0.606 mg/L), and zinc (<0.008 to 0.144 mg/L) (Ray and Vohden, 1992). Groundwater from the adjacent alluvium has concentrations of several dissolved metal analytes, which are elevated compared to concentrations of the Moose coal seam aquifer. The metals include barium, cadmium, iron, manganese, nickel, and zinc (Ray and Vohden, 1992).

Surface Water

The Yukon River Basin contains many streams and rivers. Using the Alaska Hydrologic Unit Classification system (Seaber, et al., 1994; USGS, 2013b) and a similar classification system for Canada, the Yukon River Basin can be divided into 13 major basins. These basins represent the eight major tributaries to the Yukon River and the major lowland areas that drain directly into the Yukon River (Brabets, et al., 2000). The Tanana River Basin encompasses the Alaskan coal mining area within the overall Yukon River Basin. The Tanana River Basin is approximately 44,300 square miles in area, and primarily drains the north side of the Alaska Mountain Range, including glaciers (Seaber et al., 1994).

Stream Morphology

The coal resources of Alaska for this DEIS exist within the northern foothills of the Alaska Range. The terrain includes steep bluffs and gently rolling plateau topography with deep stream valleys and steep slopes. At lower elevation, the topography transitions to irregular hummocky terrain.

Characteristic stream forms in this coal region include ephemeral, intermittent, and perennial headwater Rosgen "A" and "B" types. These streams are steep to very steep, straight, single-channel streams that are laterally confined. Stream substrates include combinations of exposed bedrock and coarse sediment (including boulders, cobbles, and gravel). In-stream features include cascading step pools, waterfalls, and alternating rapids, riffles, and pools.

At lower elevation and relief, Rosgen "C," "E," and "D" types exist. Relatively wide and shallow single channel "C" types exist in valleys of gentle gradients. These streams are characterized by moderate sinuosity in broad valleys with developed floodplains. In-stream features include alternating depositional point bar features with sections of riffles and pools. The degree of lateral migration or "meandering" of the channels varies according to the erodibility of bank materials and relative abundance of riparian vegetation. Sediment supply in these streams is high. Streams of Rosgen "E" type demonstrate higher sinuosity and lower width-to-depth ratios (narrow and deep) than the "C" type.

Rosgen "D" type streams are wide shallow multi- channel braided steams formed in broad depositional valleys of very low gradient. These streams have low sinuosity and have very high width-to-depth ratios. They are sediment transport limited, with abundant sediment supply. Through excessive deposition, longitudinal and transverse bars develop forming the characteristic braided form. Formed in non-cohesive sandy alluvium, these stream experience high bank erosion and stream widening. Stream of type "D" are common to valleys receiving glacial outwash.

Surface Water Quantity / Stream Regime

Three basic patterns of runoff are exhibited throughout the Yukon River Basin: lake runoff, snowmelt runoff, and glacier runoff. Generally, beginning in October and ending in late April to mid-May, runoff is minimal, and streamflow gradually decreases. Most runoff occurs from May to September; however, the timing of runoff in the rivers is different, depending on the particular basin characteristics (Brabets, et al., 2000). During the snowmelt period (generally late April), snow is released as stream-flow over a relatively short period, making snowmelt the major hydrological event of the year (Bonanza Creek LTER, 2011).

The overall average discharge of the Yukon River Basin is 227,000 cubic feet per second, with the Tanana River Basin providing approximately 44,600 cubic feet per second of that amount (Brabets, et al., 2000). Due to glacial activity and associated discharge contribution, the Tanana River Basin's calculated percentage of flow contribution is disproportionately large relative to its contributory drainage area.

In the Yukon River Basin, annual high flows for most of the major rivers occur during the summer rainy season. However, on the main stem of the Yukon, flooding commonly occurs from ice jams in the spring. Although levees have been built at Dawson to prevent flooding from ice jams, villages located along the lower part of the Yukon River are still subject to flooding each spring. Since 1949, three major floods have occurred in the Yukon River Basin: in 1964, 1967, and 1994. These floods covered large areas of the basin and caused considerable property damage. The 1967 flood involved a ten-inch rainfall in the middle and lower Tanana River Basin near Fairbanks, which nearly equaled the average annual precipitation for the area. Flood discharge on the Salcha River at Fairbanks was almost twice that of a 100-year recurrence interval.

Surface Water Quality

Table 3.5-21 provides designated use categories that are used to classify and protect Alaskan surface waters. The water quality assessments used as the basis for the integrated reports provide insight into the aquatic health of the region's surface waters. Table 3.5-22 shows that only 0.2 percent of Alaska's surface waters have been assessed, so any characterization using the assessment data should be used with caution. The table shows about 74 percent of the waters assessed in Alaska are not achieving their designated use ("impaired waters"). This translates into 443.4 stream miles. In Alaska, over 26 percent of the assessed streams are achieving their designated use (158.4 miles). The assessment includes all causes of stream impairment and is not limited to mining-related impairments.

Table 3.5-21
Selected State-Defined Designated Use – Northwestern Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water
Alaska
Water Supply - Drinking, culinary, and food processing
Water Supply - Agriculture, including irrigation and stock waering
Water Supply - Aquaculture
Water Supply - Industrial
Water Recreation - Contact
Water Recreation - Secondary
Growth and Propagation of fish, shellfish, other aquatic life, and wildlife

Source: U.S. EPA, 2013i

Table 3.5-22
Summary of State CWA Water Quality Assessments – Northwestern Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)	
	Alaska (2010)
Good Waters	158.4
Threatened Waters	NA
Impaired Waters	443.4
Total Assessed Waters	601.8
Total Waters	365,000.0
Percent of Waters Assessed	0.2
*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.	
** NA = Not Avaliable	

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports - Northwestern Coal Region

State	Hyperlink
Alaska	http://www.dec.state.ak.us/water/wqsar/waterbody/integratedreport.htm

Water Usage

The use of groundwater by the coal operators and wildlife within the producing Usibelli permit and adjacent area is negligible. The Usibelli Coal Mine withdraws alluvial groundwater at the mouth of Hoseanna Creek for vehicle washing and industrial uses (Usibelli Coal Mine Inc., 1996. Potable water for the Usibelli Coal Mine is obtained from the Nenana River alluvium.

3.5.3.7 Western Interior Coal-Producing Region

Groundwater

The Western Interior Coal region includes the bituminous coal reserves of central and southern Iowa, northwestern and central Missouri, southeastern Nebraska, eastern Kansas, eastern Oklahoma, and west-central Arkansas. These coal deposits are Pennsylvanian in age and mostly located within three distinct structural basins: the Forest City Basin which includes about 47,000 square miles in Iowa, Nebraska, Kansas, and Missouri; the Cherokee Basin consisting of about 26,500 square miles in Kansas, Missouri, and Oklahoma; and the Arkoma Basin which includes about 13,500 square miles in Oklahoma and Arkansas (U.S. EPA, 2004a). Additional coal resources in Oklahoma are located in the northeast Oklahoma platform. The limited bituminous coal reserves in Texas are not included in this discussion as these reserves are not currently mined.

The majority of the Western Interior region is located within the Central Lowland physiographic province with lesser areas within the Quachita province, Ozark Plateaus, and Coastal Plain province. In the northern portion of the region, unconsolidated deposits consist of alluvium along streams and rivers, and glacial drift and loess deposits; these deposits are evidence of the extensive glacial history of this area. Further south, terrace deposits and alluvium of sandy and clayey silts are common along with occasional thin lenses of sand and gravel. Bedrock underlying the unconsolidated material consists predominantly of upper Paleozoic-age, marine and non-marine deposits of shale and siltstone interbedded with varying amounts of sandstone, limestone, and coal (Detroy, et al., 1983; Marcher, et al., 1984; Marcher, et al., 1987).

Primary Aquifers

The most productive aquifers within the Western Interior are sand and gravel deposits of alluvial and glacial origin. Those found along major waterways or within buried valleys can provide significant volumes of water. The upper Paleozoic strata may also be a source of potable water; however, the yields are generally much less than the unconsolidated aquifers and are more highly variable. With few exceptions, the Lower Paleozoic rocks usually contain groundwater that is not suitable for consumption (Detroy, et al., 1983; Marcher, et al., 1984; Marcher, et al., 1987).

Unconsolidated Aquifers

The most significant unconsolidated aquifers in the Western Interior Coal region consist of sand and gravel deposits. Within the glaciated section of the region, these surficial deposits may be found in buried valleys and within alluvium along major waterways. Farther south into the non-glaciated areas, the sands and gravels are again within alluvial deposits associated with significant rivers and streams and also within terrace deposits, although the terrace units generally supply much less water due to the composition of the layers (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

The unconsolidated aquifers can produce water at highly variable rates, depending on the thickness and aerial extent of the sand and gravel deposits. Wells completed in thick, buried channel deposits have been found to yield up to 1,000 gallons per minute with quality generally suitable for most purposes. Alluvial sands and gravels up to 150 feet thick have been noted to produce upwards of 2,000 gallons per minute in wells along the Missouri River (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

Recharge to the unconsolidated aquifers in the Western Interior is from direct precipitation, infiltration from overlying unconsolidated material, or seepage from adjacent streams. Groundwater movement, although highly variable, is generally towards nearby streams and rivers and down valleys (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

Primary Bedrock Aquifers

Within the Western Interior, Pennsylvanian-age strata are the most widespread Paleozoic units immediately underlying the surficial unconsolidated material. These strata generally consist of shale and siltstone interbedded with thin sandstone and limestone. Although the sandstones and limestones are potential sources of groundwater, yields are generally limited. Some wells completed in the Pennsylvania rocks have reported yields of 20 gallons per minute or more, but the average yield is generally less than five gallons per minute. Regardless of the low rate, these limited aquifers are often the only source of water for those living in some rural areas. The quality of the groundwater is also variable but often suitable for domestic purposes (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

Underlying the Pennsylvanian strata are Mississippian-age rocks that may provide a potable source of groundwater. These units actually underlie unconsolidated materials in those areas where the Pennsylvanian units have been eroded (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

In the northern part of the Western Interior region, the Mississippian aquifer underlies most of northern Missouri. Miller and Appel (1997) state that "The Mississippian aquifer is so named because it consists of limestone of Mississippian age. The Keokuk, the Burlington, the Fern Glen, the Sedalia, and the Chouteau Limestones compose the aquifer; of these formations, the Keokuk and the Burlington are the principal water-yielding rocks. Both formations consist of crystalline limestone and yield water primarily from solution cavities. In most places, the aquifer is overlain by a confining unit of Pennsylvanian shale and sandstone and is everywhere underlain by a confining unit of Mississippian shale. The thickness of the Mississippian aquifer averages about 200 feet but locally exceeds 400 feet in northwestern Missouri. The aquifer is thickest in part of the Forest City Basin, which is a structural downwarp that extends northward into Iowa, and is thinnest near the Mississippi and the Missouri Rivers where it has been dissected or partially removed by erosion."

Mississippian-age rocks in the southern part of the Western Interior may also serve as local aquifers. In the Oklahoma and southwest Missouri area, cherty limestone with thin sandy or shaley zones can provide groundwater of suitable quality at rates up 300 gallons per minute, although most yields are less than ten gallons per minute. The units often have a combined thickness of 300 to 400 feet (Miller and Appel, 1997).

On a local scale, groundwater in the Mississippian aquifer of northern Missouri moves towards nearby streams. Regional groundwater movement has not been determined (Miller and Appel, 1997).

As reported in Marcher, et al., 1983, Cambrian and Ordovician rocks comprise a significant aquifer in discreet areas of the Western Interior, including northeast Oklahoma, southeast Kansas, and central Missouri. The aquifer consists mostly of dolomite with lesser amounts of sandstone, siltstone, and shale for a combined thickness locally of 1,400 feet. Although these rocks are present throughout this region, they are generally very deep and contain poor-quality water. In the Oklahoma-Kansas-Missouri area, the Cambrian-Ordovician rocks are shallower and outcrop in some areas with suitable quality for most domestic uses. Reported well yields in the tri-state area vary from small quantities to 1,000 gallons per minute. The direction of water movement is towards the west/northwest.

The Cambrian-Ordovician aquifer extends northwards into Iowa at greater depths (upwards of 3,000 feet) as compared to the Oklahoma-Kansas-Missouri area. Well yields up to 1,000 gallons per minute are also reported in Iowa; however, the quality of the water is often considered marginal (Detroy, et al., 1983). Regardless of the depth and quality of the water, the Cambrian-Ordovician aquifer is the only source of groundwater in some areas (Detroy, et al., 1983).

The bedrock aquifers are recharged mostly by infiltration from overlying units, from direct precipitation at outcrops, or seepage from adjacent streams. Recharge may also occur through solution-enhanced zones, particularly in the Cambrian-Ordovician and Mississippian-age aquifers (Detroy, et al., 1983).

Figure 3.5-2 illustrates the general extent of the aquifers making up the Western Interior region aquifer system.

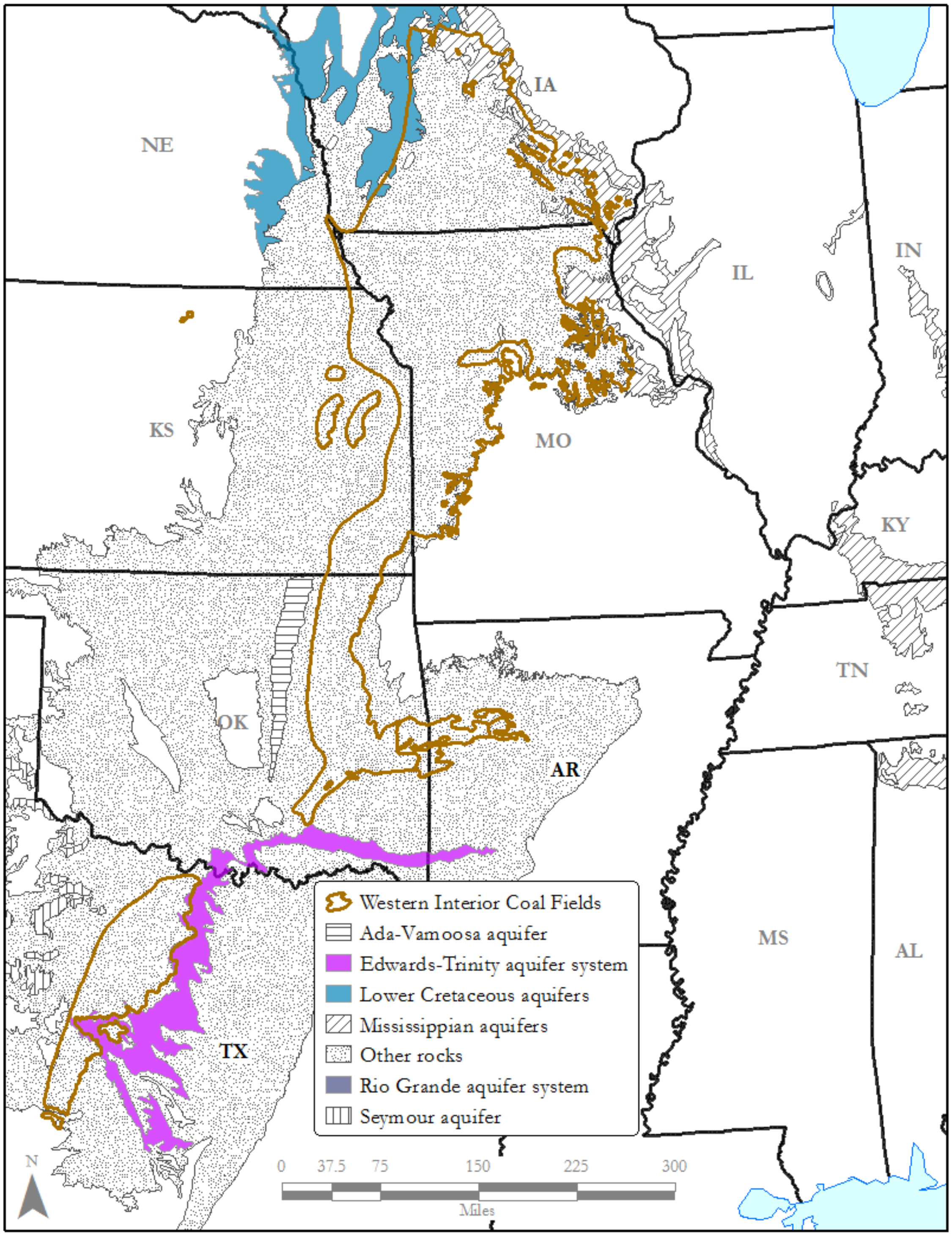
Groundwater Quality

As noted in Detroy, et al., 1983, water within the glacial sand and gravel aquifers generally exhibited a neutral pH, alkalinity averaging 266 milligrams per liter, and dissolved solids of 840 milligrams per liter. Nitrate concentrations averaged 24.6 milligrams per liter with wide ranges in iron (0.01 to 16 milligrams per liter) and manganese (0.01 to 2.1 milligrams per liter). Water from the alluvial aquifers within the glaciated region was found to be similar to that within the glacial sand and gravel deposits in pH, alkalinity, dissolved solids, and iron concentrations. Nitrates were less (average of 3.2 milligrams per liter), but the range in manganese was greater (0.05 to 17 milligrams per liter).

Alluvial and terrace deposits in non-glaciated areas of the Western Interior have been found to contain water that is alkaline, with dissolved solids ranging from 148 to 889 milligrams per liter. The following ranges (presented in milligrams per liter) were also noted: sodium, 5.3 to 250; sulfate, 0 to 3,970; manganese, ten to 1,750; iron, ten to 34,000; and chloride, 0.8 to 454 (Marcher, et al., 1983; Marcher, et al., 1987). Marcher, et al. (1983) observe that "Large concentrations of sodium, chloride, and particularly sulfate may be present in unconsolidated deposits in the smaller valleys. Sulfate is a major component of groundwater in stream valleys draining shale of Pennsylvanian age. Water with a pH of less than 6.5, sulfate concentrations greater than 250 to 300 milligrams per liter, and dissolved iron and manganese concentrations of more than 100 to 200 milligrams per liter may indicate mineralization from pyritic materials associated with coal or metal mines."

Water within the Mississippian aquifer varies from relatively fresh in the eastern portion of the Western Interior, to very saline in the west. Similar to the Mississippian aquifers in the Illinois Basin, the volume of overlying material (and therefore the depth to the aquifer) is an important factor with regards to dissolved solid concentrations. The greater thickness in overburden generally correlates to higher dissolved solids.

Figure 3.5-2 Western Interior Region Aquifers



Source: USGS, 2003, Principal Aquifers of the United States. http://water.usgs.gov/ogw/aquifer/map.html

Mississippian strata in the southern part of the region may also serve as local aquifers, with water quality that is generally suitable for most purposes (Miller and Appel, 1997). Groundwater in this area is generally alkaline with low concentrations of dissolved solids. Average concentrations of chloride, fluoride, manganese, nitrates, sodium, iron, and sulfate are also low (Marcher, et al., 1983).

Surface Water

The major drainage basins for this region are the Upper Mississippi, Missouri, and Arkansas River basins. The Upper Mississippi River basin drains 189,000 square miles from its source in Itasca, Minnesota to the confluence of the Mississippi and Ohio Rivers in southern Illinois (Upper Mississippi River Basin Association, 2011)). The Missouri River drainage area consists of 529,000 square miles across much of the north-central U. S. from Montana to near St. Louis, Missouri (Kammerer, 1990). The Arkansas River basin drains 161,000 square miles in seven states from Colorado eastwards to Arkansas (Kammerer, 1990).

Stream Morphology

In the northern portion of the region, unconsolidated deposits consist of alluvium along streams and rivers and glacial drift and loess deposits. Further south, terrace deposits and alluvium of sandy and clayey silts are common, along with occasional thin lenses of sand and gravel (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987). The general topography of the region is very flat plain, with elevations ranging from 500 to 1,200 feet above mean sea level, with very little local relief. An exception to this is in the Ozark Plateau province, which resembles the Appalachian Province but with lower average altitudes and relief. "A maximum altitude of 2,000 feet is reached in the southern part of this province" (Vogel, 1981).

The dominant stream forms in this coal region include intermittent and perennial streams of Rosgen "C" type. These streams exist in areas of low relief within well-developed floodplains. They are generally described as wide and shallow, exhibiting high width/depth ratios (>12). Typical in-stream features include alternating riffles and pools, runs, glides and characteristic point bars within the active channel. They are representative of the classic sinuous meandering stream. Streams of Rosgen type "E" and "F" also persist and are distinguished from Rosgen "C" types by their relative degree of entrenchment, width-to-depth ratio, and sinuosity. Streams of Rosgen "E" type demonstrate higher sinuosity and lower width-to-depth ratios (narrow and deep) than the "C" type. Rosgen "F" types are distinguished by their moderately to highly entrenched (incised) steam profile, with little to no developed floodplain. Ephemeral streams are also widespread across the Western Interior region.

Surface Water Quantity / Stream Regime

Daily and seasonal variations in precipitation cause considerable differences in monthly and yearly stream flow patterns and volumes. Most of the precipitation in the Western Interior occurs in the form of rain, typically in the spring and summer months as a result of storms moving eastward across the region. Corresponding with this increased rainfall, streamflows are generally higher in spring and early summer, followed by lower flows in late summer and fall. The lower flow volumes in the latter part of the year are exacerbated by evapotranspiration, which peaks during this time. As a result, it is common for many streams in this region to experience periods of no flow, particularly those with limited drainage areas (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987).

During periods of low precipitation and high evapotranspiration, low groundwater levels result in little baseflow to streams. In addition, many waterways are surrounded by low-permeability materials that impede groundwater infiltration, or are underlain by competent bedrock with limited storage and transmittal properties (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987). Due to the high variability in streamflows, especially in those areas with limited groundwater resources (e.g., central Oklahoma), surface water is often stored in lakes and reservoirs in order to meet demand (Marcher, et al., 1987).

Flooding along many waterways is not uncommon in the Western Interior, particularly during early spring and summer when precipitation amounts are greatest, although precipitation alone does not ensure flooding will occur. Land slopes, drainage patterns, and other basin characteristics, along with land use and development patterns, influence flooding patterns and frequencies. Many states in the Western Interior have statistically evaluated flood-frequency data on gaged streams to better predict future discharge rates and the time intervals that may be expected for any particular rate to occur. For streams that are not monitored on a regular basis, flood-frequency curves have been developed using region-specific equations. The ability to plan for future flood conditions based on typical patterns is crucial for development and municipal planning (Detroy, et al., 1983; Marcher, et al., 1983; Marcher, et al., 1987). Man-made structures, such as reservoirs and ponds that have been constructed along the Arkansas River, can help moderate both the frequency and magnitude of floods (Marcher, et al., 1987).

Surface Water Quality

Table 3.5-23 lists designated use categories used to classify and protect the surface waters in the Western Interior region. Oklahoma has the least number of state-defined designated uses while Missouri has the most. The water quality assessments used as the basis for the integrated reports provide insight into the health of the region's surface waters. The percentage of water assessed within each of the three states ranges from 15.8 percent (Oklahoma) to 21.8 percent (Kansas). Table 3.5-24 shows about 88 percent of the waters assessed in Kansas are not achieving their designated use ("impaired waters") while Missouri classifies 53.1 percent of its streams as impaired. Kansas has the greatest number of impaired stream miles (25,755.8 miles) while Missouri has the least (5,412.6 miles). Missouri contains the highest number of stream miles achieving designated use (4,776.9 miles) while Oklahoma has the least (2,297.8 miles).

Overall, the Western Interior region contains 265,094 miles of streams, of which only 51,997.5 have been assessed. Approximately 10,653.5 of the 51,997.5 stream miles that have been assessed (20 percent) are achieving their designated, use while 41,344 (80 percent) are considered impaired. The assessment includes all causes of stream impairment and is not limited to mining-related impairments.

Table 3.5-23
Selected State-Defined Designated Uses – Western Interior Coal-Producing Region

Selected State-Defined Designated Uses for Surface Water		
Kansas	**Missouri**	**Oklahoma**
Agricultural water supply - Irrigation	Warm-water aquatic community	**Public and private water supply**
Agricultural water supply - Livestock watering	Cool-water aquatic community	Fish and wildlife propagation
Aquatic life support - Special aquatic life	Cold-water aquatic community	Agriculture
Aquatic life support - Expected aquatic life	Modified aquatic community	Primary body contact recreation (such as swimming)
Aquatic life support - Restricted aquatic life	Exceptional aquatic community	Seconary body contact recreation (such as boating/fishing)
Domestic Water Supply	While body contact recreation	Navigation
Food procurement	Secondary contact recreation	Aesthetics
Groundwater recharge	Human health protection	
Industrial water supply	Livestock and wildlife pretection	
Recreational - Primary contact :swimming beach	Drinking water supply	
Recreational - Primary contact: Public access	Irrigation	
Recreational - Primary contact: restricted access	Industrial water supply	
Recreational - Secondary contact: restricted	Aesthetics	
	Runoff storage and attenuation	
	Wildlife habitat protection	
	Recreational, cultural, educational, scientifiec, and natural aesthetic use protection	
	Hydrologic cycle mainteance	
	Outstanding resource waters	

Source: U.S. EPA, 2013i

Table 3.5-24
Summary of State CWA Water Quality Assessments – Western Interior Coal-Producing Region

Results of Clean Water Use Assessment: Water Quality Summary for Rivers and Streams (miles)				
	Kansas (2012)	Missouri (2012)	Oklahoma (2010)	Summation of Western Interior Region
Good Waters	3,578.8	4,776.9	2,297.8	10,653.5
Threatened Waters	NA	NA	NA	
Impaired Waters	25,755.8	5,412.6	10,175.6	41,344.0
Total Assessed Waters	29,334.6	10,189.5	12,473.4	51,997.5
Total Waters	134,338.0	51,978.0	78,778.0	265,094.0
Percent of Waters Assessed	21.8	19.6	15.8	19.6
*Data from EPA ATTAINS database and website. See http://epa.gov/waters/ir/ for additional information.				
** NA = Not Avaliable				

Source: U.S. EPA, 2012c

Hyperlinks to Integrated CWA Reports - Western Interior Coal Region

The following links provide additional detail on water quality in the Western Interior region.

State	Hyperlink
Kansas	http://www.kdheks.gov/befs/
Missouri	http://dnr.mo.gov/env/wpp/waterquality/303d.htm
Oklahoma	http://www.deq.state.ok.us/WQDnew/305b_303d/index.html

Water Usage

Based on 2005 USGS data, water resources in this region are used primarily for thermoelectric power generation (72 percent). Public water suppliers use 18 percent, agricultural operations use seven percent, and industrial/commercial establishments use two percent. Mining and domestic wells use less than one percent each. The total water usage for the year 2005 was 5,265 MGD (USGS, 2010b).

Precipitation is the primary source of recharge to the stream valley aquifers (Miller and Appel 1997; Ryder, 1996). Equal portions (42 percent each) of groundwater withdrawals are for both agriculture and public supply. Approximately five percent of groundwater withdrawals are associated with private domestic wells (USGS, 2010b).

Within the Western Interior region basin, a widespread water table decline has not been identified, but isolated areas of 40-foot water table declines have been identified (Reilly, et al., 2008). This would indicate that, for the most part, water demand and associated stress on the aquifer is confined to isolated areas and is not widespread.

About 78 percent of surface water withdrawn is utilized by thermoelectric facilities. Public water suppliers account for approximately 16 percent of surface water withdrawals. No surface water is diverted for private domestic use.

According to 2005 USGS data, 80 percent of total drinking water withdrawals are from surface water sources. Eighty-two percent of these public water supply withdrawals are from surface water. Additionally, since 1985, domestic water withdrawals have decreased 27 percent, and public water supply withdrawals have increased 39 percent, indicating that regional drinking water demand is increasing on net.

A review of USGS water use data for the years 1985 to 2005 indicates that the total proportion of the population supplied by a public water supplier is increasing while the total population and proportion of the population that is self-supplied is decreasing, as summarized in Table 3.5-25. In 2005, the domestic self-supply population was about 0.3 million, five percent of the total regional population. This self-supply population relies primarily on private wells for their water supply (all domestic water is supplied from groundwater) (USGS, 2010b). Because these wells are not routinely monitored or treated, this population is particularly susceptible to changes in groundwater quality and supply.

Table 3.5-25
Summary of Domestic Water Supply of Population (thousands/percent of total) – Western Interior Coal-Producing Region

Year	Self-Supply Population	Public Supply Population
2005	291 (5%)	5,377 (95%)
2000	322 (6%)	5,160 (94%)
1995	527 (10%)	4,653 (90%)
1990	676 (14%)	4,294 (87%)
1985	731 (15%)	4,221 (85%)

Source: USGS 2010a, USGS 2010b.

3.6 AIR QUALITY, GREENHOUSE GAS EMISSIONS, AND CLIMATE CHANGE

3.6.1 Introduction and Background

Air emissions from coal mining operations are primarily governed by federal regulations promulgated under the authority of the Clean Air Act (CAA) (42 U.S.C. § 7401 et seq.). Implementation of performance standards for blasting, however, also falls under the purview of SMCRA. The purpose and need for the proposed action considered in this Draft Environmental Impact Statement has no direct connection to air resources; OSMRE is not proposing to change any of our regulations that pertain to the control of emissions from mining activities and OSMRE does not regulate emissions related to the combustion of the coal for electricity generation or any other end use. The regulatory alternatives may, however, have an indirect effect on emissions from mining and combustion. The discussion below provides a brief review of existing conditions in the coal regions in respect to air quality parameters, and a brief review of air quality regulations to put this information into context. Air quality effects that result from mining and combustion are discussed in the corresponding section of Chapter 4, specifically in section 4.2.4.

The Western region office of OSMRE has recently completed an EIS for the Four Corners Power Plant and Navajo Mine Energy Project (OSMRE, 2015b). Detailed discussions of the sources of emissions involved in mining and combustion and the requirements of the Clean Air Act related to those emissions are contained in the "Regulatory Compliance Framework" discussion contained on pages 4.1-1 through 4.1-17 of the Four Corners Power Plant and Navajo Mine Energy Project (FCPP) EIS. These discussions are summarized and incorporated into the text below where appropriate.

As discussed in the FCPP Final EIS coal mining and the use of coal involves both stationary and mobile sources of air pollutants. Coal mining causes air emissions from combustion of motor fuels (diesel and gasoline) used to operate mining equipment, portable equipment, and support vehicles. Some mining activities also cause air emissions, specifically nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO) from explosives detonation and fugitive dust released during earthmoving activities. In addition as discussed in section 3.6.1.2. below, some emissions occur from the disturbance of the coal and surrounding rock; for example, coal seams and surrounding rock strata may contain methane (CH_4), which can be released during mining.

After the coal is mined, transportation of the coal from the mine site to the end user may generate emissions. Similarly, because virtually all of the coal is burned at some point, the combustion of the coal will generate emissions. Most coal mined in the U.S. is used to generate electricity; however, some is used to produce coke and for other industrial, commercial, and institutional purposes (U.S. EIA, 2014e). In the context of electricity generation, power plants are generally large stationary sources that emit substantial amounts of NO_X and SO_2, along with coarse particulate matter (PM_{10}, particulate matter up to ten micrometers in size) and fine particulate matter ($PM_{2.5}$, particulate matter up to 2.5 micrometers in size). Power plant operation and maintenance would cause air emissions from the combustion of coal in boilers as well as motor fuels (diesel and gasoline) used in off-road equipment, portable equipment, and support vehicles.

3.6.1.1 Clean Air Act Regulatory Framework

Air Quality Standards

Air quality in a given location is determined by the concentration of various pollutants in the atmosphere. The EPA has established National Ambient Air Quality Standards (NAAQS) under the CAA of 1970 (amended 1977 and 1990, 42 U.S.C. § 7401 et seq.). Table 4.1-1 of the FCPP Final EIS presents the NAAQS for each pollutant for which there is a standard.

The NAAQS represent maximum levels of background pollution that are considered safe, with an adequate margin of safety, to protect public health (primary standards) and welfare (secondary standards such as diminished production and quality of agricultural crops, reduced visibility, degraded soils, materials and infrastructure damage, and damaged vegetation). Recently, the EPA has proposed developing new secondary standards for SO_2 and NO_X aimed at reducing the effects of atmospheric deposition on surface waters (Government Accounting Office (GAO), 2013). Individual states have the option to adopt more stringent standards than the NAAQS and to include other pollution sources.

Federal law defines criteria pollutants to include ozone (O_3), NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and lead (Pb). Elimination of tetraethyl lead in motor gasoline has eliminated emissions of Pb from vehicles and portable equipment. O_3 is not directly emitted, rather, its precursors NO_X and volatile organic compounds (VOCs) are the pollutants which react with sunlight to form ground-level photochemical O_3 and contribute to regional haze, along with SO_2 and particulate matter. Criteria emissions – also referred to as regulated pollutants – caused by coal mining activities and combustion would include reactive organic compounds (ROCs) or VOCs, NO_X as NO and NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$. Discussions of each of these pollutants, and recent and proposed EPA rulemaking regarding these standards and their health effects can be found on pages 4.1-1 to 4.1-7 of the FCPP Final EIS.

In the 1977 CAA amendments, Congress classified those areas that meet or exceed the NAAQS as Class I, Class II, or Class III (42 U.S.C. § 7472). Based on an area's classification, regulatory authorities can permit certain amounts of increased pollution. The difference between a preexisting level of pollution and a new level is called an "increment." Congress decided that most national parks and wilderness areas already in existence at the time of the 1977 amendments would be designated as Class I areas, where only a small increase in pollution levels could be permitted. The legislation designated the rest of the clean air areas as Class II, where some additional pollution could occur. In addition, Congress allowed states to designate some areas as Class III, where the most pollution would be allowed but still not enough to cause a violation of the NAAQS. In the coal-producing regions, areas which have attained the NAAQS for criteria pollutants are designated as Class I, II, or "unclassifiable" and are regulated under the Prevention of Significant Deterioration (PSD) program.

As discussed below in 3.6.2, within the coal-producing regions, there are NAAQS nonattainment areas for the following criteria air pollutants: $PM_{2.5}$, PM_{10}, Ozone, and SO_2. Mining activities and associated coal combusting activities in proximity to these nonattainment areas may contribute to further degradation of the air quality and may be subject to more stringent requirements to minimize emissions.

Hazardous Air Pollutants

Hazardous Air Pollutants (HAPs), also known as toxic air pollutants or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. Title III of the CAA Amendments of 1990 currently identifies 187 pollutants as HAPs, the federal term for air toxics. In 2001, the EPA identified 21 HAPs as mobile source air toxics, six of which are designated priority pollutants (66 FR 17230): acetaldehyde, acrolein, benzene-1, 3-butadiene, diesel exhaust (PM and organic gases), and formaldehyde. Diesel particulate matter (DPM) is considered a carcinogenic air toxic. An EPA assessment "examined information regarding the possible health hazards associated with exposure to diesel engine exhaust (DE), which is a mixture of gases and particles. The assessment concludes that long-term (i.e., chronic) inhalation exposure to DPM is likely to pose a lung cancer hazard to humans, as well as damage the lung in other ways depending on exposure. Short-term (i.e., acute) exposures to DPM can cause irritation and inflammatory symptoms of a transient nature, these being highly variable across the population" (EPA 2002).

In addition to DPM from mining equipment and heavy trucks, coal combustion emits a wide range of inorganic and organic HAPs from stacks, according to the EPA (EPA 2011a, 40 CFR 63 Subpart UUUUU). Inorganic metals include: antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), and selenium (Se). Organics and nonmetallic inorganics include: acetaldehyde, acetophenone, acrolein, benzene, benzyl chloride, bis(2-ethylhexyl)phthalate (DEHP), carbon disulfide, chlorobenzene, chloroform, cyanide, 2,4-dinitrotoluene, ethyl benzene, ethyl chloride, formaldehyde, hexane, hydrogen chloride, hydrogen fluoride, isophorone, methyl bromide, methyl chloride, methyl ethyl ketone, methylene chloride, polycyclic aromatic hydrocarbons (PAHs), phenol, propionaldehyde, tetrachloroethylene, toluene, styrene, and xylenes (ortho-, meta-, para- isomers).

Coal-fired power plants are the largest source of mercury and acid gas emissions in the U.S. and are responsible for about 50 percent of mercury emissions and about 77 percent of acid gas emissions. For more discussion of the topic of mercury and air toxic standards specifically refer to page 4.1-9 of the FCPP Final EIS.

On March 28, 2013, the EPA finalized updates to certain emission limits for new power plants under the Mercury and Air Toxics Standards rule, including mercury, PM, SO_2, acid gases, and certain individual metals. Additionally, certain testing and monitoring requirements that apply to new sources were adjusted. The new standards affect only new coal- and oil-fired units that will be built in the future (78 FR 24073). The update does not change the final emission limits or other requirements for existing power plants.

Federal Visibility Protection and Atmospheric Deposition Control Programs

Visibility and haze are regulated under the Regional Haze Rule of the CAA (40 CFR 51 Subpart P). Under the CAA, Class I areas are those in which visibility is protected more stringently than under NAAQS. Class I areas include national parks and monuments, wilderness areas, and other areas of special national and cultural significance. Section 169A (42 U.S.C. § 7491) of the CAA sets forth a national goal for visibility which is the ''prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution.''

There are 156 Class I areas in the U.S., 49 of which are national parks and monuments. The Regional Haze Rule, enacted in 1999, requires states to establish goals and emission reduction strategies for improving visibility in all Class I areas as part of State Implementation Plans (SIPs) as geographically applicable (64 FR 35714). In addition, the EPA encourages states to work together in regional partnerships to develop and implement multistate strategies to reduce emissions of visibility-impairing fine particle ($PM_{2.5}$) pollution (64 FR 35714). Due to long range transport of visibility-impairing fine particles, all 50 states are required to participate in planning, analysis, and in many cases, emission control programs.

For more information related to the relationship of visibility standards to NAAQS, and Best Available Retrofit Technology in relation to coal combustion at power plants refer to page 4.1-10 to 4.1-11 of the FCPP Final EIS.

Atmospheric Deposition

Since the 1970s, implementation of CAA regulations has reduced emissions of NO_X, SO_2, and mercury and reduced the impact of atmospheric deposition on water quality and aquatic ecosystems. Three key regulations or programs have contributed to reductions in acid rain precursors: (1) Title II emission standards for mobile sources (motor vehicles), (2) actions designed to meet primary NAAQS, and (3) the Acid Rain Program.

The Acid Rain Program implements requirements for significant decreases in the emissions of NO_X and SO_2 from power plants to improve air quality and protect ecosystems that have been damaged by acid rain, including aquatic ecosystems. According to the 2011 National Acid Rain Precipitation Assessment Program report, the Acid Rain Program has been successful in reducing NO_X and SO_2 emissions from electric power generation to below levels set by Congress in 1990. By 2009, SO_2 emissions from power plants were 3.25 million tons lower than the final 2010 cap level of 8.95 million tons, and NO_X emissions were 6.1 million tons less than the levels projected for 2000.

Similar to NO_X and SO_2 emission reductions, mercury emissions from power plants also declined from about 59 tons of mercury in 1990 to about 30 tons of mercury in 2008 (EPA 2011b; GAO, 2013). When fully implemented, EPA projects that the Mercury and Air Toxics Standards rule will reduce future mercury emissions from domestic power plants to about 9 tons by 2016, a 70 percent reduction from 2008 (GAO, 2013).

Federal Prevention of Significant Deterioration Program

PSD (40 CFR 51.166 and 52.21) provides the overall regulatory framework for permitting new or existing stationary sources, such as oil refineries, factories, or power plants. PSD permitting applies to new major sources or major modifications at existing sources located in NAAQS attainment or unclassified areas for applicable pollutants.

Federal Stationary Source Regulations

Title V Operating Permits Parts 70 and 71 implement Title V of the CAA, 42 U.S.C. § 7661, et seq. Title V operating permits are legally enforceable documents that permitting authorities issue to major stationary sources of air pollution regulating their emissions. Title V major source thresholds are defined by the NAAQS attainment status of the jurisdiction, with progressively lower (more stringent) thresholds in moderate, serious, severe, and extreme nonattainment areas. Part 70 permits are issued by state and local (county or district) permitting authorities. Part 71 permits are issued either directly by the EPA or through tribal EPAs on sovereign tribal lands. There are many other Parts within the Section that provide additional requirements for monitoring and limits on emissions at stationary sources such as coal burning power plants. Pages 4.1-15 through 4.1-16 of the FCPP Final EIS provide a thorough description of requirements related to the Four Corners Power Plant, including enforceable limitations on SO_2, NO_x, PM, and opacity emissions that would be applicable to all power plants (40 CFR 49.23), and we are incorporating that discussion here by reference.

Mobile Source Regulations

A vehicle may have an engine that both propels the vehicle and powers equipment mounted on the vehicle, typically via hydraulics. Single-engine vehicles are considered to be mobile sources and are generally exempt from direct regulation by states, air districts, or sovereign tribes. However, not included in most exemption provisions is any non-driveline engine-powered equipment mounted on a vehicle that would otherwise require a permit under state, air district, or tribal regulations. An example of this dual-engine configuration would be a vacuum street sweeper where an auxiliary engine drives the vacuum blower. Another example would be a mobile crane or drilling rig with an independent hoist or draw-works engine, respectively.

Federal Tier 1 standards for off-road diesel engines were adopted in 1995. Federal Tier 2 and Tier 3 standards were adopted in 2000 and selectively apply to the full range of diesel off-road engine power categories. Both Tier 2 and Tier 3 standards include durability requirements to ensure compliance with the standards throughout the useful life of the engine (40 CFR 89.112). On May 11, 2004, the EPA signed the final rule implementing Tier 4 emission standards which are to be phased-in over the period of 2008 to 2015 (69 FR 38957-39273, June 29, 2004). The Tier 4 standards require that emissions of PM and NO_X be further reduced by about 90 percent. Such emission reductions can be achieved through the use of advanced control technologies – including advanced exhaust gas after treatment similar to those required by the 2007-2010 standards for highway diesel engines. It should be noted that diesel engines used in underground mining equipment are exempt from these requirements as diesel emissions and air quality from such engines are regulated by the Mine Safety and Health Administration (MSHA).

3.6.1.2 Greenhouse Gas Emissions

Greenhouse gases (GHG) trap solar energy in the atmosphere and cause it to warm. This phenomenon is called the greenhouse effect and is necessary to support life on Earth; however, excessive buildup of GHGs can change Earth's climate and result in undesirable effects on ecosystems, which affects human health and welfare (EPA 2012i). GHG emissions from the combustion of fossil fuels for energy include carbon dioxide (CO_2), methane (CH_4) and Nitrous

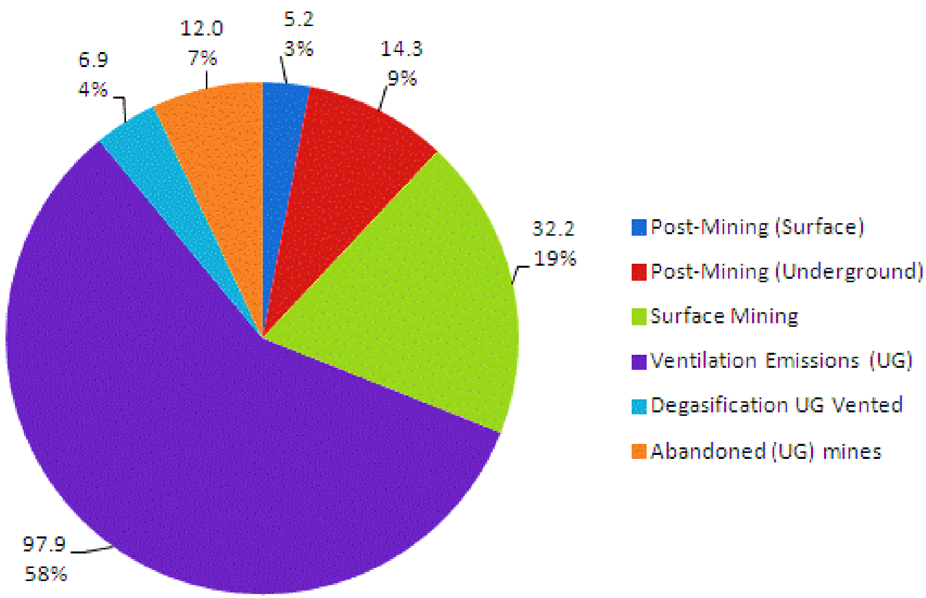
Oxides (N_2O), and represent the largest share of U.S. total GHG emissions (U.S. EPA, 2013a; U.S. EPA, 2013b).

The EPA tracks GHG emissions in the U.S. and publishes an annual update to its Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2012b, 2014). From the current report, the main source of GHG emissions in the U.S. is electric power generation, which accounts for 32 percent of GHG emissions nationwide. Over 70 percent of electric power is generated by burning fossil fuels, mainly coal and natural gas. GHG emissions from electric power generation in the U.S. have increased by about 24 percent since 1990 as demand for electric power has grown, and fossil fuels have remained the dominant energy source for generation due to their low cost and high reliability. Coal combustion is much more carbon-intensive than burning natural gas or petroleum to generate electricity. In 2012, consumption of energy generated by coal decreased by 12.3 percent. Coal generated about 33 percent of electric power in the U.S. and in 2012 accounted for about 40 percent of CO_2 emissions from the power sector (EPA 2014b).

The amount of CH_4 released during coal mining depends on a number of factors, the most important of which are coal rank, coal seam depth, and method of mining. Coal rank represents the differences in the stages of coal formation and depends on the temperature history of the coal seam. As coal rank increases, the amount of CH_4 produced also increases. Because pressure increases with the depth of the coal seam and the adsorption capacity of coal increases with pressure, deeper coal seams generally contain more methane than shallow seams of the same rank. In addition, over time methane can be released to the atmosphere from near surface coal seams through natural fractures in overburden strata. Coal extraction tends to lead to the release of more methane than was originally trapped within the mined coal seam itself because the drop in pressure draws in additional gas from surrounding strata. Also, the mining process tends to fracture the surrounding strata including neighboring seams, particularly where longwall extraction is used. Underground coal mining typically releases more methane than surface mining because of the higher gas content of deeper seams (Irving and Tailakov, 1999).

The 2011 U.S. EPA Greenhouse Gas Inventory Report, (U.S. EPA, 2013a), provides a detailed description of methane emissions from coal mining and how they are estimated. According to the EPA's report, three types of coal mining and related activities release methane to the atmosphere: underground mining, surface mining, and postmining (i.e., coal-handling) activities. Underground coal mines contribute the largest share of CH_4 emissions (Figure 3.6-1). Underground coal mines employ ventilation systems to maintain safe CH_4 levels for workers. These systems can exhaust significant amounts of CH_4 to the atmosphere in low concentrations. Additionally, some U.S. coal mines supplement ventilation systems with degasification systems. Degasification systems are wells drilled from the surface or boreholes drilled inside the mine that remove large volumes of CH_4 before, during, or after mining. In 2011, 14 coal mines collected CH_4 from degasification systems and used this gas, thus reducing emissions to the atmosphere; all of these mines sold CH_4 to the natural gas pipeline, including one that also used CH_4 to fuel a thermal coal dryer. Surface coal mines also release CH_4 as the overburden is removed and the coal is exposed, but the level of emissions is much lower than from underground mines. Finally, some of the CH_4 retained in the coal after mining is released during processing, storage, and transport of the coal. Total CH_4 emissions from coal mining in 2011 have declined by 25 percent since 1990 (U.S. EPA, 2013a).

Figure 3.6-1 Sources of Coalbed Methane - 2011 U.S. CMM Emissions (Billion Cubic Feet)



Source: U.S. EPA 2013a. 2011 U.S. Emissions Inventory, 1990- 2011 Report. http://www.epa.gov/cmop/basic.html

The EPA has established a voluntary program to reduce methane emissions in the coal mining industry. This program, known as the Coalbed Methane Outreach Program (CMOP), helps the coal industry identify the technologies, markets, and finance sources to profitably use or sell the methane that coal mines would otherwise vent to the atmosphere (U.S. EPA, 2013c).

3.6.1.3 Greenhouse Gas Permitting for Stationary Sources

On May 13, 2010, EPA issued the Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (75 FR 31514), which addressed GHG emissions from stationary sources under the CAA permitting programs. This final rule set thresholds for GHG emissions, defining when CAA major source permits are required for new and existing industrial facilities that emit GHGs. While this rule had the potential to affect methane and CO_2 emissions from coal mining activities, EPA determined in response to a June 2010 petition filed by Earthjustice, et al., that such facilities would not be listed under CAA Section 111 at this time, and, therefore, EPA would not pursue federal standards of performance for existing, new, and modified sources in the coal-mines category (U.S. EPA. 2013h).

3.6.1.4 Greenhouse Gas Reporting Program (GHGRP)

Federal GHG regulations and reporting requirements do not apply to surface coal mining operations. On October 30, 2009, the EPA issued the Mandatory Reporting of Greenhouse Gases rule (74 FR 56260, 40 CFR part 98, effective December 29, 2009), which requires reporting of GHG data and other relevant information from large sources and suppliers in the U.S. pursuant to Fiscal Year 2008 Consolidated Appropriations Act (Pub. L. No. 110-161).

The rule facilitates collection of accurate and comprehensive emissions data to provide a basis for future EPA policy decisions and regulatory initiatives. The rule requires specified industrial source categories and facilities with an aggregated heat input capacity of 30 mmBTU or more per hour or that emit 25,000 metric tonnes or more per year (MT/yr) of CO_2 equivalent (CO_2e) GHGs to submit annual reports to the EPA. The gases covered by the rule are CO_2, CH_4, N_2O, and hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride (SF6), and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers.

On July 12, 2010, EPA published a final rule, Mandatory Reporting of Greenhouse Gases from Magnesium Production, Underground Coal Mines, Industrial Wastewater Treatment, and Industrial Waste Landfills (75 FR 39736). Under that rule underground coal mines that were subject to quarterly (or more frequent) sampling of ventilation systems by MSHA were subject to 40 CFR part 98 regardless of the actual facility emissions. On November 29, 2011 (76 FR 73886), EPA amended specific provisions in the Mandatory Reporting of Greenhouse Gases Rule to correct certain technical and editorial errors. EPA revised the threshold for underground coal mines subject to subpart FF to include only those that have ventilation emissions of 36,500,000 actual cubic feet (acf) of CH_4 or more per year. This revision excluded approximately 500 mines from mandatory reporting. Underground mines that meet this threshold are required to report the following:

- Quarterly CH_4 liberation from ventilation and degasification systems; and
- Quarterly CH_4 destruction for ventilation and degasification systems and resultant CO_2 emissions, if destruction takes place on-site.

In addition, each facility must report GHG emissions of other source categories for which calculation methods are provided in the rule. For example, facilities must report CO_2, N_2O, and CH_4 emissions from each stationary combustion unit on site by following the requirements of 40 CFR part 98, subpart C (General Stationary Fuel Combustion Sources). Reporting year 2011 was the first year emissions data was collected for this industry sector (Table 3.6-1).

EPA chose not to include abandoned underground mines and active surface mines because EPA determined that measuring and/or monitoring emissions from these sources would be difficult due to the current lack of robust facility-level monitoring methods available to measure fugitive emissions.

The 2012 reported emissions data (U.S. EPA) revealed that the primary sources of GHG emissions from underground mines are located in West Virginia and Pennsylvania. These two states comprise 57.7 percent of the total reported emissions nationwide (Figure 3.6-2).

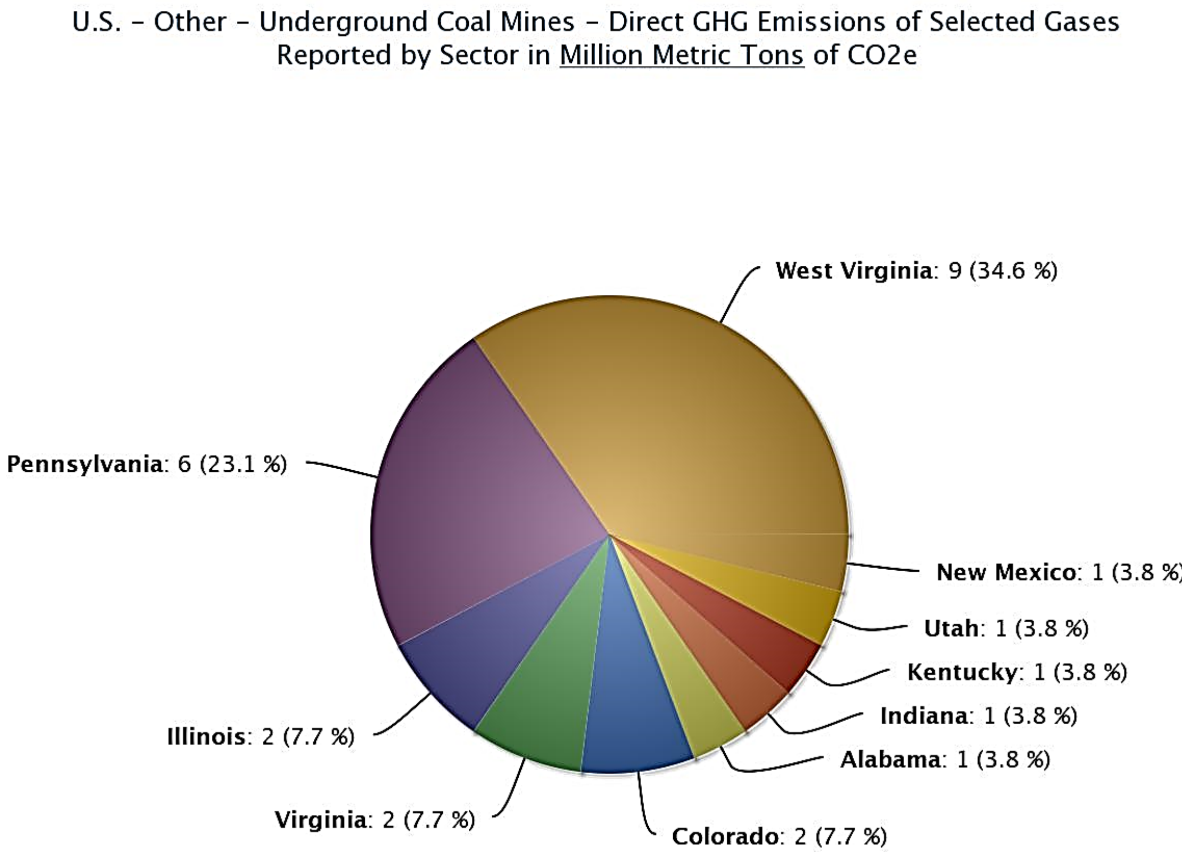
Table 3.6-1
Greenhouse Gas Emissions from Underground Mines , million metric tons CO_2e

	2012	2011	2010
Number of facilities:	151	149	NR
Total emissions (CO_2e):	28.0	30	NR
Emissions by greenhouse gas (CO_2e)			
Carbon dioxide (CO_2):	0.53	0.51	NR
Methane (CH_4):	27.2	29.4	NR
Nitrous oxide (N_2O):	**	**	NR

Source: U.S. EPA, 2013e. GreenHouse Gas Reporting Program, Underground Coal Mines. http://www.epa.gov/ghgreporting/ghgdata/reported/coalmines.html

Notes:
Totals may not equal sum of individual GHGs due to independent rounding.
NR means that this value was not reported.
** Total reported emissions are less than 0.05 million metric tons CO_2e.

Figure 3.6-2 U.S. EPA – 2012 GHG Reported Emissions – Underground Mines



Source: U.S. EPA, 2012a. Greenhouse Gas Emissions from Large Facilities. Facility Level Information on GreenHouse Gases Tool (FLIGHT). http://ghgdata.epa.gov/ghgp/main.do

3.6.2 Air Quality by Coal-Producing Region

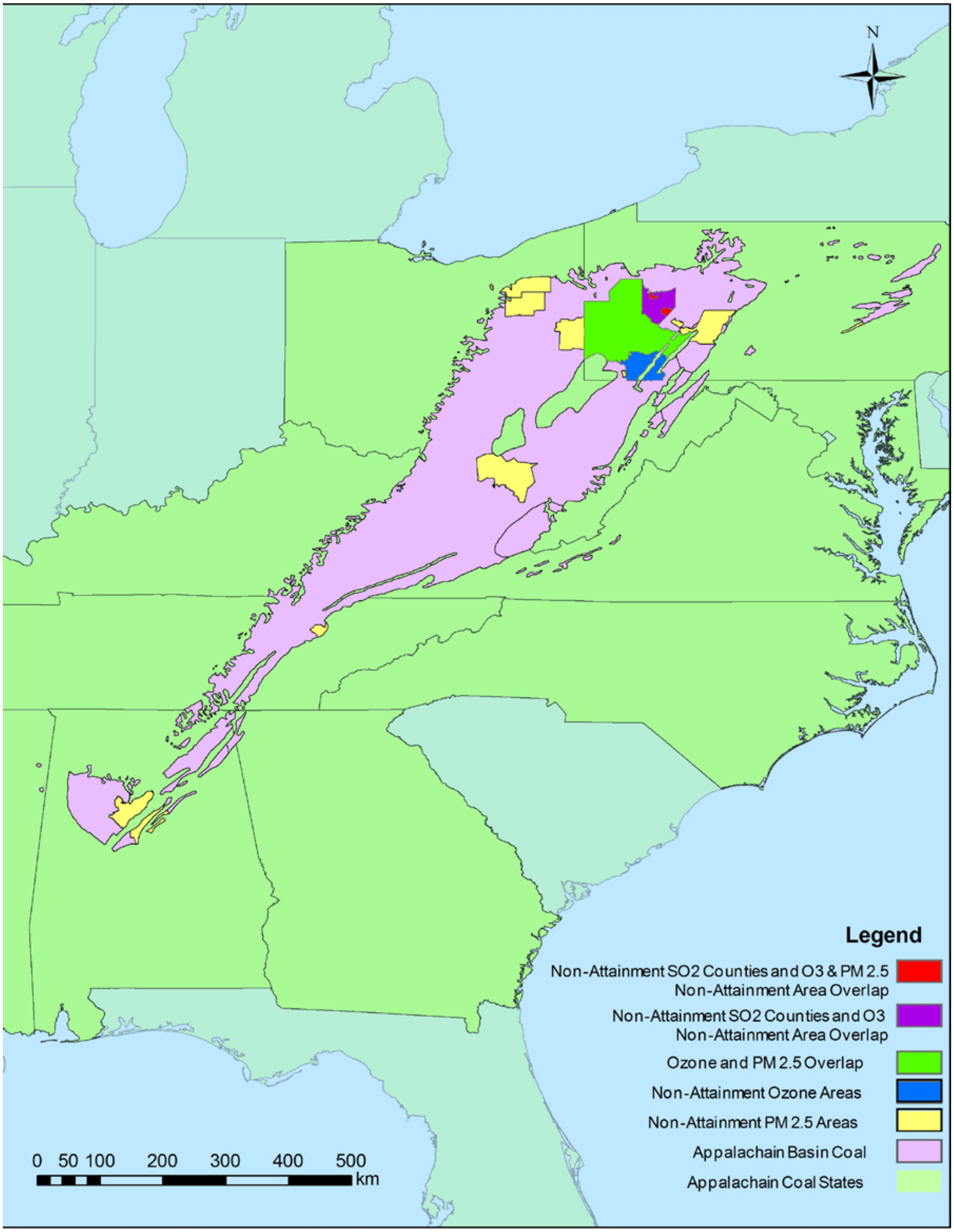
As discussed below, within the coal-producing regions, there are NAAQS nonattainment areas for the following criteria air pollutants: $PM_{2.5}$, PM_{10}, ozone, and SO_2. Mining activities in proximity to these nonattainment areas may contribute to further degradation of the air quality and may be subject to more stringent requirements to minimize emissions.

3.6.2.1 Appalachian Basin Region

Nonattainment Areas

Three ambient air pollutants in the Appalachian Basin exist in concentrations that exceed ambient air quality standards: $PM_{2.5}$, ozone, and sulfur dioxide (U.S. EPA, 2011b). Figure 3.6-3 depicts the locations of these nonattainment areas.

Figure 3.6-3 Nonattainment Areas in the Appalachian Basin Region



Source: Data- U.S. EPA, 2011c, The Green Book Nonattainment Areas for Criteria Pollutants, http://www.epa.gov/oar/oaqps/greenbk/index.html

Air quality readings exceed the 24-hour standard $PM_{2.5}$ in some cities in Alabama, Ohio, Pennsylvania, Tennessee, and West Virginia. Air quality readings exceed the annual $PM_{2.5}$ standard in parts of every state of the Appalachian Basin (U.S. EPA, 2011b).

Within the Appalachian coal basin, Pennsylvania is the only state containing nonattainment areas of the current 8-hour ozone standard (U.S. EPA, 2011b). The northeast region of the U.S. experiences high levels of ozone due to high-altitude transport of pollutants from Midwest and eastern power plants and other large industrial sources. As a result, state rules in these affected states (which include Pennsylvania) regulate new emission sources of VOC and NOx under nonattainment rules.

Armstrong County (Pennsylvania) is the only county within the Appalachian coal basin that contains SO_2 nonattainment areas.

The following PM and ozone nonattainment areas and SO_2 nonattainment counties are within the Appalachian Basin:

- **Alabama**: $PM_{2.5}$: Jefferson, Shelby, and Walker Counties;
- **Ohio**: $PM_{2.5}$: Portage, Summit, Jefferson, and Stark Counties;
- **Pennsylvania**:
    - Ozone: Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, and Westmoreland Counties;
    - $PM_{2.5}$: Allegheny, Armstrong, Beaver, Butler, Cambria, Dauphin, Greene, Indiana, Lawrence, Lebanon, Washington, and Westmoreland Counties;
    - SO_2: Armstrong County;
- **Tennessee**: $PM_{2.5}$: Anderson County; and
- **West Virginia**: $PM_{2.5}$: Putnam, Brooke, Kanawha, and Hancock Counties (U.S. EPA, 2011b).

<u>Pollutants of Concern</u>

Throughout the Appalachian Basin, ample forestland and trees are a source of biogenic VOC, such that in this region NOx is the only limiting factor for ozone formation. NOx is formed as a result of combustion; consequently any fuel combustion at mine, power plant, or other facility can potentially contribute to ozone formation.

Appalachian coal generally contains a significant amount of sulfur, although Virginia coal has less than one percent sulfur. Some mines require washing of the coal to remove this sulfur or ash material. Before this coal can be shipped, it must be dried using conveyor dryers or kilns. Hot air is supplied to these dryers by burning fuel. When coal is burned at the mine to supply heat to the dryer, the sulfur in the coal is oxidized to sulfur dioxide that contributes to SO_2 and fine particulate formation ($PM_{2.5}$) in the atmosphere. It also would be a primary contributor in an area that is in nonattainment with the air quality standards for these pollutants. Therefore, operations that burn coal at the mines for use in coal processing activities may be required to install air pollution controls on these sources, especially in Armstrong County, which is classified as a nonattainment area for sulfur dioxide in Pennsylvania.

State and Local Air Quality Authorities

Each state in the Appalachian Basin has an EPA-approved State Implementation Plan (SIP) that grants states permitting authority over their air management districts. In addition to state permitting authorities, Alabama, Kentucky, Tennessee, Ohio, and Pennsylvania have local permitting authorities that issue air permits within their jurisdictions. Permitting in other states is done by state agencies (U.S. EPA, 2011c).

Federal Class I Air Quality Areas

Federal Class I areas include designated federal parks and wilderness areas and other lands where air quality is subject to a higher level of protection. In the Appalachian Basin, there are numerous Class I areas around the Smoky Mountains and other portions of the Appalachian Mountain chain. A mine subject to PSD regulation must review its impact on all Class I areas within 300 kilometers (km).

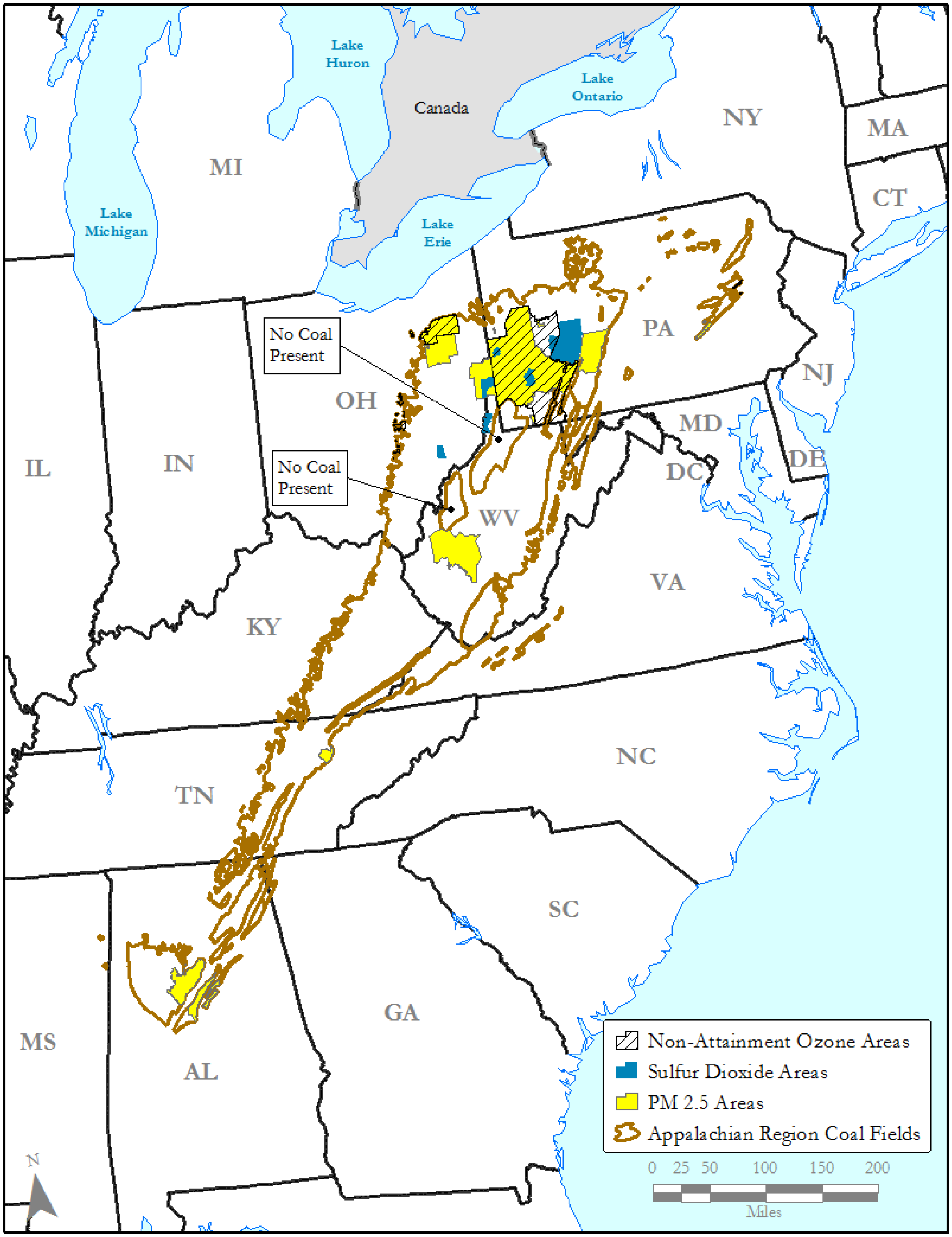
Figure 3.6-4 shows the locations of the Class I areas within 300 kilometers of the Appalachian Basin. The numbered areas are presented in Table 3.6-2 (U.S. EPA, 2011e; National Atlas of the United States, 2005).

Table 3.6-2
Federal Class I Areas in the Appalachian Basin

FEATURE ID	NAME	STATE
0	Sipsey Wilderness	AL
1	Shining Rock Wilderness	NC
2	Otter Creek Wilderness	WV
3	Lye Brook Wilderness	VT
4	Linville Gorge Wilderness	NC
5	Joyce Kilmer-Slickrock Wilderness	TN-NC
6	James River Face Wilderness	VA
7	Dolly Sods Wilderness	WV
8	Cohutta Wilderness	TN-GA
9	Shenandoah NP	VA
10	Great Smoky Mountains NP	TN
11	Mammoth Cave NP	KY
12	Brigantine Wilderness	NJ

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005.

Figure 3.6-4 Federal Class I Areas in the Appalachian Basin Region



Source: National Atlas of the United States, 2005, federal lands of the United States, USGS, U.S. DOI. http://nationalatlas.gov/atlasftp.html

3.6.2.2 Colorado Plateau Region

Nonattainment Areas

There are no NAAQS nonattainment areas for counties in the Colorado Plateau region.

Pollutants of Concern

Sulfur dioxide is a pollutant of concern in Arizona, which has neighboring counties classified as nonattainment for this criteria pollutant. The coal from this region has low ash content and low sulfur content (U.S. EIA, 1989). The low ash content is expected to produce lower particulate emissions while the low sulfur content is expected to reduce the amount of coal cleaning necessary.

State and Local Air Quality Authorities

Each state in the Colorado Plateau has an EPA-approved SIP that grants permitting authority over their air management districts. In addition to state permitting authorities, the counties of Maricopa, Pima, and Pinal in Arizona have local permitting authorities that issue air permits within their jurisdiction (U.S. EPA, 2011c; National Atlas of the United States, 2005).

Federal Class I Areas

In the Colorado Plateau, there are numerous Class I areas around the Rocky Mountains and in the deserts of Arizona and New Mexico where air quality is subject to a higher level of protection. A mine subject to PSD regulation must review its impact on all Class I areas within 300 kilometers.

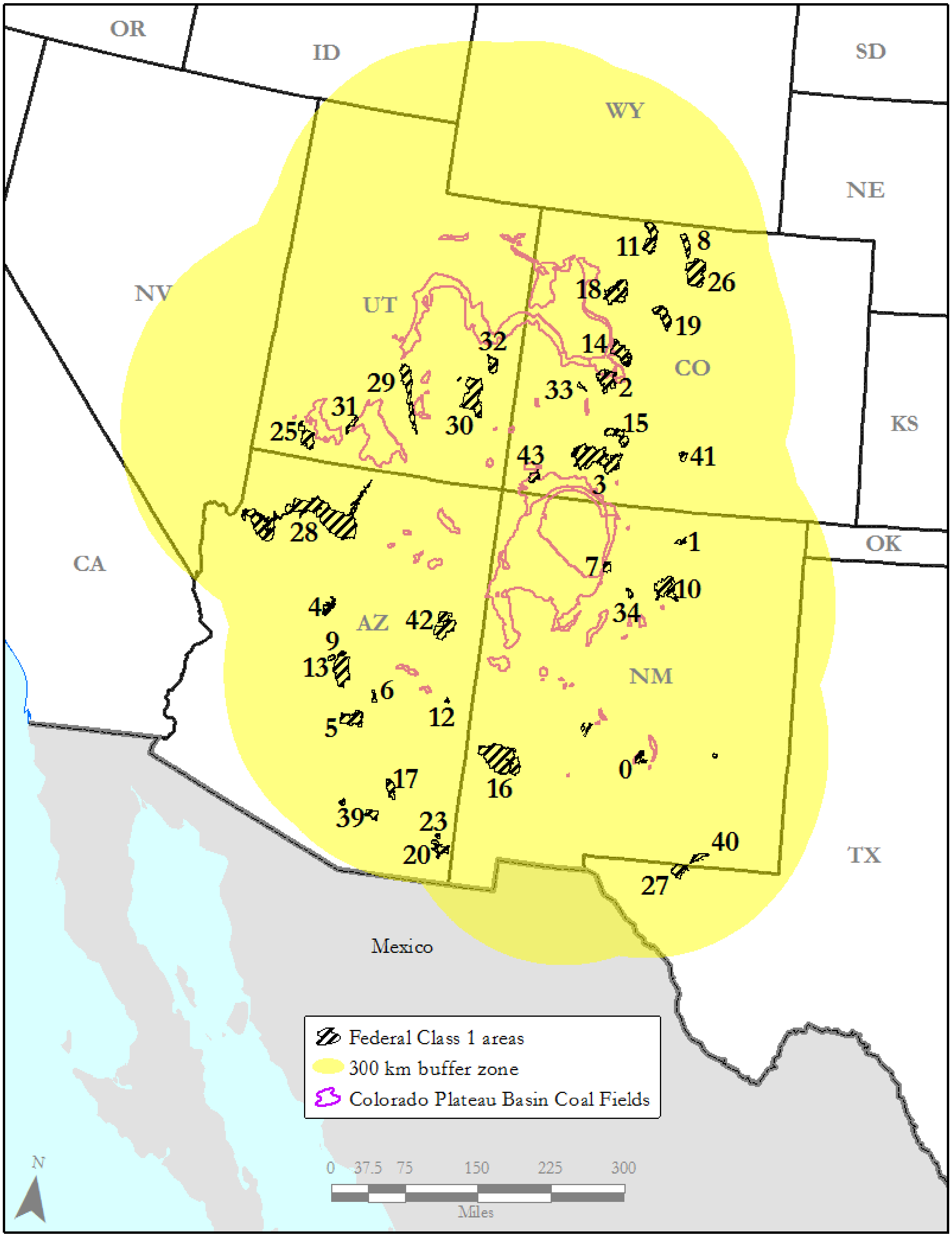
Figure 3.6-5 depicts the locations of these Class I areas, with the numbers corresponding to the following sites. The numbered areas are presented in Table 3.6-3.

Table 3.6-3
Federal Class I areas in the Colorado Plateau Region

FEATURE ID	NAME	STATE
0	White Mountain Wilderness	NM
1	Wheeler Peak Wilderness	NM
2	West Elk Wilderness	CO
3	Weminuche Wilderness	CO
4	Sycamore Canyon Wilderness	AZ
5	Superstition Wilderness	AZ
6	Sierra Ancha Wilderness	AZ
7	San Pedro Parks Wilderness	NM
8	Rawah Wilderness	CO
9	Pine Mountain Wilderness	Az
10	Pecos Wilderness	NM
11	Mount Zirkel Wilderness	CO
12	Mount Baldy Wilderness	AZ
13	Mazatzal Wilderness	AZ
14	Maroon Bells-Snowmass Wilderness	CO
15	La Garita Wilderness	CO
16	Gila Wilderness	NM
17	Galiuro Wilderness	AZ
18	Flat Tops Wilderness	CO
19	Eagles Nest Wilderness	CO
20	Chiricahua Wilderness	AZ
21	Chiricahua NM Wilderness-Not Studied	AZ
23	Chiricahua NM Wilderness-Designated Wilderness	AZ
25	Zion NP	UT
26	Rocky Mountain NP	CO
27	Guadalupe Mountains NP	TX
28	Grand Canyon NP	AZ
29	Capitol Reef NP	UT
30	Canyonlands NP	UT
31	Bryce Canyon NP	UT
32	Arches NP	UT
33	Black Canyon of the Gunnison Wilderness	CO
34	Bandelier Wilderness	NM
39	Saguaro Wilderness	AZ
40	Carlsbad Caverns NP	NM
41	Great Sand Dunes Wilderness-nps	CO
42	Petrified Forest NP	AZ
43	Mesa Verde NP	CO
44	Salt Creek Wilderness	NM
45	Bosque del Apache (Little San Pascual Unit)	NM
46	Bosque del Apache (Indian Well Unit)	NM
47	Bosque del Apache (Chupadera Unit)	NM

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005

Figure 3.6-5 Federal Class I Areas in the Colorado Plateau Region



Source: National Atlas of the United States, 2005, Federal Lands of the United States, USGS, U.S. DOI. http://nationalatlas.gov/atlasftp.html

3.6.2.3 Gulf Coast Region

Nonattainment Areas

There are no NAAQS nonattainment areas in the Gulf Coast region.

Pollutants of Concern

Throughout the Gulf Coast region, ample crops, forestland, and trees are a source of biogenic VOC, such that only NOx is the limiting factor for ozone formation. NOx is formed as a result of combustion, so any fuel combustion at a mine can potentially contribute to ozone formation.

The Gulf Coast region has surface mining and coal preparation plants only (U.S. EIA, 2011b). The coal from this region has very high ash content and median sulfur content (U.S. EIA, 1989). The high ash content would produce higher particulate emissions during handling, storage, and drying of coal, increasing the need for higher air pollution control at these sources.

State and Local Air Quality Authorities

Each state in the Gulf Coast region has an EPA-approved SIP that grants permitting authority over their air management districts (U.S. EPA, 2011c). No local air quality regulations exist in the Gulf Coast region coal-producing counties.

Federal Class I Areas

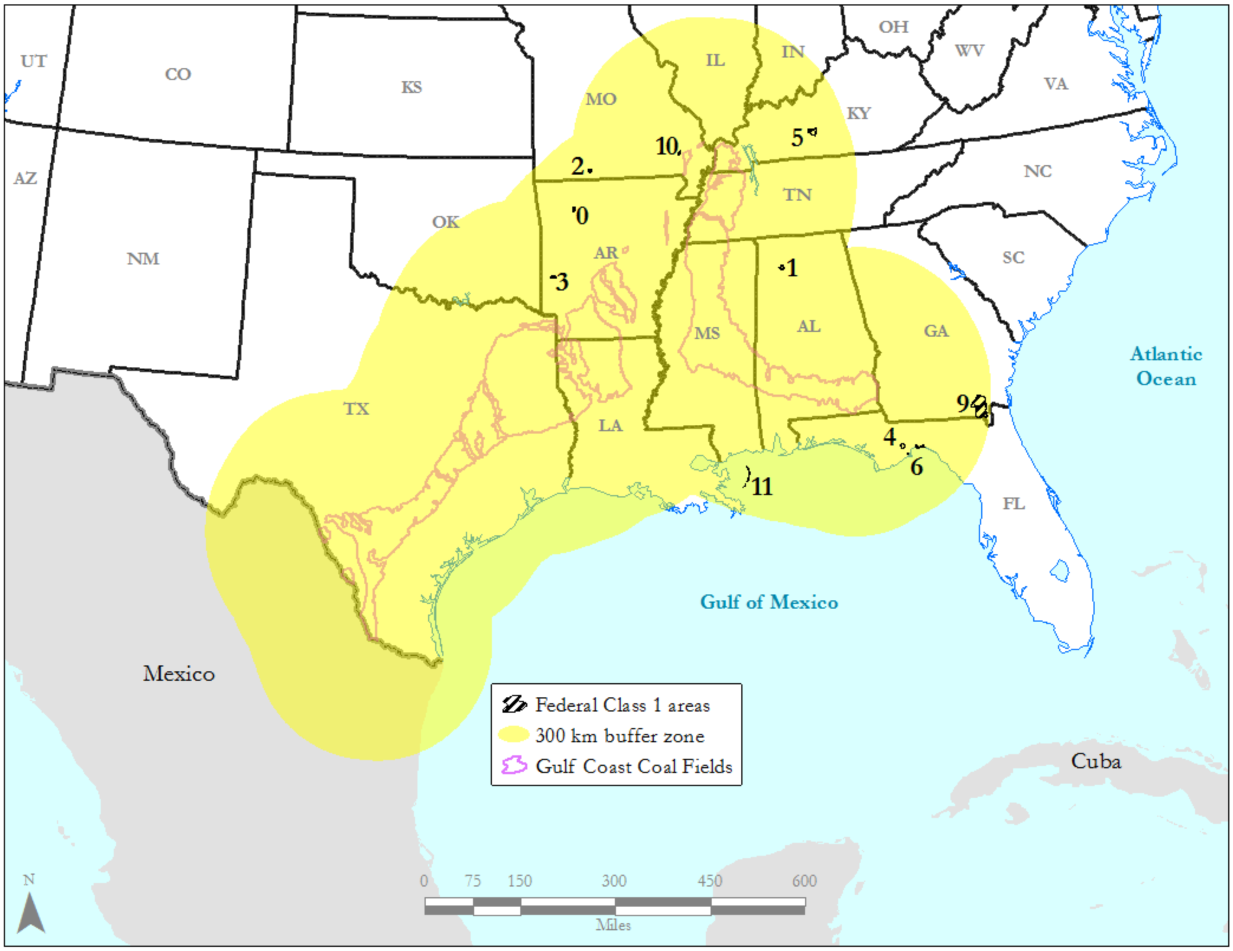
Federal Class I areas are designated federal lands, such as national parks and wilderness areas where air quality is subject to a higher level of protection. A mine subject to PSD regulation must review its impact on all Class I areas within 300 kilometers of the mine. In and around the Gulf Coast region, there are numerous Class I areas. These areas are depicted in Figure 3.6-6 and include (U.S. EPA, 2011e; National Atlas of the United States, 2005). The numbered areas are presented in Table 3.6-4.

Table 3.6-4
Federal Class I Areas in the Gulf Coast Region

FEATURE ID	NAME	STATE
0	Upper Buffalo Wilderness	AR
1	Sipsey Wilderness	AL
2	Hercules-Glades Wilderness	MO
3	Caney Creek Wilderness	AR
4	Bradwell Bay Wilderness	FL
5	Mammoth Cave NP	KY
6	Saint Marks Wilderness	FL
9	Okefenokee Wilderness	GA
10	Mingo Wilderness	MO
11	Breton Wilderness	LA

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005

**Figure 3.6-6	Federal Class I Areas in the Gulf Coast Region**



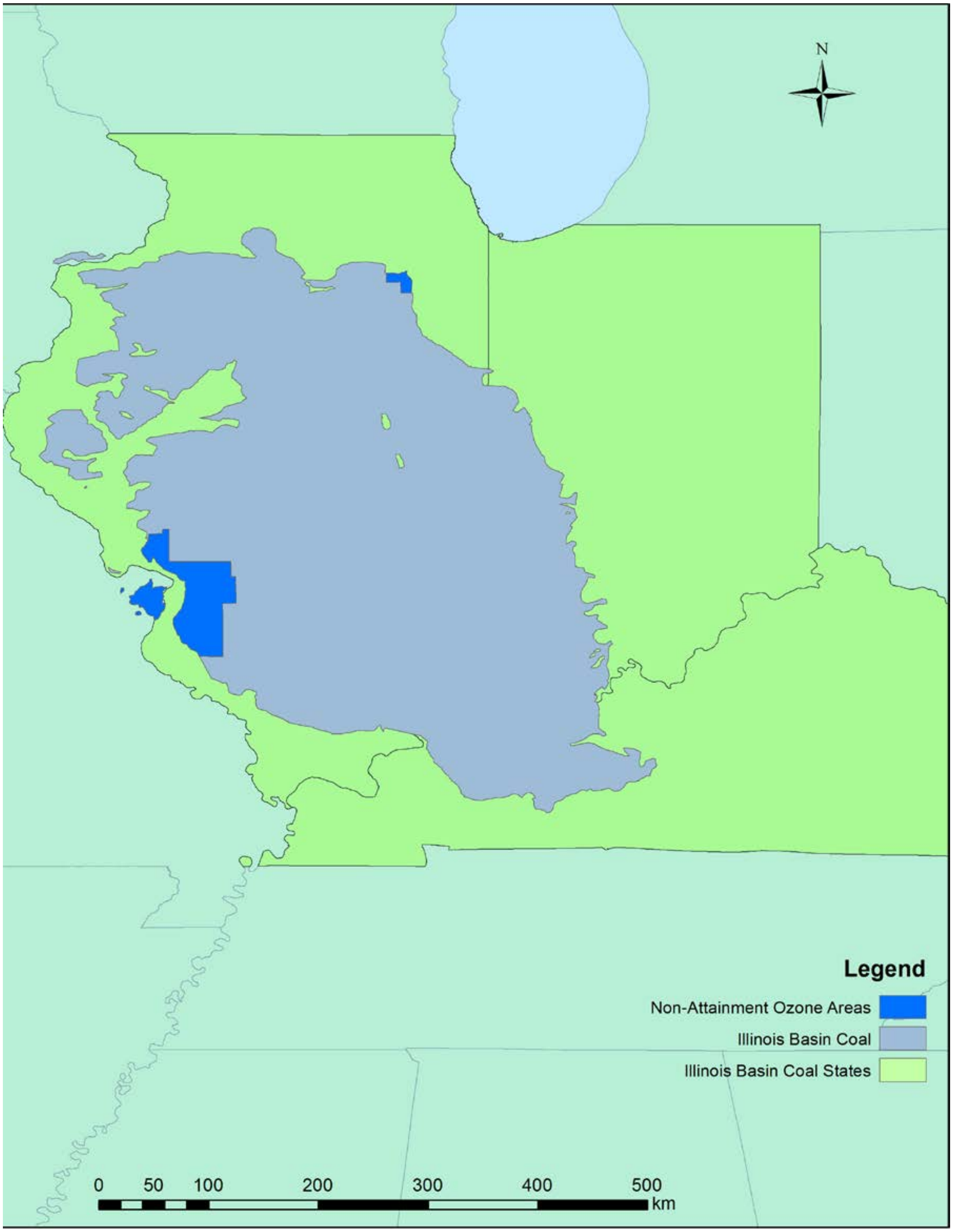
Source: National Atlas of the United States, 2005, federal lands of the United States, USGS. http://nationalatlas.gov/atlasftp.html

3.6.2.4 Illinois Basin Region

Nonattainment Areas

In the Illinois Basin, ozone (O_3) is the only pollutant that currently exists in concentrations exceeding ambient air quality standards (U.S. EPA, 2011b). Figure 3.6-7 shows the locations of these nonattainment areas, which include Grundy, Will, Jersey, Madison, St. Clair, and Monroe Counties.

Figure 3.6-7 Nonattainment Areas in the Illinois Basin Region



Source: U.S. EPA, 2011c, The Green Book Nonattainment Areas for Criteria Pollutants, http://www.epa.gov/oar/oaqps/greenbk/index.html

Pollutants of Concern

Coal mined in the Illinois Basin generally contains a significant amount of sulfur. When burned, this sulfur is oxidized to sulfur dioxide, which contributes to fine particulate formation ($PM_{2.5}$) in the atmosphere. Therefore, when coal is burned at the mines for coal processing activities, air pollution controls or alternative fuels should be considered.

The Illinois Basin region has both surface mining and underground mining operations, as well as coal preparation plants (U.S. EIA, 2011b). The coal from this region has median ash content and very high sulfur content (U.S. EIA, 1989). This sulfur and ash content would increase the amount of coal cleaning necessary. As a result, the coal dryers may potentially cause greater particulate emissions (and possibly sulfur dioxide depending on the fuel) than at comparable mines in other regions.

State and Local Air Quality Authorities

Each state has an EPA-approved SIP that grants permitting authority over their air management districts. In addition to state permitting authorities, Jefferson County in Kentucky has a local permitting authority that issues air permits within its jurisdiction (U.S. EPA, 2011c).

Federal Class I Air Quality Areas

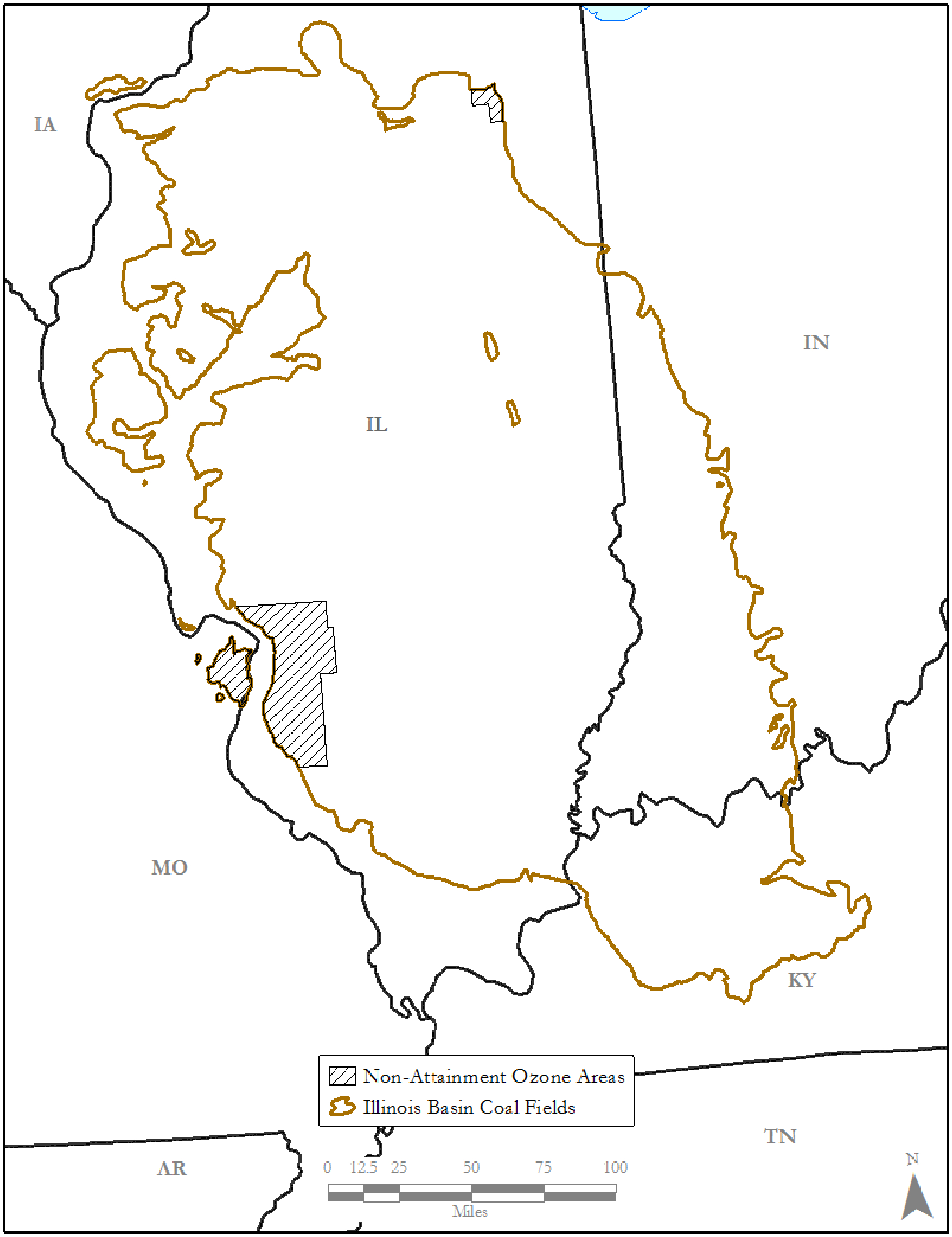
Federal Class I areas are designated federal lands where air quality is subject to a higher level of protection. In the Illinois Basin, there are numerous Class I areas. A mine subject to PSD regulation will need to review its impact on all Class I areas within 300 kilometers. Figure 3.6-8 shows the locations of the Class I areas within 300 kilometers of the region, which include (U.S. EPA, 2011e; National Atlas of the United States, 2005). The numbered areas are presented in Table 3.6-5.

Table 3.6-5
Federal Class I Areas in the Gulf Coast Region

FEATURE ID	NAME	STATE
0	Sipsey Wilderness	AL
1	Joyce Kilmer-Slickrock Wilderness	TN-NC
2	Mammoth Cave NP	KY
3	Mingo Wilderness	MO

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005

Figure 3.6-8 Federal Class I Areas in the Illinois Basin Region



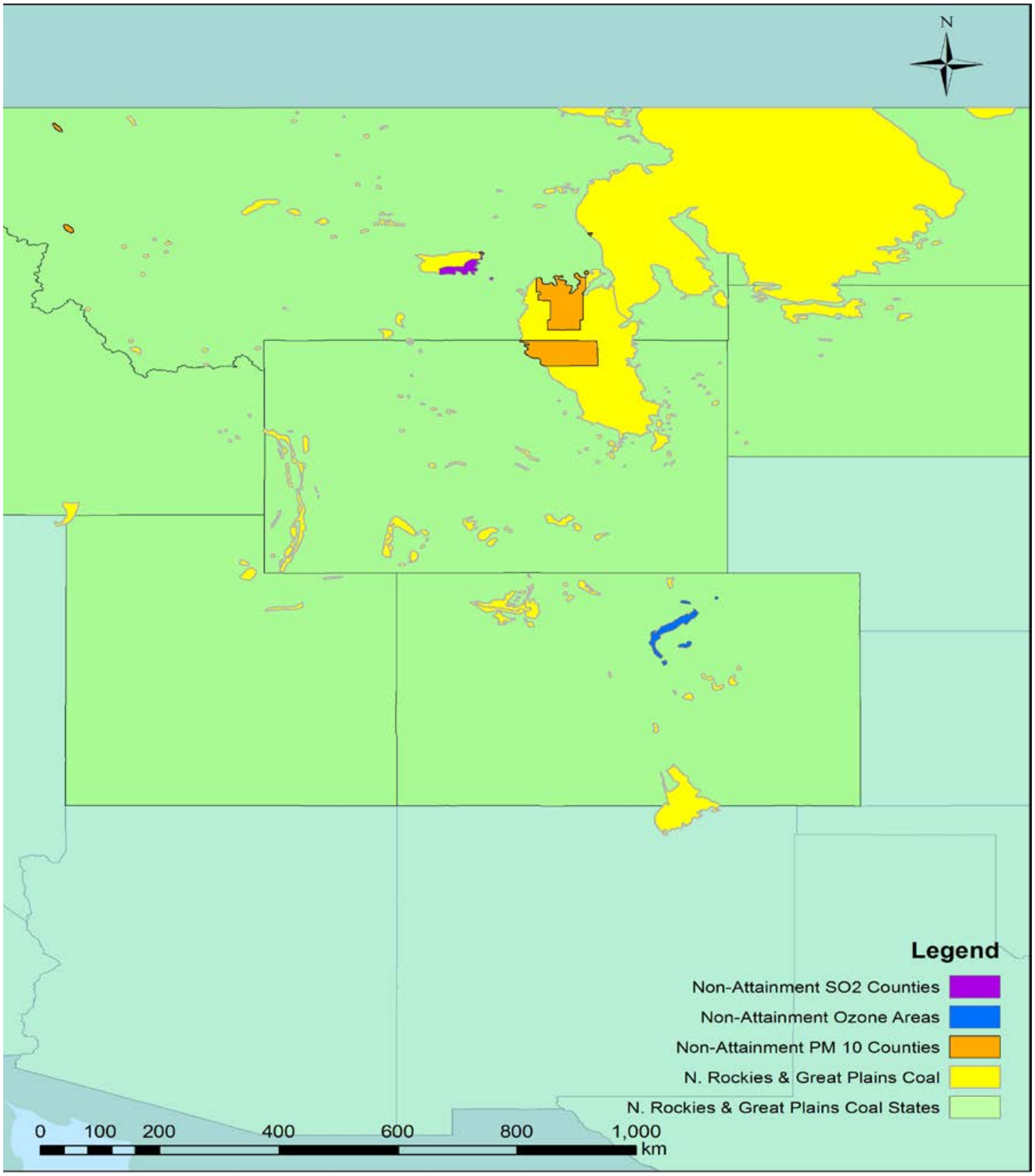
Source: National Atlas of the United States, 2005, federal lands of the United States, USGS, U.S. DOI . http://nationalatlas.gov/atlasftp.html

3.6.2.5 Northern Rocky Mountains and Great Plains Region

Nonattainment Areas

Coarse particulates (PM_{10}), ozone, and SO_2 in the Northern Rocky Mountains and Great Plains region currently exceed ambient air quality standards (U.S. EPA, 2011b). Figure 3.6-9 depicts nonattainment areas within the Northern Rocky Mountains and Great Plains region.

Figure 3.6-9 Nonattainment Areas in the Northern Rocky Mountains and Great Plains Region



Source: U.S. EPA, 2011c, The Green Book Nonattainment Areas for Criteria Pollutants, http://www.epa.gov/oar/oaqps/greenbk/index.html

Montana and Wyoming are the only two states within the Northern Rocky Mountains and Great Plains coal basin with counties that contain nonattainment PM_{10} areas (U.S. EPA, 2011b). The Denver, CO area is in nonattainment for the current 8-hour ozone standard. Southwest Wyoming is proposed for designation as nonattainment for ozone (U.S. EPA, 2011b). Montana is the only state in this coal basin with counties that contain nonattainment SO_2 areas (U.S. EPA, 2011b).

The following nonattainment areas (U.S. EPA, 2011b) are within the Northern Rocky Mountains and Great Plains region:

- **Colorado**:
  - PM_{10}: Rosebud, Flathead, and Missoula Counties;
  - Ozone: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, and Weld Counties;
- **Montana**:
  - PM_{10}: Rosebud Co;
  - SO_2: Yellowstone County; and
- **Wyoming**: PM_{10}: Sheridan County.

Pollutants of Concern

Most of the mining in this area is surface mining, which would generate more surface disturbance and result in more dust generation. Therefore, dust emissions from mining activities caused by haul roads and conveyors are a concern in this region. The coal from this region has relatively low ash and sulfur content (U.S. EIA, 1989). Less coal cleaning is needed and particulate emissions from coal are low relative to other regions.

State and Local Air Quality Authorities

Each state has an EPA-approved SIP that grants permitting authority over their air management districts. Therefore, air permits for mining operations are issued by the states (U.S. EPA, 2011c).

Federal Class I Air Quality Areas

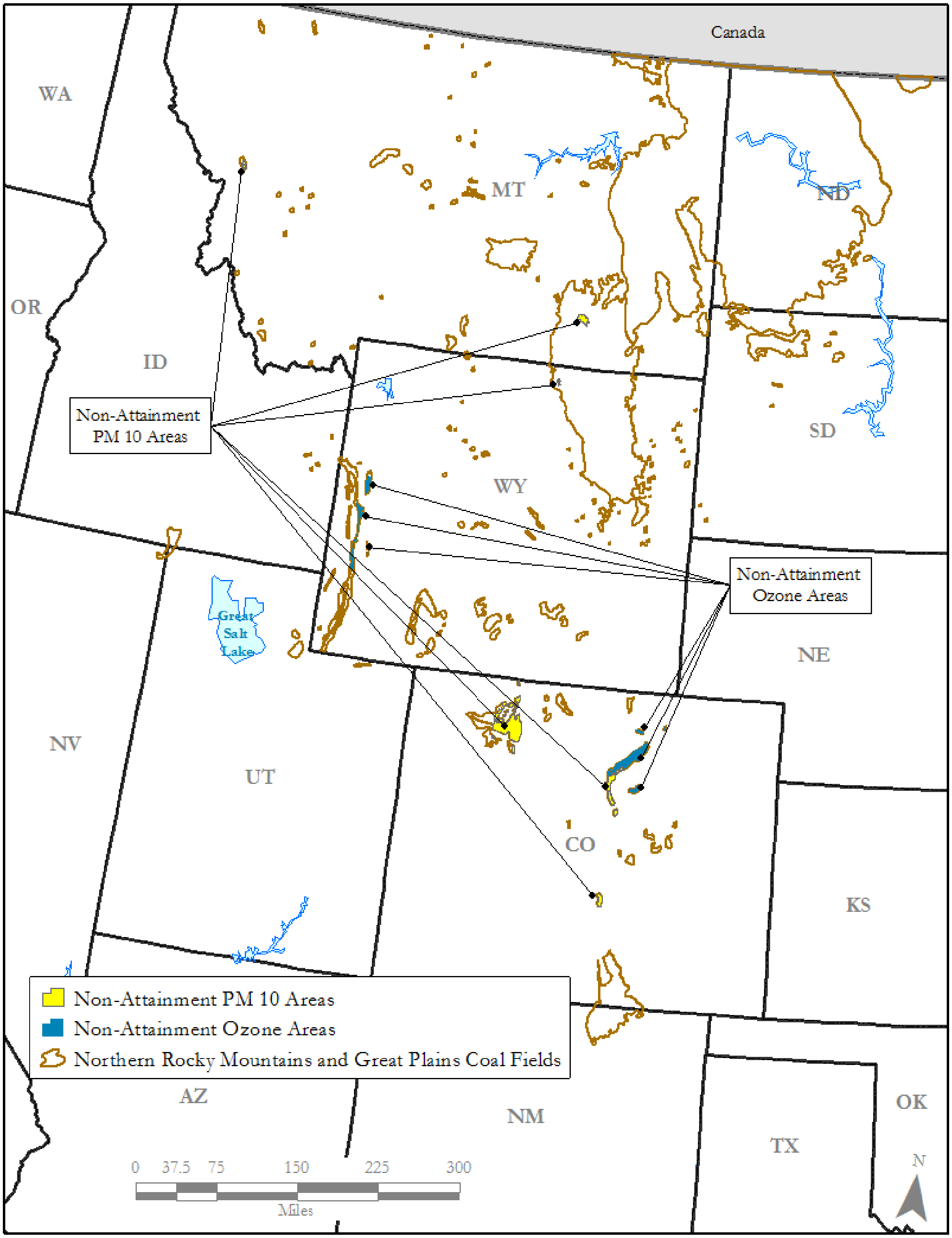
Federal Class I areas are designated federal lands where air quality is subject to a higher level of protection. A mine subject to PSD regulation will need to review its impact on all Class I areas within 300 kilometers. In the Northern Rocky Mountains and Great Plains region, numerous Class I areas exist around the Rocky Mountains and in other areas. Figure 3.6-10 depicts the locations of these areas, which include the following (U.S. EPA, 2011e; National Atlas of the United States, 2005):

FEATURE ID	NAME	STATE
0	Wheeler Peak Wilderness	NM
1	West Elk Wilderness	CO
2	Weminuche Wilderness	CO
3	Washakie Wilderness	WY
4	Teton Wilderness	WY
5	Selway-Bitterroot Wilderness	MT-ID

FEATURE ID	NAME	STATE
6	Scapegoat Wilderness	MT
7	Sawtooth Wilderness	ID
8	San Pedro Parks Wilderness	NM
9	Rawah Wilderness	CO
10	Pecos Wilderness	NM
11	North Absaroka Wilderness	WY
12	Mount Zirkel Wilderness	CO
13	Mission Mountains Wilderness	MT
14	Maroon Bells-Snowmass Wilderness	CO
15	La Garita Wilderness	CO
16	Jarbridge Wilderness	NV
17	Hells Canyon Wilderness	ID-OR
18	Gates of the Mountains Wilderness	MT
19	Flat Tops Wilderness	CO
20	Fitzpatrick Wilderness	WY
21	Eagles Nest Wilderness	CO
22	Eagle Cap Wilderness	OR
23	Cabinet Mountains Wilderness	MT
24	Bridger Wilderness	WY
25	Bob Marshall Wilderness	MT
26	Anaconda Pintler Wilderness	MT
27	Yellowstone NP	WY
28	Rocky Mountain NP	CO
29	Grand Teton NP	WY
30	Glacier NP	MT
31	Capitol Reef NP	UT
32	Canyonlands NP	UT
33	Arches NP	UT
34	Craters of the Moon Wilderness	ID
35	Black Canyon of the Gunnison Wilderness	CO
36	Bandelier Wilderness	NM
37	Badlands/Sage Creek Wilderness 1	ND
38	Badlands/Sage Creek Wilderness 2	ND
39	Wind Cave National Park	SD
40	Theodore Roosevelt NP	ND
41	Great Sand Dunes Wilderness-nps	CO
42	Mesa Verde NP	CO
43	UL Bend Wilderness	MT
47	Red Rock Lakes Wilderness	MT
51	Medicine Lake Wilderness	MT
53	Lostwood Wilderness	ND

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005

Figure 3.6-10 Federal Class I Areas in the Northern Rocky Mountains and Great Plains Region



Source: National Atlas of the United States, 2005, federal lands of the United States, USGS, U.S. DOI . http://nationalatlas.gov/atlasftp.html

3.6.2.6 Northwest Region (Alaska) Regional Air Quality, Meteorology and Noise

Alaska is the only state included in the DEIS as it has an active coal mine with coal extraction. As discussed in 3.0 coal production is not predicted to occur in the reasonably foreseeable future in the other portions of the Northwest region and therefore these areas are not included here in this discussion of air quality.

Nonattainment Areas

There are no NAAQS nonattainment areas within the Northwest region.

Pollutants of Concern

There are no specific pollutants of concern in the Northwest region. There are currently surface mining and coal preparation operations associated with the one actively producing mining area in the Northwest region. The coal from this region has low ash and sulfur content (U.S. EIA, 1989). The low ash content would produce lower particulate emissions while the low sulfur content would reduce the amount of coal cleaning necessary.

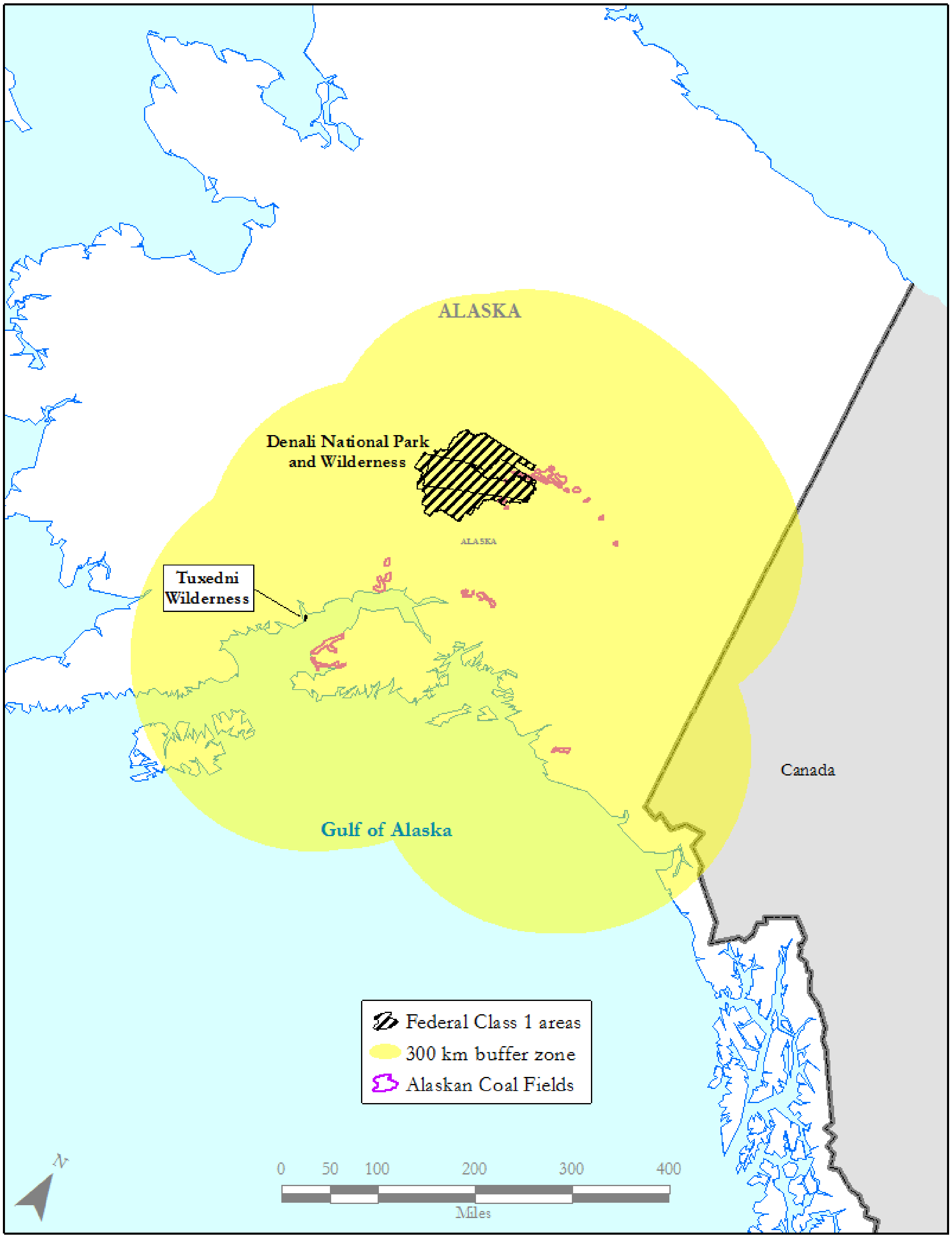
State and Local Air Quality Authorities

Alaska has an EPA-approved SIP that grants permitting authority over its air management districts. Therefore, any air permits for a mining operation would be granted by the state (U.S. EPA, 2011c). There are no local air quality authorities.

Federal Class I Air Quality Areas

Federal Class I areas are designated federal lands where air quality is subject to a higher level of protection. Denali National Park and Denali National Park and Wilderness are the only Class I areas within 300 kilometers of the subject coal fields. A coal mine permit would include a review of its impact on the Class I area (U.S. EPA, 2011e; National Atlas of the United States, 2005). Figure 3.6-11 shows the locations of these Class I areas.

Figure 3.6-11 Federal Class I Areas in the Northwest Region



Source: National Atlas of the United States, 2005, federal lands of the United States, USGS, U.S. DOI. http://nationalatlas.gov/atlasftp.html

3.6.2.7 Western Interior Region

Nonattainment Areas

There are no NAAQS nonattainment areas within the Western Interior region.

Pollutants of Concern

There are no specific pollutants of concern in the Western Interior region. There are currently underground mining, surface mining, and coal preparation operations in the Western Interior region (U.S. EIA, 2011b). The coal from this region has medium to high ash content and generally high sulfur content (U.S. EIA, 1989). This sulfur and ash content would increase the amount of coal cleaning necessary. As a result, coal dryers potentially could cause greater particulate emissions (and possibly sulfur dioxide emissions, depending on the fuel used in the dryers) than comparable mines in other regions.

State and Local Air Quality Authorities

Each state has an EPA-approved SIP that grants permitting authority over their air management districts. Therefore, air permits for mining operations are granted by the states (U.S. EPA, 2011c).

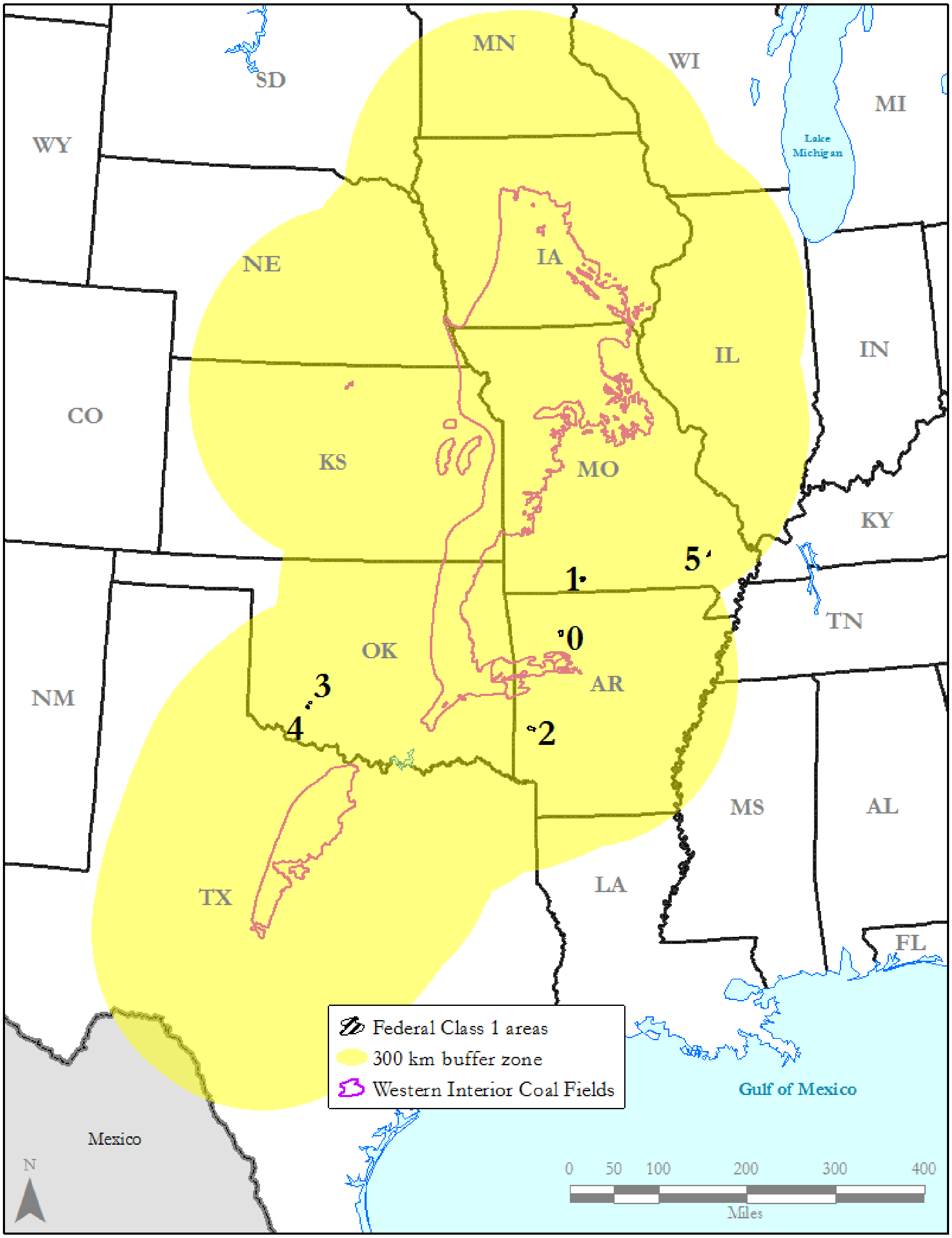
Federal Class I Air Quality Areas

Federal Class I areas are designated federal lands where air quality is subject to greater protection. A mine subject to PSD regulation will need to review its impact on all Class I areas within 300 kilometers. Within 300 kilometers of the Western Interior region, there are numerous Class I areas. Figure 3.6-12 shows the locations of these Class I areas, which include (U.S. EPA, 2011e; National Atlas of the United States, 2005):

FEATURE ID	NAME	STATE
0	Upper Buffalo Wilderness	AR
1	Hercules-Glades Wilderness	MO
2	Caney Creek Wilderness	AR
3	Wichita Mountains (North Mountain Unit)	OK
4	Wichita Mountains (Charons Garden Unit)	OK
5	Mingo Wilderness	MO

Source: U.S. EPA, 2011e; National Atlas of the United States, 2005

Figure 3.6-12 Federal Class I Areas in the Western Interior Region



Source: National Atlas of the United States, 2005, federal lands of the United States, USGS, U.S. DOI. http://nationalatlas.gov/atlasftp.html

3.7 LAND USE

3.7.1 Land and Mineral Ownership

Mineral ownership in the U.S. is often comprised of split estates, in which different parties own the surface and subsurface rights. Such estates are common throughout the coal-producing regions. In many instances, interests in the mineral estate (coal) were sold or otherwise severed long before the current surface owners acquired the land. State property law and legal instruments of conveyance determine the extent to which the owner of the mineral estate may exercise his or her rights to the detriment of the owner of the surface estate. Section 510 of SMCRA, however, requires that an applicant proposing to remove coal by surface mining methods must demonstrate a valid right of entry. In addition, Section 714 of SMCRA provides qualified surface owners, whose property overlies federal coal, with additional protections before the coal is leased for anticipated surface mining operations. Appendix G provides a detailed breakdown of land use percentages for the individual states and county study areas described by region below.

3.7.2 Federal and Indian Lands

The area of study includes seven coal-producing regions containing lands where the federal government holds title to the coal, the surface estate, or both. Recent USGS assessments estimate federally owned coal reserves in the U.S. at 957,000 million short tons (MMton), of which the Powder River Basin contains 58 percent (550,000 MMton) and the Colorado Plateau contains 38 percent (361,860 MMton). The remaining four percent of federally owned coal is distributed throughout other coal regions (USGS, 2007).

Federal surface lands in the eastern U.S. include National Forests, U.S. military properties, National Parks, water bodies, other recreational areas, and historical sites. In the coal-bearing area of the Appalachian Basin, about 90 percent of federal land is in National Forests.

USGS assessments of federally owned coal in the Northern and Central Appalachian coal regions indicated that federal coal ownership comprised 2 to 13 percent of the remaining reserves within those regions, while federal coal ownership in the West comprises approximately 70 percent to 80 percent of the total coal reserves in that region. (USGS, 2002b)

The Bureau of Land Management (BLM) has the authority to grant leases to operators wishing to mine federally owned coal. The Mineral Leasing Act of 1920 (MLA), as amended, and the Mineral Leasing Act for Acquired Lands of 1947, as amended, designates the BLM as the primary agency responsible for coal leasing on approximately 570 million acres of the 700 million acres of mineral estate owned by the federal government.

Not all federal lands are available for coal exploration or leasing. Under the BLM land use planning process, four land-use screening steps are used to identify which federal lands are acceptable for consideration for coal leasing and development:

- Identification of coal with potential for development;
- Determination if the lands are unsuitable for coal development;

- Consideration of multiple-use conflicts; and
- Surface owner consultation.

Specific coordination occurs during the review of permits for mining on federal lands and mining of federal coal. Mining of federal coal on lands where the surface is managed by a federal agency requires OSMRE to consult with the federal land managing agency during the permit application review. Mining of federal coal on lands where the surface is managed by a federal agency not within DOI requires OSMRE to consult with the managing agency to obtain consent on the terms of the mining plan prior to approval by the DOI Assistant Secretary, Land and Minerals Management (ALSM). Where the federal land is within a National Forest certain findings must be made before a permit for conducting surface coal mining operations on these lands may be issued. A prospective operator may assert valid existing rights to conduct surface mining of private coal on federal lands; in these instances it is ASLM and not the state regulatory authority that determines whether the operator has valid existing rights. 30 CFR 740.4(a)(4).

Prior to mining federal coal, a lessee/applicant must traverse a three step process: the BLM must issue a coal lease, the SMCRA regulatory authority must issue a surface mining permit, and the ALSM must approve a mining plan. Similarly, if an existing federal coal lessee seeks a surface mining permit revision, OSMRE must also determine whether the revision constitutes a mining plan modification that requires an additional ASLM mining plan approval.

As part of the first step—the federal coal leasing process—the BLM approves the applicant's Resource Recovery and Protection Plan (R2P2), which "show[s] tha the proposed operation meets the requriements of the MLA for development, production, resource recovery and protection, diligent development, continued operation, [maximum economic recovery], and [other applicable regulations] for the life-of-the-mine." 43 CFR 3480.0-5(a)(34); see also 43 CFR 3482.1(b).

As part of the second step—the SMCRA permitting process—the applicant must submit a permit application package (PAP) to the SMCRA regulatory authority and to OSMRE, if OSMRE is not the regulatory authority. The identity of the regulatory authority is determined by whether a state has primacy and a formal State-Federal cooperative agreement that delegates the responsibility to regulate coal mining on federal lands to the State.

The requirements for the development, approval and administration of cooperative agreements are specified in 30 CFR Part 745—State-Federal Cooperative Agreements. Completed State-Federal cooperative agreements are found within 30 CFR 900 through 955. As of May 2015, fifteen states had cooperative agreements that designate them as the regulatory authority for federal lands: Alabama, Colorado, Illinois, Indiana, Kentucky, Montana, Nebraska, New Mexico, North Dakota, Ohio, Oklahoma, Utah, Virginia, West Virginia, and Wyoming. In most states this cooperative agreement allows the states to grant permits for federal leased coal; however, pursuant to the terms of West Virginia's cooperative agreement, OSMRE is the issuer of permits for federal leased coal. In the states of Tennessee and Washington, OSMRE is the regulatory authority for federal and non-federal lands.

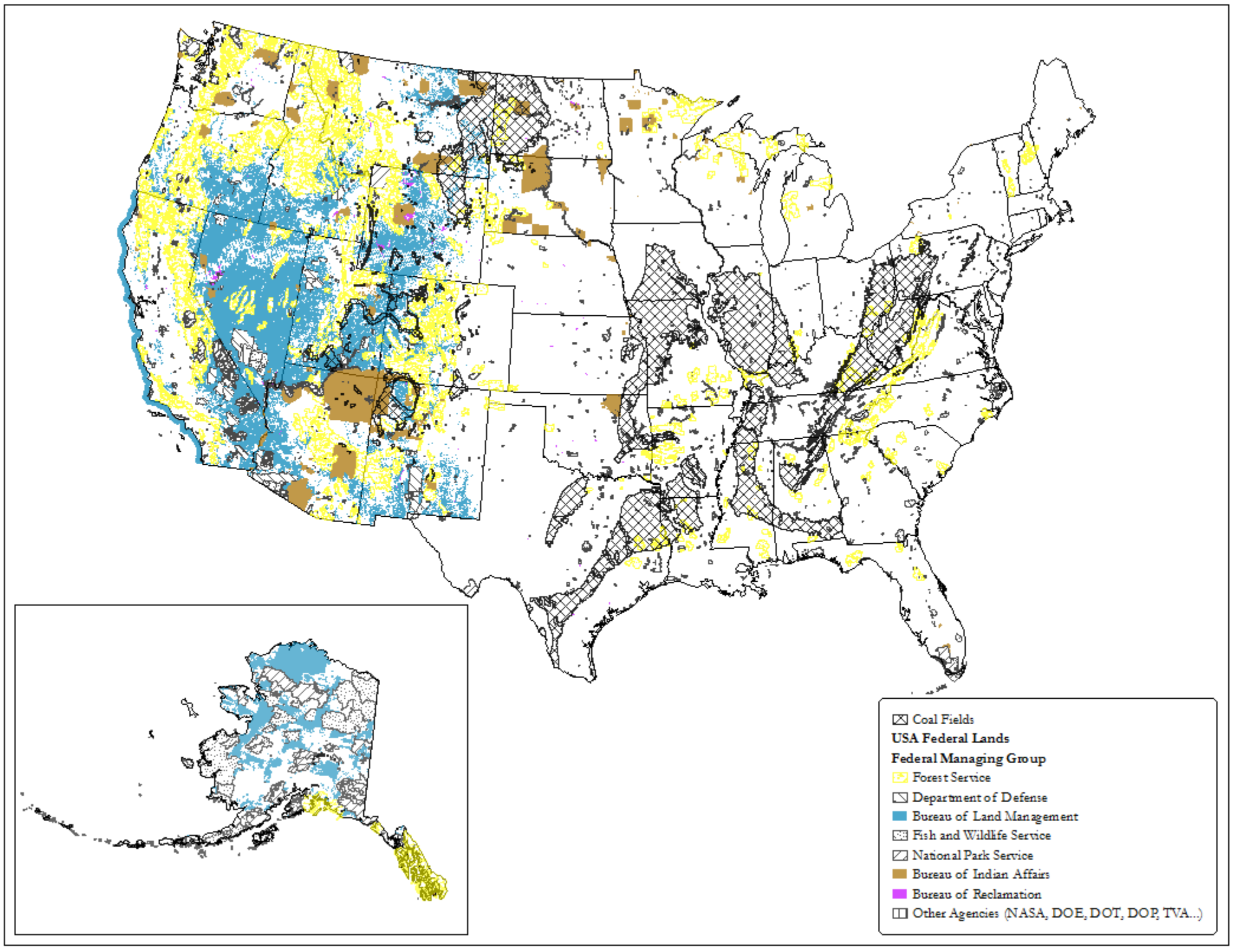
The SMCRA regulatory authority will review and approve, approve with conditions, or disapprove the proposed SMCRA permit application.

In most cases, the SMCRA permit will be approved prior to OSMRE beginning its development and review of the mining plan and the Mine Plan Decision Document (MPDD), the third step required prior to extraction of federal coal. Once OSMRE, in consultation with other appropriate federal and state agencies, assesses the completeness and adequacy of the MPDD, OSMRE will recommend approval, approval with conditions, or disapproval of the mine plan to the ASLM. The MPDD is the document by which the ASLM will act on the mining plan. The ASLM is not required to follow OSMRE's recommendation.

The authorization for coal leasing on Indian lands is provided by the Indian Mineral Leasing Act of 1938 and the Indian Minerals Development Act of 1982 (IMDA). Most leasing on tribal land is currently done under the IMDA. This act establishes that tribes have the authority to enter into agreements to develop coal reserves on Indian lands independently without federal oversight. The IMDA also provides that the federal government will provide advice, assistance, and information during this process. The assistance to tribes is facilitated by the Bureau of Indian Affairs (BIA) in coordination with the BLM, the Office of Natural Resources Revenue (ONRR), OSMRE, and other agencies as necessary. Once leasing agreements have been approved by the Tribe and the BIA, the BLM must approve the mining plan, including the R2P2, and OSMRE must approve the SMCRA permit application for the proposed surface coal mining and reclamation operations. The BLM regulates coal exploration activities on Indian lands.

Figure 3.7-1 shows federal lands and Indian lands in the conterminous U.S. in relationship to the coal fields, (this map does not distinguish between mineable and non-mineable coal). However, this figure does not include lands where the federal government or Indian tribe owns the mineral resources but not the surface estate.

Figure 3.7-1 Federal Lands and Coal Fields in the Conterminous United States



Source: USGS, 2013d. Coal Fields and Federal Lands of the Conterminous United States. Open-File Report 97-461. U.S. Department of the Interior. http://pubs.usgs.gov/of/1997/ofr-97-0461/

3.7.3 Regional Land Use

3.7.3.1 Appalachian Basin Region

Approximately 60 percent of the premining land in the Appalachian Basin is deciduous forest. There are several large national forests within the area including the Daniel Boone National Forest and the Monongahela National Forest. Most of the farmland in the Appalachian coal regions is in Northern Appalachia, with small agricultural areas in central and southern Appalachia. Approximately 10 percent of the land in the Appalachian Basin is pasture/hayland, and four percent is used for cultivated crops. Table 3.7-1 (see Appendix G) provides a detailed breakdown of land use percentages for the individual states and county study areas within this region (USGS, 2001b).

In 2003, OSMRE in conjunction with the EPA, U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (U.S. FWS), and West Virginia Department of Environmental

Protection (WV DEP), prepared a programmatic Environmental Impact Statement (EIS) to evaluate the impacts of mountaintop mining and valley fills (U.S. EPA, et al., 2003). The purpose of the final EIS was: "to evaluate options for improving agency programs under the Clean Water Act (CWA), SMCRA and the Endangered Species Act (ESA) that will contribute to reducing the adverse environmental impacts of mountaintop mining operations and excess spoil valley fills in Appalachia" (U.S. EPA, et al., 2003). The study area for this EIS was approximately 12 million acres encompassing most of eastern Kentucky, southern West Virginia, western Virginia, and scattered areas of eastern Tennessee. The following information is derived from that study.

The overwhelming land use in the study area is forest, which covers approximately 11 million acres or 92 percent of the total 12 million acre study area. Deciduous forests cover over nine million acres or 79 percent of the study area. Mixed deciduous and evergreen forests encompass nine percent of the study area. Developed areas (residential, commercial and industrial) account for about one percent of the study area.

West Virginia Study Area

The 2002 West Virginia University Land Use Assessment was conducted to examine land use issues associated with mountaintop mining[3] in the 14-county study region of southern West Virginia (Yuill, 2002). The results were derived from Landsat satellite data. The satellite data was classified and converted to Geographic Information System (GIS) coverage for analysis and display. Results confirmed the forested/lightly developed character of the West Virginia mountaintop mining region. Almost 88 percent, or slightly over four million acres, was classified as mature forest land, with the diverse mesophytic forest type, which was most prevalent at almost three million acres. All developed land uses (intensive urban, moderately intensive urban, light urban, populated areas, major roads, and infrastructure such as power lines) accounted for 155,000 acres or roughly three percent of the land area. Agricultural land uses were found on approximately a quarter of a million acres or five percent of the land area. Other general land use/land cover categories include: shrub land and woodland areas with slightly over 63,000 acres; water/wetlands with 56,000 acres or one percent of the land area; and barren land/mining with 74,000 acres or 1.5 percent of the study area.

Patterns of Land Use Changes, West Virginia Study Area

The general land use/land cover changes for the 14-county West Virginia study area were examined during three different time periods: 1950, 1976, and 2001.

[3]The term "mountaintop mining" used in the 2003 Mountaintop Mining-Valley Fills DEIS encompasses three different kinds of surface mining operations (contour mining, area mining, and mountaintop removal mining) that create valley fills. This is a broader definition than the legal definition used in SMCRA "mountaintop removal mining." Mountaintop removal mining totally extracts underlying coal seams, and the reclaimed land is left in a flat or gently rolling configuration capable of supporting certain postmining land uses, such as industrial, commercial, residential, agricultural, or public facilities (including recreational facilities). Mountaintop removal operations are subject to the approximate original contour (AOC) variance provisions of SMCRA, in order to provide for the development of such lands to alternative uses that could not otherwise be achieved if the lands were restored to AOC. Steep slope AOC variances are also allowed under SMCRA for the purpose of developing alternative land uses; however, unlike mountaintop removal AOC variances, agricultural land uses are not allowed.

An analysis of the data from the three periods noted above revealed the following general patterns of land use change in the region:

- The acreage of developed area increased from 42,533 acres in 1950 to 154,966 acres in 2001. This acreage likely does not include much of the dispersed development that dominates the region.
- Agricultural acreage decreased from almost a million acres in 1950 to 188,000 acres in 1976, then increased to 246,000 acres by 2001. Much of the acreage increase in the second period is due to coal mining and reclamation that converted areas from existing forest land to grassland/pasture.
- Forest areas increased from under four million acres in 1950 to almost 4.5 million acres in 1976, and then fell to under 4.3 million acres by 2001. The current loss of forest land is due to mine reclamation that converted land from forest to grassland/pasture, as well as to new urban development.
- Disturbed areas increased from just over 3,000 acres in 1950 to a high of 85,000 acres in 1976 and are presently over 73,000 acres. This acreage is comprised of areas where vegetation was not established during those time periods. Lands which are not vegetated and otherwise do not fit into other categories are classified as “disturbed.” Revegetated mined lands do not fall under this category.

A separate estimation of the extent of mining was developed by West Virginia University for the land use study. This is due to other sources significantly underestimating mined areas by placing reclaimed areas into other land use/land cover categories such as grassland/pasture and forest. A compilation of various data sources indicate that over 244,000 acres or approximately five percent of the West Virginia mountaintop mining study area contains evidence of disturbance from past or current mining practices. Mining-related land uses are the second most prevalent land use/land cover in the region, after forest land.

Current Studies of Postmining Land Use in the Appalachian Basin

Current studies indicate that the most common uses of reclaimed mine lands in the Appalachian coal region are hay and grass pastureland (Simmons et al., 2008). According to Burger et al., (2009), thousands of acres of Appalachian mined land that were originally forested have been reclaimed as hayland, pasture, or wildlife habitat. Grass and legume species used to revegetate reclaimed surface-mined lands in the Central Appalachian coal region are also used for cattle production (Ditsch et al., 2009).

Current regulations require revegetation in accordance with premining land use, unless an approved alternate Postmining Land Use (post mining land use) has been granted by the regulatory authority. Current practice often results in premining forested lands being converted to post mining land use designations as agriculture (i.e., pasture or hayland), fish and wildlife habitat (combined with another use), and commercial or industrial development, decreasing the percentage of forest lands while increasing the percentage of agricultural, grassland, or developed land. According to findings from the USGS’s Land Cover Trends project, forested lands have decreased over the timeframe of 1973 through 2000. The results vary by ecoregion, and the ecoregions do not exactly overlay the coal resource regions. However, the data supports the hypothesis that forested land has been slowly converted to other land uses. Mining is not the sole reason for this trend because urban expansion and clearing for agricultural uses also contribute to the reduction in forested lands. This general trend does not imply that the reduction is consistent throughout each ecoregion given that various reclamation techniques are employed by different regulatory authorities. For example, in Virginia, a majority of reclaimed mine land is restored as unmanaged forest, and the overall area of hardwood forest types has increased steadily since the first forest inventory in 1940 (Burger and Zipper, 2009; Virginia DOF, 2013).

Forested mine sites (anywhere, not just in this region) must be logged before mining and economically recoverable forest products are removed from the site. The remaining forest material may be subsequently windrowed at the edge of the mine site to provide wildlife habitat enhancement. Some portion may be burned and/or buried beneath the backfill. Selection of ground cover species for reclamation within the Appalachian Basin region has typically been oriented to those species relatively easy to establish for maximum control of erosion, with minimal postmining maintenance or management costs required. Consequently, selected post mining land uses often minimize or eliminate the reestablishment of trees. post mining land uses without trees were historically perceived to be easier to achieve and less costly. In addition, they result in a shorter liability period for release of the performance bonds required by SMCRA.

Current Trends in Postmining Land Uses in Kentucky and West Virginia

In December 2009, the Government Accountability Office (GAO) completed a study titled "Characteristics of Mining in Mountainous Areas of Kentucky and West Virginia." Completed at the request of Congress, the study reported on the characteristics of surface coal mining and reclaimed lands that were disturbed by surface coal mining in the mountainous, eastern part of Kentucky and West Virginia. The study focused on approved post mining land uses, restoration of AOC and associated variances, and the number and size of excess spoil fills.

During the compilation of its report, GAO used data from the states for permits issued from January 2000 through July 2008. This data provided information on the approved post mining land use, the extent to which the land is restored to its AOC, and the number and size of fills created from excess spoil.

In addition to post mining land use types, the state data contained information on the type of land use associated with the permitted area immediately prior to mining or the premining land use. The most common types of premining land use in permits issued from January 2000 through July 2008 were the same for both states: forestland and previously mined but unreclaimed lands.

Kentucky's data shows that, for permits issued between January 2000 and July 2008, 415 permits had a premining land use of forestland, while 290 were previously mined (as with post mining land use, permits can identify more than one premining land use type). Moreover, 44 permits identified hay or pastureland, and 43 permits identified other types of premining land use, including 24 permits with undeveloped land.

Over the same period, West Virginia's data shows 174 permits had a premining land use of forestland, and 59 were previously mined. Additionally, 43 permits had a premining land use type of fish and wildlife/recreation, while 45 permits identified other types of premining land use, including 23 for hay or pastureland.

In Kentucky, between January 2000 through July 2008, 216 permits were approved for fish and wildlife habitat as a post mining land use, followed by 209 permits approved for hay or pastureland, and 109 permits approved for forestland. Fifty-nine permits issued during that time were approved for other post mining land use types including 22 residential, 19 industrial, and 12 commercial.

In West Virginia, between January 2000 through July 2008, 141 permits were approved for forestland as a post mining land use, followed by 46 approved permits for fish and wildlife habitat/recreation and 34 permits approved for hay or pastureland. Sixty permits issued during this time were approved for other post mining land use types, including 23 for commercial forestry or woodland, and 12 for industrial/commercial uses.

The most common post mining land uses approved for permits issued in January 2000 through July 2008 were fish and wildlife habitat in Kentucky and forestland in West Virginia.

Current Trends in AOC Variances

The 2009 GAO report on Surface Coal Mining (U.S. GAO, 2009) also provided data on Kentucky's and West Virginia's AOC variances. Between January 2002 and July 2008, Kentucky approved AOC variances for 24 percent of the permits issued, for a total of 99 variances. Of those AOC variances, 79 were for remining, five for mountaintop removal mining and 15 for steep slope mining. During the same period, West Virginia approved AOC variances for 15 percent of the permits issued, for a total of 33 variances. Of those AOC variances, nine were for remining, 18 were for mountaintop removal mining, and six for steep slope mining.

Mountaintop Removal and Steep Slope AOC Variance Postmining Land Uses

Between July 1, 2006 and June 30, 2012, OSMRE reviewed data from Tennessee, Virginia, Kentucky, and West Virginia regarding the approved post mining land use associated with MTR and steep slope AOC variances. Tennessee and Virginia did not have any MTR AOC variances approved within the six year review. Kentucky had one MTR AOC variance totaling 284 acres, with a Hay/Grazing post mining land use. West Virginia had four MTR AOC variances. Three had an industrial/commercial post mining land use totaling 3960 acres while the other had a commercial forestry post mining land use of 211 acres, totaling 4,171 acres. In addition, West Virginia had one combined variance (AOC/Steep Slope) with an industrial/commercial post mining land use for a 70-acre ATV trail park.

Tennessee did not have any steep slope mining AOC variances approved within the four year time period reviewed. Virginia had two steep slope AOC variances, with an industrial/ commercial post mining land use totaling 80 acres. Kentucky had five steep slope AOC variances with one industrial/commercial post mining land use of 553 acres, one public facility/recreation post mining land use of 111 acres and two residential post mining land use totaling five acres, for a total of 669 acres of steep slope AOC variances. West Virginia had one steep slope AOC variance, with an industrial/commercial post mining land use for a horse park/campground totaling 70 acres.

Economic Development of Mountaintop Mining Areas

In December 2009, a study was conducted concerning the reclaimed mountaintop sites in the coal surface mining regions of Kentucky, West Virginia, Virginia, and Tennessee (Geredien, 2009).[4] The study sought to determine how much of the postmining landscape was converted to new land uses such as industrial, commercial, or residential development. This study identified land uses that could be classified as "post-mining economic development" including "industrial, commercial, residential, or public" uses. Specific development sites were identified using information published by the National Mining Association.

The results of the study indicated the following:

- Twenty-seven sites revealed verifiable postmining economic development.
- Economic development projects included:
  - One federal prison;
  - Three oil/gas fields;
  - Two airports;
  - One hospital;
  - One ATV training center;
  - Three golf courses;
  - Four industrial/business parks;
  - Two county/municipal parks; and
  - One county fairground.
- Nine sites were developed for commercial agriculture or farming.

3.7.3.2 Colorado Plateau Region

A substantial percentage of the surface land in the Colorado Plateau coal region is federally owned. Additionally, most of the coal in the Colorado Plateau region is federally owned. A significant portion of the remaining coal (approximately 20 percent of western region coal) is non-federally owned but minable only in association with federal coal.[5]

As previously mentioned, surface features overlying federal coal reserves would be protected under BLM's land use planning procedures. Unique to the Colorado Plateau are significant areas of coal resources located on Indian Lands of the Hopi and Navajo reservations in Arizona and New Mexico. The Navajo Mine (owned by the Navajo Nation) is located on the Navajo Reservation in San Juan County, New Mexico. Approximately 50 percent of the surface of the

[4] The study evaluated 410 known mountains and ridges within an existing geographic information system database where the elevation had been reduced by at least 50 feet due to mining. The authors assert that such elevation reductions constitute mountaintop removal operations, however such elevation changes may also represent areas mined that were returned to AOC, therefore any conclusions relative to mountaintop removal mining, as that term is used in SMCRA, are not presented here.

[5] Land ownership alternates in a checkerboard fashion throughout the western US due to 19th century federal land grants to railroads. Surface and mineral rights have been since been sold in many areas but alternating property owners often remains an impediment to economical mineral extraction.

coal-bearing area in this region is administered by the federal government. Approximately 23 percent consists of Tribal lands. While these lands are held in trust by the U.S. government, they are not considered federal lands. The remaining percentage of approximately 26 percent is administered by state agencies or is privately owned (Kirschbaum et al., 2000).

Approximately 47 percent of the land in the Colorado Plateau consists of shrub/scrubland. Nearly 24 percent is evergreen forest. Less than three percent of the land in the Colorado Plateau is used for agricultural purposes (cultivated crops and pasture land). A large portion of this region is sparsely populated, and there are few urban areas.

The counties included in this table are not intended to represent all coal mining counties within the states or those that could occur in the future. However, they are considered representative of typical land uses that might be encountered within the coal region in those states.

Typical premining land uses in this coal-bearing region are agricultural activities (including cropland and livestock grazing lands), dispersed recreation, wildlife habitat, and industrial uses such as oil and gas development (U.S. BLM, 2009a). Typical post mining land uses in this region tend to mirror premining land uses mentioned above and would principally be approved as grazing land, wildlife habitat, and to a lesser degree pasturelands or croplands.

3.7.3.3 Gulf Coast Region

The Gulf Coast region is over 26 percent pastureland. Premining land use in Texas generally reflects agricultural activities identified by SMCRA as pasture/hayland and grazing land uses. Shrub/scrub land accounts for almost 16 percent of the land in the region. Compared to other regions in the study area, the Gulf Coast region has the highest percentage of wetlands at close to 11 percent of the total land. Much of these wetlands occur in Louisiana, which has two operating lignite mines. Mines located in Mississippi and Louisiana are predominantly located in areas with forestry premining land uses and some pastureland and cropland. Table 3.7-3 (see Appendix G) provides a detailed breakdown of land use percentages for the individual states and county study areas within this region (USGS, 2001b). The counties included in this table are not intended to represent all coal mining counties within the states or future coal mining counties. However, they are considered representative of typical land uses that might be encountered within the coal region in those states.

SMCRA post mining land uses in Texas are dominated by pasture/hay land and grazing land uses. Developed water in the form of final cut lakes also exists, with fish and wildlife land uses in areas adjacent to streams and lakes. In regions of Texas that receive more precipitation, forestry in upland areas has become an important post mining land use. At Mississippi and Louisiana lignite mines, approved forestry post mining land uses dominate with some pasture/hay land and occasional cropland uses.

3.7.3.4 Illinois Basin Region

The Illinois Basin covers the southern two-thirds of the state of Illinois, the southwestern portion of Indiana and parts of western Kentucky. In comparison to the other coal-producing regions in the study area, the Illinois Basin has the highest instance of cultivated cropland. Cropland accounts for over 48 percent of the land use in this region. The majority of the cropland is located in Illinois and Indiana. Deciduous forest lands are also a predominant feature in this region, making up nearly 26 percent of the landscape. The third most common land use in this region is pasture and hay lands, which make up almost 11 percent of the area. Table 3.7-4 (see Appendix G) provides a detailed breakdown of land use percentages for the individual states and county study areas within this region (USGS, 2001b). The land uses included in this table are not intended to represent all coal mining counties within the states or those that could occur in the future. However, they are considered representative of typical land uses that might be encountered within the coal-producing regions in those states.

SMCRA post mining land uses in Illinois and Indiana are dominated by agricultural land uses, including cropland (much of it prime farmland) and pasture/hay land uses to a lesser extent. Fish and wildlife and developed water, from final cut lakes, are also important post mining land uses in both states. Recently, there has been a noticeable increase in forestry post mining land uses in Indiana. Kentucky postmining uses are largely pasture/hayland and fish and wildlife uses.

3.7.3.5 Northern Rocky Mountains and Great Plains Region

Like the Colorado Plateau, most of this region is federal land or federal mineral estate, and therefore subject to the restrictions outlined in subsection 3.7.3.2. To a much lesser extent than in the Colorado Plateau, areas of coal resources on Indian Lands in this region exist predominantly on Crow and Northern Cheyenne Tribal Lands. Approximately 80 percent of the available coal resources in the region are federally owned, and about 15 percent occur beneath federally managed lands. The rest of the coal occurs beneath state, tribal, or privately owned lands (USGS, 1999).

Similar to the Colorado Plateau, the Northern Rocky Mountains and Great Plains region is also predominantly shrub/scrublands. This feature makes up 45 percent of the regional land use. Wyoming accounts for a substantial part of this area, with 65 percent shrub/scrublands. Grasslands also provide a substantial percentage of the land use, nearly 30 percent for the region. This region is sparsely populated, with widely scattered population centers. All three categories of urban land use (low, medium and high intensity) collectively make up for only 0.36 percent of the total land use. Table 3.7-5 (refer to Appendix G) provides a detailed breakdown of land use percentages for the individual states and county study areas within this region (USGS, 2001b). The land uses included in this table are not intended to represent all coal mining counties within the states or those that could occur in the future. However, they are considered representative of typical land uses that might be encountered within the coal-producing region in those states.

Typical premining land uses in the Northern Rocky Mountains and Great Plains region include croplands, livestock grazing lands, and wildlife habitat, with gas production, recreation, and renewable energy being secondary uses (U.S. BLM, 2010a). In certain cases, additional secondary uses include communication/power lines and transportation (U.S. BLM, 2009b). Typical post mining land uses approved in this coal-bearing region generally mirror premining land uses. Most approved post mining land uses in this region include grazing land and wildlife habitat. In North Dakota, cropland post mining land uses are very common as well. However, in certain instances a post mining land use may differ from premining land use. For example, at the Dave Johnston Mine in Wyoming, portions of the reclaimed mine have been approved for an industrial post mining land use in support of wind energy development.

3.7.3.6 Northwest Region

The Northwest region currently has one active coal mine, the Usibelli Mine is southwest of Fairbanks, Alaska and northeast of Healey, Alaska. This area is surrounded by the Denali National Park and Denali State Wilderness to the west, the Tanata Valley State Forest to the north and east, and Nelchina Public Use Area to the south. Specific land use data for this area are not available. Premining land use in this coal-bearing state is typically dominated by wildlife habitat. A typical post mining land use in this coal-bearing region would include reclaiming the mined areas for wildlife habitat (Alaska Department of Natural Resources, 2013).

According to an October 1998 report by the BLM, approximately 65 percent of Alaska is owned and managed by the federal government as public lands, including a multitude of national forests, national parks, and national wildlife refuges. Of these, the BLM manages 87 million acres (350,000 km^2), or 23.8 percent of the state. The coal underlying the Usibelli Mine is owned by the State of Alaska and leased to the Usibelli Mining Company.

3.7.3.7 Western Interior Region

The dominant premining land use in the Western Interior region is pasture and grazing, accounting for over 38 percent of the landscape in Kansas and Oklahoma. Over one-quarter of Oklahoma and Arkansas is covered in deciduous forestlands. Missouri has a high occurrence of cultivated crops, which accounts for over 31 percent of the land use in that state. Table 3.7-6 (see Appendix G) provides a detailed breakdown of land use percentages for the individual states and county study areas within this region (USGS, 2001b). The land uses included in this table are not intended to represent all current or future coal mining counties. However, they are considered representative of typical land uses that might be encountered within the Western Interior coal region.

SMCRA post mining land uses in Oklahoma are dominated by pasture/hay lands, grazing land, fish and wildlife, and developed water from final cut lakes. Both Missouri and Kansas post mining land uses are similar, with mainly agricultural land uses of cropland and pasture/hay lands dominating. Some fish and wildlife and developed water land uses exist as well. Arkansas mines have generally been reclaimed to pasture/hay lands and forestry land uses.

3.8 BIOLOGICAL RESOURCES (EXCLUDING WETLANDS)

3.8.1 Introduction

A wide variety of habitats are distributed throughout the coal regions of the U.S. This section presents a general description of the terrestrial and aquatic habitats occurring in the coal-producing areas that comprise the study area for this document. The discussion is organized around vegetative cover types for terrestrial systems and around flowing (lotic) versus pooled (lentic) water for aquatic systems.

The discussion is intended to describe general trends that apply across each region. It is not intended to present baseline environmental conditions for any particular mine site. Common names are used throughout the report to identify species found in the cover types and aquatic ecosystems of each coal region; within this section scientific names are provided at the first mention of each species.

The text below provides a general ecological discussion in the “General Ecological Setting” section of each region through the application of a system of description for ecological units adopted and maintained through the U.S. Department of Agriculture (USDA) – U.S. Forest Service (USFS). A discussion of representative species for each of the region, including common vegetative and animal communities, follows the discussion of ecological units.

A variety of other physical and chemical factors affect the biological resources of each coal region. Those are described elsewhere in this document; of particular importance are: topography (Section 3.4), meteorology (climate and precipitation) (Section 3.6), geology (Section 3.2), and soils (Section 3.3).

3.8.2 Biological Resource Topics

3.8.2.1 The USDA-Forest Service Terrestrial Ecological Units

The USDA USFS adopted a national hierarchical framework of terrestrial ecological units to use an ecological approach to natural resource management (Bailey, 1995). The framework consists of seven levels of ecological units that are grouped into four application scales: ecoregions, sub-regions, landscapes, and land units (Cleland et al., 1997). The USFS Ecoregion Classification is useful in providing a general ecological description (Table 3.8-1) for the terrestrial and aquatic biology of each coal region. OSMRE has applied these ecological units to the coal regions to provide a general discussion of the ecological character of each region. Each region description below contains a figure depicting the extent of the ecological units across the respective region.

The USDA-USFS classification system interchangeably uses the terms “cover type” and “potential natural communities” to describe predominant vegetation in a section. A potential natural community is defined as the ultimate biotic community that would become established on a site under the present environmental conditions, if all stages in the succession were completed without interference from humans. The narrative below uses the term cover type. In highly altered landscapes (e.g., agricultural areas, towns, and roads), natural cover types occur infrequently but understanding what cover types would occur in undisturbed conditions is helpful to understanding what conditions would be like in a given area if disturbance is avoided or restoration is achieved.

Table 3.8-1
USFS Ecoregion Classification System

Application Scale	Ecological Units (Map Scale Range)	Principal Map Unit Design Criteria
National (Ecoregions)	Domain (1:30,000,000 or smaller)	Broad climatic zones or groups (e.g., dry, humid, tropical)
	Division (1:30,000,000 to 1:7,500,000)	Regional climatic types, vegetation affinities (e.g., prairie or forest), soil order
	Province (1:15,000,000 to 1:5,000,000)	Dominant potential natural vegetation, highlands or mountains with complex vertical climate-vegetation-soil zonation
Regional (Subregions)	Section (1:7,500,000 to 1:3,500,000)	Geomorphic province, geologic age, stratigraphy and lithology, phases of soil orders, potential natural vegetation, potential natural communities (PNC)
	Subsection (1:3,500,000 to 1:250,000)	Geomorphic process, surficial geology, phases of soil orders, subregion climatic data, PNC formation or series
Watershed/National Forest (Landscape)	Land Type Association (1:250,000 to 1:60,000)	Geomorphic process, geologic formation, surficial geology, and elevation, Phases of soil subgroups, families, or series, Local climate, PNC—series, subseries, plant associations
Project (Land Unit)	Land Type (1:60,000 to 1:24,000)	Landform and topography (elevation, aspect, slope gradient, and position), Phases of soil subgroups, families, or series, Rock type, geomorphic process, PNC—plant associations

Source: Cleland et al., 1997

3.8.2.2 Federally Protected and Regulated Species

The U.S. FWS administers a variety of laws protecting wildlife and plant species. These include the Migratory Bird Treaty Act (MBTA) (16 U.S.C. §§ 703-712), the Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. §§ 668-668d). The MBTA prohibits the taking, killing, possession, and transportation of migratory birds, eggs, feathers (and other body parts), and nests without a permit. The BGEPA affords further protection of bald and golden eagles beyond the MBTA by making it unlawful to disturb eagles or destroy their nests.

Federal agencies must also consult with the U.S. FWS and the National Marine Fisheries Service (NMFS), under section 7(a)(2) of the ESA (16 U.S.C. § 1531 et seq.)., on activities that may affect a listed species. These interagency consultations, or section 7 consultations, are designed to assist Federal agencies in fulfilling their duty to ensure federal actions do not jeopardize the continued existence of a species or destroy or adversely modify critical habitat. The ESA makes it unlawful to “take” (defined at Section 3(19) of the ESA as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct”) federally listed threatened or endangered species without a permit on federal lands.

In addition to these laws, migratory birds receive protection under Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) (66 FR 3853), which promotes conservation of migratory birds. The Executive Order includes support of various conservation planning efforts already underway, such as the Partners in Flight initiative and North American Waterfowl Management Plan; incorporating bird conservation considerations into agency planning, including NEPA analyses; annual reporting on the level of take of migratory birds; and generally promotion of conservation of migratory birds where consistent with the agency mission. OSMRE is in the process of crafting a Memorandum of Understanding with the U.S. FWS to better implement the principles of Executive Order 13186 in its programs. Appendix D contains additional discussion of migratory flyways and describes how the flyways intersect with the coal regions in the U.S.

Upon request, the U.S. FWS provided OSMRE a list of threatened and endangered species occurring within or near the coal resource areas of the U.S., i.e., the affected area analyzed within this DEIS. OSMRE then reviewed the list and excluded certain species for which it is reasonably certain that coal mining activities (not including the end use of the coal) would have no direct or indirect effects either due to location or specific habitat preferences. The remaining list of 180 federally listed species is included in Appendix F. Of these 180 species 3 are amphibians, 11 are birds, 2 are crustaceans, 33 are fishes, 2 are insects, 13 are mammals, 60 are mollusks, 49 are plants, and 7 are reptiles. The remaining list includes 60 species with designated critical habitat. The critical habitat of 39 of these 60 species occurs partially or entirely within the coal resources areas studied in this EIS. As shown in appendix F, Table F-2 Critical Habitat Overlap with coal regions, 100% of the critical habitat for the Laurel dace (*Chrosomus saylori)* occurs in areas with mineable coal. Similarly 82% of the critical habitat for the Cumberland elktoe (*Alasmidonta atropurpurea),* and 55% of the habitat for the spotfin chub (*Erimonax monachus)* occur in areas with mineable coal. The degree of overlap of critical habitat with mineable areas is less but still considerable (between 10–30%) for fifteen other aquatic species.

Reasons for a particular species' decline are varied. Impacts to individuals are often natural (e.g., predation, succession, disease, etc.). However, impacts that affect the species at a population level are often attributable to human factors (e.g., development, the introduction of noxious weeds, over-hunting and/or collecting, pesticides and other pollutants).

Mining (including but not limited to coal mining) has been identified as a contributing factor in the past and ongoing decline of some species. For example, the U.S. FWS described a primary threat to greater sage grouse as ongoing fragmentation and loss and fragmentation of shrub-steppe habitats through a variety of mechanisms related to activity that transforms the land, including agriculture, oil and gas development, mining, urbanization, and infrastructure development that includes roads and power lines that convert or bisect habitats and introduce invasive species (75 FR 13909 (March 23, 2010).

Another recent issue of concern for species that overlap mining areas is white-nose syndrome, a syndrome caused by the white fungus (*Pseudogymnoascus destructans*), which is causing fatalities in hibernating bats from the northeastern to the central U.S. The USGS reports that northeastern U.S. bat populations have declined approximately 80% since the emergence of the disease (USGS, 2015).

Each of the regional discussions below provides a count of species by type (birds, mammals, plants, etc.). A general discussion of how each alternative would impact ESA listed species is included in the discussion of Environmental Consequences in Chapter 4. The Final EIS for the Stream Protection Rule will contain a U.S. FWS Biological Opinion on the impacts of the preferred alternative prepared in accordance with Section 7(a)(2) of the ESA.

3.8.2.3 Additional Information

Additional detailed information on certain biological resource topics is included in the appendices. Appendix B provides a description of bioassessment methods used by federal and state agencies in the U.S. The appendix provides context for understanding the complex issues involved in studying and classifying aquatic resources (particularly stream ecosystems). A discussion of general ecological principles of running water, lakes, and reservoirs is contained in Appendix C.

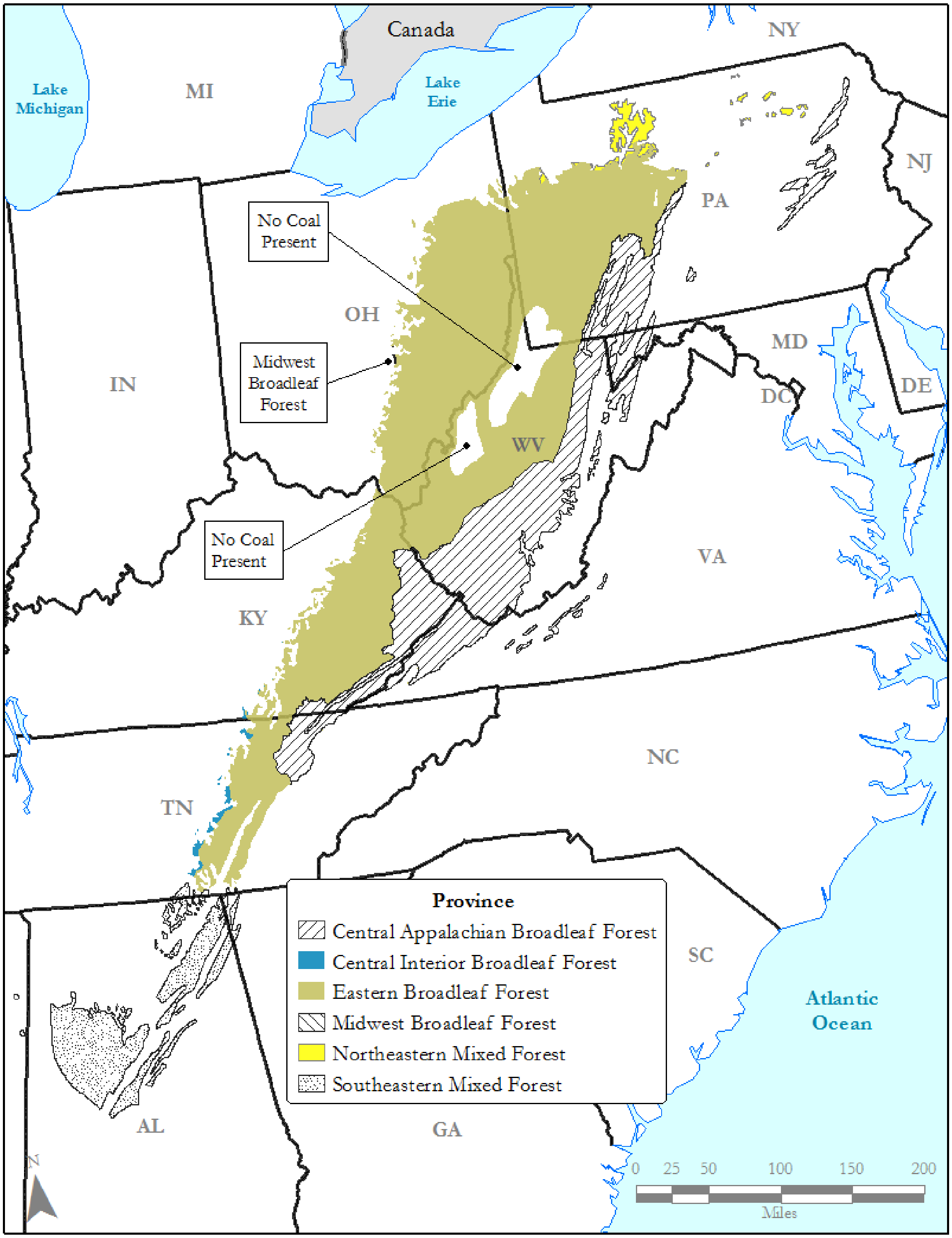
Appendix E provides information on invasive species and noxious weeds. A noxious weed is a term for an invasive plant that is designated and regulated by state and federal laws, such as the federal Plant Protection Act, 7 U.S.C. § 7701 et seq. Noxious weeds have biological traits that enable them to colonize new areas and successfully out-compete native species. They can transform the structure and function of ecosystems through: direct competition; changes in nutrient cycling, succession, and disturbance regimes; and shifts in evolutionary selection pressures (Mack and D'Antonio 1998). The spread of noxious weeds threatens the structure and function of many ecosystems worldwide, and certain species have the ability to spread over large areas or acutely threaten an ecosystem over its continental range (Hobbs and Humphries, 1995).

3.8.3 Appalachian Basin Region

3.8.3.1 General Ecological Setting

The Appalachian Basin encompasses significant portions of the states of Pennsylvania, Ohio, Kentucky, West Virginia, Virginia, Tennessee, and Alabama, including sizeable areas in which current coal mining activities take place (Figure 3.8-1). Table 3.8-2 shows the area of each ecological province within the Appalachian Coal Basin.

Figure 3.8-1 Ecological Provinces within the Appalachian Coal Basin Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Table 3.8-2
USFS Provinces Associated with the Appalachian Basin Region

Ecological Province	Area of Coal Region in Province (square miles)
Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow	16,408
Central Interior Broadleaf Forest	238
Eastern Broadleaf Forest	37,887
Midwest Broadleaf Forest	5
Northeastern Mixed Forest	878
Southeastern Mixed Forest	5,789
Total	**61,204**

Unless otherwise noted, the following descriptions of the ecological provinces within the Appalachian Basin coal region come from Bailey (1995), McNab and Avers (1994), Cleland et al. (1997), and McNab et al. (2007).

Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow Province

This province has a temperate climate with cool summers and short, mild winters. Annual precipitation is plentiful and evenly distributed with short, infrequent periods of water deficit. Landscapes of the province are predominantly mountainous, but sections vary in predominant elevation, geologic substrate, and physiography. The vegetation in this province is characterized by a tall, closed canopy of deciduous broadleaf forests with mesophytic and drought-tolerant species. Vegetation changes to coniferous forest or shrub lands at higher elevations. The Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow province covers approximately 65,172 square miles in the U.S., a large portion of which is in the Appalachian Basin coal region.

Central Interior Broadleaf Forest Province

The vegetation in this province is broadleaf deciduous forests with somewhat open canopy and greater density of species tolerant of drought. The Central Interior Broadleaf Forest province covers approximately 119,790 square miles in the U.S., of which only a very small fraction is in the Appalachian Basin coal region.

Eastern Broadleaf Forest Province

The vegetation in this province is characterized by tall, cold-deciduous broadleaf forests that have a high proportion of mesophytic species. This province covers approximately 101,902 square miles in the U.S., of which about 25 percent is in the Appalachian Basin coal region.

This region contains some of the greatest aquatic animal diversity in North America, especially for species of amphibians, fishes, mollusks, aquatic insects, and crayfishes (U.S. EPA, 2006). This province contains many small natural lakes, small artificial ponds, and several large reservoirs which occur along perennial streams. Stream gradients in the western Alleghenies range from steep, headwater streams to low-gradient rivers that flow into larger bodies of water.

Midwest Broadleaf Forest Province

The vegetation in this province consists of cold-deciduous, hardwood-dominated forests with a high proportion of species able to tolerate mild, brief, periodic drought during the late summer. The Midwest Broadleaf Forest province covers approximately 141,746 square miles in the U.S., only a tiny fraction of which occurs in the Appalachian Basin coal region.

There is moderate to high density of streams in this province; low gradient streams and rivers are predominant, and typically have substrates composed of sand, gravel, bedrock, and boulders.

Southeastern Mixed Forest Province

The forest vegetation in this province is a mixture of deciduous hardwoods and conifers. The Southeastern Mixed Forest Province occurs mainly in Alabama and has a moderate density of small to medium size perennial streams and associated rivers, mostly with low to moderate rates of flow and moderate velocity (McNab and Avers, 1994). The streams of Alabama are noted for their diversity of native freshwater fishes, native freshwater gill-breathing snails, freshwater mussels, and native freshwater turtles.

Northeastern Mixed Forest Province

Among the coal-bearing states of Appalachian Basin region this province occurs only in Pennsylvania. The vegetation of this province consists of forests that provide a transition between boreal conifers and broadleaf deciduous. Streams in this province are characterized by deeply incised high-gradient and bedrock-controlled systems in the upland, and low and moderate-gradient, mature streams in the valleys. Numerous waterfalls and rapids exist where streams cross beds of resistant rock. There are a large number of rapidly moving streams and rivers that flow into the Allegheny and Susquehanna Rivers.

3.8.3.2 Terrestrial Resources

The Appalachian Basin coal region includes many different terrestrial habitats distributed over a broad area of the eastern U.S., extending from Mississippi northeast to Pennsylvania. The text below summarizes species presence with information adapted from Bailey (1995), McNab and Avers (1994), Cleland et al. (1997), and McNab et al. (2007).

In its southern range, this region is characterized by oak-pine, loblolly-shortleaf pine, and oak-hickory cover types. These forests are usually dominated by deciduous hardwood trees such as oak (*Quercus* spp.) and hickory (*Carya* spp.) and coniferous trees such as loblolly pine (*Pinus taeda*), shortleaf pine (*Pinus echinata*), or other southern yellow pines (*Pinus palustris*). Other common trees in these cover types include Maple (*Acer* spp.), yellow-poplar (*Liriodendron tulipifera*), Sweetgum (*Liquidambar styraciflua*), and red cedar (*Juniperus virginiana*).

Mature Appalachian Basin region forests typically have closed canopies, where the leaf cover of the trees rarely allow direct sunlight through to the forest floor. Younger forests have more open canopies with significant sunlight reaching the understory vegetation. In areas of open canopy, therefore, there is a thicker understory of young trees, shrubs, vines, and herbaceous plants. The major shrubs are blueberry (*Vaccinium* spp.), *Viburnum* spp., dogwood (*Cornus* spp.), *Rhododendron* spp., American beautyberry (*Callicarpa Americana*), and sumac (*Rhus* spp.).

The major vines are woodbine (*Parthenocissus* spp.), grape *(Vitis* spp.), poison ivy (*Rhus radicans)*, greenbrier (*Smilax* spp.), and blackberry (*Rubus* spp.). Important herbaceous plants are sedge (*Carex* spp.), *Panicum* spp., bluestem (*Andropogon* spp.), longleaf uniola (*Chasmanthium sessiliflora*), *Lespedeza* spp., tick clover (*Desmodium* spp.), goldenrod (*Solidago* spp.*)*, pussytoes (*Antennaria* spp.), and *Aster* spp.; many more are abundant locally.

Where the region extends to the north into Maryland, Tennessee, Kentucky, Ohio, West Virginia, and Pennsylvania, the vegetation is characterized by oak-pine, loblolly-shortleaf pine, maple-beech-birch, and aspen-birch cover types. Much of the vegetation is similar to the southern range of this region (described above), but also includes beech (*Fagus* spp.), yellow birch (*Betula alleghaniensis*), aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), and gray birch (*Betula populifolia*) as dominant tree species. Other common trees that differ from the southern zone description above include hemlock (*Tsuga* spp.), basswood (*Tilia Americana*), and white pine (*Pinus strobes*). In general, more maple species are found in this area as well.

Common mammal species that extend throughout this region include the white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), white-footed mouse (*Peromyscus leucopus*), and Northern Long-Eared Bat (*Myotis septentrionalis*). Mammals once thought to extend throughout this range but that are now considered either extirpated or extremely rare include two predators; the eastern cougar (*Puma concolor couguar*) and wolves (*Canis rufus, Canis lupus rufus*); as well as the American bison (*Bison bison*), and eastern elk (*Cervus canadensis canadensis*).

Bird species that extend throughout this region and use this region for breeding and/or wintering range include turkey (*Meleagris gallopavo*), mourning doves (*Zenaida macroura*), ruffed grouse (*Bonasa umbellus*), bobwhite (*Colinus virginianus*), northern cardinal (*Cardinalis cardinalis*), tufted titmouse (*Parus bicolor*), pine warbler (*Dendroica pinus*), wood thrush (*Hylocichla mustelina*), ruby-throated hummingbird (*Archilochus colubris*), red-tailed hawk (*Buteo jamaicensis*), and barn owl (*Tyto alba*).

Common reptiles include the box turtles (*Terrapene spp.*), painted turtle (*Chrysemys picta*) common garter snake (*Thamnophis sirtalis*), eastern fence lizard (*Sceloporus undulatus*), and copperhead (*Agkistrodon contortrix*). An example of a rare but widespread species is the timber rattlesnake (*Crotalus horridus*).

Common amphibians with distributions across this region include red-spotted newt (*Notophthalmus viridescens*), dusky salamanders (*Desmognathus spp*.), and American toad (*Anaxyrus americanus*).

3.8.3.3 Aquatic Resources

Lotic Systems (Rivers and Streams)

Most of the major rivers and tributaries in the U.S. east of the Mississippi originate in the mountains of the Appalachian region (U.S. EPA et al., 2003). First- through twelfth-order streams (as defined by Vannote et al., 1980), ephemeral streams, and intermittent streams occur in the Appalachian region, with headwater streams generally originating at higher elevations (U.S. EPA et al., 2003). Major rivers that originate in this region include, but are not limited to; the Cumberland, Ohio, Susquehanna, James, Potomac, and New Rivers, and rivers that contribute to the Chesapeake Bay watershed.

A variety of flowing-water habitats are present in the Appalachian Basin coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. As described in Section 3.5 (see Table 3.5-5) there are a total of 69,798 miles of intermittent streams, and 56,929 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features of these types of streams is presented in Appendix C.

Energy Flow/Primary Production

Organic materials that fall into, and are transported in, streams provide energy to the stream. Leaf litter fall and lateral movement of leaves and wood have been found to be the predominant energy source in high-gradient streams of the southern Appalachians; however, stream width affects the amount of input. Woody debris comprises about 25 percent to 50 percent of total input. Dissolved organic carbon (DOC) is also another potential energy source and may include groundwater inputs, leaching from detritus stored in the streambed, and dissolved exudates from biota (Wallace et al., 1992).

Primary production rates in high-gradient Appalachian streams have been shown to vary with stream order, season, degree of shading, nutrients, and water hardness (Wallace et al., 1992). Plant and algal communities of high-gradient streams in the Appalachian Basin are reduced compared to low-gradient streams and lentic systems as these high-gradient stream communities are typically densely shaded and subject to high current velocities (Wallace et al., 1992). As a result, plant and algal communities occurring along high-gradient streams contain flora uniquely adapted to this type of environment (Wallace et al., 1992), and many species are considered to be endemic to this region (Patrick, 1948). Hornleaf riverweed (*Podostemum ceratophyllum*) is an example of a vascular plant found along high-gradient streams (Wallace et al., 1992), and is broadly distributed in the southern Appalachian Mountains (Meijer, 1976). Water willow (*Justicia americana*), another important vascular plant found in southeastern streams, is the dominant emergent plant of the New River, contributing approximately 12 percent of the aquatic macrophyte biomass (Hill, 1981).

Mosses and liverworts are among the dominant flora in turbulent flows. Four bryophytes dominate Appalachian streams: fontinalis moss (*Fontinalis dalecarlica*), streamside hygroamblystegium moss (*Hygroamblystegium fluviatile*), Lescur's platylomella moss (*Sciaromium lescurii*), and Chokai marimo (*Scapania undulate*) (Glime, 1968).

Endemic and unique species of algae are common to the high-gradient streams of the southern Appalachians. Like bryophytes, these algae are also attached to stable substrates. Dominant algal flora in the high-gradient streams of the southeast U.S. include filamentous red algae, filamentous green algae, and diatoms (Wallace et al., 1992). Camburn and Lowe (1978) described a diatom from high-gradient streams in the Great Smokies (*Achnanthes subrostrata* var. *appalachiana*) which comprised as much as 73 percent of the algal community. Diatoms are a major group of algae, and are one of the most common types of phytoplankton. Diatoms have been used as indicators of stream condition and water quality, reflecting parameters such as pH, trophic status, metal concentrations, and other environmental conditions, especially in lakes. Diatoms can also be used as quantitative indicators of ecological conditions in lotic systems (Pan et al., 1996).

Invertebrates

Appalachian headwater streams support an abundant and diverse epibenthic fauna, although they are subject to seasonal flow and occasionally to large storm events (Angradi et al., 2001). Typical benthic macroinvertebrates found in headwater streams in the Appalachian coal region include mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), beetles (Coleoptera), dobsonflies and alderflies (Megaloptera), true bugs (Hemiptera), springtails (Collembola), and true flies (Diptera) (U.S. EPA et al., 2003). Other macroinvertebrates that have been collected include crayfish (Decapoda), isopods (Isopoda), worms (Oligochaeta and Annelida) and snails (Gastropoda) (U.S. EPA et al., 2003). Many streams in the Central Appalachian Basin region harbor a diverse and unique array of invertebrates. This has been attributed to the unique geological, climatological and hydrological features of this region. A number of the unique species are known from only one or two isolated locations in the Appalachians. In the southern Appalachian Mountains, macroinvertebrates in the Ephemeroptera, Plecoptera, and Tricoptera (EPT) taxonomic groups have been found to be rich in species, including many endemic species and species considered to be rare (U.S. EPA et al., 2003). The proportion of the macroinvertebrate assemblage made up by species in the EPT taxonomic group is used as an indicator of stream condition, with a higher proportion of EPT representatives expected in less impacted streams. Other biological indices which are used to describe stream condition in the states of the Appalachian Basin coal region are provided in Appendix B.

There are few differences between the numbers of invertebrate taxa in permanent streams versus those found in intermittent stream reaches in several northern Alabama streams (Feminella, 1996). Similar trends have been observed for other stream systems in the Appalachian Basin region (Stout and Wallace, 2003). This suggests that there is sufficient water present in the headwaters for long-lived taxa with multi-year life cycles to complete their juvenile development prior to reaching the aerial adult stage. During periods of no visible stream flow, interstitial water flows through the material below the stream. This special hydrology creates a unique habitat, called the hyporheic zone. Specially adapted macroinvertebrates are able to continue their life cycles by burrowing into the hyporheic zone, especially in times of drought. Other macroinvertebrates live completely within the hyporheic zone (see Appendix C for further discussion of the biota of the hyporheic zone).

There are about 390 native crayfish species (primarily Cambaridae) in North America, with most restricted to eastern North America (Lodge et al., 2000). Studies of Appalachian headwater streams show that *C. bartonii* usually accounts for the majority of benthic macroinvertebrate biomass (Seiler and Turner, 2004). Crayfish are important in that they can regulate periphyton standing crops, are often a large portion of fish diets, and are a component in the processing of leaf litter (Seiler and Turner, 2004). Based on the important role that crayfish play in the stream food web, any disturbance to crayfish abundance may have a negative impact on the stream ecosystem (Seiler and Turner, 2004).

Many crayfish species have small ranges in the southeastern U.S., making their persistence vulnerable, primarily due to non-native crayfish species. As documented in Lodge et al. (2000) and Loughman and Welsh (2010), non-native crayfish species have negatively impacted North American lake and stream ecosystems and fisheries, and have led to the extirpation of many populations of native crayfishes. Lodge et al. (2000) also listed the impacts of several species of introduced crayfishes have been documented and include: reduction of the abundance of macrophytes by more than 80 percent; reduction in the abundance of algae through direct consumption/destruction of macrophytes on which some algae grow; reduction in the abundance of some macroinvertebrates (particularly snails); and the reduction in the abundance of native crayfishes, often to the point of local extirpation. Lodge et al. (2000) also listed other studies showing the impacts of non-native crawfish species on amphibians and fishes. The mechanisms by which native crayfishes are impacted include competition, predation, and reproductive interference.

The central and southern portions of the Appalachian Basin region also contain substantial freshwater mussel (Bivalvia: Unionidae) populations. Approximately 70 percent of the approximately 300 North American mussel taxa are endangered, threatened, or locally at risk (Strayer et al., 2004). Declines in mussel populations have resulted from factors such as impoundments, exotic species, and degraded water quality (Lydeard et al., 2004).

Freshwater mussel communities are important components of food webs; they are omnivores that feed across trophic levels on bacteria, algae, detritus, and zooplankton (Vaughn et al., 2008). Mussel communities link and influence multiple trophic levels, and effect nutrient translocation and cycling depending on their abundance, species composition, and environmental conditions (Vaughn et al., 2008). The dispersal ability of mussels is limited by their reproductive cycle. The larval stage (called the glochidium) of mussels is an obligate parasite on the gills or fins of host fishes; thus mussel dispersal is linked to the mobility of the host fishes. Consequently, the presence and abundance of certain host fishes is an important component of the life cycle of freshwater mussels. A study conducted by Haag and Warren (1998) indicated that patterns of mussel community variation were correlated with patterns of fish community variation, but not with habitat.

Non-native mussel species introduced and spread within the southeastern U.S. have been adversarial to native mollusk assemblages (Neves et al., 1997). The greatest threat to southeastern mollusk populations comes from the non-native zebra mussel (*Dreissena polymorpha*). This species has made its way up the Tennessee River to Knoxville, Tennessee (Neves et al., 1997).

Vertebrates

Many types of amphibians are unique to the Appalachian Mountain region. Salamanders are a significant component of high-gradient stream communities in the Appalachians. Typically, salamanders are the predators that occupy small, high-gradient headwater streams, while predatory fish occur farther downstream. Predation by fish is believed to restrict salamanders to smaller streams or the banks of large streams (Wallace et al., 1992). The most common aquatic salamanders in the Appalachian Basin region include those of the genus *Desmognathus*, with two-lined salamanders (*Eurycea bislineata*) and shovel-nosed salamanders (*Leurognathus marmoratus*) also being common (Wallace et al., 1992).

Aquatic salamanders may spend a portion of their life cycle within adjacent terrestrial habitats. According to a study conducted along streamside forests in western North Carolina and eastern Tennessee (Petranka and Smith, 2005), the overall abundance of aquatic-breeders (primarily *Desmognathus* spp.) within adjacent terrestrial habitat (118 to 125 feet from aquatic habitat) declined with elevation. Further, this study found that the number of aquatic breeders were most abundant within eight meters of aquatic habitats (49 percent of total terrestrial catch of aquatic-breeders), particularly at low elevation sites. The terrestrial zone provided core habitat to six semi-aquatic species (*Desmognathus* spp., *Gyrinophilus porphyriticus*, and *Eurycea wilderae*) that were broadly distributed throughout the study plots, and acted as an aquatic buffer for four highly aquatic species (*Desmognathus* spp.).

Based on studies conducted by the West Virginia Division of Natural Resources (2003), there are 87 known species of amphibians and reptiles in West Virginia. Less common salamanders (e.g. the Blue Ridge two-lined salamander, *Eurycea wilderae*), skinks (e.g. the coal skink, *Eumeces anthracinus*), frogs (e.g., the cricket frog, *Acris crepitans*), turtles (e.g. the spotted turtle, *Clemmys guttata*), and snakes (e.g. the Eastern black kingsnake, *Lampropeltis getula niger*) are all associated with aquatic habitats. Amphibian species found in the Northern Cumberland Plateau section (eastern Tennessee and Kentucky) include the green salamander, Kentucky spring salamander (*Gyrinophilus porphyriticus duryi*), Black Mountain salamander (*Desmognathus welteri*), seal salamander (*Desmognathus monticola*), slimy salamander (*Plethodon glutinosus*), spotted salamander (*Ambystoma maculatum*), American toad (*Bufo americanus*), mountain chorus frog (*Pseudacris brachyphona*), green frog (*Rana clamitans*), pickerel frog (*Lithobates palustris*), and wood frog (*Rana sylvatica*) (OSMRE, 2008).

The fish assemblages of the Central Appalachian area tend to contain a relatively large number of endemic and unique species (U.S. EPA et al., 2003). In the southern Appalachian Mountains south of the Roanoke and New Rivers, there are about 350 fish species, 64 of which are considered imperiled (Walsh et al., 1995). Both fish and mollusks exhibit high degrees of endemism in the southeast, which is a major contributing factor to species endangerment (Dobson et al., 1997; Warren and Burr, 1994).

The diversity and distribution of fishes in West Virginia is related to drainage divides (Stauffer and Ferreri, 2002). Kanawha Falls is the primary physical barrier that divides the distinct fish fauna of the New River System from that of the Upper Ohio River system (Hocutt et al., 1986). The Kanawha/New River system above the Kanawha Falls has a unique fauna with up to 45 native species, including eight endemic species (Messinger and Chambers, 2001). Fish species found in the upper Kanawha/New River system include bigmouth chub (*Nocomis platyrhynchus*), New River shiner (*Notropis scabriceps*), Kanawha minnow (*Phenacobius teretulus*), candy darter (*Etheostoma osburni*), Kanawha darter (*Etheostoma kanawhae*), and Appalachia darter (*Percina gymnocephala*), with all but the Kanawha darter occurring in West Virginia (Stauffer and Ferreri, 2002). Common fish on the Ohio River and lower portions of its tributaries include black bass (*Micropterus* spp**.)**, sunfish (*Lepomis* spp.), sauger (*Sander* spp.), catfish (order Siluriformes), the hybrid saugeye (*Sander vitreus x Sander canadense*), and striped bass (*Morone saxatilis*) (McNab and Avers, 1994; OSMRE, 2008).

Many high-altitude (headwater) streams are cold and support trout populations, particularly where these streams are draining areas larger than 100 square miles (Messinger and Chambers, 2001). In Appalachia, high elevation streams are often headwaters, but not all headwaters are high gradient, high elevation streams. Fish species collected in headwaters of West Virginia include rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), and slimy sculpin (*Cottus cognatus*) (Stauffer and Ferreri, 2002). In general, common fish species found in smaller streams in Appalachia include southern redbelly dace (*Phoxinus erythrogaster*), creek chub, barred fantail darter (*Etheostoma flabellare*), and greenside darter (*Etheostoma blennioides*), whereas largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and crappie (*Pomoxis* spp.) are found in the large, man-made reservoirs (McNab and Avers, 1994; OSMRE, 2008).

Brook trout, a native salmonid species of streams in the southern Appalachian Mountains, is found mainly in small headwater streams. The distribution of brook trout is thought to be influenced by the presence of the non-native rainbow trout, as documented in the in Great Smoky Mountains National Park (Larson et al., 1995). Within the Park, the competitive advantage of rainbow trout over brook trout was evident when rainbow trout were removed and the abundance and biomass of brook trout populations rebounded (Moore et al., 1983).

According to a study conducted in the Southern Unglaciated Allegheny Plateau (Clear Fork or Spruce Laurel Fork), fish commonly collected include mottled sculpin (*Cottus bairdii*), bluebreast darter (*Etheostoma camurum*), river carpsucker (*Carpiodes carpio*), blacknose dace, and longnose dace (*Rhinichthys cataractae*) (Messinger and Chambers, 2001).

Studies conducted in Central Appalachian drainages of eastern Kentucky have found approximately 277 native freshwater fish species distributed among 22 families, with minnows (Cyprinidae), suckers (Catostomidae), catfishes (Ictaluridae), sunfishes, and perches (*Perca* spp.) being the most predominant (U.S. EPA, 1983). A diverse fish assemblage is found in eastern Kentucky due to the numerous geological, climatic, and hydrological events (U.S. EPA, 1983). Uncommon fish species found in the Northern Cumberland Plateau section (Tennessee and Kentucky) include the paddlefish (*Polyodon spathula*), sturgeon (Acipenseridae), eastern sand darter (*Ammocrypta pellucida*), spotted darter (*Etheostoma maculatum*), Tippecanoe darter (*Etheostoma tippecanoe*), and the redside dace (*Clinostomus elongatus*) (OSMRE, 2008). Larger populations of redside dace are found within a small range in Kentucky (OSMRE, 2008).

<u>Lentic Systems (Ponds, Lakes and Reservoirs)</u>

The following discussion of lentic systems in the Appalachian basin is divided into discussions of small ponds/impoundments and reservoirs. Natural lakes are largely absent in the Appalachian coal region. Small ponds/impoundments are common in the southeastern portion of the U.S.; most are formed by damming small streams (Wallace et al., 1992).

Energy Flow/Primary Production

Submersed macrophytes (macroscopic algae and aquatic vascular plants), periphyton (attached algae), and phytoplankton (suspended algae) communities are closely linked in small impoundments (Wallace et al., 1992). In the Appalachian Basin region, small lentic systems tend to be highly productive, eutrophic systems (high in nutrients, low in dissolved oxygen), although some small ponds and impoundments may be oligotrophic where there are low concentrations of plant nutrients and low productivity (Wallace et al., 1992). The main source of primary production (production of organic matter) in these smaller lentic systems is submergent or emergent vegetation (Menzel and Cooper, 1992). Floating macrophytes such as duckweed (*Lemna* spp.), spatterdock (*Nuphar* spp.), and yellow lotus (*Nelumbo* spp.), are widely distributed in the southeastern U.S. (Wallace et al., 1992). If floating macrophytes cover an entire surface area of a pond, photosynthesis will be greatly reduced in the water column, resulting in decreased dissolved oxygen concentrations that may inhibit fish populations. Fungi and bacteria are the primary decomposers of organic matter in small impoundments.

In reservoirs, as with other smaller impoundment types, phytoplankton, periphyton, and macrophytes supply most of the organic matter to the food web. Due to fluctuating water levels, phytoplankton production dominates most impoundments; however, rooted and floating macrophytes can dominate where water levels are stable in a reservoir. Reservoirs in the Appalachian Basin region are generally nutrient rich and productive. Nutrient loads to downstream aquatic systems are higher than that in most natural lakes.

Invertebrates

Common invertebrate species found in Appalachian ponds include rotifers, protozoans, and crustaceans (Cladocera and Copepoda). Within the benthos of most ponds and reservoirs in the southeastern U.S., larvae of true midges (Diptera: Chironomidae) and oligochaete worms are the dominant macroinvertebrates (Diggins and Thorpe, 1985).

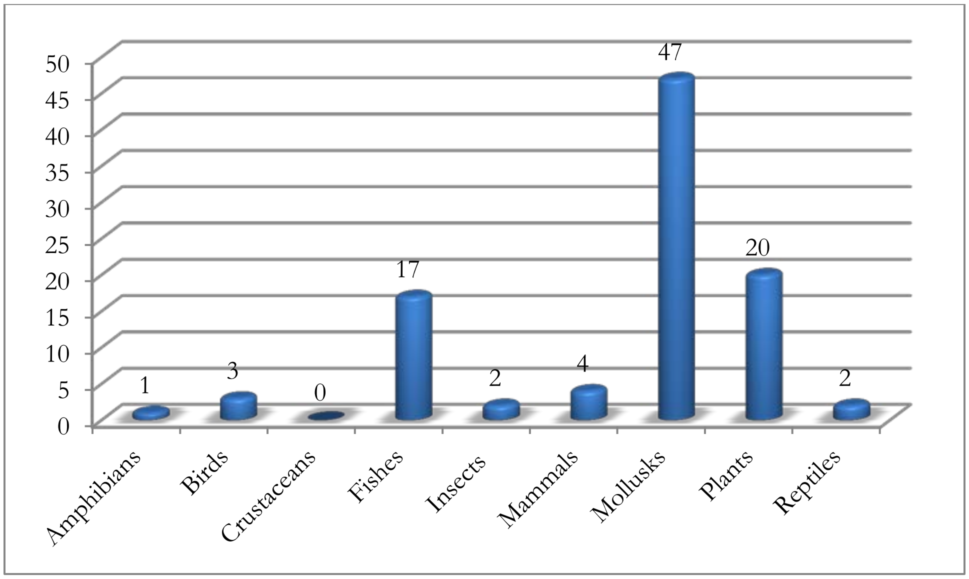
Vertebrates

Fish, amphibians, reptiles, birds, and mammals are the main groups of vertebrates associated with ponds and reservoirs in the Appalachian basin. These vertebrates may be present throughout their lifecycles, or may occupy the area only during a portion of their life cycle (Wallace et al., 1992). Fish populations are mainly comprised of forage fishes, including shads (*Alosa* spp.) and silversides (order Atheriniformes) in reservoirs, and sunfishes in ponds (Noble, 1981). The dominant predators in ponds are typically largemouth bass.

3.8.3.4 Protected Species in the Coal Mining Areas of the Appalachian Basin

The Appalachian Basin coal region supports nearly 100 federally listed species. The listed species include birds, fish, insects, mammals, mollusks, amphibians, reptiles, and vascular plants (see Appendix F for species names). Figure 3.8-2 depicts the number of listed species and relative proportion for each taxonomic group in the Appalachian Basin region.

Figure 3.8-2 Count of Federally listed species in the Appalachian Basin Coal-Producing Region



Mollusks are of particular concern within the Appalachian Basin region. Mollusks account for nearly 50 percent of the total federally listed species within the Appalachian Basin coal region. Only seven of the forty seven mollusk species listed are freshwater snails; the remaining listed mollusks are freshwater mussels. Freshwater mussels are in decline nationwide and particularly in the Southeast. According to Neves et al. (1997):

> The current status and prognosis for the Southeast region's mussel fauna is grim. Of the 269 species in the Southeast, 13 percent are presumed extinct, 28 percent are endangered, 14 percent are threatened, 18 percent are of special concern, and only 25 percent are considered stable at this time.

According to this study, as of 1997 up to 75 percent of the mussel species native to the Southeast had been ecologically impacted, and a significant concern remained regarding the vulnerability of these species due to their limited geographic distribution of many mussel species; many are endemic to small areas, and some limited to single watersheds (Neves et al., 1997). Therefore, these mussel species are extremely vulnerable to extirpation as a result of single catastrophic events. Regardless of the nationwide decline in mussel species, Appalachia is a mussel biodiversity "hotspot" in the United States, as demonstrated by the 43 federally listed freshwater mussel species reported for the Appalachian Basin coal region. Thirty-eight of the freshwater mussel species are listed as Endangered, while five mussel species are listed as Threatened.

Among the listed mammals, bats are also of particular concern in the Appalachian Basin region. White nose syndrome is a disease named after the white fungus, *Pseudogymnoascus destructans,* which infects the skin of hibernating bats on the muzzle, ears, and wings. White-nose syndrome has already caused population declines in northeastern U.S. bat populations of approximately 80%, and it continues to spread to other areas. According to the USGS National Wildlife Health Center, the disease continues to spread with new confirmed occurrences reported in Alabama,

Indiana, Kentucky, Tennessee, and Missouri
http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome).

The remaining federally listed and proposed listed non-mollusk species that occur in the Appalachian Basin coal mining areas include: twenty species of vascular plants, seventeen species of fish, three species of birds, four species of mammals, two species of insects, two species of reptiles, and one species of amphibian.

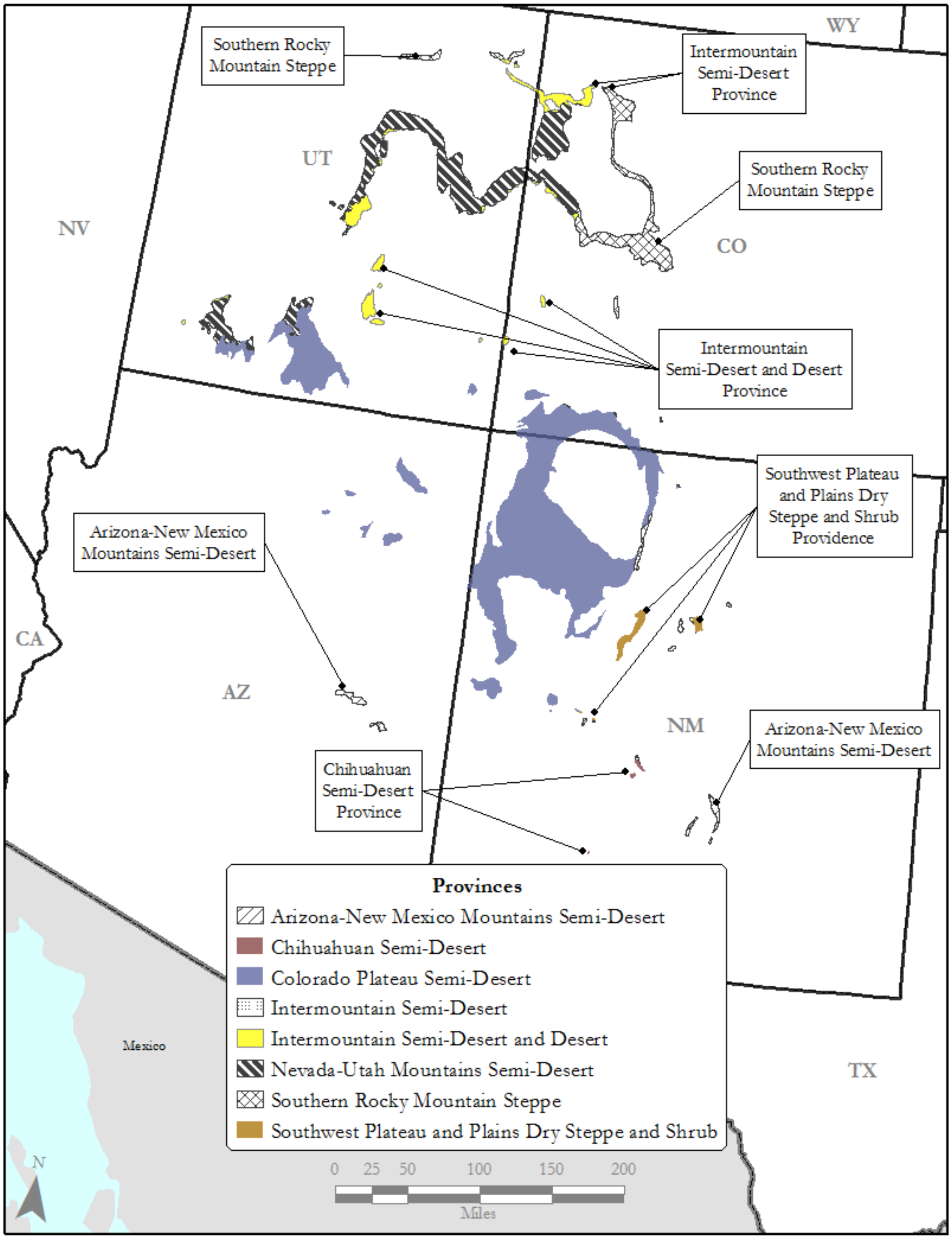
3.8.4 Colorado Plateau Region

3.8.4.1 General Ecological Setting

The Colorado Plateau coal region encompasses coal-bearing areas of Arizona, Colorado, New Mexico, and Utah (Figure 3.8-3). Table 3.8-3 shows the area of each ecological province within the Colorado Plateau Basin.

The descriptions provided below for the ecological provinces within the Colorado Plateau coal region come from Bailey (1995), Cleland et al. (1997), McNab and Avers (1994), McNab et al. (2005), and McNab et al. (2007).

Figure 3.8-3 Ecological Provinces Located Within the Colorado Plateau Region



Source:
Data: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields **http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol**

Table 3.8-3
USFS Provinces Associated with the Colorado Plateau Region

Ecological Province	Area of Coal Region in Province (square miles)
Arizona-New Mexico Mountains Semi-Desert - Open Woodland - Coniferous Forest - Alpine Meadow	263
Colorado Plateau Semi-Desert	10,853
Intermountain Semi-Desert	15
Intermountain Semi-Desert and Desert	958
Nevada-Utah Mountains Semi-Desert - Coniferous Forest - Alpine Meadow	3,687
Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow	1,602
Chihuahuan Semi-Desert	36
Southwest Plateau and Plains Dry Steppe - Open Woodland - Coniferous Forest - Alpine Meadow	252
Total	**17,666**

Arizona-New Mexico Mountains Semi-Desert-Open Woodland-Coniferous Forest-Alpine Meadow Province

This province consists mostly of steep foothills and mountains but includes some deeply dissected high plateaus. The vegetation varies by elevation zones and, from low to high, ranges from herbaceous to shrubland, to woodland, to forest. The province is approximately 34,439 square miles; the Colorado Plateau coal region is only a small amount of this province.

Several large perennial streams exist in this province. Much of the water is stored in reservoirs, small impoundments, and ponds. Ground water usually occurs at great depths. This province contains land in the watershed of the Rio Grande and Pecos Valley basins.

Colorado Plateau Semi-Desert Province

This province consists of tablelands with moderate to considerable relief in Arizona, New Mexico, and Utah. The vegetation in this province varies by altitude and varies from herbaceous and dwarf-shrubland at low elevation, shrubland and woodland at moderate elevation, to needleleaf forest at upper elevations. Water is scarce in the Colorado Plateau Semi-Desert Province. The Colorado River and its tributaries drain the coal-bearing areas of this region. The largest river in the province is the Colorado River, which crosses the northern part of the province in Arizona to Utah. Many other streams and rivers flow year-round, but the volume of water fluctuates considerably. These streams and rivers are narrow and located in deep, widely spaced valleys. Ground water supplies are deep and limited. Smaller lakes, impoundments, and reservoirs are present; Lake Powell is the largest.

Intermountain Semi-Desert and Desert Province

The vegetation in this province consists of shrubland on plains and woodlands on steeper slopes. Water is scarce in this province. The lands of the province are eroded by the Colorado River and its tributaries and are located in parts of Colorado, Arizona, and Utah. Few lakes and reservoirs occur, and the area is drained by the Colorado and Green Rivers and their tributaries. A small portion of Lake Powell occurs in Northern Canyonlands in this province. In the Uinta Basin in northeast Utah, some streams and rivers bring water into the surrounding areas from adjoining mountains. Major rivers that flow through the Uinta Basin are the Green, Duchesne, and Strawberry. Few lakes and reservoirs occur in the Uinta Basin; examples are the Strawberry reservoir, Starvation reservoir, and Steinaker reservoir.

Intermountain Semi-Desert Province

This province covers the plains and tablelands of the Columbia-Snake River Plateaus and Wyoming Basin. The vegetation in this province is herbaceous and dwarf-shrubland on plains, changing to shrubland and woodland on higher slopes.

In northeast Utah, there is a low to moderate frequency of rapidly flowing rivers and streams. Streams generally flow into the Great Basin or Snake River drainage. Few lakes and wet meadows are associated with higher areas above 5,000 feet (1,500 meters). Large lakes include Bear Lake, Gray's Lake, Palisades Reservoir, and Blackfoot Reservoir. The portions of the Intermountain Semi-Desert province in northwest Colorado are part of the Green River basin ecological subregion. Water is scarce in the Green River Basin, but some major rivers (e.g., Green and Lower Snake Rivers) and small streams flow through here. Part of the Flaming Gorge Reservoir is also found in this area.

Nevada-Utah Mountains-Semi-Desert-Coniferous Forest-Alpine Meadow Province

Vegetation is stratified by altitude, ranging from herbaceous and dwarf-shrubland on plateaus to woodlands at middle slopes and needleleaf evergreen forests on higher mountain slopes. Although some valleys are closed, none contain perennial lakes.

Generally, streams in this province are rare. Few are perennial, except in the southern Utah High Plateau Section. In the Tavaputs Plateau Section of this province, which is found in eastern-central Utah and in western Colorado, water is confined to the Green and White Rivers. Smaller drainages such as Timber, Sowards, and Indian Canyon deliver water to the Green River system after flowing into the Strawberry River in the Uinta Basin. There are few lakes and reservoirs in the Tavaputs Plateau Section, and many water developments exist on public lands to distribute to livestock and to provide water for wildlife. In the areas of the province found in south-central Utah, streams, lakes, and ground water supplies provide adequate water for grazing and forest growth. Perennial streams in southern Utah are more common and drain into the Sevier, Virgin, or Colorado Rivers. Some of the major lakes are larger impoundments of perennial streams: Piute Reservoir, Panguitch Lake, Scofield Reservoir, Joes Valley Reservoir, Fish Lake, and Otter Creek Reservoir.

Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province

The vegetation of this province is mainly evergreen, needleleaf forest that varies in composition with altitude and aspect. In northern New Mexico and southwest Colorado, the landscape is rugged with high, steeply crested mountains etched with deep valleys. The northwestern areas of Colorado within this province have topography dominated by flat-topped mountains that are dissected by narrow stream valleys. Snowfields exist on higher-elevation upper slopes and crests, which provide a source of water into the summer months. The Rio Grande, Animas, Gunnison, Yampa, White, Colorado, Eagle, Arkansas, Taylor, Crystal, Roaring Fork, San Miguel and Frying Pan are the larger perennial rivers flowing through here. Water from streams and lakes is abundant in this province and ground water is also plentiful.

Chihuahuan Semi-Desert Province

This province has a subtropical arid climate of short winters and long, hot summers. It includes isolated embedded areas of mountain climates of cooler temperatures, lower relative humidity, and increased orographic precipitation. Most precipitation occurs during mid to late summer, mainly as thunderstorms that cause rapid runoff. Vegetation is almost entirely dwarf-shrubland and sparse coverage, although small areas of woodland do occur on higher mountains.

Southwest Plateau and Plains Dry Steppe and Shrub Province

A description of the Southwest Plateau and Plains Dry Steppe and Shrub province is provided below in the discussion of Gulf Coast provinces.

3.8.4.2 Terrestrial Resources

The Colorado Plateau coal region encompasses coal-bearing areas of Arizona, Colorado, New Mexico, and Utah. The text below summarizes aspects of terrestrial resources in areas of the region as classified under the USDA-USFSTerrestrial Ecological Unit designation (see also Figure 3.8-3) and adapted from Bailey (1995), McNab and Avers (1994), Cleland et al. (1997), and McNab et al. (2007). Table 3.8-3 lists the aerial extent of each unit within the Appalachian Coal Basin.

Vegetation

In Utah, most of the coal region is associated with the Intermountain Semi-desert and Desert Province and the associated Nevada-Utah Mountains Semi-desert-Coniferous Forest-Alpine Meadow Province. Cover types include: desert shrub; pinyon-juniper; sagebrush and chaparral-mountain shrub desert grasslands; ponderosa pine; western hardwoods; and Douglas-fir. The common vegetation and fauna in each cover type described in this report are described briefly in Appendix G.

Along its northern edge in Utah and extending across Colorado south into New Mexico, the coal region is located within the Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province. This area is characterized by the following cover types: lodgepole pine; fir-spruce; sagebrush; alpine tundra chaparral-mountain shrub; ponderosa pine; and pinyon-juniper.

In the four corners area at the intersection of Utah, Colorado, Arizona, and New Mexico, the coal region is within the Colorado Plateau Semi-desert Province. This area is characterized by sagebrush, pinyon-juniper, ponderosa pine, southwestern shrub-steppe, desert grasslands, and desert shrub cover types.

South of the Four Corners area in central-eastern Arizona and into central New Mexico, the coal region is located within the Arizona-New Mexico Mountains Semi-desert-Open Woodland-Coniferous Forest-Alpine Meadow Province. Ecoregion sections are characterized by ponderosa pine, pinyon-juniper, desert grasslands, and southwestern shrub-steppe cover types.

The fauna that occur in the arid and semi-arid areas of this coal region have adapted to its harsh climatic conditions. The composition of animal communities in and surrounding the lotic systems of this region are influenced by the vegetative communities that occur. Compared to the rest of the landscape, microclimates in and around the streams support the greatest concentrations of wildlife and provide the primary: habitat; predator protection; breeding and nesting sites; shade; movement corridors; migration stopover sites; and food sources (Levick et al., 2008).

Some physical features of wildlife habitat along ephemeral and intermittent streams include: the deposits of river material (sediment and debris); rock and subsurface soil layers exposed by erosion; the provision of shade through topographic relief; the creation of microclimatic zones; and the sequestration of moisture and nutrients in alluvium. River bank material provides shelter for numerous wildlife species including reptiles, amphibians, birds, mammals, and invertebrates. Specifically, dry wash embankments can contain numerous small caves and crevices that provide critical shelters from predators and the harsh environmental conditions for a variety of species (Van Devender, 2002; Levick et al., 2008).

Major wildlife species in the coal-bearing areas of southeastern Utah, southwest Colorado and northern New Mexico include mule deer (*Odocoileus virginianus*), elk (*Cervus canadensis*), coyote (*Canis latrans*), black bear, mountain lion (*Puma concolor*), black-tailed jackrabbit (*Lepus californicus*), Gunnison's prairie dog (*Cynomys gunnisoni*), badger (*Taxidea taxus*), piñon jay (*Gymnorhinus cyanocephalus*), black-billed magpie (*Pica hudsonia*), mountain chickadee (*Poecile gambeli*), red-breasted nuthatch (*Sitta Canadensis*), white-breasted nuthatch (*Sitta carolinensis*), collared lizard (*Crotaphytus collaris*), western fence lizard (*Sceloporus occidentalis*), and western rattlesnake (*Crotalus viridis*).

Some of the major wildlife species occurring in east central Utah to mid-central Colorado include coyote, kit fox (*Vulpes macrotis*), white-tailed prairie dog (*Cynomys leucurus*), white-tailed jackrabbit (*Lepus townsendii*), pronghorn (*Antilocapra americana*), mule deer, elk, American kestrel (*Falco sparverius*), sage grouse (*Centrocercus* spp.), turkey vulture (*Cathartes aura*), screech owls (*Megascops* spp.), mourning dove, piñon jay, common raven (*Corvus corax*), sage sparrow (*Artemisiospiza nevadensis*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), western rattlesnake, bullsnakes (*Pituophis* spp.), western fence lizard, and sagebrush lizard (*Sceloporus graciosus*).

Faunal communities are highly related to the habitat as influenced by altitude. Rocky Mountain bighorn sheep (*Ovis canadensis*) and white tailed ptarmigan (*Lagopus leucura*) inhabit the higher elevations of some portions of the region. In desert shrub communities common wildlife species include rock wren (*Salpinctes obsoletus*), lark sparrow (*Chondestes grammacus*), loggerhead shrike (*Lanius ludovicianus*), horned lark (*Eremophila alpestris*), green-tailed towhee (*Pipilo chlorurus*), Brewer's sparrow (*Spizella breweri*), red-tailed hawks, golden eagle, northern harrier (*Circus cyaneus*), and the American kestrel. In pinyon-juniper and mountain brush habitats mountain bluebird (*Sialia currucoides*), blue-gray gnatcatcher (*Polioptila caerulea*), red breasted nuthatch, flycatchers (Family Tyrannidae), great horned owl (*Bubo virginianus*) and red-tailed hawk are common. Mountain bluebirds are common summer nesters. The piñon jay and piñon mouse (*Peromyscus truei*) are obligate species in the pinyon-juniper and mountain brush habitat.

In the high elevation sagebrush communities typical species include sage grouse, mule deer, pronghorn, mountain lion, black bear, California myotis (*Myotis californicus*) and pygmy faded rattlesnake (*Crotolus viridis concolor*). Typical forest-dwelling avifauna include Clark's nutcracker (*Nucifraga columbiana*), gray jay (*Perisoreus canadensis*), northern flicker (*Colaptes auratus*), and Steller's jay (*Cyanocitta stelleri*). Bird species representative of aspen and coniferous forest specifically can include brown creeper (*Certhia americana*), western wood peewee (*Contopus sordidulus*), warbling vireo (*Vireo gilvus*), MacGillivray's warbler (*Geothlypis tolmiei*), Townsend's solitaire (*Myadestes townsendi*), three-toed woodpecker (*Picoides dorsalis*), red-naped sapsucker (*Sphyrapicus nuchalis*), hairy (*Leuconotopicus villosus*) and downy woodpeckers (*Picoides pubescens*), red-tailed hawk, goshawk (*Accipiter gentilis*), Cooper's hawk (*Accipiter cooperii*), and sharp-shinned hawk (*Accipiter striatus*). Typical mammal species in these aspen and coniferous forests include red squirrel (*Sciurus vulgaris*), northern flying squirrel (*Glaucomys sabrinus*), deer, elk, mountain lion, bear, coyote, and hoary bat (*Lasiurus cinereus*).

In the riparian areas bird species can include yellow warbler (*Setophaga petechia*), tree swallow (*Tachycineta bicolor*), western kingbird (*Tyrannus verticalis*), house wren (*Troglodytes aedon*), rufous-sided towhee (*Pipilo erythrophthalmus*), song sparrow (*Melospiza melodia*), loggerhead shrike, hairy woodpecker, red-tailed hawk, and golden eagle. Riparian areas also support a variety of mammals including deer, elk, moose (*Alces alces*), mountain lion, bear, beaver (*Castor canadensis*) and silver-haired bat (*Lasionycteris noctivagans*), along with amphibians such as the Utah tiger salamander (*Ambystoma Tigrinum*). Two common amphibian species include chorus frogs (*Pseudacris* spp.), and leopard frogs (*Rana* spp.).

Soil salinity also affects this region's vegetative communities and the fauna that use them. Within southeast Utah, northeastern Arizona, and northwest New Mexico high elevation desert shrub and woodland vegetation the plant and animal communities change. High elevation pinyon-juniper woodland and sagebrush have an understory of galleta (*Hilaria* spp.), blue grama (*Bouteloua gracilis*), black grama (*Bouteloua eriopoda*), and western wheatgrass (*Pascopyrum smithii*). Galleta grass, alkali sacaton (*Sporobolus airoides*), Indian ricegrass (Oryzopsis hymenoides), bottlebrush squirreltail (*Elymus elymoides*), and needlegrasses (*Achnatherum* spp.) intermixed with fourwing saltbush (*Atriplex canescens*) and winterfat (*Krascheninnikovia lanata*) are at the lower elevations. Greasewood (*Sarcobatus* spp.) and shadscale (*Atriplex confertifolia*) are part of the plant community on salty soils. Blackbrush (*Coleogyne ramosissima*) may be dominant at the lower elevations.

3.8.4.3 Aquatic Resources

In the Colorado Plateau coal region, each province has unique climatic, physiographic, and geologic properties that influence the types of aquatic systems and biota that occur within them.

Lotic Systems (River and Streams)

Major perennial rivers that run through the provinces found in the coal region include the Green, Yampa, White, Little Colorado, Colorado, Rio Grande, Pecos, Gila, San Juan, San Francisco, and Little Snake. The largest watershed in this coal region is the Colorado River watershed.

Over 81 percent of streams in the Southwest (Arizona, New Mexico, Nevada, Utah, Colorado and California) are ephemeral or intermittent, according to the USGS National Hydrography Dataset (NHD) (USGS, 2011a). Ephemeral and intermittent streams in the desert and semi-desert areas of this coal region are unique in their function when compared to perennial streams located in wetter, more humid mountainous provinces. Most streams in the more xeric, desert-like areas of the coal region drain erodible sedimentary rock, making the waters turbid, and sudden rains flush sediments down smaller streams to the perennial reaches (U.S. EPA, 2006). These smaller streams in the xeric regions are often subject to rapid change as a result of flash floods and debris flows (U.S. EPA, 2006). In the southern areas, the extreme xeric conditions and water withdrawals produce internal drainages that end in saline lakes (U.S. EPA, 2006) or desert wallows called playas (Levick et al., 2008). The seasonal rainfall patterns in this coal region vary, which as a result have an effect on stream flows throughout.

A variety of flowing water habitats is present in the Colorado Plateau coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. As listed in Table 3.5-5, there are a total of 43,482 miles of intermittent streams, and 2,811 miles of perennial streams, in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C.

Ephemeral and intermittent stream channels provide critical wildlife movement corridors in arid and semi-arid regions because they often contain continuous chains of vegetation that provide food and cover for wildlife. Small floods that occur during the summer monsoons create corridors of water that allow the dispersal of herpetofauna such as garter snakes and various amphibians (Levick et al., 2008).

Energy Flow/Primary Production

The riparian areas surrounding lotic systems in this coal region are vital to the persistence of biota. Riparian ecosystems occupy small portions of the landscape in arid and semi-arid areas of the coal region, yet they exert substantial influence on hydrologic, geomorphic, and ecological processes (Shaw and Cooper, 2008), and typically support the great majority of biodiversity in these regions (Levick et al., 2008). Plant communities along ephemeral and intermittent streams of this coal region provide food, cover, nesting and breeding habitat, and movement/migration corridors for wildlife that are not as available in the adjacent uplands (Levick et al., 2008). Furthermore, these plant communities moderate soil and air temperatures, stabilize channel banks and interfluves, provide seed banks, trap silt and fine sediment favorable to the establishment of diverse floral and faunal species, and dissipate stream energy, which aids in flood control (Levick et al., 2008). Ephemeral streams in this region provide support to aquatic species within their own reaches and transfer nutrients, food, and other materials to the more perennial downstream reaches, aiding the biota in these habitats as well.

Algal communities comprised of diatoms, filamentous algae, and cyanobacteria are the predominant primary producers in intermittent and ephemeral streams of the more arid areas of the Colorado Basin coal region. These algal communities are prolific due to the high levels of sunlight. After flood events, algal blooms can occur in areas with stored water and provide the base of the food chain in these systems. When stored water is accessible, primary production can be high for much of the growing season (Atchley et al., 1999; Levick et al., 2008).

As the hydrologic regime shifts from perennial to ephemeral, the presence of drought-tolerant species increases, vegetative cover declines, riparian areas transition from forests to shrublands, and canopy height and upper canopy vegetation volume decline (Leenhouts et al., 2006; Stromberg et al., 2007; Levick et al., 2008). Ephemeral streams with intermediate water availability support drought-tolerant shrubs such as wolfberry (*Lycium* spp.), brickellbush (*Brickellia* spp.), and small-leaved trees such as velvet mesquite (*Prosopis velutina*) (Hardy et al., 2004; Levick et al., 2008). Along the intermittent and perennial streams, riparian scrublands include seepwillow or batamote (*Baccharis glutinosa*), broom (*Baccharis sarothroides* or *B. emoryi*), arrowweed (*Pluchea sericea*), and tamarisk (*Tamarix chinensis*) (Brown et al., 1977; Levick et al., 2008). Hydro-obligate broad-leaved trees (e.g., the mesoriparian species Arizona walnut, *Juglans major*, and the Fremont cottonwood, *Populus fremontii*) are typically sustained on large washes by floodwater stored in perched ground-water reservoirs (Levick et al., 2008).

Invertebrates

Aquatic invertebrates are important contributors to the biological integrity of stream networks throughout this coal region. Invertebrates constitute a majority of faunal diversity, and aquatic invertebrates are a significant component of the food chain. Many invertebrates require a hydrologic connection for their spatial dispersal, even if the connection is ephemeral or intermittent (Nadeau and Rains, 2007). Ephemeral streams in this coal region can contain rich assemblages of invertebrates. Microinvertebrates in these ephemeral systems include copepods, ostracods, and cladocerans (Levick et al., 2008). Intermittent streams in the Southwest provide food sources for numerous macroinvertebrates found within them and in surrounding areas. For example, Graham (2002) studied temporary pools in watercourses in Wupatki National Monument, Arizona, and found 22 taxa of aquatic macroinvertebrates and two taxa of amphibians. Disturbances caused by intermittent flows may actually improve production and food quality and consequently increase insect production in warm-temperate desert streams (Fisher and Gray, 1983; Jackson and Fisher, 1986; Grimm and Fisher, 1989; Huryn and Wallace, 2000; Levick et al., 2008). Whiles and Goldowitz (2005) investigated macroinvertebrate diversity across a hydrologic gradient from ephemeral to perennial streams and found the highest taxa richness and diversity at intermittent sites (Levick et al., 2008). Del Rosario and Resh (2000) compared species richness and abundance of invertebrates in the hyporheic zones of intermittent and perennial streams, and found that intermittent streams had lower densities, similar richness, but higher species diversity than perennial streams.

Various mollusks are found within this coal region and function as filter feeders that eat algae, detritus, and other submersed items on the rocks and substrate within the streams. Mollusks are important sources of food for fish, birds, and some mammals. Mussels rely on specific fish species as hosts for their larvae (called glochidia) to complete their life cycle, and removal of these hosts has led to the decline of some species (Harrold and Guralnick, 2010). Specifically, as of 2010, Colorado has 83 mollusk species (eight gastropod families and three bivalve families) known to occur in various waters throughout the state (Harrald and Guralnick, 2010).

Crustaceans that occur in the Colorado Plateau are various crayfish and freshwater shrimp, and many species are imperiled by pollution, habitat loss, and invasive species. Exotic mollusks have been a threat to ecological communities in Utah (Sutter et al., 2005). Native crustacean species are rare in Utah and of limited distribution (Sutter et al., 2005). Invasive crayfish populations' effects on streams, especially in sensitive headwater areas, are receiving increased attention. Crayfish, such as the rusty crayfish (*Orconectes rusticus*), are omnivorous and aggressively consume submerged aquatic vegetation, other macroinvertebrates, and fish species, and they compete for habitat and resources with fish, frogs, reptiles, and snails (Arizona Invasive Species Advisory Council, 2008).

Vertebrates

Fish communities in the Colorado Plateau coal region range from assemblages of warm water fish (e.g., centrarchids, cyprinids, topminnows, catfishes, perches, catostomids) in the lower elevations to assemblages of more coolwater species (e.g. darters, sculpins, cyprinids, and salmonids) in the higher gradient streams in the upper elevations. However, the Southwest has among the greatest species endemism in the U.S. Cyprinids and cyprinodontids appear to be the most specious groups of fishes that occur in the various lotic systems in the coal region, and some of the largest members of the family Cyprinidae occur in this coal region. The southwestern deserts of the Basin and Range Province, which encompasses some of the coal region, contain 182 native species of fish, of which 149 are endemic. In these areas, the fish occupy isolated pools within streams that are supplied by underground springs, intermittent marshes, and arroyo habitats which are supplied by water that originates in the wetter mountainous areas (Helfman et al., 1997). Fish communities in the desert areas tend to belong to five major families: Poeciliidae, Cyprinodontidae (e.g., desert pupfish), Cyprinidae, Catostomidae, and Salmonidae (Helfman et al., 1997). Populations of native desert fishes are rapidly dwindling due to destruction of aquatic habitats from urbanization, channelization, land-use change, over grazing by cattle, ground-water pumping, dams, water diversions, and pollution (Rinne and Minckley, 1991).

Fish in the extremely arid areas of this coal region are adapted to harsh and variable desert conditions. For this reason (and others) the ephemeral and intermittent streams, and the isolated pools within them, are important. For example, pupfish (*Cyprinodon* spp.) can withstand the high temperatures, alkalinity, and salinity of small desert pools (Pister, 1995; Levick et al., 2008). Another example, longfin dace (*Agosia chrysogaster*) have the most widespread distribution of any native fish in the Southwest and are highly adapted to drought (Rinne and Minckley, 1991). Longfin dace can survive in relatively high water temperatures, poor water quality and availability, and have been found alive in moist algal mats where there was not enough water to swim (Hulen, 2007; Rinne and Minckley, 1991; Levick et al., 2008).

Larger fishes of the coal region occur in the larger, higher-order perennial streams and rivers, including the Green, Colorado, Yampa, and San Juan Rivers; many are highly threatened as a result of anthropogenic disturbances and invasive species.

Cutthroat trout (*Oncorhynchus clarkii*) serve as an important recreation species in Utah (Sutter et al., 2005). The historical distribution of cutthroat trout covers the broadest range of any stream-dwelling trout in the Western Hemisphere. The rugged topography of their range has led to isolation, which in turn has given rise to fourteen recognized subspecies. Four of these evolved in Colorado and three are of particular interest: the Colorado River cutthroat trout (*O. clarkii pleuriticus)* in drainages west of the continental divide, Greenback cutthroat trout (*O. clarkii stomias*) in the South Platte and Arkansas River drainages, and the Rio Grande cutthroat trout (*O. clarkii virginalis*) in streams that drain into the San Luis Valley (Colorado Division of Wildlife, 2010).

The greenback cutthroat trout was thought to be extinct in 1937; however, numerous pure populations have since been discovered. The historic range for greenback cutthroat trout lies in the headwaters of the South Platte and Arkansas Rivers. Many of those waters have been reclaimed and restocked with pure greenback cutthroat trout. The success of those projects led to the 1978 down listing of greenback cutthroat trout from endangered to threatened under the ESA (Colorado Division of Wildlife, 2010).

The Colorado River cutthroat trout historically occupied portions of the Colorado River drainage in Wyoming, Colorado, Utah, Arizona, and New Mexico. Widespread introductions of non-native salmonids over the last century have served to limit current distributions primarily to isolated headwater streams and lakes. As such, the Colorado River cutthroat trout is designated as a species of special concern in Colorado, and significant resources have been dedicated to conservation of the subspecies. The Conservation Agreement for Colorado River cutthroat trout is a collaborative effort among state and federal resource agencies designed to provide a framework for the long-term conservation of Colorado River cutthroat trout and to reduce or eliminate the threats that warrant its status as a species of special concern (Colorado Division of Wildlife, 2010).

The Rio Grande cutthroat trout is the third subspecies of native trout found in Colorado. They range further south than any other cutthroat trout, historically occupying waters down to southern New Mexico. As with other subspecies of cutthroat trout, widespread introductions of non-native salmonids over the last century have served to limit their current distribution to isolated headwater streams and lakes. A conservation plan developed in 2004 has been used to guide conservation efforts thus far. A Conservation Agreement (Rio Grande Conservation Team, 2009) provides a collaborative framework among state, federal, and tribal resource agencies outlining long-term conservation objectives for this subspecies.

The Colorado Plateau coal region has high herpetofauna diversity, most of which are reptiles. However, there are some introduced species such as the bullfrog (*Lithobates catesbeianus*) that have imperiled other species in some areas of the coal region (Arizona Invasive Species Advisory Council, 2006). Bullfrogs, which are aggressive predators, have been introduced into many locations in the Colorado Plateau coal region and have locally depleted and displaced populations of native amphibians, reptiles, fish, and even small mammals and birds (Arizona Invasive Species Advisory Council, 2008).

Lentic Systems

Lentic systems in the Colorado Plateau coal region tend to be smaller intermittent or ephemeral wallows called playa lakes, or larger reservoirs created by impoundment of stream flow. Of the 802 lakes surveyed in the "Xeric ecoregion" of the EPA's National Lakes Assessment (U.S. EPA, 2009b), which includes the Colorado Plateau coal region, 91 percent were constructed reservoirs. Damming the Colorado River has created large man-made lakes and reservoirs (e.g., Lake Powell) (U.S. EPA, 2009b). Smaller impounded streams comprise numerous man-made lentic systems that provide energy and water supply for various municipalities.

Playas fill with water after seasonal rainstorms when freshwater collects in the round depressions of the generally flat landscape. Some saltwater-filled playas are also found in the region and these systems are fed by water from underlying aquifers that transfer salt as water percolates upward through the soil (U.S. EPA, 2012). The saline environment in these playas is inhospitable to many organisms and results in a fauna uniquely adapted to these conditions. Playas are important because they store water in areas commonly subjected to drought, where there are no permanent rivers or streams. Consequently, playas create an oasis-like area that provides habitat for a variety of species, especially in the more arid areas of the coal region. Because playa lakes support such a wide variety of animals, they contribute significantly to the biodiversity of this coal region.

Energy Flow/Primary Production

Flora found in and surrounding the playas can be variable depending upon the periodicity of rain events, agriculture, and substrate (Bolen et al., 1989). During wetter periods, emergent vegetation such as bulrushes (family Cyperaceae), cattails (*Typha* spp.), pondweeds and smartweeds (family Polygonaceae), and barnyard grasses (*Echinochloa* spp.) can be present (Bolen et al., 1989).

Energy flow and primary production in lentic systems within the Colorado Plateau coal region are variable by location but are similar to those described for the semi-arid provinces in the Other Western Interior, Northern Rocky Mountains and Great Plains, and Gulf Coast coal regions.

Invertebrates

Invertebrate populations are heavily exploited by the animal community. During their breeding season, various waterfowl and their broods rely on aquatic macroinvertebrates as important sources of protein. Invertebrates in the littoral zones of playas also provide food for a number of shorebirds (Baldassarre and Fischer, 1984; Bolen et al., 1989). Merickel and Wangberg (1981) collected more than 60 species of macroinvertebrates in playa lakes; however, such biodiversity will vary depending on location, type of playa, and surrounding flora (Bolen et al., 1989).

In some communities of playas, biotic interactions are thought to lead a relatively ordered and predictable succession of organisms (MacKay et al., 1990). MacKay et al. (1990) also noted that after flood events, macroinvertebrate productivity increased with the oviposition of flying insects such as mosquitoes (*Aedes* spp.). Immediately following these floods, mosquito larvae pupated and left the playa within eight days; simultaneously, freshwater shrimp (*Eulimnadia* spp., *Streptocephalus* spp., *Triops* spp., and *Thamnocephalus* spp.) densities increased and then dissipated as the playa dried. This provides evidence that such species in playa lakes likely have adapted quick life cycles to avoid direct competition and predation by other organisms.

Vertebrates

Amphibian species and their dependence on playas are poorly understood. However, multiple species have been documented to use playas, primarily during periods of peaked rainfall that triggers their breeding activities (Bolen et al., 1989). Tiger salamanders (*Ambystoma tigrinum*) use playas in the Southern High Plains to spawn, and leopard frogs (*Rana pipiens*), bullfrogs, cricket frogs (*Acris* spp.), spotted chorus frogs (*Pseudacris* spp.), Great Plains toads (*Bufo cognatus*) and spadefoot toads (*Scaphiopus* spp.) also occur in these playas (Bolen et al., 1989; MacKay et al., 1990).

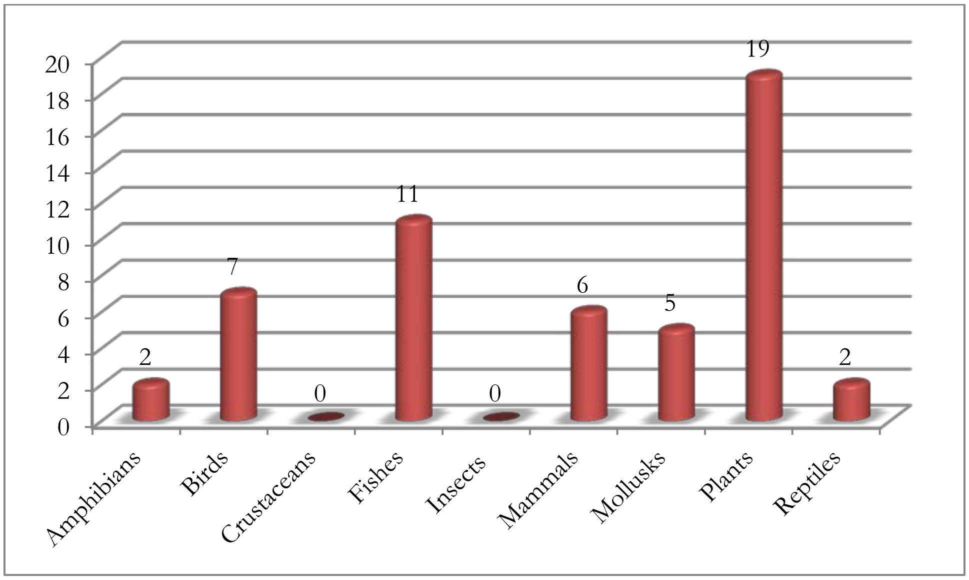
Fish do not commonly inhabit playas because they are ephemeral bodies of water. Playas that have been altered for irrigation and agriculture have had introductions of various fish species to support some angling activity. Bolen et al. (1989) noted that playas that historically contained no fish populations now support black bullhead (*Ameiurus melas*).

Waterfowl commonly winter in the playa lakes of the region (Bolen et al., 1989); the EPA (2012) noted up to two million waterfowl can use playas. Whooping cranes (*Grus americana*) and up to 400,000 sandhill cranes (*G. canadensis*) have been documented to use the playas as wading and feeding habitat (Bolen et al., 1989). Ring-necked pheasants (*Phasianus colchicus*) also use playa lakes as wintering habitat in this region (Bolen et al., 1989). Species native to areas surrounding these systems survive because of the existence of playa lakes.

3.8.4.4 Protected Species in the Coal Mining Areas of the Colorado Plateau

In the Colorado Plateau coal region, there are a total of 52 federally listed (and proposed listed) species. See Appendix F for the species names and status information. Figure 3.8-4 depicts the number of listed species and relative proportion for each taxonomic group in the Colorado Plateau coal region.

Figure 3.8-4 Count of Federally listed species in the Colorado Plateau Region

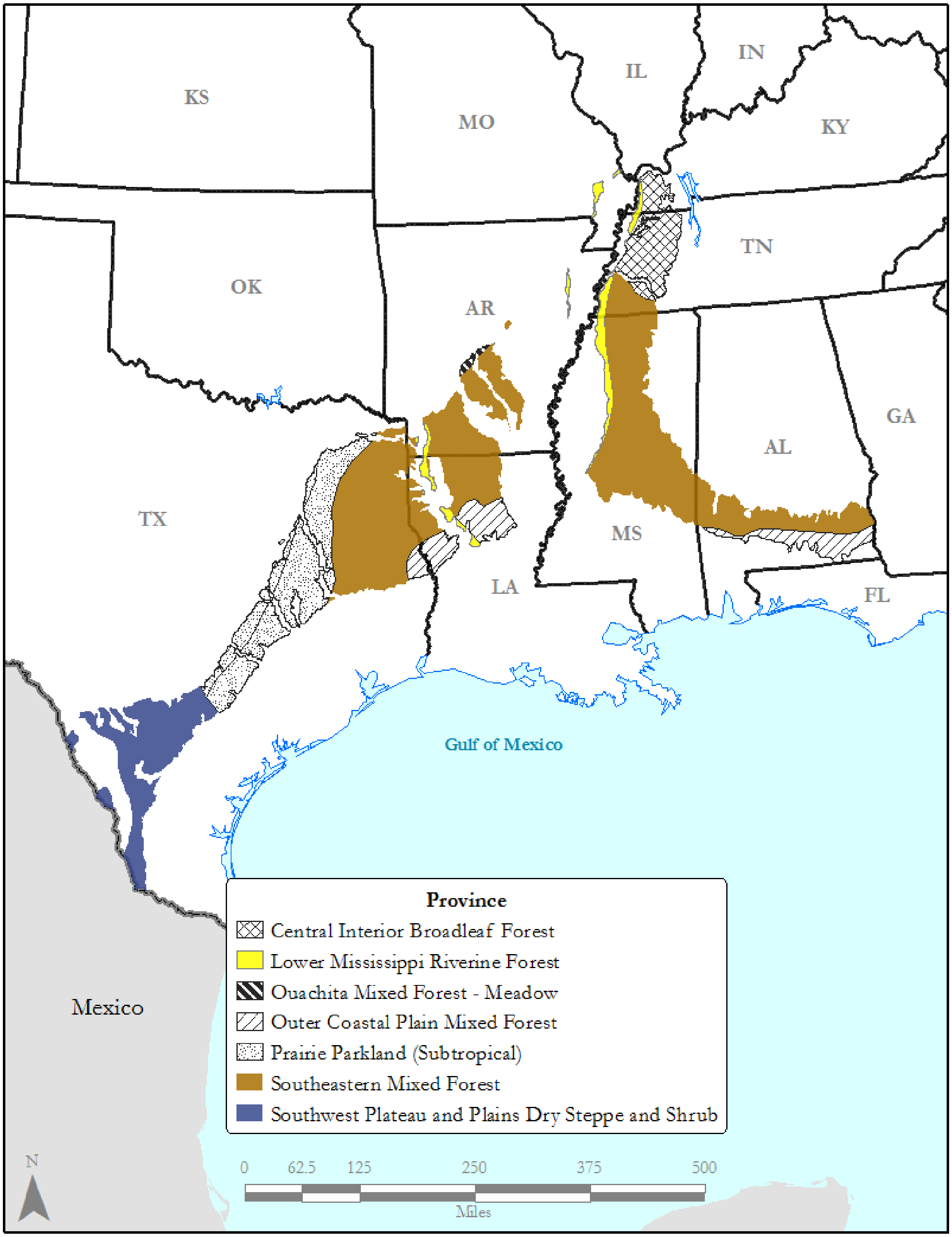


3.8.5 Gulf Coast Region

3.8.5.1 General Ecological Setting

The coal region of the Gulf Coast is an area of approximately 9,735 square miles and includes the coal mining areas located in Texas, Louisiana, and Mississippi (Figure 3.8-5). A variety of physical and chemical factors affect the biological resources of this coal region. Table 3.8-4 lists the ecological provinces located within this coal region and the approximate area of each.

Figure 3.8-5 Ecological Provinces Located Within the Gulf Coast Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Table 3.8-4
USFS Provinces Associated with the Gulf Coast Region

Ecological Province	Area of Coal Region in Province (square miles)
Outer Coastal Plain Mixed Forest	12,107
Prairie Parkland (Subtropical)	12,258
Southeastern Mixed Forest	46,193
Southwest Plateau and Plains Dry Steppe and Shrub	9,566
Lower Mississippi Riverine Forest	623
Central Interior Broadleaf Forest	27
Ouachita Mixed Forest-Meadow	101
Total	**80,876**

The descriptions provided below for the ecological provinces distributed within the Gulf Coast coal region come from Bailey (1995), Cleland et al. (1997), McNab and Avers (1994), and McNab et al. (2007).

Outer Coastal Plain Mixed Forest Province

Most of the province's numerous streams are intermittent to perennial, and sluggish; marshes, swamps, and lakes are numerous. Major rivers that run through the province in the coal region include the Sabine, Red, Mississippi, Mobile, Chattahoochee, and the Flint. Few natural lakes and reservoirs are present, but small ponds and impoundments are abundant.

Prairie Parkland (Subtropical) Province

This province is a region of gently rolling to flat plains. The vegetation is mainly herbaceous with areas of deciduous broadleaf woodland, particularly along floodplains. In the central Texas area of the province, there is a low to moderate density of perennial streams and associated rivers that form dendritic drainage patterns. These streams mostly have low to moderate rates of flow and moderate velocity. One of the major rivers draining this area is the Red River. A relatively large number of water reservoirs have also been constructed. Along the Texas coast, fluvial deposition and shore-zone processes are active in developing and maintaining beaches, swamps, and mud flats. There is a low density of small to medium size perennial streams and associated rivers, most with moderate volume of water flowing at low velocity. A major river draining this area is the Trinity. In the southern areas of the province small to medium size perennial streams and a low density of associated rivers occur, most with moderate volume of water flowing at very low velocity. Approaching the coast, the water table is high, resulting in poor natural drainage and abundance of wetlands. A poorly defined drainage pattern has developed on very young plains near the coast. An abundance of palustrine (non-tidal wetlands) systems are present, having seasonally high water levels.

Southeastern Mixed Forest Province

In eastern Texas, northwest Louisiana, and eastern Mississippi small to medium size perennial streams and associated rivers occur, most with a moderate volume of water flowing at low velocity. These lotic systems form a dendritic (branching) drainage pattern and tend to lack bedrock control. Major rivers in this ecological province within the Gulf Coast coal region are the Arkansas, Red, and Ouachita.

Southwest Plateau and Plains Dry Steppe and Shrub Province

This is a region of flat to rolling plains and plateaus occasionally dissected by canyons at the western end of the Gulf Coastal Plain and the southern end of the Great Plains. The vegetation of this province is mainly herbaceous with shrubland increasing to woodland on steeper slopes. Aquatic systems in the Edwards Plateau consist of small intermittent and occasional perennial streams forming a dendritic drainage pattern. All streams generally have a low volume of water flowing at low velocity, except along the plateau escarpment, where flow rates can be high. In the southern portion of this province, small to medium intermittent streams are present in a dendritic drainage pattern, and major rivers include the Rio Grande and Nueces.

Central Interior Broadleaf Forest Province

A description of the Central Interior Broadleaf Forest province is provided above in Section 3.8.2.

Lower Mississippi Riverine Forest Province

The climate of this province is characterized by warm winters and hot summers. Precipitation occurs throughout the year, although least in fall. Much of this subregion is influenced by periodic flooding of the Mississippi River. Vegetation was initially forests of cold-deciduous, mesophytic hardwoods, which have now largely been cleared and cultivated.

Ouachita Mixed Forest-Meadow Province

This province has a continental climate, with short, cool winters and long, hot summers. Precipitation occurs throughout the year, but summers are dry. Vegetation consists of mixed needle leaf and cold-deciduous broadleaf forests.

3.8.5.2 Terrestrial Resources

The Gulf Coast coal region study area includes many different terrestrial habits over a broad area of the southeastern United States, ranging from desert habitats in west Texas to coastal areas of the Florida panhandle. The coal counties with active mines extend from Texas to Mississippi. Except as noted, all of the ecoregion descriptions and vegetation cover type descriptions are taken from McMahan et al. (1984) and McNab et al. (2007).

In central Texas, the Gulf Coast coal belt consists of three ecoregion sections: the Rolling Plains Section; the Southwest Plateau and Plains Dry Steppe; and Shrub Province (characterized by Great Plains grasslands, prairie cover types, and oak-hickory). The eastern portion of this coal region is within the Prairie Parkland Province, characterized by cropland; mesquite-lotebush shrub areas with *Yucca* spp., juniper (*Juniperus* spp.), bluestems and snakeweed (*Gutierrezia* *sarothrae*); and mesquite brush (*Prosopus* spp.) areas with yucca (*Yucca* spp.), prickly pear (*Opuntia* spp.), and grama (*Bouteloua* spp.).

The most significant portion of the Gulf Coast coal belt crosses numerous ecoregions. The eastern portion is characterized by cropland; mesquite-lotebush shrub areas with *yucca*, juniper, bluestems and snakeweed; and mesquite brush areas with yucca, prickly pear, and grama. In southern Texas, the coal region includes the Southwest Plateau and Plains Dry Steppe and Shrub Province and associated with the Texas savanna and oak-hickory cover types, including with extensive cropland, mesquite-blackbrush brush, and mesquite-Granjeno parks. Common wildlife species include white-tailed deer, coyote, bobcat, beaver, raccoon, cottontail rabbit (*Sylvilagus* spp.), fox squirrel (*Sciurus niger*), turkey, bobwhite, and mourning dove.

East of Texas, the coal region is characterized by oak-hickory, oak-gum-cypress, oak-pine, loblolly-shortleaf pine, prairie, and longleaf-slash pine cover types. Further east, the coal region is within the Prairie Parkland Province, characterized by oak-hickory and oak-pine cover types. There are also extensive areas of including extensive cropland, post oak woods/forest, and post oak woods/forest/grassland. The Mississippi River and its associated environments have been a large contributing factor to the development of ecosystems in these regions. Natural vegetation in these areas varies with topography and hydrology and is incorporated into a patchwork of a predominantly open, agricultural landscape (Lower Mississippi VJV, 2007).

Common wildlife species occurring in the coal-bearing areas of Tennessee, Louisiana, Mississippi, and Alabama include white-tailed deer, black bear, bobcat, gray fox, raccoon, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole (*Microtus pinetorum*), northern short-tailed shrew (*Blarina brevicauda*), and cotton mouse (*Peromyscus gossypinus*). The turkey, ruffed grouse, bobwhite, and mourning dove are common game birds. Typical songbirds include the red-eyed vireo (*Vireo olivaceus*), cardinal (*Cardinalis spp*.), tufted titmouse, wood thrush, summer tanager (*Piranga rubra*), blue-gray gnatcatcher, hooded warbler (*Setophaga citrina*), and Carolina wren (*Thryothorus ludovicianus*). Common reptiles include box turtles, common garter snake, and timber rattlesnake. In flooded areas, such as those of the lower coastal plain in Louisiana, migratory waterfowl and colonial nesting birds such as herons (family Ardeidae) are common.

Areas of eastern Texas, Louisiana and Arkansas support loblolly-shortleaf pine, oak-pine, oak-hickory, oak-gum-cypress cover, and longleaf-slash pine types, including young forest/grassland, loblolly pine-hardwood forest, and native/introduced grasses. Common mammals include white-tailed deer, raccoon, skunk (*Mephitis* spp.), opossum (*Didelphis virginiana*), muskrat (*Ondatra zibethicus*), mink (*Neovison vison*), coyote, ringtail (*Bassariscus astutus*), ocelot (*Leopardus pardalis*), and collard peccary (*Pecari tajacu*). Smaller herbivores include plains pocket gopher (*Geomys bursarius*), fulvous harvest mouse (*Reithrodontomys fulvescens*), northern pygmy mouse (*Baiomys taylori*), southern short-tailed shrew (*Blarina carolinensis*), and least shrew (*Cryptotis parva*). Birds include many wide-spread species, such as eastern bluebird (*Sialia sialis*), eastern meadowlark (*Sturnella magna*), grasshopper sparrow (*Ammodramus savannarum*), mourning dove, Cooper’s hawk and mockingbird (*Mimus* spp.). Common amphibians and reptiles include eastern spadefoot toad (*Leptobrachium* spp.), Great Plains narrow mouthed frog (*Gastrophryne olivacea*), green toad (*Anaxyrus debilis*), yellow mud turtle

(*Kinosternon flavescens*), Texas horned lizard (*Phrynosoma cornutum*), Texas spiny lizard (*Sceloporus olivaceus*), and Texas blind snake (*Leptotyphlops dulcis*).

3.8.5.3 Aquatic Resources

Aquatic systems within the Gulf Coast coal region range from arid western Texas to the subtropical Mississippi lowlands. Aquatic systems within this coal region are diverse in structure, flows, composition, and biota. Major rivers include the Chattahoochee, Mobile, Mississippi, Red, Brazos, and the Rio Grande Rivers.

Lotic Systems

A variety of flowing water habitats is present in the Gulf Coast coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. A more detailed discussion about the general habitat features of these different types of streams is presented in Appendix C.

Streams in the Gulf Coast coal region create riparian habitat for plants and animals (U.S. EPA, 2006; Levick et al., 2008). Prairie streams found in this coal region tend to be either sand-bottomed or clay-bottomed; water in clay-bottomed prairie streams tends to have longer residence time and less water exchange with substrate when compared to sand-bottomed streams (Matthews, 1988). During summer months, the drying up of intermittent clay-bottomed streams creates small pools that provide habitat for aquatic fauna. Streams towards the humid-subtropical coastal areas of the coal region can be described as small to medium size perennial streams adjacent to larger rivers, and their arrangement within the watersheds follows a dendritic pattern. These are warm water streams, which have lower-gradient, moderate to high discharges, low turbulence, and rubble-sand-mud substrates (Winger, 1981; Felley, 1992; Hackney et al., 1992). Streams in the Gulf Coast tend to be acidic and low in conductivity, salinity, hardness, and nutrient levels, except in regions where streams drain over limestone bedrock high in phosphate (e.g., Peninsular Florida) (Felley, 1992). Streams in this region are also subject to pulsed floods that are crucial for moving nutrients and particulates downstream (Livingston, 1992).

Blackwater streams are more common along the coast than whitewater streams and alluvial rivers, and are unique in that they often contain more dissolved organic compounds than other streams (Smock and Gilinsky, 1992). The dissolved oxygen levels in medium to low gradient whitewater and alluvial streams tend to be high throughout most of the year, not dropping below 70 percent saturation (Felley, 1992; Hackney et al., 1992). Blackwater streams often face oxygen depletion during summer months as a result of increased temperatures. Furthermore, the oxygen concentrations in the hyporheic zones of smaller blackwater streams are low to anoxic during the warmer months (Smock and Gilinsky, 1992). Most upstream reaches and smaller streams are sand-bottomed. Discharge of streams in this province is seasonally variable and dependent on stream order (Felley, 1992; Hackney et al., 1992). Often, low flows occur from June through October. A period of higher flows occurs from November to May, where flows are highest from January to March (Felley, 1992; Smock and Gilinsky, 1992). Many headwater streams in this region tend to be intermittent and dry during the summer, leaving only isolated pools (Smock and Gilinsky, 1992). During the winter rains, most discharge flows through the floodplains surrounding the streams.

As described in Section 3.5 (see Table 3.5-5), it is estimated that there are a total of 175,925 miles of intermittent streams and 46,695 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C and Section 3.5.

Energy Flow/Primary Production

The productivity of lotic systems in the Gulf Coast varies spatially and temporally. Prairie streams exhibit productivity patterns similar to desert streams. Headwater streams of southern prairies are sunlit and lack forest cover. Matthews (1988) stated that these systems may be somewhat autochthonous in that filamentous algae may serve as significant primary producers. Bott et al. (1985) found higher rates of autochthonous production in prairie streams similar to desert streams, and Matthews (1988) further noted that streams that rely on allochthonous inputs obtain them from detritus from decaying grasses surrounding the streams.

The algal community of streams in the Gulf Coastal plain is dominated by diatoms and filamentous algae. Seasonal algal blooms often occur during the late winter and early spring months (Smock and Gilinsky, 1992). The distribution of filamentous algae and its extensive growth within the blackwater streams in the Gulf Coast region is related to the presence of beavers (*Castor canadensis*) and their effects on the local habitat (Smock and Gilinsky, 1992). Unicellular producers tend to be more important in slower moving waters in the downstream reaches of streams and are rare in areas with flowing water and dense, surrounding vegetative cover (Felley, 1992). Light is a limiting factor to primary production in blackwater streams; they also tend to have low rates of primary production and are primarily heterotrophic systems (Smock and Gilinsky, 1992). Animals in these systems exploit dissolved organic compounds as their primary source of food, and Smock and Gilinsky (1992) noted that detritus processing is dependent on hydrologic events that move organic material (e.g., leaves and debris) downstream to leaf-shredding macroinvertebrates. For blackwaters, these organisms are generally found in the perennial streams. In intermittent streams, isopods and amphipods are the predominant shredders. Floodplains serve as the functional headwaters of river systems in the Gulf Coast (Smock and Gilinsky, 1992).

Submerged plants are important contributors to the primary production of streams in the Gulf Coastal plain, providing food and also cover for various aquatic animals. Typically, submerged vegetation is not as abundant in headwater streams but becomes more common in higher-order streams of the province. Water nymphs (*Najas* spp.), coontails (*Ceratophyllum* spp.), bladderworts (*Utricularia* spp.), eel grass (*Vallisneria* spp.), exotic hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichoria crassipes*) are some submerged plant species found in the province (Felley, 1992; Hackney et al., 1992). A majority of the primary production in the low-order and upstream reaches of streams occurs in the riparian or wetland areas surrounding these streams.

Emergent plants are also important lotic producers found in this region, especially those surrounding headwater streams. Many species of emergent vegetation in the Gulf Coastal plain have adapted to periodic flooding and drought conditions and can grow on saturated and drying soil (Hackney et al., 1992). Tree species such as bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*), and various grasses and rushes (*Cladium* spp., *Juncus* spp., *Rynchspora* spp., etc.), grow along the edges of low gradient streams that may remain wet for most of the year. Such species are important because they stabilize the banks of these streams as well as supply cover and food for animals, influence stream temperature, and provide nutrient input to the streams (Felley, 1992). Floating plants such as duckweed, water lettuce (*Pistia stratiotes*), water hyacinth, and alligator weed (*Alternanthera philoxeroides*) are also common (Livingston, 1992). The U.S. EPA (2006) indicated that the streams assessed in the Gulf Coastal Plains ecoregion had good condition of vegetative cover on 52 percent of stream length. Floodplains of the streams in this region also have distinctive vegetation communities. Cypress swamps can be found along the coast from Florida to Texas, as can southern bottomland hardwood swamps (Livingston, 1992).

Invertebrates

The continental and subtropical areas of the Gulf Coast coal region contain high aquatic invertebrate diversity. Multiple studies have characterized the diverse arthropod communities found in the various small and mid-sized streams in the coastal plains (Berner, 1950; Beck, 1980; Barr and Chapin, 1988; Berner and Pescador, 1988; Felley, 1992). Berner (1950) found that southeastern coastal areas of the region had more mayfly genera than any other physiographic region of the U.S. The ephemeral and intermittent streams of prairie provinces tend to support lower aquatic macroinvertebrate diversity than coastal and temperate areas of the coal region (Matthews, 1988). The lack of aquatic macroinvertebrate diversity is likely attributable to unpredictable flows, homogenous substrates, and the prevalence of mud and sandy stream bottoms. In the prairie provinces, riffles in streams serve as optimal habitat for macroinvertebrates. Furthermore, spring-fed streams in prairie regions often have higher macroinvertebrate diversity than other prairie streams (Matthews, 1988).

Invertebrate biomass varies seasonally in Gulf Coastal streams, and seasonal biomass varies among drainages (Bass and Hitt, 1977, 1978; Bass et al., 1980; Felley, 1992). Smaller streams (orders 1 through 4) have lower biomass in the summer than larger streams (order 5 or greater) which tend to have peak biomass during these months (Felley, 1992). Furthermore, Felley (1992) noted that variations in invertebrate productivity within drainages are associated with habitat types. The more productive streams in coastal areas are those with vegetation or fine sand/mud substrates with detritus; productivity is lower in streams with clean, sandy bottoms (Felley, 1992).

The primary food source exploited by the invertebrates in smaller to medium streams in this coal region is detritus, which enters coastal plain streams during the fall, winter and early spring, and enters prairie streams in the spring and early summer. In headwaters, invertebrates tend to be collectors/gatherers and scrapers; further downstream, these organisms are important, but lower in numbers as predator abundance gradually increases (Felley, 1992). Prairie streams tend to have a lower abundance of shredders than those with abundant broad-leaved riparian vegetation, and much of the processing of particulate organic matter is done by microbes (Matthews, 1988). In the extreme headwaters of coastal areas, invertebrates (e.g., copepods, cladocerans, and rotifers) are abundant and restricted to pools and temporary ponds (Felley, 1992). Larger arthropods such as odonates, culicids, isopods, and amphipods are common throughout the various reaches of streams, including the headwaters. Oligochaetes and chironomids are the dominant taxa found in the more permanent streams, but ephemeropterans, ceratopogonids, and gastropods are also abundant (Felley; 1992). Riffle beetles (Elmidae) and trichopterans tend to be abundant in sand-bottom streams (Felley, 1992).

Crayfish species are extremely diverse in the southeastern U.S., especially within the Gulf Coast region. Crayfish found in the aquatic systems of the Gulf Coast coal region are ecologically important as predators, processors of organic materials, and as food sources for a variety of fish and terrestrial species (Taylor et al., 2007).

Most of the freshwater mussel species known to occur in the U.S. are distributed in the Southeast. Fifty-three of the 300 species known to occur in the U.S. occur in Texas, 175 occur in Alabama, 84 occur in Mississippi, 63 occur in Louisiana, and 51 occur in Florida (Neves et al., 1997). The dominant mussel species in most Gulf Coastal streams are introduced Asiatic mussels (*Corbicula* spp.), but multiple native species reside in the larger perennial streams, some of which are endemic to the waters in which they are found.

Vertebrates

The southeastern U.S. is one of the most diverse regions for species of reptiles and amphibians. Snakes (*Nerodia* spp., *Farancia* spp., *Regina* spp., *Agkistrodon* spp.), turtles (*Sternotherus* spp., *Kinosternon* spp., *Clemmys* spp., *Chelydra* spp., *Pseudemys* spp., *Apalone* spp., *Graptemys* spp.), and alligators (*Alligator mississippiensis*) are some of the common reptile genera that can be found in small and medium-sized Gulf Coastal plain streams and their floodplains. Various frogs (*Rana* spp., *Pseudacris* spp., *Hyla* spp., *Acris* spp.), amphiuma (*Amphiuma* spp.), sirens (*Siren* spp.), waterdogs (*Necturus* spp.), and Ambystomatid and Plethodontid salamanders can be found as well. Many species are widely distributed and are represented by several subspecies. Felley (1992) noted that many species of map turtles (*Graptemys* spp.) found in this region are confined to particular drainages. Over half of the amphibian genera in the Southeast have species that live in small streams, seeps, bogs or swamps (Dodd, 1997; Meyer et al., 2003). Multiple species of stream salamanders require headwater seeps and small streams in forested habitats to maintain viable populations (Petranka, 1998; Meyer et al., 2003).

Fish assemblages in the Gulf Coast region tend to be very diverse. In a study conducted in prairie streams, stream size was the most important factor influencing the structure of fish assemblages (Fischer and Paukert, 2008). Spatially, fish communities of the coal region tend to become relatively more diverse from the arid western areas eastward to the more humid-subtropical areas. However, the diversity of fish communities is suspected to have decreased and become more homogenized over time (Hubbs et al., 1997).

Fish communities in the western plains tend be composed of species that have adapted to harsh seasonal conditions and are represented by generalists (e.g., cyprinids, catostomids, centrarchids, ictalurids, topminnows, etc.) (Fischer and Paukert, 2008). Fish diversity in prairie streams tends to be low because of higher saline waters and frequent droughts (Matthews, 1988). Cyprinids tend to be the dominant group of fish in prairie streams.

Fish communities of the coastal provinces are diverse and are comprised of warm water fish species such as sunfishes and black basses (Centrarchidae), darters (Percidae), minnows, suckers, and catfishes. In larger streams, black basses, gar (Lepisosteidae), bowfin (Amiidae), and catfishes are the dominant predators in these fish communities. Anadromous fishes include sturgeons (Ascipenseridae), shad (Clupeidae), and striped bass (Moronidae). There are few endemic freshwater fish species limited to the medium-low gradient streams of the province. Blackwater streams in this region are said to be more diverse than piedmont or mountain streams (Smock and Gilinsky, 1992). Ross and Baker (1983) noted that 42 species were found within a small Mississippi stream. Fish diversity increases with stream order (Livingston, 1992). Most species that are limited to the small to medium streams belong to genera that are considered to speciate readily: shiners (*Notropis spp.*), topminnows (*Fundulus spp.*), and darters (*Etheostoma spp.*) (Felley, 1992). Such species are considered to produce many eggs and have a protracted spawning season to assure that reproduction is successful despite dry periods or sudden disturbances (Heins and Clemmer, 1976; Heins and Rabito, 1986; Heins and Baker, 1987; Felley, 1992). Coastal Plain streams and their floodplains are important spawning and nursery grounds for a variety of fish species.

Lentic Systems

Lentic systems in the Gulf Coast coal region tend to be variable. They are more ephemeral and intermittent in the arid and semi-arid provinces in the west, and are more permanent in the more humid, eastern provinces. Lentic systems in the Southwest Plateau and Plains Dry Steppe Province tend to be smaller intermittent or ephemeral wallows (called playa lakes) as well as some larger reservoirs. Lentic systems in the subtropical provinces (e.g., Prairie Parkland, Lower Mississippi Riverine Forest, Southeast Mixed Forest, and Outer Coastal Plain Mixed Forest) are mostly man-made impoundments and private ponds. Natural lentic systems in this coal region are fluvial lakes (Crisman, 1992). A subset of major lakes of the region includes the Toledo Bend (TX) and Sam Rayburn Reservoirs (TX/LA), and the massive lake-wetland complexes north of the Gulf Coast (U.S. EPA, 2009b). The Coastal Plains province is also home to a variety of lakes and ponds such as southeastern blackwater lakes, Carolina “Bays,” and the limestone-rich clear lakes of the Florida peninsula (U.S. EPA, 2009b). Small impoundments and farm ponds are common in the coal region, and they are formed by impounding small perennial or intermittent streams (Menzel and Cooper, 1992).

The biotic communities of smaller ponds and impoundments in the region are more affected by natural and artificial outside influences as a result of their isolation from other water bodies. Generally, the small impoundments are constructed for water supply, recreation, and flood control. Water temperatures in these small ponds and impoundments often approximate that of the air temperature because of their small volume and shallow depth, resulting in seasonal stratification (Menzel and Cooper, 1992).

Natural lakes in the coal region usually discharge by simple overflow of surface water, whereas reservoir discharge is controlled by outlet structures that can be located at various depths. Southeastern reservoirs tend to be deep and stratify seasonally. Water released from these reservoirs is typically released from the dense bottom layer (Soballe et al., 1992). Released water can vary in nutrient content, but it tends to have cooler temperatures and the releases can have significant ecological effects on the receiving streams.

Energy Flow/Primary Production

Plants surrounding lentic systems in this coal region provide a significant amount of allochthonous energy input through leaf litter fall. The ponds, lakes, and reservoirs also receive sediments and additional nutrients from surface runoff during precipitation events, which can contribute to the energy balance. The species of phytoplankton found in lentic systems and their distribution depends on the size and location of the system. Often, smaller impoundments are dominated by benthic forms of algae that detach and become a part of the planktonic population (Menzel and Cooper, 1992). More planktonic forms and diatoms are more prevalent in larger systems. Stable water levels and prolific macrophytes prevent higher rates of primary production from occurring in reservoirs, but overall these systems tend to be nutrient-rich and moderately productive (Soballe et al., 1992). Seasonally, the algal community shifts from diatoms or green algae in the winter and spring, to blue-green algae during the summer and fall (Menzel and Cooper, 1992). Blue-green algae often become a dominant primary producer in areas that receive higher levels of nutrient inputs such as fertilizers with nitrogen and phosphorus or organic manures. Primary production by macrophytes is more important within smaller ponds and impoundments in this coal region compared to more northern latitudes, whereas phytoplankton provide much of the primary production in larger systems (Menzel and Cooper, 1992). Floating plants in lentic systems can become so dense that they shade out phytoplankton in the water column, which can lead to oxygen depletion and fish kills.

Emergent vegetation in the littoral zone varies across the coal region. Common herbaceous plants surrounding lentic systems include rushes, grasses, beggarticks (*Bidens* spp.), sedges, cattails, spikerush (*Eleocharis spp.)*, and marsh-purslane (*Ludwigia* spp.) (Menzel and Cooper, 1992). Trees such as red maple (*Acer rubrum*), hazel alder (*Alnus* spp.), sweetgum, willows (*Salix* spp.), and tupelo are common near the shores of lentic systems in this coal region.

Invertebrates

Cladocerans and copepods are major biomass contributors in lentic systems in this coal region, and they filter a significant amount of the detritus and serve as a critical link in the food chain between primary producers and fish (Menzel and Cooper, 1992; Soballe et al., 1992). Common genera of zooplankton include *Daphnia*, *Bosmina,* and *Mesocyclops*. Rotifers and protozoans also can be found, but tend to comprise a smaller percentage of biomass (Menzel and Cooper, 1992; Soballe et al., 1992). Chironomids also serve as an important food source for many species in lentic systems, including bluegill, brown bullhead, and golden shiner (*Notemigonus crysoleucas*) (Mozley, 1968; Menzel and Cooper, 1992).

Vertebrates

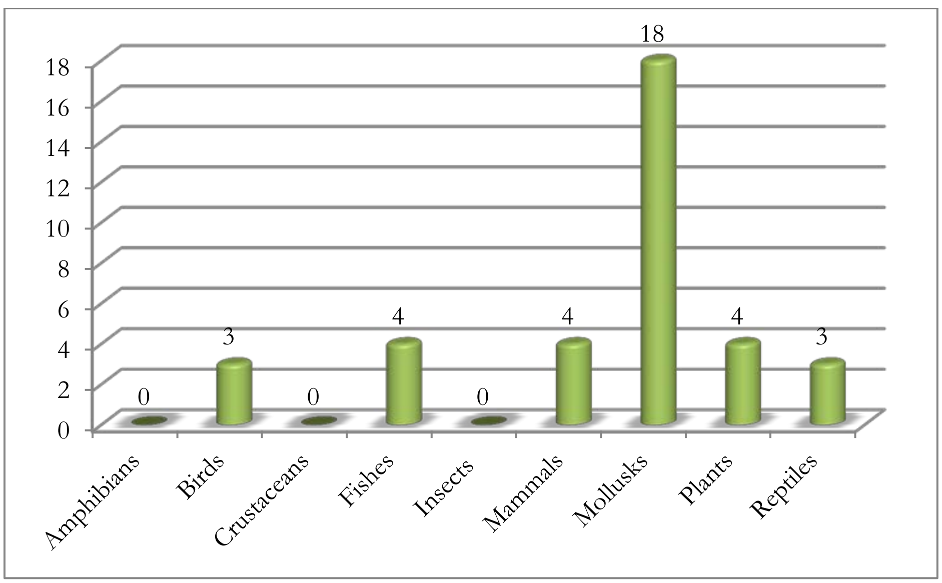
Lentic systems in the Gulf Coast coal region tend to have fish communities comprised of generalist species such as sunfishes, black basses, white bass (*Morone chrysops*), catfishes, perches, and suckers. In smaller impoundments, largemouth bass is the top predator and will eat many species of sunfishes, amphibians, reptiles, and even small birds and mammals (Menzel and Cooper, 1992). Sunfishes are important forage fish in lentic systems in the southeast, but they have the ability to overpopulate smaller systems and produce stunted individuals. Other common fish species that occur in lentic systems in this coal region are gar, bowfin, minnows, golden shiners (*Notemigonous crysoleucas*), topminnows, and introduced species such as the common carp (*Cyprinus carpio*). Many centrarchids, moronids, and ictalurids found in the lentic systems in the continental and subtropical areas support popular sport fisheries. Clupeid species (e.g., shads) are important prey for a number of the predatory fish in these lentic systems.

Reptiles and amphibians rely heavily on the littoral habitats of the lentic ecosystems for food and cover. Various species of snakes, lizards, and turtles also use littoral areas of lentic systems for foraging sites. Presence of reptiles in or near the aquatic systems in this coal region is positively correlated with increasing sedimentation, decreasing water depths, and increasing abundance of prey species (Menzel and Cooper, 1992). Amphibians, especially salamanders, tend to avoid lentic systems populated by predatory fish species (Kats et al., 1988; Figiel and Semlitsch, 1990; Kats et al., 1992). Ephemeral and intermittent ponds are especially important for breeding sites for ambystomatids like the marbled (*Ambystoma opacum*), spotted, and mole (*A. talpoideum*) salamanders, and various frog species during the fall, winter, and spring seasons.

3.8.5.4 Protected Species in the Coal Mining Areas of the Gulf Coast

In the Gulf Coast coal region, there are a total of 36 federally listed (and proposed listed) species. See Appendix F for the species names and status information. Figure 3.8-6 depicts the number of listed species and relative proportion for each taxonomic group.

Figure 3.8-6 Count of Federally listed species in the Gulf Coast Region



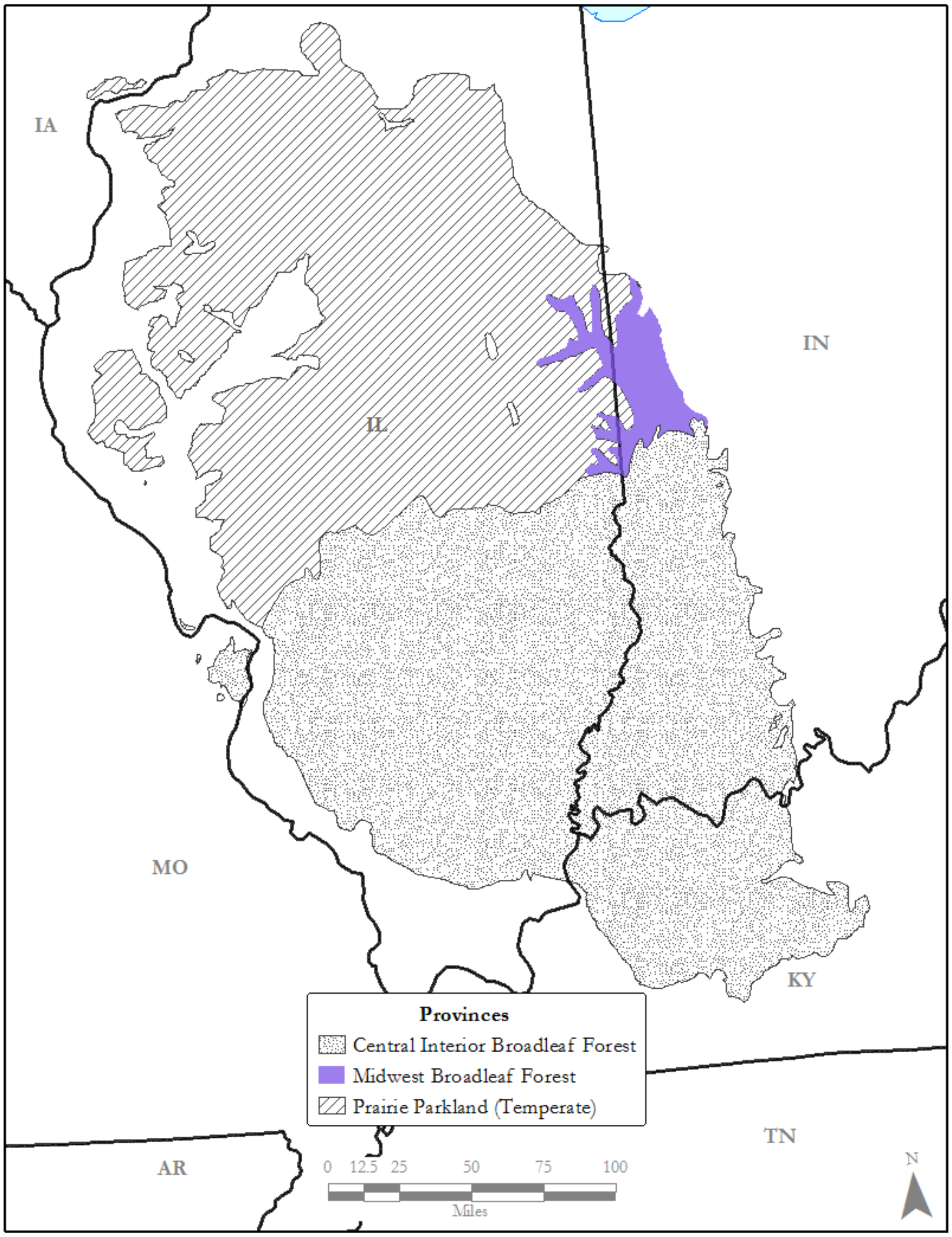
3.8.6 Illinois Basin Region

3.8.6.1 General Ecological Setting

The active mining in the Illinois Basin coal region stretches across three primary states: Illinois, Indiana, and Kentucky. Most of the coal region lies within the state of Illinois (Figure 3.8-7).

Table 3.8-5 lists the ecological provinces located within this coal region and the approximate area of each.

Figure 3.8-7 Ecological Provinces Located within the Illinois Basin Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Table 3.8-5
USFS Provinces Associated with the Illinois Basin Region

Ecological Province	Area of Coal Region in Province (square miles)
Central Interior Broadleaf Forest	24,673
Midwest Broadleaf Forest	1,366
Prairie Parkland (Temperate)	21,936
Total	**47,975**

The descriptions provided below for the ecological provinces distributed within the Illinois Basin coal region come from Bailey (1995), Cleland et al. (1997), McNab and Avers (1994), and McNab et al. (2007). The common vegetation and fauna in each cover type are described briefly in Appendix G.

Prairie Parkland (Temperate) Province

This province covers an extensive area from Canada to Oklahoma, with alternating prairie and deciduous forest. The vegetation was once herbaceous with woodland of scattered deciduous broadleaf trees along floodplains of major rivers; almost all woodland has now been cleared for agriculture.

Stream and river systems in this province are well developed and have integrated dendritic drainage networks that are carved into the land surface. Allochthonous energy sources for streams in this province include plains with native vegetation of herbaceous prairies and woodlands (McNab et al., 2005). Illinois has a system of lakes dominated by manmade bodies of water ranging in scale from huge flood control reservoirs to worked-out stone quarries, gravel pits, and farm ponds (Illinois DNR, 1994a). Natural lakes and ponds are rare or non-existent in this province.

Midwest Broadleaf Forest Province

A description of the Midwest Broadleaf Forest province is provided above in Section 3.8.2. Streams in the Indiana portion of this province are in the Ohio River watershed. Lakes in this province are generally small to medium size. Wetlands are formed in extensive low-lying areas in former glacial lakebeds. There is moderate to high density of streams in this province; low gradient streams and rivers predominate, and typically have substrates composed of sand, gravel, bedrock, and boulders. Vegetation in this province consists of cold-deciduous, hardwood-dominated forests with a high proportion of species able to tolerate mild, brief, periodic drought during the late summer.

Central Interior Broadleaf Forest Province

A description of the Central Interior Broadleaf Forest province is provided above in Section 3.8.2. The geomorphology of the province leads to drainage areas of shallow entrenchment, and in some local areas, exposed limestone and sandstone bedrock. There is a moderate density of medium to large perennial streams, most with moderate volume of water at low velocity, composed of dendritic drainage patterns. This area has a handful of natural lakes from previous glacial events; however, most of the lakes in the region are manmade (Illinois DNR, 1994a). The few natural lentic systems in the Central Interior Broadleaf Forest Province predominantly consist of lakes and wetlands in oxbows along the Kaskaskia, Big Muddy, and Wabash river flood plains.

3.8.6.2 Terrestrial Resources

The coal-producing portions of the Illinois Basin are characterized by mostly agricultural land, with natural vegetation consisting of oak-hickory, elm-ash-cottonwood, oak-gum-cypress, prairie, oak-pine, maple-beech-birch, and aspen-birch cover types. As mentioned above in the introduction to Section 3.8, native cover types in highly altered landscapes, like those found in the Illinois basin, can be rare.

Beginning in the northern portion of this coal region in central Illinois and Indiana, this area originally supported prairie vegetation with hardwood forests on scattered upland sites. Areas of tall prairie grasses are characterized by big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*). White oak (*Quercus alba*), shingle oak (*Quercus imbricaria*), black oak (*Quercus velutina*), hickory, white ash (*Fraxinus americana*), basswood, sugar maple (*Acer saccharum*), and walnut (*Juglans* spp.) grow on the better drained soils. Silver maple (*Acer saccharinum*), black willow (*Salix nigra*), cottonwood (*Populus* spp.), and sycamore grow on flood plains.

Some of the common wildlife species include white-tailed deer, jack rabbits (*Lepus* spp.), cottontails, opossum, and many small rodents. Common predators include swift foxes (*Vulpes velox*), kit foxes, bobcats, and coyotes. Grassland dwelling species are plentiful, for example bobwhites, horned larks, and meadowlarks (*Sturnella* spp.). Cooper's hawks, barred owls (*Strix varia*), and long-eared owls (*Asio otus*) are examples of year round residents. Common reptiles include snapping turtles (*Chelydra serpentina*), box turtles, bullfrogs, ringneck snakes (*Diadophis punctatus*), and bull snakes. Other common wildlife species include coyote, turkey, red fox (*Vulpes vulpes*), beaver, raccoon, skunk, muskrat, opossum, cottontail rabbit, fox squirrel, Canada goose (*Branta canadensis*) (*Ardea Herodias*), wood duck (*Aix sponsa*), mallard duck (Anas platyrhynchos), redheaded woodpecker (*Melanerpes erythrocephalus*), quail (*Coturnix coturnix*), and ring-necked pheasant.

Areas of southeastern Illinois originally supported tall prairie grasses, mainly big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*). The present potential for natural vegetation on these soils is unknown. Forests of post oak (*Quercus stellata*), swamp white oak (*Quercus bicolor*), blackjack oak (*Quercus marilandica*), and pin oak (*Quercus palustris*) grow on poorly drained soils. White oak (*Quercus alba*), shingle oak (*Quercus imbricaria*), black oak (*Quercus velutina*), hickory (*Fraxinus americana*), white ash, basswood (*Acer saccharum*), sugar maple (*Acer saccharum*), , and walnut (*Juglans spp.)* grow on the better drained soils. Species such as silver maple (*Acer saccharium*), black willow (*Salix nigra*), cottonwood (*Populus spp*.), and sycamore grow on the flood plains.

Some of the major wildlife species in this area are white-tailed deer, coyote, turkey, and bobwhite. Small mammals include masked shrew (*Sorex cinereus*), meadow vole (*Microtus* *pennsylvanicus*), and western harvest mouse (*Reithrodontomys megalotis*). Common avian species include black-capped chickadee (*Poecile atricapillus*), northern harrier, upland sandpiper (*Bartramia longicauda*), long-eared owl, and Henslow's sparrows (*Ammodramus henslowii*). Sora (*Porzana carolina*), black-crowned night herons (*Nycticorax nycticorax*) and veery (*Catharus fuscescens*) are found in sedge meadows and swamps. Common amphibians include the Illinois chorus frog (*Pseudacris illinoensis*) and the Plains leopard frog (*Lithobates blairi*); common reptiles include the Kirtland's snake (*Clonophis kirtlandii*), and Illinois mud turtle (*Kinosternon flavescens*).

Areas of southwest Illinois, Missouri, southwest Indiana and Kentucky support natural hardwoods. Oak, hickory, beech, and sugar maple are the dominant species in the forest overstory. Native grasses grow in some scattered areas between the trees including big bluestem and little bluestem (*Schizachyrium scoparium*). The soils on lowlands support mixed forest vegetation. Pin oak, shingle oak, hickory, sweetgum, and black oak are the dominant species on the wetter sites. White oak, black oak, red oak (*Quercus rubra*), hickory, yellow-poplar, ash, sugar maple, and black walnut (*Juglans nigra*) grow on the better drained sites. Honeylocust (*Gleditsia triacanthos*) is dominant on soils that formed in shaly limestone residuum. Red cedar commonly grows on the shallower soils overlying limestone. Silver maple, cottonwood, sycamore, pin oak, river birch (*Betula nigra*), pecan (*Carya illinoinensis*), willow, cherrybark oak (*Quercus pagoda*), Shumard oak (*Quercus shumardii*), and sweetgum grow along rivers, streams, and floodplains. Black walnut is abundant on deep, well drained soils on some small flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Some of the major wildlife species in this area are white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, turkey vulture, turkey, woodcock (*Scolopax* spp.), ruffed grouse, great horned owl, wood duck, pileated woodpecker (*Hylatomus pileatus*), red-bellied woodpecker (*Melanerpes carolinus*), ring-necked pheasant, and bobwhite. Canada geese and other waterfowl winter in large concentrations in the broader valleys and flat low lands. Forest–interior birds such as the Cerulean warbler (*Setophaga cerulea*) and the wood thrush live in the forested uplands, while the Swainson's warbler (*Limnothlypis swainsonii*) nests in the bottomland forests. Two common amphibians include the central newt (*Notophthalmus viridescens louisianensis*), zigzag salamander (*Plethodon dorsalis*). Eastern mud turtle (*Kinosternon subrubrum*) and worm snake (*Carphophis amoenus amoenus*) are important reptiles of the area.

3.8.6.3 Aquatic Resources

Lotic Systems

A variety of flowing water habitats is present in the Illinois Basin coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. A more detailed discussion about the general habitat features of these different types of streams is presented in Appendix C.

The major rivers in the coal region include the Illinois, Ohio, Wabash, and the Upper Mississippi Rivers. The flat and rolling topography of the Illinois Basin has facilitated the development of these rivers and streams into predominantly dendritic drainage patterns. Historically, streams in this basin, particularly in Illinois, have been heavily impacted by anthropogenic manipulation and influence. Channelization has profoundly affected the function of many streams. More than 25 percent of the total length of sizeable streams in the Rock, Sangamon, Fox/Des Plaines, and Kankakee/Vermilion/Mackinaw basins has been straightened (Illinois DNR, 1994b). In addition, nearly every sizeable stream in Illinois is dammed in at least one spot, creating a total inventory of nearly 1,200 dams (Illinois DNR, 1994b). In large rivers, dams combined with high levees have prevented the natural flooding and drying cycle in the floodplains which formerly maintained a highly productive and diverse biota (Illinois DNR, 1994b). Physical changes remain a perturbing force in Illinois Basin stream ecology, with erosion and sedimentation among the current regional problems. Much of this sedimentation and erosion is attributed to agricultural activities and the lack of riparian vegetation.

The rivers and streams of the Illinois Basin coal region are affected by the surrounding land uses. Nutrient inputs (e.g., nitrogen and phosphorus) from terrestrial sources are important to aquatic systems as a unit of nutrient cycling. The transport of nutrients into aquatic systems in the Illinois Basin is largely attributed to nonpoint overland sheet flow (Gentry et al., 2007). However, there is a problem of excessive nutrient loads from nonpoint pollution sources in the Illinois Basin, contributing to poor water quality. Anthropogenic sources of phosphorus and nitrogen include sewage, agricultural runoff, lawn fertilizers, pet wastes, and atmospheric pollution (Dodson, 2005). Although sewage effluent is still a large nutrient source, agriculture has been identified as the major nonpoint source of nutrients to surface waters, due largely to the use of commercial fertilizers (Gentry et al., 2007).

As described in Section 3.5 (see Table 3.5-5), there are a total of approximately 70,645 miles of intermittent streams and 24,073 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C and Section 3.5.

Energy Flow/Primary Production

Carbon compounds have a large influence on ecosystem processes in these streams. The primary energy source for aquatic systems can be based on carbon fixed by photosynthesis within the system (autochthonous), or on inputs of carbon-containing organic materials from outside of the system (allochthonous). A common source of carbon is dissolved organic carbon (DOC), typically produced from particulate organic carbon, such as leaf litter inputs, which serve as an allochthonous energy source for Illinois Basin aquatic systems. Detritivores that remobilize carbon into food webs is an important part of energy production, particularly in small streams of the Illinois Basin (Hart and Reynolds, 2002). Carbon, particularly inorganic carbon, supports the major pH buffering system in freshwater (Dodson, 2005). A primary source of inorganic carbon in these streams is carbonate found in limestone and dolomite bedrocks and soils, which are common throughout the coal region (McNab et al., 2005).

Algal biomass consisting of cyanobacteria, filamentous chlorophytes, halophilic diatoms, and other diatoms comprises the most of the primary production in streams of this region. The species and type of these organisms is influenced by water chemistry, land use, and geology (Leland and Porter, 2000). Light and nutrients are key determinants controlling algal productivity.

Though the streams in this coal region are dominated by algal production, aquatic plants are also important to these ecosystems, providing food and cover for fauna, and recycling nutrients (Illinois DNR, 1994b). Many streams provide the shallow-water habitats that facilitate the development of rich aquatic plant communities. The growth and maintenance of these communities are dependent on slope, substrate, and the stability of stream discharge (Reid, 1961). In flowing waters, rooted aquatic plants are more common than floating species. Macrophytes common in streams in the Illinois coal basin include yellow water-lily (*Nuphar lutea*), arrowleaf (*Sagittaria* spp.), water-plantains (*Alisma* spp.), and creeping water primrose (*Ludwigia* sp.) (Roegge and Evans, 2003). Common herbaceous species which occur along the banks and shores of nearly all rivers and streams are woodreed (*Cinna arundinacea*), pony grass (*Eragrostis hypnoides*), sedges, tall hempweed (*Acnida altissima*), stalkless watercress (*Rorippa sessiliflora*), *Gerardia lenuifolia*, narrowleaf paleseed (*Leucospora multifida*), and willow aster (*Aster praealtus*) (Mohlenbrock et al., 1961). In the Illinois Basin common woody species along stream banks which contribute allochthonous carbon, stabilize banks, and shade the stream include American sycamore (*Platanus occidentalis*), river birch (*Betula nigra*), sandbar willow (*Salix interior*), and swamp chestnut (*Quercus michauxii*) (Mohlenbrock et al., 1961

Invertebrates

Segmented worms (Annelida) are typically abundant in the streams of the Illinois Basin. They consume considerable quantities of organic substances and the continual working of these burrowing species turn over much of the material in the sediment, which aids in the assimilation of carbon into the aquatic system (Reid, 1961). Annelids are also integral items in the diets of larger organisms, such as fish. Common stream insects in the Illinois Basin include stoneflies (Plecoptera); damselflies and dragon flies (Odonata); mayflies (Ephemeroptera); caddisflies (Tricoptera); mosquitoes, and blackflies and craneflies (Diptera). A large number of these insects shred and scrape decaying organic material, which aids in the assimilation of allochthonous inputs to the aquatic system (Dodson, 2005). Many aquatic insects are predatory, and actively feed on smaller insects and other invertebrates.

Mussels are important species in the aquatic systems of the Illinois Basin. Unionid mussels often constitute the highest percentage of biomass relative to other benthic stream animals; therefore, they are a key link in the food chain between aquatic microorganisms, such as algae and bacteria, and large animals that prey on them, like otter, turtles, fish, and hellbenders (Badra, 2005). The Illinois Basin is very rich in freshwater mussel diversity. Of the over 300 species of freshwater mussels known to occur in North America, approximately 27 percent (80 species) are known to occur in Illinois alone (Warren, 1995), and 104 species are known to occur in Kentucky (Cicerello and Schuster, 2003).

Crayfish are relatively common freshwater crustaceans that inhabit very diverse niches that include small streams, large rivers, lakes, and even subterranean environments (Fetzner Jr., 1996). Like freshwater mussels, crayfish are abundantly diverse in the Illinois Basin coal region. Illinois is home to 23 species, while 17 species are known to occur in Indiana, and 51 species in Kentucky (Fetzner Jr., 2010). These species totals represent only moderate overlap between states, as crayfish are commonly restricted geographically. Species of crayfish that are known to occur in each state of the Illinois Basin include devil crawfish (*Cambarus diogenes*), big water crayfish (*Cambarus robustus*), digger crayfish (*Fallicambarus fodiens*), calico crayfish

(*Orconectes immunis*), virile crayfish (*Orconectes virilis*), and white river crawfish (*Procambarus acutus acutus*). Crayfish have significant roles in aquatic ecosystems and are a major component of the food web. They are omnivorous and process organic matter in addition to feeding on snails, small fish, and aquatic insects; they transform energy between different levels in the food chain and are themselves eaten by more than 240 predators (Butler et al., 2003).

Vertebrates

Amphibians account for a considerable portion of energy flow; their ingested energy is efficiently transferred to other trophic levels in the food web (Pough, 1980; Regester et al., 2005). In the Illinois Basin, salamanders are an abundant and diverse group and perform multiple ecological roles in aquatic systems (Regester et al., 2005). In Illinois, 20 species of salamanders are known to occur (Illinois Natural History Survey, 2012). There are also 23 species in Indiana (Indiana DNR, 2013a), and 19 species in western Kentucky (WKU, 2010). Though some salamanders are terrestrial for much of the year and inhabit forest burrows or are found under logs, rocks, and leaves, they breed in water. Salamander larvae and aquatic adults rely on rivers, creeks, lakes, ponds, swamps, and ditches as habitat.

Due to their permeable skin, frogs are semi-aquatic. Frogs and toads typically depend on streams, ponds, or lakes for their larvae to develop in water. There are 22 species of frogs and toads in Illinois (Illinois Natural History Survey, 2012), 17 species in Indiana (Indiana DNR, 2013a; Indiana DNR, 2013b), and 16 species in western Kentucky (WKU, 2009). Like most amphibians, frogs are ecosystem indicators; because of their skin permeability, frogs are susceptible to the absorption of many pollutants in waters of poor quality. Frogs are an important component of the vertebrate food chain and are consumed by a variety of predators, including fish, snakes, and turtles (Moler, 1994).

Turtles (both aquatic and terrestrial) inhabit a unique blend of niches from wetlands to uplands. There are 17 species of turtles in Illinois (Illinois Natural History Survey, 2012), 18 species in Indiana (Indiana DNR, 2012; Indiana DNR, 2013a), and 17 species in Kentucky (Daviess County Audubon Society, 2011a).

There are a total of 39 species of snakes that inhabit Illinois (Illinois Natural History Survey, 2012), 33 species in Indiana (Indiana DNR, 2013a), and 44 species in Kentucky (Daviess County Audubon Society, 2011b). They dwell in forests, grasslands, marshes, swamps, ponds, lakes, streams, rivers, and sloughs. Many species are semi-aquatic and are important components of the food web that transfer energy between terrestrial and aquatic environments.

Fish assemblages are variable across the basin and depend on stream type. Species overlap between stream types is significant, and the descriptions below represent common assemblages.

Shallowly entrenched, slow-flowing, meandering streams are common in most of the Illinois Basin. Fish assemblages in this stream type commonly include largemouth bass, channel catfish, crappie, bluegill, yellow perch (*Perca flavescens*), striped shiner (*Luxilus chrysocephalus*), silverjaw minnow (*Notropis buccatus*), bluntnose minnow (*Pimephales notatus*), sand shiner (*Notropis stramineus*), quillback (*Carpiodes cyprinus*), and silver redhorse (*Moxostoma anisurum*) (OSMRE, 2008; Pescitelli and Rung, 2009). Medium to large perennial streams and associated rivers are common to the rolling landscapes throughout the Illinois Basin. Fish assemblages in this stream type commonly include smallmouth bass (*Micropterus dolomieu*), channel catfish, bluegill, walleye (*Sander vitreus*), the central stoneroller (*Campostoma anomalum*), the bluntnose minnow, the sand shiner, and the horny head chub (*Nocomis biguttatus*) (Pescitelli and Rung, 2009).

Upland clear, rocky streams are typically cool-water streams that are typically found in the upper reaches of watersheds. They are present across the Illinois Basin, but are more common in the southern tip of Illinois and western Kentucky. Fish assemblages in this stream type commonly include the central stoneroller, the bluntnose minnow, the sand shiner, the horny head chub, the spotfin shiner (*Cyprinella spiloptera*), striped shiner, large-scale stoneroller (*Campostoma oligolepis*), banded darter (*Etheostoma zonale*), creek chub, and the white sucker (*Catostomus commersonii*) (Pescitelli and Rung, 2009). Other species of note are the least brook lamprey (*Lampetra aepyptera*), blackspotted topminnow (*Fundulus olivaceus*), and the spottail darter (*Etheostoma squamiceps*) (OSMRE, 2008).

Anthropogenic impacts have drastically changed the fish assemblages in the Illinois Basin; from 1900-1994, approximately one in five fish species has been extirpated or is threatened by extinction (Illinois DNR, 1994b). Selective overfishing, extensive watershed modifications, draining of wetlands, and the introduction of exotics, sea lamprey (*Petromyzon marinus*), alewife (*Alosa pseudoharengus*), and salmonids (family Salmonidae), have all contributed to the decline of fish assemblages in the Illinois Basin (Karr et al., 1985).

Lentic Systems

Numerous lakes and wetlands exist in the Illinois Basin due to past geologic events and the construction of reservoirs and ponds. In contrast, natural lakes are rare in the prairie sections of Illinois. However, there are prairie potholes and historic oxbows along the floodplains of meandering streams and rivers.

Lentic systems have been heavily impacted by indirect filling through the process of erosion and sedimentation from agricultural activities in the Illinois Basin (Illinois DNR, 1994a). Unlike the flow-through system of streams, lakes tend to collect sediment and most of the pollutants that are washed into them. Thus, they function, in part, as environmental sinks for pollutants such as nitrogen- and phosphorous-containing compounds. This has resulted in excessive algal and macrophyte growth in ponds and lakes in the Illinois Basin caused by nutrients from farm fields and septic fields, such as hog and cattle lagoons (Illinois DNR, 1994a).

Energy Flow/Primary Production

In the Illinois Basin, the littoral zone of ponds and lakes generally extends from the depth of rooted plant growth, usually 15 to 25 feet deep, as submersed plants generally do not grow below a depth of 30 feet due to light and pressure limitations (O'Neal and Soulliere, 2006). A large number of plants contribute to primary production in the littoral zone and the shoreline. These plants are responsible for a significant portion of the primary production for the entire lentic systems (Ozimek et al., 1990; Wetzel, 2001). Common aquatic plants in lakes and ponds in the Illinois basin are similar to those listed above for the streams in this basin.

Invertebrates

The macroinvertebrates that are common in the lentic systems of the Illinois Basin can include annelids, plecopterans, odonates, ephemeropterans, trichopterans, and a variety of dipterans.

As mentioned above in the discussion for lentic systems, freshwater mussels are abundant and diverse in the Illinois Basin coal region. Different mussel species have varying habitat preferences, some live in large rivers, some in small creeks, and some in lentic systems with standing water, such as ponds or lakes. Their role in the food web, their water filtering activities, and their habitat production are very important to the aquatic systems the mussels inhabit.

Crayfish are abundant in lentic systems in the Illinois Basin. In ponds, crayfish are generally found in shallow waters such as the littoral zone and typically inhabit waters less than a meter in depth (Pennak, 1989). Despite this limitation, lakes and ponds can attain production as high as 1,500 pounds of crayfish per acre, though averages are usually closer to 100 pounds per acre (Pennak, 1989). This abundance indicates the importance of crayfish in lentic food webs, both for processing organic matter, and as a food source for turtles, fish, and otters (*Lontra Canadensis*).

Vertebrates

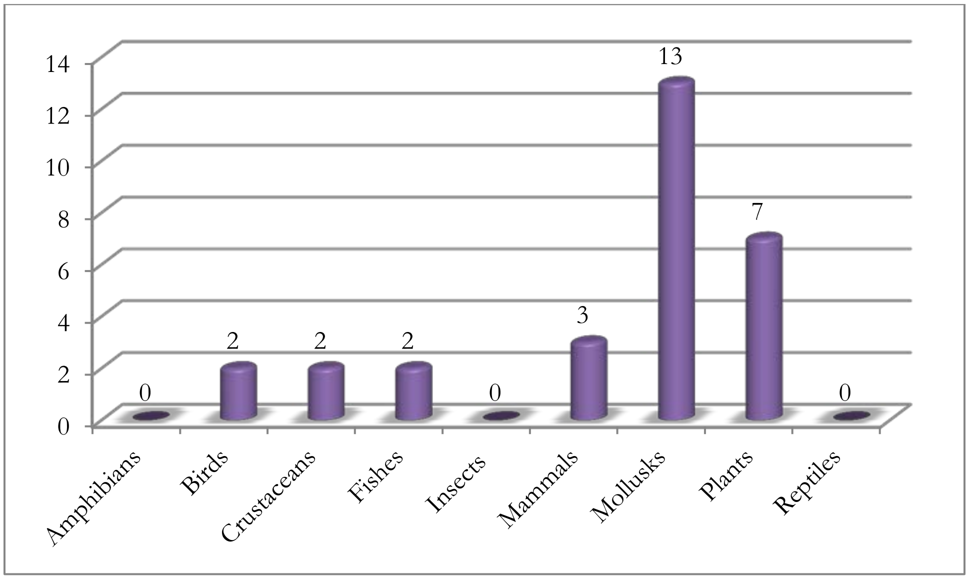
The importance of salamanders in the Illinois Basin was discussed above for lotic systems. Lentic systems are particularly important to terrestrial salamanders, which use ponds, lakes, and wetlands for reproduction and larval growth. As with lotic systems, the main threats to salamanders in lentic systems are habitat loss, fragmentation, and degradation. The draining or filling of wetlands can be a particular threat to terrestrial salamanders. Frogs and toads typically depend on streams, ponds, or lakes, for their larval development. They are an important component of the food chain in these lentic systems; they are abundant, efficiently transfer energy to other trophic levels in the food web, and are consumed by a variety of predators.

Reptiles are an important part of lentic systems in the Illinois Basin. Aquatic turtles can represent a significant portion of biomass in a lentic system. In a recent study in a southern Illinois lentic system, four of the ten turtles present were found to have a biomass greater than 55 pounds per acre (Dreslik et al., 2005). Semi-aquatic snake species are also important components of the food web because they transfer energy between terrestrial and lentic environments. In the lentic systems of Illinois, fish assemblages are usually a mix of warm water species and commonly include largemouth bass, bluegill, crappie, bullhead catfish, channel catfish, common carp, white bass, hybrid striped bass (*M. saxatilis* x *M. chrysops*), freshwater drum (*Aplodinotus grunniens*), and various sunfish species (Cruse and Wight, 1996a; Cruse and Wight, 1996b; Cruse and Wight, 1998). Other notable species in Illinois basin lentic systems include walleye, yellow bass (*Morone mississippiensis*), northern pike (*Esox lucius*), and muskellunge (*Esox masquinongy*) (Cruse and Wight, 1996a; Cruse and Wight, 1996b; Cruse and Wight, 1998). Historical selective overfishing, draining wetlands, and the introduction of exotics, especially the sea lamprey, alewife, and salmonids, have all contributed to the decline of fish assemblages in the Illinois Basin (Karr et al., 1985).

3.8.6.4 Protected Species in the Coal Mining Areas of the Illinois Basin Coal Region

In mining areas of the Illinois Basin coal region, there are a total of 29 federally listed (and proposed listed) species. Figure 3.8-8 depicts the number of listed species and relative proportion for each taxonomic group. The three mammals listed are all bats, including the recently listed Northern long-eared bat (*Myotis septentrionalis).* The Indiana bat's range stretches over 13 coal-producing states. In 2009, a team comprised of representatives from OSMRE, U.S. FWS, and a representative group of state regulatory authorities developed, "Range-wide Indiana Bat Protection and Enhancement Plan (PEP) Guidelines." See Appendix F for all species names and status information.

Figure 3.8-8 Count of Federally listed species in the Illinois Basin Region

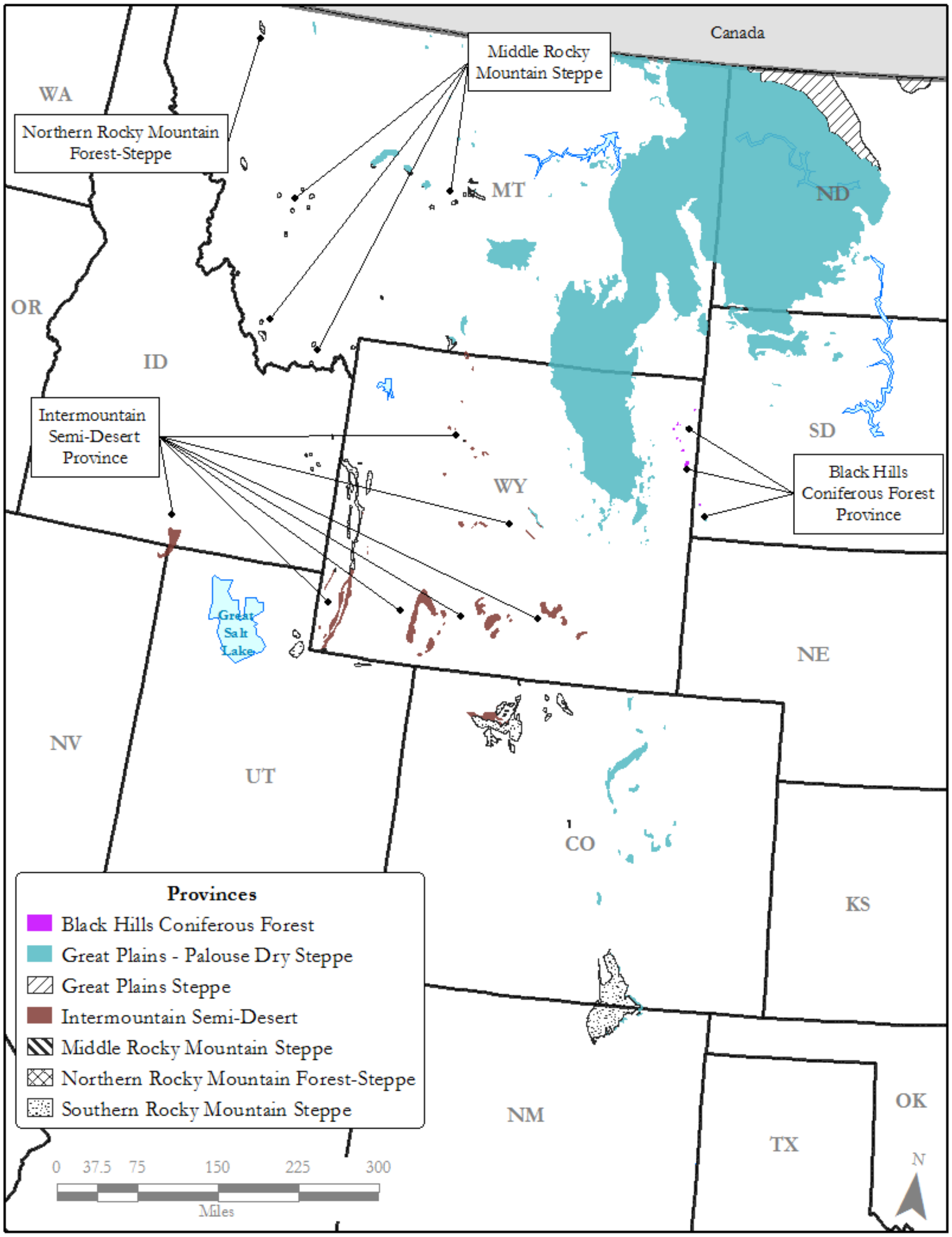


3.8.7 Northern Rocky Mountains and Great Plains Region

3.8.7.1 General Ecological Setting

The coal mining in the Northern Rocky Mountains and Great Plains region straddles the continental divide, including primary areas in Colorado, Wyoming, Montana, and North Dakota (Figure 3.8-9). A variety of physical and chemical factors affect the biological resources of this coal region. Table 3.8-6 lists the ecological provinces located within this coal region and the approximate area of each.

Figure 3.8-9 Ecological Provinces within the Northern Rocky Mountains and Great Plains Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Table 3.8-6
USFS Provinces Associated with the Northern Rocky Mountains and Great Plains Region

Ecological Province	Area of Coal Region in Province (square miles)
Great Plains - Palouse Dry Steppe	58,308
Great Plains Steppe	3,154
Intermountain Semi-Desert	2,046
Middle Rocky Mountain Steppe - Coniferous Forest - Alpine Meadow	306
Southern Rocky Mountain Steppe - Open Woodland - Coniferous Forest - Alpine Meadow	3,346
Northern Rocky Mountain Forest-Steppe - Coniferous Forest - Alpine Meadow	29
Black Hills Coniferous Forest	51
Total	**67,242**

The descriptions provided below for the ecological provinces distributed within the Northern Rocky Mountains and Great Plains coal region come from Bailey (1995), Cleland et al. (1997), McNab and Avers (1994), and McNab et al. (2007).

Great Plains-Palouse Dry Steppe Province

This region is characterized by rolling plains and tablelands of moderate relief. The vegetation in this province is predominantly herbaceous with lesser areas of shrubland. Major rivers in the province are large plains rivers such as the Platte, Missouri, and Arkansas.

Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province

The vegetation in this province is mainly evergreen, needleleaf forest that varies in composition with altitude, although lower slopes and plains are dominated by shrubland and herbaceous cover. Perennial streams have a dominant dendritic drainage pattern and are fairly widely spaced in the eastern portion of the province; however, drainage patterns are increasingly complicated in westward portions of the province due to complex geology. Larger streams such as the Salmon and Missouri Rivers also flow through the province and are often deeply incised in V-shaped canyons as they leave the mountains. Reservoir lakes, such as Holter Lake and Canyon Ferry Lake, are found in this province, while smaller natural alpine lakes produced by glacial events occur at higher elevations in the province.

Intermountain Semi-Desert Province

This province covers the plains and tablelands of the Columbia-Snake River Plateaus and Wyoming Basin. The plateaus include most of the Northwest’s lava fields. The vegetation in this province consists of shrubland on the plains and woodlands on steeper slopes.

Water is scarce in some areas of this province, though rivers exist. These include the Green River, the Lower Snake River, and Platte River. These rivers are moderate to deeply incised, have warm water, and are third to fifth order systems with dendritic drainage patterns. The province also supports some small and intermittent streams and cool water streams.

Great Plains Steppe Province

This region is characterized by flat and rolling plains. The vegetation of this province is predominantly herbaceous with woodlands along riparian areas of waterways.

Internal drainage patterns of warm water streams are complex, with many glacial pothole lakes and ponds, and some long, lineal drainages fed by a high density of dendritic drainages. In the coal region, the major river of the province is the Mouse River.

Southern Rocky Mountain Steppe – Open Woodland – Coniferous Forest – Alpine Meadow

A description of the Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow province is provided above in Section 3.8.2. Rapidly flowing, cool water perennial rivers and streams occur in this province, including many short, steep tributaries with high water and sediment delivery efficiencies. Many lakes and wet meadows are associated with areas above 6,000 feet, occurring in glaciated terrain, as well as in high elevation cirques and basins. Major rivers in this province include the Platte and Canadian Rivers.

Northern Rocky Mountain Forest-Steppe - Coniferous Forest-Alpine Meadow Province

High-elevation, high-relief mountains are the main landforms in this province. Vegetation is mainly evergreen deciduous, needleleaf forest that varies in composition with altitude and aspect. Common cover types include lodgepole pine, fir-spruce, larch, and mountain grasslands.

Black Hills Coniferous Forest Province

The climate of this province is characterized by relatively long, cold winters and warm to hot summers. Annual precipitation is low and occurs mostly as snow. The ecoregion is a highly eroded, old, isolated, unglaciated large mountain dome of Precambrian origin that is surrounded by plains. The vegetation is forest, mostly of evergreen needleleaf species, although several deciduous broadleaf species common to more northern latitudes may be present. In Wyoming, this can be characterized by ponderosa pine and Great Plains grasslands cover types.

3.8.7.2 Terrestrial Resources

The Northern Rocky Mountains and Great Plains coal region includes numerous disconnected bands that extend across the north-central U.S., including portions of Montana, North Dakota, Wyoming, and Colorado. All of the ecoregion descriptions and vegetation cover type descriptions below are adapted from McNab et al. (2005 and 2007). The common vegetation and fauna in each cover type are described briefly in Appendix G.

Most of the area in this coal region is contained within four ecoregion provinces. In the less mountainous areas of Montana, North Dakota, Colorado, and Wyoming, the coal region is within the Great Plains-Palouse Dry Steppe Province. Vegetation in this province includes mountain grasslands, Great Plains grasslands, ponderosa pine, sagebrush, prairie, and pinyon-juniper cover types.

In the more mountainous regions along its northern side, the coal region is located within the Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province. Vegetation in this province includes Douglas fir, lodgepole pine, sagebrush, and mountain grasslands cover types.

In the mountainous regions south of the Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province is the Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province. Vegetation in this province includes lodgepole pine, fir-spruce, sagebrush, alpine tundra, ponderosa pine, chaparral-mountain shrub, and hemlock-Sitka spruce cover types.

In southern Idaho, Wyoming, and Colorado, the coal belt is located within the Intermountain Semi-desert Province. Vegetation in this province includes sagebrush, desert shrub, chaparral-mountain shrub, Great Plains grasslands, pinyon-juniper, and Douglas-fir cover types.

Isolated areas of the coal belt are also located in Great Plains Steppe Province in northern North Dakota, characterized by Great Plains grasslands and aspen-birch cover types; the Northern Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow Province in northwest Montana, characterized by lodgepole pine, fir-spruce, larch, and mountain grasslands cover types; and the Black Hills Coniferous Forest Province in east Wyoming, characterized by ponderosa pine and Great Plains grasslands cover types.

Beginning in the northern part of this coal region, the area of northeast Montana and northwest North Dakota moving through the central and southcentral portion of that state supports natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, big bluestem, and blue grama. Little bluestem is an important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, and slim sedge are important species on wet soils. Western snowberry, stiff goldenrod, echinacea, and prairie rose are commonly interspersed throughout the area. The major wildlife species in this area are mule deer, whitetailed deer, red fox, raccoon, muskrat, mink, jackrabbit, fox squirrel, antelope, pheasant, sharp-tailed grouse, gray partridge, Hungarian partridge, sharptailed grouse, mourning dove, Canadian goose, mallard, blue-winged teal, pintail, and pelican.

The middle and southwest parts of North Dakota and northwest South Dakota support natural prairie vegetation characterized by western wheatgrass, needleandthread, green needlegrass, threadleaf sedge, and blue grama. Little bluestem, prairie sandreed, and sideoats grama are important species on shallow soils. Prairie rose, leadplant, and patches of western snowberry are interspersed throughout the area. Green ash, chokecherry, western snowberry, and buffaloberry occur in draws and narrow valleys. North-facing slopes support Rocky Mountain juniper, green ash, and chokecherry and an understory of little bluestem, porcupinegrass, and needleandthread. Some of the major wildlife species in this area are whitetailed deer, mule deer, pronghorn antelope, red fox, coyote, white-tailed jackrabbit, prairie dog, ring-necked pheasant, gray partridge, sharp-tailed grouse, hawks, turkey, ducks, and geese.

The area of central and southeast Montana supports grassland vegetation. Western wheatgrass, bluebunch wheatgrass, green needlegrass, and needleandthread are the dominant species. In the eastern part of the area, little bluestem replaces bluebunch wheatgrass as the dominant species. Some of the major wildlife species in this area are mule deer, white-tailed deer, antelope, coyote, fox, badger, beaver, raccoon, jackrabbit, cottontail, muskrat, mink, ground squirrel, pheasant, sharp-tailed grouse, Hungarian partridge, sage grouse, geese, and ducks.

Continuing south into northeast Wyoming, this area supports grassland vegetation. Rhizomatous wheatgrasses, green needlegrass, needleandthread, and blue grama are the dominant species on deep soils. Rhizomatous wheatgrasses, bluebunch wheatgrass, Indian ricegrass, and needleandthread are the major species on shallow soils on hills and ridges. Basin wildrye, green needlegrass, rhizomatous wheatgrasses, and shrubs are dominant along bottom land and streams. Big sagebrush is the dominant shrub. Some of the major wildlife species in this area are elk, deer, antelope, coyote, beaver, muskrat, jackrabbit, cottontail rabbit, sage grouse, and turkey.

Further south, through the lower half of Wyoming and the portions of Colorado and New Mexico within this coal region, the vegetation varies from one precipitation zone to another. The salt desert zone occurs in small areas receiving less than 8 inches (205 millimeters) of annual precipitation. The representative plant species are Gardner's saltbush, mat saltbush, greasewood, shadscale, bud sagebrush, winterfat, Indian ricegrass, and western wheatgrass. Wyoming big sagebrush may occur but only as a few widely spaced plants. A semi-desert grass-shrub zone, the largest in the MLRA, is characterized by a vast sagebrush steppe. This zone occurs in the areas receiving 8 to 16 inches (205 to 405 millimeters) of annual precipitation. The representative vegetation includes Wyoming big sagebrush, early sagebrush, antelope bitterbrush, bluebunch wheatgrass, western wheatgrass, prairie junegrass, needleandthread, and Indian ricegrass. Utah juniper may occur in small areas. Cottonwood and willows grow in riparian zones along the major perennial streams and rivers. A foothill-mountain zone in Wyoming is in the narrow mountain ranges that receive more than 16 inches (405 millimeters) of annual precipitation. The vegetation on these ranges includes ponderosa pine, limber pine, lodgepole pine, and Engelmann spruce and an understory of big sagebrush, Oregon-grape, Saskatoon serviceberry, antelope bitterbrush, bluebunch wheatgrass, and Idaho fescue. A lower foothill-mountain zone along the southern boundary of Wyoming and in Colorado occurs on the higher hills and mesas receiving more than 12 inches (305 millimeters) of annual precipitation. This zone is characterized by forested areas of Utah juniper with lesser amounts of pinyon pine and with an understory of Gambel oak, Wyoming big sagebrush, mountain mahogany, muttongrass, needleandthread, prairie junegrass, and Indian ricegrass. Some of the major wildlife species in this region are whitetailed prairie dog, white-tailed jackrabbit, desert cottontail rabbit, coyote, red fox, badger, pronghorn, mule deer, elk, sage grouse, golden eagle, bald eagle, screech owl, common raven, sage sparrow, Brewer's sparrow, western rattlesnake, and bull snake.

3.8.7.3 Aquatic Resources

The Northern Rocky Mountains and Great Plains coal region includes streams on both sides of the continental divide. The major rivers that drain to the Pacific include the Green, Colorado, and Snake Rivers. The major rivers that drain to the Atlantic include the Platte, Yellowstone, Missouri, Arkansas, and Canadian Rivers.

Lotic Systems

A variety of flowing water habitats is present in the Northern Rocky Mountains and Great Plains coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. A more detailed discussion about the general habitat features of these different types of streams is presented in Appendix C.

The predominant stream type in the coal region varies with topography. In general, in the mountain and valley streams and rivers are often perennial (U.S. ACE, 2010). The lower relief topography of the plains and plateaus in this coal region, which are typically more arid, has predominantly ephemeral and intermittent streams. Although major rivers run through these areas, their headwaters are typically found outside of the semiarid regions in the Middle Rockies (U.S. ACE, 2010). These mountain headwater streams are rapidly flowing, having steep staircase-like channels with steps and plunge pools, and with pools and riffles appearing as stream slope decreases towards the plains and plateaus (U.S. EPA, 2006). Streams on the plains are typically low-sloped with riffles, runs, pools, and few rapids, and are often deeply incised as they exit mountainous areas. Many plains streams have intermittent stream flow with perennial pools that are sustained by groundwater (Peterson et al., 2009).

Many streams in this coal region have diversion dams or dams that are used for irrigation withdrawals and reservoirs, in addition to numerous small impoundments which have been built on small tributary streams (Peterson et al., 2009). The streams and rivers of the coal region have been influenced by a high level of disturbance, with riparian disturbance exceeding 38 percent in the mountains, and 62 percent in the plains (Stoddard et al., 2005). In addition, sedimentation from erosion and agricultural activities remain stream habitat stressors, with the vast majority of streams having low stream bed stability, indicating that their substrates are dominated by finer or smaller sediments than would be expected. In the plains, 40 percent of stream lengths have excessive sedimentation (Stoddard et al., 2005).

As described in Section 3.5 (see Table 3.5-5), it is estimated that there are a total of 147,003 miles of intermittent streams and 8,645 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C and Section 3.5.

Energy Flow/Primary Production

Streams in mountainous areas of the coal region drain forested catchments that provide abundant woody debris as an allochthonous energy source (U.S. EPA, 2006). At lower elevations, hardwoods in riparian corridors provide an allochthonous energy source of leaves and woody debris (Peterson et al., 2009).

Algal biomass consisting of cyanobacteria, filamentous chlorophytes, halophilic diatoms, and diatoms comprises a major unit of primary production in the stream of the Northern Rocky Mountains and Great Plains coal region. Although diatoms contribute the most to overall taxa richness, blue-green algae (cyanobacteria) and green algae account for a substantial amount of periphyton abundance in this coal region (Peterson et al., 2009). In heavily shaded mountain and canyon streams, light availability can be the overriding factor controlling the algal biomass and primary production, even in the presence of high nutrient concentrations (Mosisch et al., 2001). Although moderate algal biomass is recorded in lower elevation streams of the coal region, in mountainous areas concentrations of chlorophyll *a* (an indicator of algal biomass) have been found to be generally small, suggesting that primary production is higher in the lower elevations (Peterson et al., 2009). Non-algal macrophytes, such as bryophytes (liverworts, hornworts, and mosses), and emergent and aquatic vascular plants (e.g., sedges, rushes, grasses, and shrubs) are important primary producers. The growth and maintenance of the macrophyte communities are dependent on slope, substrate, and the stability of stream discharge (Reid, 1961).

Invertebrates

The most abundant aquatic insects in the Northern Rocky Mountains and Great Plains include midges, mosquitoes, blackflies and craneflies (Diptera); mayflies (Ephemeroptera); caddisflies (Tricoptera); stoneflies (Plecoptera); beetles (Coleoptera); and damselflies and dragon flies (Odonata) (Peterson et al., 2009). A large number of these insects shred and scrape decaying organic material, which aids in the assimilation of allochthonous inputs to the aquatic system (Dodson, 2005). Many aquatic insects are predatory and actively feed on smaller insects and other invertebrates.

In areas of increased disturbance, chironomid (Chironomidae) and other groups like crustacean scuds, mites (Hydrachnidiae**)**, and pond snails (Lymnaeoidea) increase in abundance.

Vertebrates

The fish assemblages the Northern Rocky Mountains and Great Plains coal region are diverse, as they include both cold- and warm-water species. However, these assemblages have been heavily impacted by the introduction of non-native fish species and loss of habitat due to stream alteration and damming. Rivers reaching the Pacific Ocean historically had large runs of salmon and trout, including pink salmon (*Oncorhynchus gorbuscha*), Chinook salmon (*O. tshawytscha*), Coho salmon (*O. kisutch*), and cutthroat trout (*O. clarkii*) (U.S. EPA, 2006). Non-native fishes were and are stocked as sport fish; the most common non-native species currently reported in the coal region are brown trout, brook trout, rainbow trout, common carp, smallmouth bass, green sunfish (*Lepomis cyanellus*), and largemouth bass (Stoddard et al., 2005). Other notable introduced species to the coal region include northern pike, yellow perch, rock bass (*Ambloplites rupestris*), northern plains killifish (*Fundulus kansae*), and bullhead catfishes.

Fish diversity can be high at sites in this coal region. In a recent fisheries survey in the Powder River Basin, an area that contains both cold- and warm-water habitats, 36 species were identified, but only 17 were native (Peterson et al., 2009). The most abundant species in that Powder River Basin study (in order of relative abundance) were fathead minnows (*Pimephales promelas*), smallmouth bass, sand shiners, rock bass, white suckers, common carp, green sunfish, and the shorthead redhorse (*Maxostoma macrolepidotum*). Fish assemblages in the coal region change in composition from the cooler waters in headwater and mountain streams to the warmer waters of lower sloped streams in the plains. These communities change from larger percentages of mountain sucker, white sucker, northern plains killifish, and longnose dace at sites farthest upstream, to larger percentages of channel catfish, stonecat, river carpsucker, and goldeye at the sites farthest downstream (Peterson et al., 2009).

In Wyoming, the heart of this coal region, there are 11 species of amphibians (Wyoming Game and Fish Department, 2005). Common aquatic species in the coal region's largest coal area, the Powder River Basin, include Woodhouse's toad (*Bufo woodhousii*), the northern leopard frog (*Rana pipiens*), the tiger salamander, and the boreal chorus frog (*Pseudacris maculata*) (Wyoming Game and Fish Department, 2005). The invasive bull frog is negatively influencing native species and has become well established throughout the coal region, competing for resources and habitat (Stoddard et al., 2005). Turtle diversity is low in this coal region; in Wyoming there are four species of turtles, three of which are aquatic, the western spiny softshell (*Apalone spinifera hartwegi*), the western painted turtle (*Chrysemys picta bellii*), and the snapping turtle (Cerovski et al., 2004).

Lentic Systems

In the Great Plains area there are glacial pothole lakes and ponds, along with many manmade impoundments and farm ponds. In the more mountainous areas of the coal region, reservoir lakes, such as Holter Lake and Canyon Ferry Lake are the main lentic systems, while smaller natural alpine lakes occur in glaciated terrain, as well as in high elevation cirques and basins (McNab and Avers, 1994). In the more arid areas of the coal region, some drainages lack outlets, producing temporary saline ponds and lakes (U.S. ACE, 2010).

Energy Flow/Primary Production

Allochthonous carbon sources are important to the lentic systems in this coal region. Litter fall from the surrounding forests of spruce, fir, hemlock, pine, Douglas fir, aspen, and cottonwood provides the major food supply for many invertebrate consumers. The arid climate and fluctuating precipitation throughout the year can cause variability in the shorelines of lakes and ponds, and can greatly reduce the amount of macrophytes present in some lentic systems. However, other lentic systems with perennial sources of water from streams and springs can provide habitat for the development and establishment of macrophyte communities. In the Northern Rocky Mountains and Great Plains, the littoral zone generally extends from the depth of rooted plant growth, usually 15 to 25 feet deep, as submersed plants generally do not grow below a depth of 30 feet due to light and pressure limitations (O'Neal and Soulliere, 2006). Aquatic macrophytes are responsible for a significant portion of the primary production for the lake systems (Ozimek et al., 1990; Wetzel, 2001). The macrophyte species present in lentic systems within the coal region do not generally differ from those that are known to occur in lotic systems.

Invertebrates

The macroinvertebrates that are common in the lentic systems of the Northern Rocky Mountains and Great Plains can include annelids, plecopterans, odonates, ephemeropterans, trichopterans, and dipterans.

Vertebrates

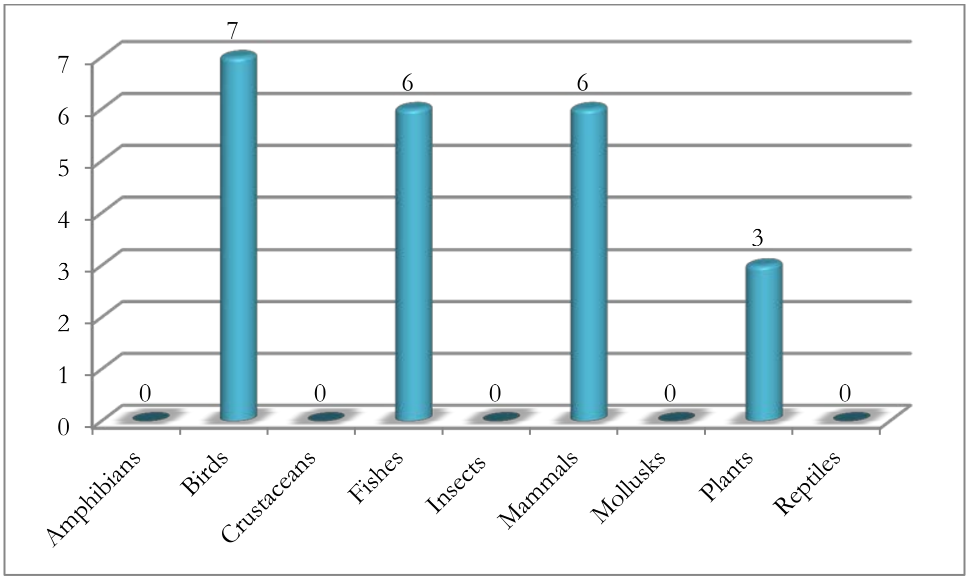
Amphibians found in natural alpine lakes are particularly impacted by introduced fish species that compete with amphibians for aquatic insects.

In the lentic systems of this coal region, fish assemblages generally include species similar to the lotic systems as described above. The non-native species that state agencies stock into lentic systems commonly move into lotic systems; threats to native fish assemblages remain from the introduction of exotic species, loss of habitat from sedimentation, and potential overfishing in lotic and lentic systems.

3.8.7.4 Protected Species in the Coal Mining Areas of the Northern Rocky Mountains and Great Plains

A total of 22 federally listed and proposed species occur in the active coal mining areas of the Northern Rocky Mountains and Great Plains coal region. Figure 3.8-10 depicts the number of listed species and relative proportion for each taxonomic group. See Appendix F for the species names and status information.

Figure 3.8-10 Count of Federally listed species in the Northern Rocky Mountains and Great Plains Region

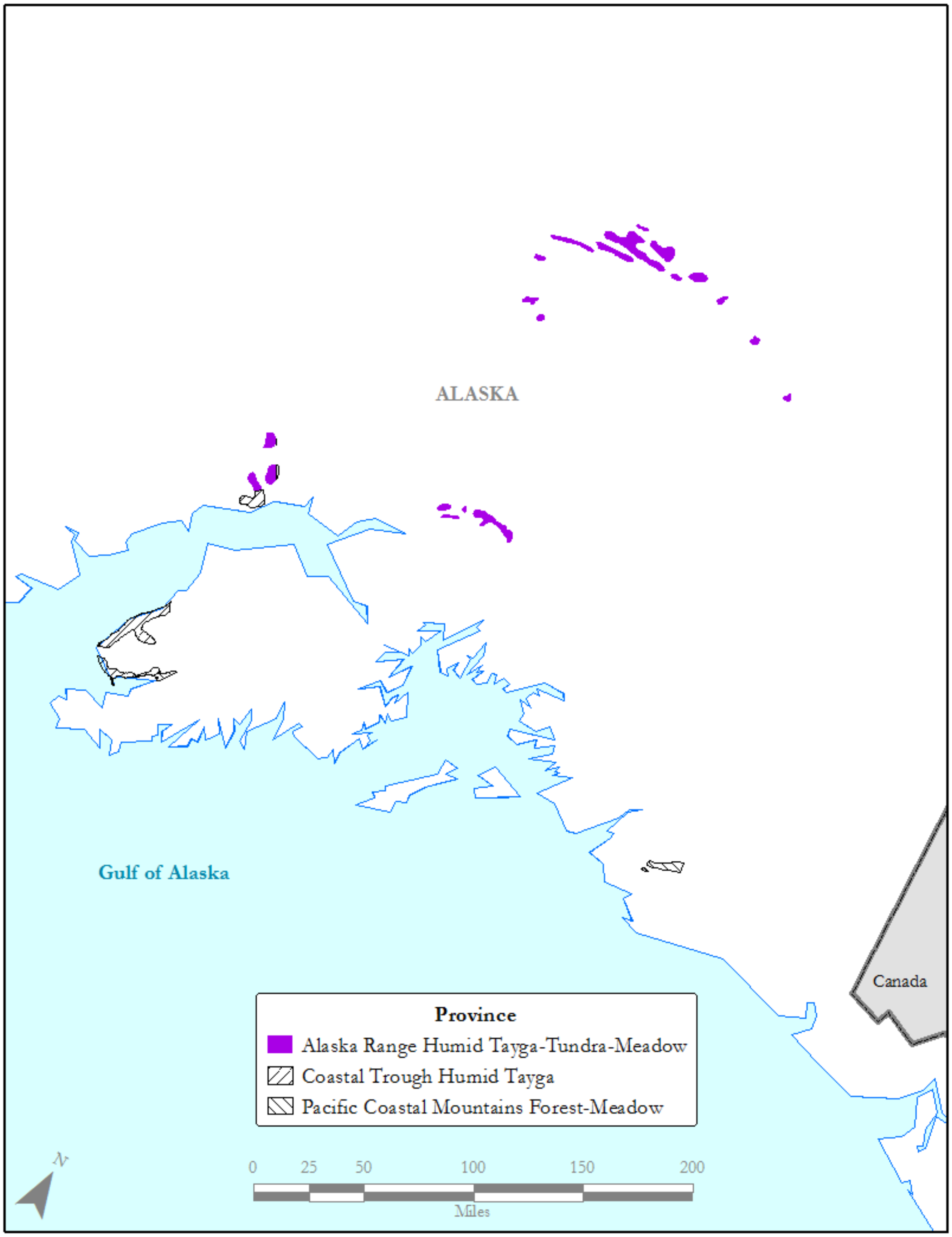


3.8.8 Northwest Region

3.8.8.1 General Ecological Setting

Presently, there is only one actively producing mine in the Northwest coal region, located near Healy, Alaska. Thismine is located in Denali Borough, near the mouth of Healy Creek on the Nenana River in the Nenana coal field. There are approved permits in the Matanuska coal field, but no active mine or mining exists here presently; however, mining could reasonably occur in the future. Figure 3.8-11 presents the ecological provinces in the Northwest region, while Table 3.8-7 lists the provinces and their approximate area.

Figure 3.8-11 Ecological Provinces within the Northwest Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Table 3.8-7
USFS Provinces Associated with the Northwest Region

Ecological Province	Area of Coal Region in Province (square miles)
Interior Forested Lowlands and Uplands	16
Alaska Range	667
Cook Inlet	56
Total	**739**

The descriptions provided below for the ecological provinces distributed within the Northwest coal region come from Gallant et al. (1995).

Interior Forested Lowlands and Uplands Province

This ecoregion represents a patchwork of ecological characteristics. Region-wide unifying features include a lack of Pleistocene glaciations, a continental climate, a mantling of undifferentiated alluvium and slope deposits, a predominance of forests dominated by spruce and hardwood species, and a very high frequency of lightning fires. On this backdrop of characteristics is superimposed a finer-grained complex of vegetation communities resulting from the interplay of permafrost, surface water, fire, local relief, and hill slope aspect.

Alaska Range Province

The mountains of south-central Alaska, the Alaska Range, are very high and steep. This ecoregion is covered by rocky slopes, ice fields, and glaciers. Much of the area is barren of vegetation. Dwarf scrub communities are common at higher elevations and on windswept sites where vegetation does exist. The Alaska Range has a continental climatic regime but because of the extreme height of many of the ridges and peaks, annual precipitation at higher elevations is similar to that measured in some ecoregions as having a maritime climate.

Cook Inlet Province

Located in the south central part of Alaska adjacent to the Cook Inlet, the ecoregion has one of the mildest climates in the State. The climate, the level to rolling topography, and the coastal proximity have attracted most of the modern human settlement and development in Alaska. The region has a variety of vegetation communities but is dominated by stands of spruce and hardwood species. The area is generally free from permafrost. Unlike many of the other non-montaine ecoregions, the Cook Inlet Ecoregion was intensely glaciated during the Pleistocene epoch.

3.8.8.2 Terrestrial Resources

The Northwest coal region study area includes small coal areas in Alaska. Vegetation occurs in zones based on moisture and altitude. Dense stands of white spruce (*Picea glauca*) and cottonwood occur on the floodplains and low terraces of the Copper and Susitna Rivers within

Alaska Range and Wrangell Mountains. Black spruce (*Picea mariana*) predominates in poorly drained areas above 1000 feet of elevation. Spruce-hardwood forests with components of white spruce, birch (*Betula* spp.), aspen (*Populus* spp.), and poplar (*Populus* spp.), and an understory dominated by moss, fern, grass, and berries are typical in areas up to the elevation of timberline (2,500 to 3,500 feet).

Coal resources occur in the area of the Cook Inlet and in the vicinity of the Copper River. Lowland spruce-hardwood forests are abundant in the Cook Inlet, with wet tundra communities along the coastline. Black spruce forests interspersed with tundra. The Copper River lowland is characterized by black spruce forest interspersed with large areas of brushy tundra. White spruce forests occur on south-facing gravelly moraines, and cottonwood-tall bush communities are common on large floodplains.

Upland sites within the region's lower elevation forest and subalpine zones are vegetated in white spruce, paper birch, and quaking aspen. On the southern Kenai Peninsula the vegetation changes and Lutz spruce becomes dominant. Cottonwoods and mixed cottonwood forests are common the flood plains and seepage areas of the mountain slopes. In the lowlands and peatlands white and black spruce woodlands occur, as do low scrub communities comprised of willows and ericaceous shrubs, with a variety of sedges and grasses in the meadows. The Cook Inlet coast is dominated by halophytic sedges and sedge-grass meadows. With the higher elevations of the subalpine zone the vegetation is again different with forest gradually giving way to grasslands of bluejoint reedgrass, tall alder scrub and low willow scrub. Dwarf scrub and herbaceous communities are characteristic in the alpine zone at and above 1800 to 2500 feet in elevation. Spruce bark beetle infestations have greatly impacted the white spruce, Lutz spruce and mixed spruce forests of the region, some of which occur in the coal-bearing areas. In some areas, the dominant forest canopy has been entirely killed off by bark beetles.

Within the true alpine zone, the primary species include a variety of dwarf scrub and herbs. Low willow scrub is common in drainages. Lichens and scattered herbs and dwarf shrubs dominate areas with exposed bedrock and very shallow soils. In general, there is little or no plant growth above about 7,500 feet (2,287 meters) elevation. Along the boundary with the Cook Inlet lowlands, there are stringers and inclusions of tall alder scrub and bluejoint reedgrass grassland, characteristic of the subalpine zone.

Common large mammals include caribou (*Rangifer tarandus*) and introduced bison (McNab and Avers, 1994, Bailey, 1995, and McNab et al., 2005). Dall sheep (*Ovis dalli*) are found in the high mountains. Typical small mammals include furbearers, such as marten (*Martes americana*), mink, shorttail (*Mustela ermine*), and least weasels (*Mustela nivalis*), as well as Hoary marmots (*Marmota caligata*) woodchucks (*Marmota monax),* arctic ground squirrels (*Spermophilus parryii*) and northern flying squirrels (*Glaucomys sabrinus*), and longtail (*Microtus longicaudus*) and yellow-cheeked (*M. xanthognathus*).

In the true alpine zone, some of the major mammal species of the area include brown bear, Dall sheep, mountain goat, caribou, moose, wolf, coyote, fox, snowshoe hare, arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

3.8.8.3 Aquatic Resources

In the Northwest coal region, each province has unique climatic, physiographic, and geologic properties that influence the types of aquatic systems and biota that occur within them.

Lotic Systems

A variety of flowing water habitats are present in the Northwest coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. A more detailed discussion about the general habitat features of these different types of streams is presented in Appendix C.

Streams of Alaska vary both in both physical and hydrological aspects (Craig and McCart, 1975; Huryn et al., 2005), which results in a wide range of disturbance regimes. Differences in disturbance regime between mountain streams and perennial spring streams have been shown to result in large differences in biological communities (Parker and Huryn, 2006). Some species cope with these disturbances while some will develop in winter to avoid disturbance related to flood events (Danks, 2007). Streams with outlets to lakes have different temperature regimes and fauna (Hieber et al., 2002). Also, a study comparing food web structure and function of a mountain stream and a spring stream by Parker and Huryn (2006) indicated that macroinvertebrate taxa richness was greater in the spring stream than in the mountain stream. Further, the mean macroinvertebrate biomass was greater in the spring stream than in mountain stream, indicating significant differences between these two stream types in the volume of material and energy flow between food-web nodes.

Streams draining permafrost-dominated watersheds have a hydrologic regime characterized by low base flows, but high storm flows with the onset of snowmelt or rainfall (Smidt and Oswood, 2002). This differs from streams draining permafrost-free watersheds as the absence of permafrost allows deeper infiltration of precipitation, allowing greater and more sustained base flows and reduced storm flows (Woo and Winter, 1993). A study by MacLean et al. (1999) showed that stream chemistry (dissolved organic carbon, dissolved organic nitrogen, and dissolved inorganic nitrogen) in permafrost-dominated watersheds was more closely associated with the chemistry of organic horizons in the upper soil as compared to the chemistry of streams draining permafrost-free watersheds. The water chemistry of runoff from permafrost-free soils is controlled by contact between water and mineral soils. This study showed that streams in permafrost-dominated watersheds are likely to be more sensitive to nutrient inputs than those in permafrost-free watersheds. Material transport of dissolved materials into streams from surrounding terrestrial landscapes can have a significant influence on the ecology of stream organisms (MacLean et al., 1999).

As described in Section 3.5 (see Table 3.5-5), it is estimated that there are a total of 3,554 miles of intermittent streams and 2,912 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C and Section 3.5.

Energy Sources, and Primary Production

Food webs in arctic Alaska are functionally seasonal and essentially no dependence on riparian vegetation exists; therefore, food webs are driven by primary production during the short summer and by old carbon from peat bogs during the long winter (Oswood et al., 2000). A study conducted by Peterson et al. (1993) on a tundra river on the north slope of Alaska found that the rocky cobble bottom of the river was colonized by filamentous algae, diatoms, and bacteria. Large amounts of organic matter were found to enter the river from peat eroding from the river banks and from dissolved organic matter leaching from the tundra landscape. Allochthonous organic matter inputs far outweighed autochthonous production of epilithic algae (Peterson et al., 1986). While allochthonous peat and dissolved organic matter strongly dominated the carbon cycle (Peterson et al., 1986), all trophic levels of the riverine food web were found to be highly responsive to fertilization by phosphorus and nitrogen, which primarily stimulated epilithic diatoms and filamentous algae.

A study by Huryn et al. (2005) identified 120 periphyton taxa from 24 streams on the northern slope of Alaska. Diatoms were found to be widespread; filamentous cyanobacteria were also observed.

Invertebrates

Typical freshwater invertebrates found in or associated with Alaskan lotic systems include Tricorythidae (mayflies), Amphipoda (malacostracan crustaceans), Rhyacophilidae and Systellognatha (stoneflies), Elmidae (riffle beetles), Hydroptilidae (micro-caddisflies), Brachycentridae (caddisflies), Oligochaeta (worms) (Corkum, 1989), and Chironomidae (Smidt and Oswood, 2002; King et al., 2012). According to Alaska's Comprehensive Wildlife Strategy (Alaska Department of Fish and Game, 2006) invertebrate species associated with clearwater river/streams include, but are not limited to, stoneflies (Plecoptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), freshwater clams (Pelecypoda), and the Yukon floater mussel (*Anodontata beringiana*).

Diversity and abundance of benthic invertebrates in Alaska's tundra streams are higher than in mountain streams but less than in spring streams (Craig and McCart, 1975). Spring streams contain the greatest diversity of benthic invertebrates, and high densities of benthic invertebrates (10,000 organisms/square meter) occur in these streams (Craig and McCart, 1975). A study conducted by Huryn et al. (2005) found that macroinvertebrate community structure was distinct among stream categories. For instance, tundra streams had significantly greater filter feeder biomass than the other stream types, and filter feeders were absent from glacial streams. In mountain streams, predator biomass was greater than any other stream types where Perlodid stoneflies (e.g., *Arcynopteryx compacta* and *Isoperla sobria*) contributed an average of 87 percent to predator biomass.

In a recent small scale study in this region, first order streams, regardless of topographic or geomorphic setting, support relatively high numbers of macroinvertebrate taxa and at least one life history stage of salmonids (King et al., 2012). The majority of these invertebrates are consumers of grass litter, which is positively correlated with supporting juvenile stages of salmonids. This study also found that pH, water temperature, substrate composition, and channel morphology were significant variables in fish and macroinvertebrate composition.

Vertebrates

Reptiles and amphibians are of minimal importance in the freshwater aquatic systems in Alaska.

The fishes with perhaps the greatest biologic and economic importance in the Northwest coal region are the salmonid species, which include salmon, trout, char, grayling, and whitefish. Salmonids require relatively cold freshwater habitats with high water quality and diverse habitat to complete all stages of their life cycle. Salmon typically use large stream and river systems but can also be found in smaller coastal streams (U.S. BLM, 2008; King et al., 2012). The vast majority of salmonids are anadromous; their life cycle includes spawning and early development in freshwater systems, followed by foraging activities in the ocean during juvenile stages, and finally returning to freshwater systems to spawn.

According to studies reviewed by Oswood et al. (2000), fish faunas vary from the Arctic region to the panhandle of southeast Alaska due to ecological differences over the latitudinal and marine-continental gradients of Alaska. Combined high latitude and high elevation attributes of the high mountains of Alaska create barriers to fish exchanges across headwater divides, which may result in the greater differences in fish faunas compared to regions separated by low mountains and lowlands. During the winter, the headwater streams of the Brooks Range and Alaska Range mountains can be either partially or completely dewatered and covered with ice, forcing fish to migrate to suitable overwintering areas downstream. Loss of winter habitat from substratum freezing requires that most fish migrate out to sea or move to suitable overwintering locations, which are primarily perennially flowing springs.

Based on a study conducted by Craig and McCart (1975), mountain streams have low biological productivity during the summer compared to tundra streams and spring-fed streams. In mountain and spring streams, arctic char (*Salvelinus alpinus*) are commonly found, and grayling (*Thymallus arcticus*) also occur. Tundra streams are used as spawning and rearing grounds by grayling. Other fish species found in arctic streams included round whitefish (*Prosopium cylindraceum*), slimy sculpin, and ninespine stickleback (*Pungitius pungitius*).

According to Alaska's Comprehensive Wildlife Strategy (Alaska Department of Fish and Game, 2006), fish species associated with glacial river/streams include rainbow smelt (*Osmerus mordax*), eulachon (*Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), and pygmy whitefish (*Prosopium coulteri*). Species associated with clearwater river/stream include, but are not limited to, Alaska blackfish (*Dallia pectoralis*), arctic lamprey (*Lampetra camtschatica*), broad whitefish (*Coregonus nasus*), and ninespine stickleback. The trout-perch (*Percopsis omiscomaycus*) is an endemic species found in the Yukon River.

A study conducted by Adams et al. (1993) at two refuges on the Alaska Peninsula (Bering Tundra Province) found that length, weight, and age characteristics of chum (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon, and Arctic char from the study area generally exhibit similar characteristics to other Alaska populations. This study also found that tundra streams exhibited greater fish species diversity than upland streams, and that the mean lengths of juvenile coho salmon captured from tundra streams were greater than those captured from upland streams.

Lentic Systems

According to Alaska's Comprehensive Wildlife Strategy (Alaska Department of Fish and Game, 2006), Alaska has more than three million lakes greater than five acres in size, many of which are distributed in the coal region. Lakes are differentiated by the Alaska Department of Fish and

Game (2006) as either glacier influenced or clearwater lakes. Lakes can also form as a result of glaciers flowing across tributary valleys and trapping runoff. Most of the state's lakes are glacially formed, particularly those in the southwest and south-central portions of the state. Glacial lakes are important to both resident and anadromous fishes for overwintering. Clearwater lakes can have surface or groundwater sources, or both, and water levels, thermal regimes, and chemical composition are determined by flow regime, groundwater source, and connectivity. Alaska has many isolated lakes with no surface water connection; examples include lakes/ponds of thermokarst, fluvial, and volcanic origin. Subsurface flows may still exist with isolated lakes/ponds such as through underlying permafrost. Isolated lakes/ponds tend to have unique biological assemblages; however, most isolated lakes/ponds provide the same functions as non-isolated systems.

Energy Sources and Primary Production

A study conducted by Goldman (1960) produced the following results and observations. Photosynthetic carbon fixation by phytoplankton and bacteria demonstrated to represent the major part of the organic production in Alaskan lakes; chemosynthetic productivity is of secondary importance. Changes and differences in productivity may influence the rate of accumulation of organic matter in successive trophic levels. Results in Naknek Lake, Brooks Lake, and Lake Becharof on the Alaska Peninsula found that primary productivity per unit volume at comparable depths consistently increased towards the tributary end of the lake and that magnesium was a limiting factor for phytoplankton production throughout the summer. Seasonal changes in the total phytoplankton at Brooks Lake supported the relationship between standing crop and rate of production estimates for major changes in productivity during a season, although it was noted in this study that standing crop measurements would give very unreliable values for the rate of production if nutrient or other factors are limiting. Diatoms were the dominant algal phylum followed by green algae.

According to studies reviewed by Pfauth and Sytsma (2005), native aquatic plants found in lentic systems in Alaska include 15 species of pondweed (*Potamogeton* spp.), two species of water milfoil (*Myriophyllum* spp.) as well as duckweeds, and bladderworts. This survey also reported that in southern (Kenai Peninsula) and central (near Telin National Wildlife Refuge) portions of Alaska 33 submersed and floating-leaved aquatic plant species were found and included two aquatic mosses, one macro-alga, and one liverwort. Non-native aquatic plant species were not discovered during this survey.

Invertebrates

Small invertebrates associated with lakes and ponds differ from those found in streams and rivers. Lake/pond dwelling insects or benthic invertebrates live in the bottom sediments on aquatic plants and are an important food source for fish. Invertebrate species commonly associated with lakes/ponds in Alaska include, but are not limited to, dragonflies (suborder Anisoptera), damselflies (Suborder Zygoptera), mayflies, water fleas (*Daphnia* spp.), and bivalve mollusks such as the Yukon floater. Water fleas are the dominant plankton found in freshwater habitats and are an important food source for fish and predatory insects. The invertebrates of the Northwest Coal region do not greatly differ between lotic and lentic aquatic systems. Common aquatic invertebrates in the region include mayfly, stonefly nymphs, caddisfly larvae, Riffle beetles, fly larvae, aquatic worms, roundworms, freshwater earthworms, amphipods, and mollusks (U.S. EPA, 2009b). However, invertebrates more common in lentic systems than lotic include benthic organisms such as dragonfly and damselfly larvae, mayfly nymphs, water fleas (*Daphnia* spp.), and some bivalve mollusks.

Vertebrates

There are only six native species of amphibians in Alaska that have an association with lotic systems; these species are also found in lentic systems. Of these six species, only two, the wood frog and the western toad (*Bufo boreas)* are thought to possibly occur in the Nenana and/or Matanuska coal fields. The wood frog is widely distributed throughout Alaska and is the only amphibian found above the Arctic Circle (MacDonald, 2010). The western toad, Alaska's only toad species, has a recorded distribution from southeast Alaska along the mainland coast to Prince William Sound (Alaska Department of Fish and Game, 2006). Non-native species associated with aquatic environments (both lotic and lentic) that are known to occur in Alaska include the Pacific chorus frog (*Pseudacris regilla*) that breeds in slow-moving streams as well as marshes, lakes, ponds; and the red-legged frog (*Rana aurora*) whose habitat includes quiet permanent waters of streams, marshes, or ponds (McClory and Gotthardt, 2008; Alaska Department of Fish and Game, 2006; MacDonald, 2010).

3.8.8.4 Protected Species in the Coal Mining Areas of the Northwest

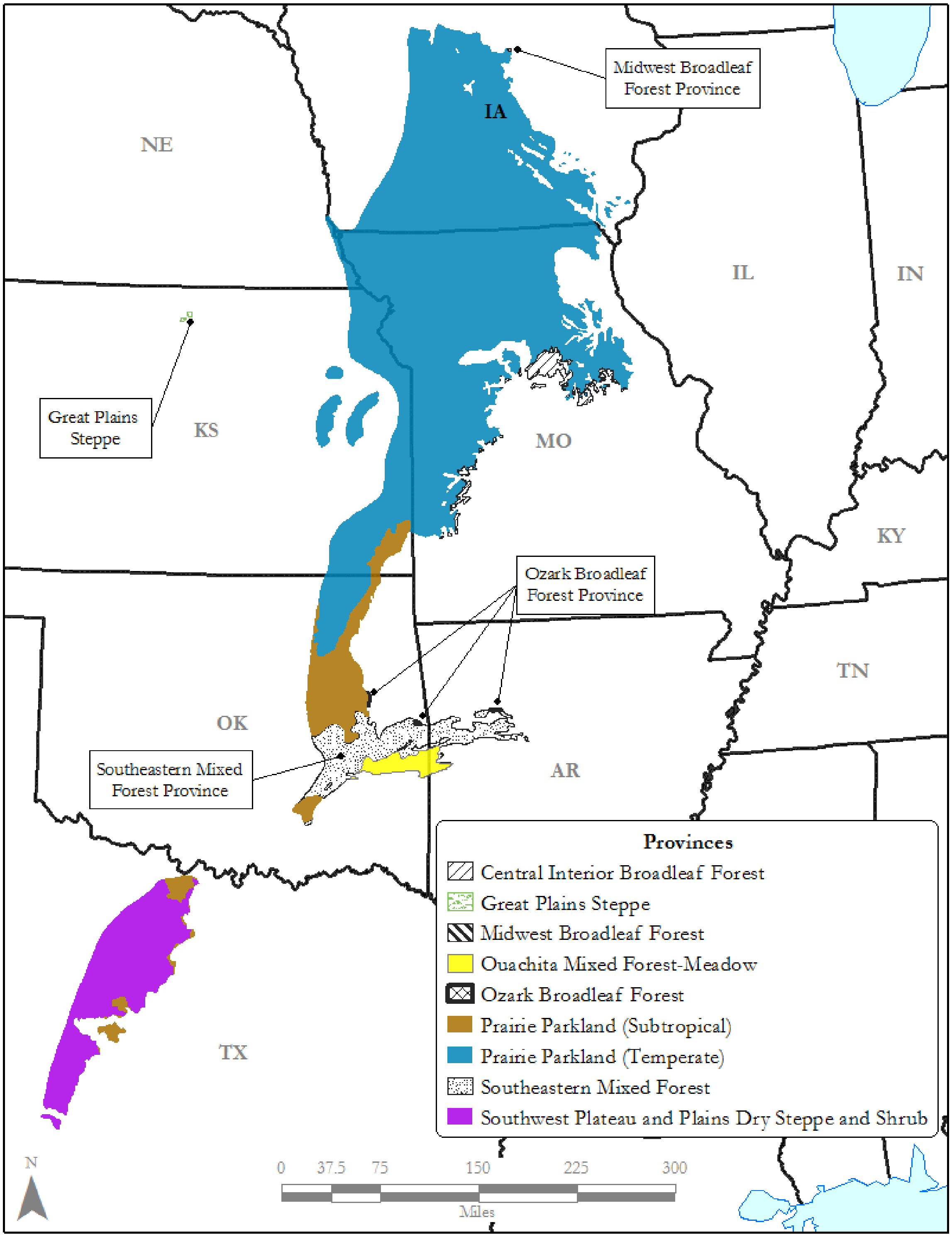
Upon review of the U.S. FWS species list OSMRE determined that there were no federally listed species within the area of direct or indirect effects from coal mining.

Therefore no listed species are identified here for this region. The list of affected species is part of the Section 7(a)(2) consultation requirement; therefore these determinations may change as OSMRE completes consultation with the U.S. FWS and NMFS.

3.8.9 Western Interior Coal-Producing Region

The Western Interior coal region is described by three coal basins, the Arkoma, the Cherokee and the Forest City Basins (U.S. EPA, 2004a). The counties with active mines in these three coal basins are distributed in four states including Arkansas, Oklahoma, Kansas, and Missouri (Figure 3.8-12).

Figure 3.8-12 Ecological Provinces within the Western Interior Region



Source: USFS, 2015, Ecological Provinces, http://data.fs.usda.gov/geodata/;
USGS, 2011, Coal Fields, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

3.8.9.1 General Ecological Setting

A wide variety of habitat types are distributed in this coal region because of the geographic extent and climatic extremes represented over this area. The Western Interior coal region is largely located in the climate of the Humid Temperate Domain, an area governed by both tropical and polar air masses, with strong annual cycles of temperature and precipitation, causing seasonal fluctuation of energy and temperature greater than the diurnal fluctuation (Bailey, 1995). Table 3.8-8 lists the ecological provinces located in this coal region and the area of each province.

Table 3.8-8
USFS Provinces Associated with the Western Interior Region

Ecological Province	Area of Coal Region in Province (square miles)
Central Interior Broadleaf Forest	915
Ouachita Mixed Forest-Meadow	871
Prairie Parkland (Subtropical)	4,612
Prairie Parkland (Temperate)	48,606
Southeastern Mixed Forest	3,603
Midwest Broadleaf Forest	5
Great Plains steppe	21
Ozark Broadleaf Forest	14
Southwest Plateau and Plains Dry Steppe and Shrub	6,971
Total	**65,619**

The descriptions provided below for the ecological provinces distributed within the Western Interior coal region come from Bailey (1995), McNab and Avers (1994), Cleland et al. (1997), and McNab et al. (2007). The common vegetation and fauna in each cover type are described briefly in Appendix G.

Central Interior Broadleaf Forest

A description of the Central Interior Broadleaf Forest Province is presented in the discussion of the Appalachian Basin.

Prairie Parkland (Subtropical)

A description of the Prairie Parkland (Subtropical) province is presented in the discussion of the Gulf Coast.

Prairie Parkland (Temperate)

A description of the Prairie Parkland (Temperate) province is presented in the discussion of the Illinois Basin.

Ouachita Mixed Forest – Meadow

This province is found in west Arkansas and southeast Oklahoma, consisting of oak-hickory-pine forest with a conifer understory and hardwood overstory. Generally shortleaf pine-dominated communities occur on poor upland soils and loblolly pine-dominated communities are distributed on richer valley soils. Hillsides have a mix of shortleaf oak on southerly slopes and oak-hickory on northerly slopes.

There is a high density of small-to-medium size perennial streams and associated rivers in this province; those in intermountain basins have moderate rates of flow, and some on mountainsides are characterized by high rates of flow and velocity. A trellis drainage pattern has developed largely with bedrock structural control; major rivers include the Fourche and Dutch Creek, which flow into the Arkansas River.

Southeastern Mixed Forest

A description of the Southeastern Mixed Forest province is presented in the discussion of the Appalachian Basin.

Midwest Broadleaf Forest

A description of the Midwest Broadleaf Forest province is provided in Section 3.8.1. Streams in the Michigan portion of this province drain to the Great Lakes, while streams in the Indiana portion of this province are in the Ohio River watershed. Lakes in this province are generally small-t- medium in size. Wetlands are formed in extensive low-lying areas in former glacial lakebeds in the province. There is moderate to high density of streams in this province; low gradient streams and rivers predominate and typically have substrates composed of sand, gravel, bedrock, and boulders.

Southwest Plateau and Plains Dry Steppe and Shrub Province

A description of the Southwest Plateau and Plains Dry Steppe and Shrub province is provided in the discussion of the Colorado Plateau.

Great Plains Steppe Province

A description of the Great Plains Steppe province is provided in the discussion of the Northern Rocky Mountains and Great Plains.

3.8.9.2 Terrestrial Resources

The Western Interior coal region study area includes several different terrestrial habits within the central U.S., within the states of Kansas, Missouri, Oklahoma, and Arkansas. Except as noted, all of the ecoregion descriptions and vegetation cover type descriptions below are taken from McNab et al. (2007). Many provinces and cover types are represented in this region, and as a result, the list of representative species is long. As with the other regions, detailed descriptions of the cover types are included in Appendix G.

In general this coal region is dominated by agricultural land interspersed with oak-hickory and prairie cover types, and elm-ash-cottonwood cover types. Near its southern limits, the coal region crosses several different provinces. The Prairie Parkland (Subtropical) Province is located in Oklahoma and is characterized by oak-hickory and Great Plains grasslands cover types. The Central Interior Broadleaf Forest Province is located in Missouri and Oklahoma and consists of oak-hickory and oak-pine cover types. The Ozark Broadleaf Forest-Meadow Province is located in Oklahoma and consists of oak-hickory and oak-pine cover types. The Southeastern Mixed Forest Province is located in Oklahoma and Arkansas and consists of oak-hickory, oak-pine, and loblolly-shortleaf pine cover types. The Ouachita Mixed Forest-Meadow Province is located within Oklahoma and Arkansas and consists of loblolly-shortleaf pine, oak-pine, and oak-hickory cover types.

Representative fauna for this region include many of the same species discussed for other regions due to the overlap of cover types. Typical representatives of the oak-hickory cover type are similar to that of other eastern hardwood and hardwood-conifer areas and vary somewhat from north to south. Important species include the white-tailed deer, black bear, bobcat, gray fox, raccoon, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole, northern short-tailed shrew, and cotton mouse.

Birds such as turkey, ruffed grouse, bobwhite, and mourning dove are game birds in forested parts of the region, including those covered in the oak-hickory cover type. Abundant breeding birds include the cardinal, tufted titmouse, wood thrush, summer tanager, red-eyed vireo, blue-gray gnatcatcher, hooded warbler, and Carolina wren. The box turtle, common garter snake, and timber rattlesnake are characteristic reptiles. Other important wildlife species in the wooded areas include the Indiana bat, spotted skunk, blue grosbeak, great crested flycatcher, western meadowlark, western fox snake, smooth green snake, speckled king snake, western worm snake, brown snake, smallmouth salamander, and Woodhouse's toad.

Within the grassland and prairie cover types the predominant species change to include jackrabbits as common residents of the prairie, and cottontail rabbits in areas with abundant streams and cover. Typical burrowing rodents include ground squirrels, prairie dogs (*Cynomys* spp.), pocket gophers (family Geomyidae), and many smaller rodents. Burrowing predators include the badger and the black-footed ferret (*Mustela nigripes*). The coyote is still common. Other important wildlife species in the prairies include barn and longeared owls, broad-winged hawk, Henslow's sparrow, northern harrier, Leonard's skipper, Pawnee skipper, Ottoe skipper, dusted skipper, wild indigo dusky wing, sleepy dusky wing, zebra swallowtail, Great Plains toad, plains leopard frog, plains spadefoot, massasauga rattlesnake, prairie skink, ornate box turtle, six lined racerunner, bobcat, black-tailed jackrabbit, plains pocket mouse, whitetailed deer, raccoon, skunk, opossum, muskrat, cottontail, mink, squirrel, and least shrew.

Migratory waterfowl rely on areas of the region within the prairie cover type for breeding and overwintering. Mourning doves are abundant, as are sharp-tailed grouse (*Tympanuchus phasianellus*), greater prairie chicken (*Tympanuchus cupido*), and bobwhite.

3.8.9.3 Aquatic Resources

The Western Interior coal region is very ecologically diverse. Major rivers such as the Missouri River, Mississippi River, Arkansas River, Canadian River, Red River, Brazos River, and the Pecos River drain portions of the coal region.

Lotic Systems

A variety of flowing water habitats are present in the Western Interior coal region. These include ephemeral, intermittent, low order (first through third) and higher order (fourth through sixth) streams as well as rivers. A more detailed discussion of the general habitat features of these different types of streams is presented in Appendix C.

Lotic systems in the Western Interior coal region are diverse, ranging from perennial spring-fed mountain streams to ephemeral desert streams. Rivers that exist in the plains prairies, which exist sporadically throughout the Prairie Parkland provinces and constitute a majority of the areas that are used for coal mining, start from prairie potholes and springs. Agricultural runoff also contributes to river flow. These prairie rivers carry large volumes of fine sediments and tend to be turbid, wide, and shallow. Major rivers in the coal region include the Arkansas, Missouri, and Red Rivers. The large rivers within the coal region historically experienced spikes in flows during the spring and early summer, which enabled sediment to be transported and deposited, and enabled channels to meander and migrate. Anthropogenic manipulations of these river systems have reduced natural flows and affected the system processes.

Rivers in this area have been heavily affected by channelization and flow controls, such as dikes and levees that restrict natural channels. Rivers are also affected by the construction of dams that have altered many natural riverine processes, such as sediment transportation and annual flooding. Agricultural activities have also caused impacts on streams, such as sedimentation and eutrophication. The leading stress indicators in lotic systems of the coal region include total nitrogen, riparian disturbance, and the reduction of in-stream fish habitat and riparian vegetative cover (U.S. EPA, 2006). The rivers and streams of the Western Interior coal region are affected by the surrounding land uses. Nutrient loading in this coal basin has become a major concern of the state environmental agencies due to the rapid growth of agricultural activities (Haggard et al., 2001). Anthropogenic sources of phosphorus and nitrogen include sewage, agricultural runoff, lawn fertilizers, pet wastes, and atmospheric pollution (Dodson, 2005).

As described in Section 3.5 (see Table 3.5-5), it is estimated that there are a total of 91,932 miles of intermittent streams and 65,673 miles of perennial streams in this coal region. A more detailed discussion about the general habitat features and hydrology of these different types of streams is presented in Appendix C and Section 3.5.

Energy Flow/Primary Production

A major unit of primary production in the Western Interior coal region is algal biomass, consisting of cyanobacteria, filamentous chlorophytes, halophilic diatoms, and diatoms. Common algal species include attached and floating filamentous species; however, phytoplankton is typically sparse (Power and Stewart, 1987). In heavily shaded mountain and canyon streams, light availability can be the overriding factor controlling the algal biomass and primary production, even in the presence of high nutrient concentrations (Mosisch et al., 2001). In mountainous areas, concentrations of chlorophyll *a* have been found to be generally small, indicating a relatively small amount of algal biomass in riffles (Peterson et al., 2009). In these areas, there can be an increased reliance on non-algal macrophytes and allochthonous sources for energy input within lotic systems.

In mountainous areas, non-algal macrophytes, such as bryophytes (liverworts, hornworts, and mosses), and emergent and aquatic vascular plants (e.g., sedges, rushes, grasses, and shrubs) are important to the primary production of the aquatic system for habitat and autochthonous energy input. Trees are typically the main source of woody debris and leaf pack material, except in the plains, where herbaceous plants and shrubs are a major component. Broadleaf cover types are typical of the coal region, consisting of common species of oak, hickory, hackberry (*Celtis* sp.), rough-leafed dogwood (*Cornis drummondi*) and sycamore (*Platanus* spp.), which line the stream banks in the region (Power and Stewart, 1987). Federally listed aquatic noxious weeds are also present in this region (Appendix E).

<u>Invertebrates</u>

Common insect orders found in streams in the Western Interior coal region include midges, mosquitoes, blackflies, and craneflies (Diptera); mayflies (Ephemeroptera); caddisflies (Tricoptera); stoneflies (Plecoptera); beetles (Coleoptera); damselflies and dragon flies (Odonata); springtails (Collembolan); water boatmen, water scorpions, pondskaters, and water striders (Hemiptera); and alderflies, dobsonflies and fishflies (Megaloptera). A large number of these insects shred and scrape decaying organic material, which aid in the assimilation of allochthonous inputs to the aquatic system (Dodson, 2005). Many aquatic insects are predatory and actively feed on smaller insects and other invertebrates. Non-insect invertebrates also common to lotic systems in the coal region include megadrile and microdrile worms (Oligochaeta); haplotaxid worms (Haplotaxida); water fleas (Cladocera); copepods (Copepoda); isopods (Isopoda); amphipods (Amphipoda); crayfish (Decapoda); arachnids (Acari); and snails (Basommatophora).

Another invertebrate group important to the region is freshwater mussels. Although not as rich as in the Appalachian Basin region, the Western Interior coal region has a relatively sizeable mussel fauna. Common species include the three-ridge (*Amblema plicata*), the pistolgrip (*Tritogonia verrucosa*), the plain pocketbook (*Lampsilis cardium*), and the pigtoe (*Fusconaia flava*) (Spooner and Vaughn, 2007). Unionid mussels often constitute the highest percentage of biomass relative to other benthic stream animals and are a key link in the food chain between aquatic microorganisms, such as algae and bacteria, and large animals like otter, turtles, fish, and hellbenders that eat unionids (Badra, 2005). Mussel populations have declined in recent decades to become the most imperiled group in North America because of siltation, pollution, and competition from exotic mollusks like the zebra mussel (Warren, 1995).

Crayfish are another relatively common freshwater invertebrate that inhabit very diverse niches, including small streams, large rivers, lakes, and even subterranean environments (Fetzner, 1996). Like freshwater mussels, crayfish are abundantly diverse in the Western Interior region. Arkansas is home to 61 species, while 32 species are known to occur in Missouri, 28 species in Oklahoma, and 11 species in Kansas (Fetzner, 2010). These species represent one of the largest aquatic faunal groups in North America north of Mexico but are so poorly known that over half of them do not have common names (Butler et al., 2003). However, crayfish have significant roles in aquatic ecosystems and are a major component of the food web. They are omnivorous and process organic matter in addition to feeding on snails, small fish, and aquatic insects; they transform energy between different levels in the food chain, and are themselves eaten by more than 240 predators (Butler et al., 2003).

Vertebrates

Amphibians, (frogs, toads, and salamanders) account for a considerable portion of energy flow in this region. Some of the more common amphibian species in the areas of concentrated mining include the bullfrog, the southern leopard frog (*Rana sphenocephala*), the green frog (*Lithobates clamitans*), the pickerel frog (*Lithobates palustris*), the Red River mudpuppy (*Necturus maculosus louisianensis*), the central newt (*Notophthalmus viridescens louisianensis*), and the western slimy salamander (*Plethodon albagula*) (Arkansas Herpetological Society, 2013).

The reptile species associated with lotic systems vary greatly across this coal region. Reptiles common to aquatic ecosystems in areas of the coal region where mining is currently conducted include the western cottonmouth (*Agkistrodon piscivorus leucostoma*), the plain-bellied watersnake (*Nerodia erythrogaster*), the midland watersnake (*Nerodia sipedon pleuralis*), the snapping turtle, the Ouachita map turtle (*Graptemys ouachitensis ouachitensis*), the eastern river cooter (*Pseudemys concinna concinna*), the red-eared slider (*Trachemys scripta elegans*), and the spiny softshell (*Apalone spinifera*) (Arkansas Herpetological Society, 2013). Reptiles' ingested energy is efficiently transferred to other trophic levels in the food web (Pough, 1980; Regester et al., 2005).

Due to the wide variation of environments in the Western Interior coal region, there is a high diversity of fishes. The lotic systems of the coal region range from spring-fed headwater streams to the main stem of the Missouri River. Most of the coal region is characterized by fish assemblages, including two common orders; Siluriformes, the catfishes, and Perciformes, which contains the fish families of Centrarchidae and Percidae. Common Siluriformes include black and yellow bullhead catfish (*Ictalurus melas* and *I. natalis*), and the channel catfish. Common Centrarchids in the region include largemouth bass, orange-spotted sunfish (*Lepomis humilis*), bluegill, longear sunfish (*L. megalotis*), green sunfish (*L. cyanellus*), and crappie (Stevenson et al., 1974). Common Percids include the orangethroat darters (*Etheostoma spectabile*), logperch (*Percina caprodes*), and slenderhead darters (*Percina phoxocephala*) (Stevenson et al., 1974). Fish assemblages are variable across the basin depending on stream type and climate; however, there is significant species overlap between stream types with similar ecoregions, and the assemblage descriptions below represent common groupings from areas currently targeted for coal production.

In most of the coal region, such as the prairie and plains provinces, shallowly entrenched, slow-flowing, meandering streams are the most common stream type. Fish assemblages in this stream type are commonly minnow dominated, including species such as the golden shiner, redfin shiner (*Lythrurus umbratilis*), suckermouth minnow (*Phenacobius mirabilis*), sand shiner, and fathead minnow (Pflieger, 1975). Other species of nongame fish common to the slow flowing, meandering stream type are gizzard shad (*Dorosoma cepedianum*), common carp, stonecat (*Noturus flavus*), black bullhead catfish, channel catfish, and flathead catfish (*Pylodictis olivaris*) (Pflieger, 1975). In addition to largemouth bass, other game fish such as smallmouth bass, white bass, and freshwater drum are also common. In addition to the meandering stream species, the main stems of the major rivers in the coal region include additional species indicative of larger lentic systems. These big river species include the chestnut lamprey (*Ichthyomyzon castaneus*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), pallid sturgeon (*Scaphirhynchus albus*), paddlefish, skipjack herring (*Alosa chrysochloris*), goldeye (*Hiodon alosoides*), blue sucker (*Cycleptus elongatus*), and blue catfish (*Ictalurus furcatus*) (Pflieger, 1975).

Spring-fed or upland clear, rocky streams are typically cool-water streams that are typically found in the upper reaches of watersheds. They are present across this coal region but are more commonly found in the Ouachita Mixed Forest-Meadow province. Like meandering streams, these cool streams are typically dominated by minnows such as the southern redbelly dace, horny head chub, rosyface shiner (*Notropis rubellus*), bleeding shiner (*Luxilus zonatus*), and striped shiner (Pflieger, 1975). In addition to minnows, darters are very common in these streams; widespread species include the orangethroat darter, the banded darter, the greenside darter, the rainbow darter (*E. caeruleum*), and the fantail darter. Other species common to these stream types include brook lampreys (*Lampetra* spp.), suckers such as the northern hog sucker (*Hypentelium nigricans*), black redhorse (*Moxostoma duquesni*), and golden redhorse (*Moxostoma erythrurum*), and other large species such as smallmouth bass, rock bass, longear sunfish, and in larger cool streams, walleye (Pflieger, 1975).

Lentic Systems

There are a relatively low number of warm water lakes and wetlands in the western portion of the Western Interior coal region due to the climate and topography. In the more arid areas of this coal region, some drainages lack outlets, producing temporary saline ponds and saline lakes (U.S. ACE, 2010). However, lakes produced by prior glacial action are common in the northern portion, and oxbow lakes and wetlands are abundant along the larger river systems. A large number of farm ponds are distributed throughout the agricultural areas. Water reservoirs have also been constructed throughout the coal region (McNab and Avers, 1994). In arid areas, playas are important because they store water in areas commonly subjected to drought conditions and where there are no permanent rivers or streams. Consequently, playas create an oasis-like area that provides habitat for a variety of species, especially in the more arid areas of this coal region.

Energy Flow/Primary Production

As mentioned previously in aquatic systems, primary production is accomplished by phytoplankton, macro algae, and vascular aquatic plants. The algae associated with lentic systems make a significant contribution to the primary productivity of the aquatic ecosystems in the Western Interior coal region (O'Neal et al., 1985). In general, productive lakes average approximately one gram of carbon fixed per day per square meter (Dodson, 2005).

The littoral zone generally extends from the depth of rooted plant growth, usually 15 to 25 feet deep, as submersed plants generally do not grow below a depth of 30 feet due to light and pressure limitations (O'Neal and Soulliere, 2006). These plants are essential in promoting the biodiversity of an aquatic system and are responsible for a significant portion of the primary production for entire lentic systems (Ozimek et al., 1990; Wetzel, 2001). The aquatic plant species present in lentic systems within this coal region do not generally differ from those that are known to occur in lotic systems; however, some plants are more common to lentic systems, such as coontail (*Ceratophyllum demersum*), pondweeds (*Potamogeton* spp.), water lily (*Nuphar advena*), water willow, and cattail. Though woody debris and leaf litter input are not as important to lentic systems as they are to lotic systems, they remain important as an allochthonous energy component from the surrounding forests of oak-hickory and mixed forest cover types. Arid climates with fluctuating precipitation cause variability in the shorelines of lakes and ponds, and can greatly reduce the amount of macrophytes present in the lentic system. However, lentic systems with perennial source water from streams and springs can provide habitat for the development and establishment of macrophyte communities.

Invertebrates

The invertebrate orders common in the lotic systems of the Western Interior coal region are generally the same as those found in the lentic systems of the region. These insects, worms, crayfish, and mussels form the base of the food web in lentic systems, and serve as a food source for other predators, including fish and mammals. Common pond macroinvertebrate species include mosquitoes, blackflies, and craneflies; amphipods; damselflies and dragonflies; and beetles (Bass and Potts, 2001).

Vertebrates

Reptile and amphibian species do not greatly differ between the lotic and lentic systems in this coal region. However, lentic areas are particularly important to terrestrial salamanders, which use ponds, lakes, and wetlands for reproduction and for their larval stages of life. Salamanders are abundant and efficiently transfer energy to other trophic levels in the food web.

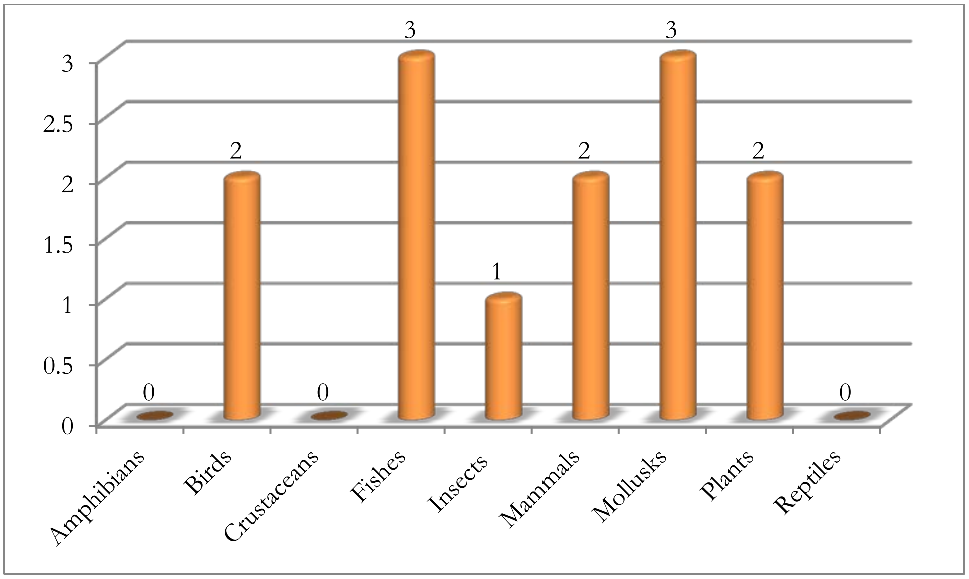
Reptiles fill important roles in the lentic ecosystems of the Western Interior coal region. Aquatic turtles are known to survive for extended lengths of time, remaining an important part of the wetland, pond, and lake systems. They can represent a significant portion of biomass in a lentic system. Semi-aquatic snake species are also important components of the food web. They transfer energy between terrestrial and lentic environments. These snakes feed on fish, frogs, tadpoles, salamander, crayfish, and insects in wetlands, lakes, and ponds.

Common lentic system species include largemouth bass, bluegill, crappie, bullhead catfish, channel catfish, carp, white bass, freshwater drum, and various sunfish species. In larger reservoirs and lakes, game fish are stocked or have been introduced; these species include northern pike, walleye, hybrid striped bass, and wiper (*Morone chrysops* x *M. saxatilis*). The non-native species that state agencies stock in lentic systems commonly move into lotic systems. Exotic species continue to threaten native fish sustainability as does loss of habitat from sedimentation, and potential overfishing in lotic and lentic systems.

3.8.9.4 Protected Species in the Coal Mining Areas of the Western Interior Region

As shown in Figure 3.8-13there are 13 federally listed and proposed listed species in the Western Interior region; two birds, three fish, three mussels, two plants, two mammals, and one insect. See Appendix F for species names and specific status.

Figure 3.8-13 Count of Federally listed species in the Western Interior Coal-Producing Region



3.9 WETLANDS

3.9.1 Introduction

Wetlands can be described as "the halfway world between terrestrial and aquatic ecosystems, exhibiting some of the characteristics of each system" (Mitsch and Gosselink, 2007). The Clean Water Act (CWA) defines a wetland as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR Part 328). Commonly used terms for wetlands include swamp, marsh, bog, wet meadow, fen, pocosin, pothole, and vernal pool.

Wetlands provide a number of ecosystem services that benefit humans. Wetlands help to control floods and erosion, trap sediments, remove excess nutrients, recharge and discharge groundwater, purify water, process chemical and organic waste, and a variety of other functions (Mitsch and Gosselink, 2007). Wetlands serve as important conduits for the movement of material, energy, flora and fauna across landscapes. They provide habitat for nearly 5,000 species of plants, one-third of all species of birds (including all species of ducks and geese), and 190 species of amphibians in the U.S. (NRCS, 1996). Riparian and wetland habitats are limited throughout the arid and semi-arid areas of the western U.S. The wildlife inhabiting wetlands in the semi-arid and arid west depend on wetlands for one or more critical stages in their life cycle; habitat abundance and quality is often the limiting factor to these wildlife populations. Wetlands also support a large number of rare species of plants and animals. Approximately a third of threatened and endangered plant species in the U.S. inhabit wetlands, and half of the threatened and endangered animal species are wetland dependent (Niering, 1988).

3.9.2 Wetlands Status and Trends

Estimates of the total wetland acres that existed within the coal-producing regions pre-settlement, compared to the acres in existence today, vary by source. Estimates of the original extent of wetlands in the U.S. range between 211 to 221 million acres (Dahl, 1990). Nevertheless, the number and acreage of wetlands has historically been on the decline over the last 200 years as a result of human activities. A large portion of that decline began with the passage of the Swamp Lands Act of 1850. Approximately 45 million acres of wetland loss is attributed to this legislation (National Research Council, 1995). The Swamp Lands Act enabled states to take possession of wetlands and begin draining them so they could be farmed. The trend of wetland loss continued unhampered until the 1970s with the passage of the 1972 Federal Water Pollution Control Amendments, which was then amended with the passage of the CWA in 1977. The CWA includes Section 404, designed to regulate the discharge of dredged and fill material into waters of the U.S., including wetlands. In 1986, Congress enacted the Emergency Wetlands Resources Act, recognizing that wetlands are nationally important resources and requiring the U.S. FWS to update wetland status of the U.S. every ten years. In 1988, under the administration of President George H.W. Bush, the wetland "No Net Loss Policy" was established, further slowing the rate of wetland loss. This policy continued under the administration of Presidents William Clinton, George W. Bush, and Barack Obama. As of 2009, the lower 48 states contained an estimated 110.1 million acres of wetlands (Dahl, 2011). The U.S. EPA is scheduled to release its initial National Wetland Condition Assessment, which is designed to provide regional and national estimates of wetland ecological integrity and rank the stressors most commonly associated with poor wetland conditions. At least 22 states have lost at least 50 percent of their original wetlands, mainly located in the East and Midwest (Mitsch and Gosselink, 2007; Dahl, 2006).

Despite regulations and a positive trend of wetland acreage, wetlands are lost in the U.S. at an estimated rate of 290,000 acres per year (Dahl, 2006). Human activity is considered to be a major cause of wetland loss; other causes include natural threats and indirect causes such as erosion, subsidence, sea level rise, climate change, droughts, hurricanes, and other large storms (Dahl, 2011; North Carolina State University, 2006). The majority of the wetland loss occurring today is the loss of marine and estuarine wetlands, which is caused by coastal erosion. Freshwater wetlands loss is mainly caused by urban and rural development (Dahl, 2006). The acreage of wetlands loss due specifically to coal mining impacts was not available, although peat mining (where occurring) is a cause of freshwater wetlands loss and is restricted to a few areas of the country.

3.9.3 Location of Wetlands

Wetlands are found in nearly every county in the United States (U.S. EPA, 2004b) and are found within all of the coal-producing regions. Wetlands can be created (and have been created) both intentionally and unintentionally by ground disturbance, including during surface and underground coal mining. Wetlands can also be created at the surface over underground mines (mainly longwall mines) due to planned subsidence, and during reclamation of surface activities. Wetlands are typically located at the interface of a body of water (such as an ocean, a lake, pond, or a stream) and land but are also found in other portions of the landscape remote from waterbodies. These isolated wetlands do not contain outlets; they are the result of groundwater at or near the soil surface or in topographically low areas where enough water collects to create saturated (hydric) soils and support a wetland plant community (Mitsch and Gosselink, 2007; Leibowitz, 2003; Whigham and Jordan, 2003).

The U.S. FWS maintains maps of the nation's wetlands. The National Wetland Inventory (NWI) Program (U.S. FWS, 2013a) produces maps and a digital database of the location, size, and status of wetlands. In addition the NWI provides the wetland cover type according to "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin et al., 1979). This classification system often is referred to as the "Cowardin Classification System," and is based on vegetation, soils, and frequency of flooding. Open water areas such as ponds and streams are also classified as wetlands under this system and are included on NWI maps.

Wetlands are mapped and classified for the NWI through aerial interpretation and limited field verification. Attempts are made to update and increase the accuracy of the mapping at a rate of one to two percent of the U.S. per year. Throughout its history, most of the NWI mapping was performed through a multi-stage process, starting from aerial photography. As GIS and mapping technology advanced, the process of data collection and map production became a single step done on-screen by the image analysts. These analysts delineated wetlands; other data were then simultaneously entered into a digital data layer that could be used to generate maps at various scales using GIS technology. Today, all of the NWI data are created through this on-screen process (Tiner, 2009). The reliance placed on the NWI and its resulting effort has provided a valid, consistent source of the location and size of wetlands within all of the coal regions. The tables within Appendix H summarize the general wetland cover types and percent acreage of each cover type, organized by coal-producing regions covered in this discussion. Data from U.S. FWS were used to calculate these estimations; however due to incomplete data sets, some regions in this Appendix H are also incomplete. These data were last updated on October 29, 2013. In the creation of these regional tables, the wetlands were sized by state based on the area that resides within the basin boundary. These sized state areas were merged together to define wetlands for the entire coal basin boundary. These areas were calculated in square meters, and then converted to acres in ArcMap for each wetland polygon within the boundary. The data was then converted to tabular form and consolidated by class, and statistics were generated for area calculations.

3.9.3.1 Appalachian Basin Region

The Appalachian Basin is characterized by mountains with steep slopes that contain high gradient streams. Wide river valleys wind around the base of the mountains, and the majority of the wetlands in this region are located in these river valleys. Large wetlands are commonly found on floodplains along rivers and perennial streams (i.e., riparian wetlands). Large wetland complexes consisting of a variety of habitats can be found in the floodplains within large river systems such as the Ohio River. Headwater streams found on the steep slopes are high-gradient with a small floodplain, typically located with a scoured channel; wetlands are typically absent next to these streams. Instead of being associated with a stream channel in these upper headwater regions, wetlands are found in depressional areas at the top of mountains and along the slopes (U.S. EPA, 2005). These wetlands are often isolated and therefore are not afforded protection under the CWA.

NWI data indicates there are approximately 727,000 acres of wetlands within the coal-producing areas of the Appalachian Basin (see Appendix H). In total, only two percent of the land area of the Basin is identified as wetland. This region has experienced wetland loss due to rural development.

3.9.3.2 Colorado Plateau Region

The Colorado Plateau coal-bearing region is located in the arid western U.S. The dry climate limits wetland development. As a result, wetlands comprise less than two percent of the region (USGS, 1996). The wetlands that do exist in this region are mainly found in association with streams, ponds, lakes, and rivers. The majority of the wetlands within this region, not including open water areas, are emergent riparian wetlands, oxbow lakes, marshes, cienegas, and bosques (USGS, 1996). The hydrology supporting these wetland communities is based on yearly snowmelt and late summer thunderstorms. They are typically found in higher elevations and have a richer diversity of plant species than the adjacent uplands. Studies in Colorado have found that more than 70 percent of Colorado's wildlife species (including fish, crustaceans, spiders and insects, and 27 percent of the state's breeding birds) use wetlands (Rocchio, 2005a). Big game species such as deer, moose, and elk seek out wetlands for lush and nutritious grasses.

Other wetlands are seasonal and can be dry for more than one year at a time. Often these wetlands are playas (USGS, 1996). Playas are typically shallow depressions within the desert basins or abandoned stream channels that are occasionally wet due to stream flow or shallow ground water. These are wetlands heavily influenced by snowmelt and heavy precipitation events. This, along with the salinity of the soil, has a strong influence on the plant community and plant coverage (Rocchio, 2005b). These wetlands are known to support threatened and endangered species, including many endemic species (USGS, 1996).

There are only 70,000 acres of wetlands within this 11.3 million-acre coal region, constituting less than 1 percent of the land area (see Appendix H). Of these wetland acres, over 80 percent (or 57,000 acres) would qualify as open water habitat.

3.9.3.3 Gulf Coast Region

The majority of the wetlands located within the Gulf Coast lignite and bituminous coal-bearing region are in the Mississippi River basin. Wetlands occupy more than 13 percent of Mississippi, and freshwater forested wetlands comprise the majority of wetlands within the state of Louisiana. Bottom-land forests, swamps, and freshwater marshes within floodplain areas of rivers account for most of Mississippi's wetland acreage (USGS, 1996). In addition, the majority of all the wetlands found in the state of Texas are located in the eastern, coal-bearing portion of the state. These wetlands are also forested wetlands, occurring within the floodplains and bottomlands of rivers (USGS, 1996).

Forested wetlands account for over 2.3 million acres within the coal-bearing portions of this region and comprise over 66 percent of all wetlands. Open water habitat such as lakes, ponds and rivers compose about 29 percent of the regions wetlands (see Appendix H). The wetlands in this region are important to wildlife, especially migrating and overwintering birds. They are also vital to the local economies.

3.9.3.4 Illinois Basin Region

The major land use in the Illinois Basin is agriculture. This portion of the country converted a large percentage of its wetland to farmland in the late 1800s and early 1900s (Dahl, 2006; USGS, 1996). Illinois has lost an estimated 90 percent of its wetlands (USGS, 1996). NWI data estimates 1,322,542 acres remain. More than 57 percent of the natural wetlands in Illinois are found within the larger river basins in the southern portion of the state (Illinois Department of Natural Resources, 2013). The southwestern portion of Indiana and western Kentucky experienced similar wetlands losses and contain similar wetlands habitat. In total, only 4 percent of the coal-producing land area is identified as wetland. Despite these losses wetlands continue to be important habitats for many species here as in other regions. The Illinois Department of Natural Resources for example recognized that 49 of the 59 mammal species in Illinois use wetlands to some extent during their life cycle, that 37 of the 41 amphibian species in Illinois depend upon wetlands at last part of the year, and that approximately 105 bird species depend upon, or are strongly associated with, Illinois wetlands (Illinois DNR, 2015).

3.9.3.5 Northern Rocky Mountains and Great Plains Region

According to the NWI database (with incomplete datasets from CO, MT, and UT) wetlands comprise 2.89 percent of the Northern Rocky Mountains and Great Plains region's 43,069,200 potential coal-producing acres. However, the prairie pothole region within the Great Plains portion of the region (including northeastern Montana and much of North Dakota) was once the greatest expanse of grasslands and small wetlands on earth (U.S. FWS, 2009). Formed by glaciers, prairie potholes are characterized by shallow depressions, generally round in shape, which support emergent vegetation. In fact, according to the NWI dataset there are more than 542,000 acres of emergent wetland within this coal region (see Appendix H). Many of these wetlands do not have inlets or outlets and are fed by runoff from the surrounding area or have a limited connection with groundwater (Savage, 2004). Sometimes the water in the potholes will evaporate in the summer. The wet-and-dry cycles are characteristic of the hydrology of the potholes and are essential to maintaining the wetland plant communities (Mitsch and Gosselink, 2007). In addition, evaporation can concentrate salts in the water, making some potholes as salty as the sea (Savage, 2004).

The prairie pothole region located throughout the central portion of North America serves as the primary breeding grounds for waterfowl (Mitsch and Gosselink, 2007). In 2010, the U.S. FWS reported an estimated 1.9 million breeding pairs of waterfowl in Montana and the Dakotas. Their annual waterfowl breeding and habitat survey noted a decline in habitat conditions due to a number of years of low precipitation (Zimpfer et al., 2010). During dry years, water impoundments used for coal mining, livestock, and bentonite clay production in this region have served as alternative breeding habitat for waterfowl and as habitat for shorebirds (Uresk and Severson, 1988).

Wetlands located in the portions of Wyoming and Colorado that are a part of this coal-producing region are similar in characteristics to the prairie potholes of the Dakotas and Montana. The lower elevations contain short grass prairies, and northeastern Wyoming contains the highest density of breeding waterfowl. There are areas containing sage brush steppe and coniferous forested wetlands, depending on the elevation (Copeland et al., 2010). The climate is more arid and many of the emergent wetlands are considered playas.

NWI data indicates there are approximately 1,244,000 acres of wetlands within the coal-producing areas of this coal-producing region (see Appendix H). In total, only three percent of the land area of the Basin is identified as wetland.

3.9.3.6 Northwest Region

The Northwest coal-bearing region includes Alaska, the state of Washington and small areas within Oregon. For the purposes of this DEIS, only mining in the state of Alaska is being considered (see Section 3.0 for rationale). Wetlands are created by permafrost, glacial melt water, snow melt, beavers, springs, and tides. Permafrost is a frozen layer of soil substrate that is present throughout the year. The frozen layer traps water near the soil surface. The tundra wetlands located in northern Alaska are the breeding grounds for many species of shorebirds, ducks, geese, and swans. The majority of the wetland habitat present in this area is freshwater scrub/shrub. Coastal estuarine wetlands are also common (Hall et al., 1994).

Extensive lowlands and peatlands support stunted white and black spruce woodland, low scrub of ericaceous shrubs and willow, and a variety of sedge and grass meadows. Some of the major mammal species of the area that use wetlands are moose, brown bear, black bear, wolf, coyote, fox, beaver, and lynx. Tundra swans, Canada geese, sandhill cranes, and a wide variety of ducks use area wetlands and lakes for nesting and as stop over sites during migration.

While 43 percent of the entire state of Alaska is wetland, the coal-bearing parts of the state are only about 13 percent (or approximately 159,000 acres) wetland according to the incomplete NWI dataset.

3.9.3.7 Western Interior Region

The Western Interior coal-bearing region is located in the heart of the Midwest and has a diversity of wetland habitats. These include prairie potholes, bottomland hardwood forested wetlands, shrub/scrub wetlands, emergent marshes, wet meadows, fens, and riparian wetlands. These wetlands provide habitat for migrating waterfowl and passerine birds along the central flyway. According to NWI data, there are 1,663,272 acres of wetlands, constituting about four percent of the land area. Of these wetland acres, about 50 percent (or 825,648 acres) are open water habitat (see Appendix H).

Agriculture is the primary land use in this region and has been for the last 200 years. As a result, more than five million acres of wetland were authorized to be drained in the states comprising the Western Interior coal-bearing region. The dramatic loss of wetland in the Midwest has made it a focal area for restoration programs, such as the USDA NRCS Wetland Reserve Program (WRP).

3.10 RECREATION

3.10.1 Introduction

This section provides an overview of the type, capacity, demand, and quality of experience associated with existing and proposed recreational facilities in the coal-producing regions. A limited amount of information is also included on economic contributions of recreational facility usage. For further discussion of socioeconomic conditions in the coal-producing regions, refer to Section 3.14.

Resident and non-resident tourists travel to various outdoor recreational sites throughout the coal-producing regions for outdoor recreation. Tourists are drawn to the many visual, cultural, and natural amenities found throughout the coal-producing regions. A variety of both public and private sector facilities are available to meet the Nation's recreational demand. For purposes of this document, information provided is focused on public sector recreational facilities but does not include specific information on: (1) public recreational facilities provided by the county or municipal levels of government; or (2) private sector recreational facilities. While local government and private facilities provide significant recreational opportunities to the public, few systematic data sources exist to characterize these resources. In accordance with 40 CFR 1502.22, this DEIS notes that such information is not included, and that the absence of quantified information on these types of recreational facilities is not essential to making a reasoned choice among the Alternatives being considered.

Recreation in active coal mining areas is largely precluded during mining and for a period of time after mine closure due to sensitivity of reclamation. For instance hunting is precluded on active mines due to safety, and may be altered elsewhere in the vicinity of mining due to human activity and noise. However, approved postmining lakes may specify water-based recreation opportunities. Designation of individual compatible recreational uses is often left up to the state land management agencies.

For the Nation at large, public lands managed by federal and state agencies are perhaps the most extensive resource available for recreational amenities. Federal lands managed by the National Park Service (NPS), USFS, and BLM provide the opportunity for visitors to participate in a variety of outdoor recreational activities such as auto touring, biking, boating, camping, climbing, fishing, hiking, horseback riding, hunting, snow skiing, swimming, and wildlife viewing.

The NPS manages some 84 million acres of land comprising 393 national parks, 2,461 national historic landmarks, 582 national natural landmarks, and 40 national heritage areas (NPS, 2013a). During 2010, the NPS recorded slightly over 281.3 million recreational visits to NPS-managed facilities (NPS, 2011). Visitation data specific to each of the coal-producing states is provided in

Appendix I, Table I-1. In FY 2010, the USFS managed 17,906 recreational sites at 155 national forests and 20 national grasslands. Total area under management was slightly less than 193 million acres. In FY 2007, the USFS properties had approximately 192 million visitors (USFS, 2011). In 2009, the BLM managed slightly less than 250 million acres of land and recorded approximately 57.4 million recreational use visits (U.S. BLM, 2010b).

State agencies also provide significant recreational opportunities. Visitors to state park and recreation areas participate in many of the same activities provided at federal parks and recreational areas. In 2007, over 7.2 million acres of state park land was under management in the 25 coal-producing states, while 2007 state park visitations for the coal states varied from a low of 0.9 million in North Dakota to high of 49.7 million in Ohio. During that same period, revenue generated as a result of these park visits varied from a low of $1.4 million in Wyoming to a high of $55 million in Kentucky (U.S. Census Bureau, 2007). Visitation, acreage, and revenue data for each of the states in the study area is available in Appendix I, Table I-3.

Tourism revenue information was not available by county or as a subset of any state; therefore, the monetary value of tourism to a specific study area is not available. The economic importance of recreation tourism specific to each individual coal mining state is presented in Appendix I, Table I-2.

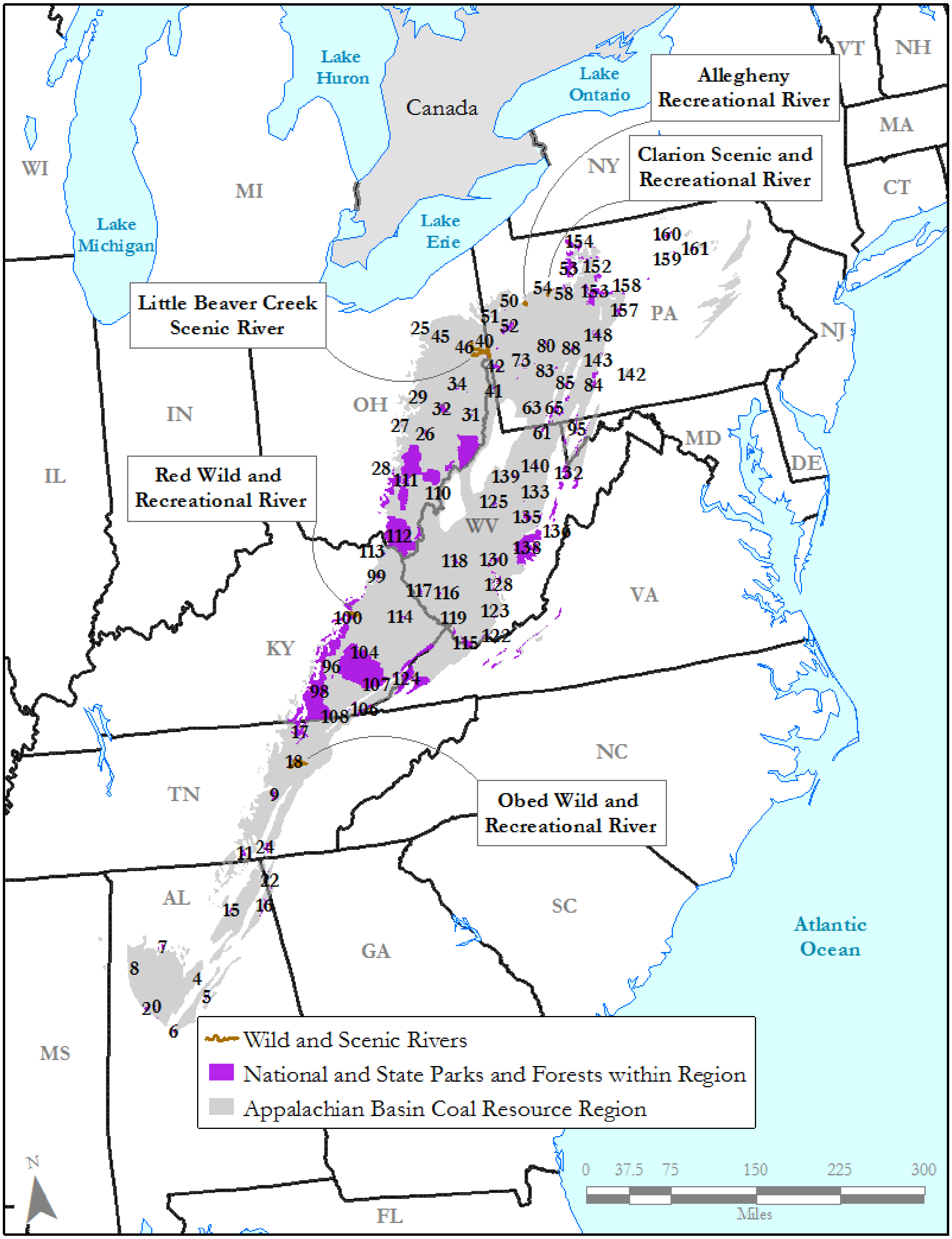
3.10.2 Appalachian Basin Region

The Appalachian Basin coal-producing region includes portions of the states of Pennsylvania, Ohio, West Virginia, Virginia, Kentucky, Maryland, Tennessee and Alabama. Within these populous eastern states, there are numerous recreational opportunities for both residents and visitors to the area. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodation-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists 2007 data for visitation, acreage, and revenue for state parks in the coal mining states.

Approximately 3.9 million acres of national forest lands fall within the boundaries of the Appalachian Basin coal-producing region. Table I-4 in Appendix I provides information on the national forests in this region. Fifteen NPS-managed facilities encompassing an estimated 243,000 acres are located within the Appalachian Basin coal-producing region. Park-specific information is displayed in Table I-5 of Appendix I.

A review of Table I-6 in Appendix I shows that 141 state-managed recreational facilities are located within this coal-producing region, totaling approximately 497,000 acres. Figure 3.10-1 locates the designated wild and scenic rivers in this region and shows where areas of the region overlap national and state parks and forests. Each national or state park or forest in Figure 3.10-1 has been assigned a number for labeling purposes, all of which are identified in Tables I-4, I-5 and I-6 of Appendix I. Table I-7 in Appendix I provides information on each of the identified wild and scenic rivers located within the Appalachian Basin coal-producing region.

Figure 3.10-1 Appalachian Basin Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

U.S. FWS conducts a survey every five years to evaluate the popularity of hunting, fishing, and wildlife watching in each state (U.S. FWS, 2011c). The 2011 survey reported fishing expenditures totaling 41.8 billion nationwide, and hunting expenditures totaling $another 33.7 billion. As illustrated by the 2011 data, the Appalachian Basin region provides ample opportunity for fishing, hunting, and wildlife-watching activities. In almost every state of the Appalachian Basin, wildlife-watching is the preferred activity of the three, followed by fishing, then hunting. Data for these three activities in the Appalachian Basin states, in addition to national totals, is provided in Table I-8 of Appendix I.

The following subsections provide state-specific information on recreational resources in the Appalachian Basin.

3.10.2.1 Alabama Tourism and Recreation

The Alabama portion of the Appalachian Basin coal-producing region is located in the tourism region that the Official Alabama Vacation Guide (Alabama Tourism Department, 2013) designates as the Alabama Mountains Region, located in the northern third of the state. The Tennessee River winds through the Appalachian Mountain foothills in this region creating a prime destination for outdoor recreation. Major tourism and recreational opportunities in the region include the Little River Canyon National Preserve and Russell Cave National Monument, along with plentiful boating, fishing, hiking, and golfing opportunities. The region is home to the William B. Bankhead National Forest, the state's largest national forest and wilderness area, with 181,000 acres of deep canyons, towering cliffs, and hidden waterfalls. The region includes six state parks including Buck's Pocket, Rickwood Caverns, DeSoto, Lake Guntersville, Lake Lurleen and Oak Mountain. Alabama is one of the premier states in the nation for hunting white-tailed deer and eastern wild turkey.

3.10.2.2 Kentucky Tourism and Recreation

The Kentucky portion of the Appalachian Basin coal-producing region is located in the tourism region designated by the Kentucky Official Visitor's Guide (Kentucky Department of Travel (DT), 2011) as the Eastern Region; the Eastern Region includes the Kentucky Appalachians and Daniel Boone sub-regions. Tourism and recreational activities in this area relate to the natural scenic beauty of the Appalachian Mountains. A significant attraction is the Daniel Boone National Forest, which includes the Red River Gorge.

The Red River Gorge is a unique landscape containing unusual flora and surrounded by more than 80 natural arches sculpted by wind and water over 70 million years. The Red River is Kentucky's only National Wild and Scenic River. Another significant attraction in the Eastern Region is the Cumberland Gap National Historic Park. This 24,000-acre area of wilderness is the largest National Historic Park in the country. The region also boasts fourteen state recreational and resort parks including Cumberland Falls, Pine Mountain, Greenbo Lake, Grayson Lake, and Jenny Wiley, among others. Elk herds were reintroduced into the mountains of eastern Kentucky on reclaimed mine sites in the late 1990s, and have since grown to nearly 10,000 animals. There are now more elk in Kentucky than anywhere else east of the Rocky

Mountains. Recreational activities in this region of Kentucky include biking, hiking, camping, golfing, skiing, boating, hunting, fishing, horseback riding, rock climbing, and wildlife watching (e.g., bald eagles and elk).

3.10.2.3 Maryland Tourism and Recreation

The Maryland portion of the Appalachian Basin coal-producing region lies in the Western Maryland tourism region as designated by the Destination Maryland (Maryland Office of Tourism, 2013) travel guide. Western Maryland represents the mountainous side of Maryland and offers rapidly flowing rivers with white-water rafting opportunities and rugged mountain trails for year-round adventure. Deep Creek Lake is Maryland's largest body of fresh water, providing fishing, swimming, and boating activities. Rock-climbing, kayaking, rafting, hiking, and cross country skiing are other popular outdoor activities. State parks in the Maryland coal fields include Swallow Falls, Savage River, Dans Mountain, and Deep Creek Lake.

3.10.2.4 Ohio Tourism and Recreation

The Ohio portion of the Appalachian Basin coal-producing region is located in the tourism regions designated by the Ohio Official State Travel Planner (Ohio Division of Tourism, 2011) as the Southeast and Northeast Regions. The Northeast Region includes the 33,000-acre Cuyahoga Valley National Park and First Ladies National Historic Site, along with at least ten state parks and four state forests. The Southeast Region is recognized for outdoor adventures in places like Hocking Hills State Park, which features towering cliffs, waterfalls, and deep gorges. The Southeast Region offers at least 21 state parks and 12 state forests. Wayne National Forest, Ohio's only national forest, has more than 300 miles of trails available for recreational usage. The Southeast Region is also home to the 34,000-acre reclamation project known as Recreation Land. This area was constructed by American Electric Power on former strip mined land, and involved the planting of more than 63 million trees and the establishment of more than 350 lakes and ponds, thus returning the former mine lands into a public recreation area.

3.10.2.5 Pennsylvania Tourism and Recreation

The Pennsylvania portion of the Appalachian Basin coal-producing region is located in the tourism regions designated by VisitPA.com website as the Laurel Highlands; Pittsburgh and Its Countryside; and the Pennsylvania Wilds (Pennsylvania Department of Community and Economic Development (PA DCED), 2013). Recreational opportunities include biking, boating, camping, caving, ATV trails, fishing, golfing, hiking, hunting, snow skiing, whitewater rafting, wildlife viewing, and state park and state forest visitation. The Laurel Highlands Region includes nine state parks and/or forests. The 68-mile Laurel Highlands Scenic Byway leads to the 90-mile Historic National Road that passes by the Fort Necessity National Battlefield and other points of interest. The Pittsburgh Countryside Region is home to five state parks including Moraine State Park with over 16,000 acres of public lands. The western part of the Pennsylvania Wilds is situated within the coal fields and offers forests and mountains that are well suited for fishing, hiking, kayaking, and other outdoor activities. The Pennsylvania Wilds includes several state parks along with the Allegheny National Forest.

3.10.2.6 Tennessee Tourism and Recreation

The Tennessee portion of the Appalachian Basin coal-producing region falls mostly within the tourism regions designated by the tnvacation.com website as the Knoxville and Middle East; and the Chattanooga and Southeast (Tennessee Department of Tourist Development (DTD), 2013). Recreational opportunities include biking, boating, camping, ATV trails, fishing, golfing, hiking, hunting, wildlife viewing, and state park visitation. Several state parks lie within this region including Fall Creek Falls, Cumberland Mountain, Frozen Head, Cove Lake, Indian Mountain, and Pickett State Park. Fall Creek Falls State Resort Park "is one of the most scenic and spectacular outdoor recreation areas in America" (Tennessee Department of Environmental Conservation (DEC), 2013).

3.10.2.7 Virginia Tourism and Recreation

The Virginia portion of the Appalachian Basin coal-producing region falls within the tourism region designated by the Virginia Travel Guide (Virginia Tourism Corporation, 2013) as the Heart of Appalachia Region. Natural wonders abound throughout the region and include the deep gorges at Breaks Interstate Park and Cumberland Gap National Historic Park. Cumberland Gap National Historic Park, located along the borders of Kentucky, Virginia and Tennessee, stretches for 26 miles along the Cumberland Mountain and contains over 24,000 acres of wilderness and recreational area. The area's past coal mining history plays a significant role in the tourism opportunities in the region, evidenced by the Southwest Virginia Museum Historical State Park and Virginia's Coal Heritage Trail.

3.10.2.8 West Virginia Tourism and Recreation

The West Virginia portion of the Appalachian Basin coal-producing region includes the tourism regions designated by the West Virginia Official State Travel Guide (West Virginia Department of Commerce, 2013) as the New River-Greenbrier Valley, Mountaineer Country, Northern Panhandle, Mountain Lakes, Metro Valley, Mid-Ohio Valley, and a portion of the Potomac Highlands. Most of West Virginia falls within the Appalachian Basin coal-producing region, with the exception of the Eastern Panhandle and part of the Potomac Highlands. West Virginia offers some of the Nation's best whitewater rafting, extensive trail systems, snow skiing, hunting, fishing, boating, camping, and other recreational opportunities. Major tourism and recreational attractions in the area include over 180,000 acres in state parks and state forests; the Hatfield-McCoy Trail System; the 300-mile Appalachian Trail; Monongahela National Forest; and Gauley River National Recreation Area and New River Gorge National River. Coal heritage also plays a prominent role in tourism in the state with attractions such as the National Coal Heritage Trail.

3.10.3 Colorado Plateau Region

The Colorado Plateau coal-producing region includes portions of the states of Colorado, New Mexico, Arizona, and Utah. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry; food service and accommodations-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists the 2007 data for visitation, acreage, and revenue generated by state parks for Colorado Plateau coal mining states.

Approximately 3.9 million acres of national forest lands fall within the boundaries of the Colorado Plateau coal-producing region. Table I-9 in Appendix I provides information on the national forests in this region. The USFS-managed Pecos Wild and Scenic River, the only designated wild and scenic river in this region, is located in New Mexico's Santa Fe National Forest (USFS, 2013). Ten NPS-managed facilities, encompassing 1,811,000 acres, are located within the boundaries of the Colorado Plateau coal-producing region. Park-specific information is displayed in Table I-10 of Appendix I. A review of Table I-11 in Appendix I shows that 13 state-managed recreational facilities are located within this coal-producing region, totaling approximately 46,000 acres. Figure 3.10-2 locates the only designated wild and scenic river in this region and depicts where the region overlaps national and state parks and forests. Each national or state park or forest in Figure 3.10-2 has been assigned a number for labeling purposes, all of which are identified in Tables I-9, I-10 and I-11 of Appendix I.

Relevant data from the U.S. FWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-12 of Appendix I. The table includes total expenditure data by state. The survey identifies Colorado as an especially popular destination for outdoor recreation, with the highest numbers of hunters, anglers, and wildlife-watchers among the states in the Colorado Plateau region.

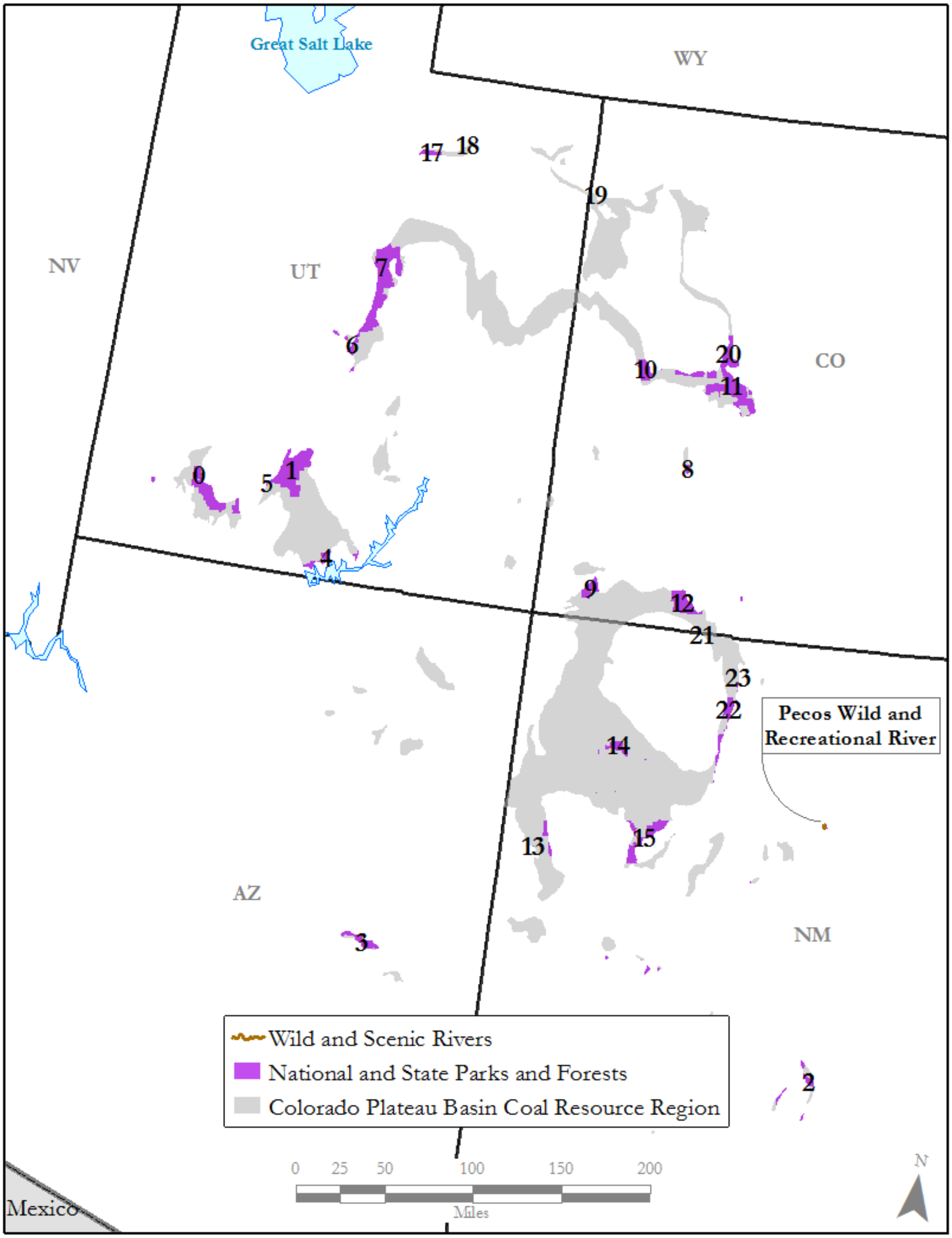
3.10.3.1 Arizona Tourism and Recreation

The area of Arizona that includes the coal-producing region lies in the northern third of the state. This area includes the Navajo Tribal Area near Lake Powell and the surrounding Glen Canyon National Recreation Area. Seven national parks, seven national monuments, and many state parks, historical sites, ghost towns, prehistoric native ruins and sculpted mesa, buttes and geologic wonders surround Lake Powell.

3.10.3.2 Colorado Tourism and Recreation

The portion of Colorado that lies in the Colorado Plateau coal-producing region is designated by the Colorado Official State Travel Guide (Colorado Tourism Office, 2013) as the Northwest and Southwest tourism regions. The Colorado River passes through the Northwest region, creating epic gorges and defining the landscape of the region. The region is best known for legendary ski resorts such as Aspen, Steamboat Springs, and Vail. The Southwest Region boasts colorful terrain, including the San Juan Mountains, Crested Butte, and Mesa Verde National Park. In addition to skiing, these regions offer whitewater rafting, hiking, mountain biking, fly fishing, hunting, wildlife viewing, and various other recreational activities.

Figure 3.10-2 Colorado Plateau Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

3.10.3.3 New Mexico Tourism and Recreation

The coal-producing region in New Mexico lies in the areas designated by the New Mexico Vacation Guide (New Mexico TD, 2013) as the Central, North Central, and Northwest Regions. In the Central region, the Sandia Mountains rise to over 10,000 feet. Popular attractions in the Central Region include Petroglyph National Monument, Jemez State Monument, and the Turquoise Trail. The Northwest region is rich in "Indian Country" culture, history, and geologic wonders. Popular attractions in the region include Aztec Ruins National Monument, Bisti/De-Na-Zin wilderness Areas, El Malpais National Monument, and El Morro National Monument. The North Central region also includes abundant cultural and historical sites. The Sangre de Cristo Mountains offer rugged adventures, and the Enchanted Circle's alpine terrain provides golfing, fishing, horseback riding, and whitewater rafting on the Rio Grande. The Turquoise Trail National Scenic Byway provides 15,000 square miles of old mining towns and natural wonders.

3.10.3.4 Utah Tourism and Recreation

A majority of the coal-producing region in Utah lies in the south central and southeastern portions of the state, including the Wasatch Plateau, Kaiparowits Plateau, and Book Cliffs areas (Utah Geological Survey, 2013; Utah Office of Tourism, 2013). This area is known for high adventure, offering spectacular outdoor activities, including boating, fishing, camping, biking, and hiking. The Green River flows through the Book Cliffs region, providing blue ribbon trout fishing and exciting whitewater rafting. The Sevier River flows through the Wasatch and Kaiparowits Plateau areas. Major recreation attractions include Bryce Canyon National Recreation Area, Fishlake National Forest, Scofield State Park, Green River State Park, San Rafael Swell, and Escalante State Park.

3.10.4 Gulf Coast Region

The Gulf Coast coal-producing region includes portions of the states of Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Tennessee, and Texas. As discussed in Section 3.1, the vast majority of current coal (lignite) production, in the region occurs in Texas, with the remainder in Mississippi and Louisiana. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodations-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists the 2007 data for visitation, acreage, and revenue generated by state parks in the coal-mining states.

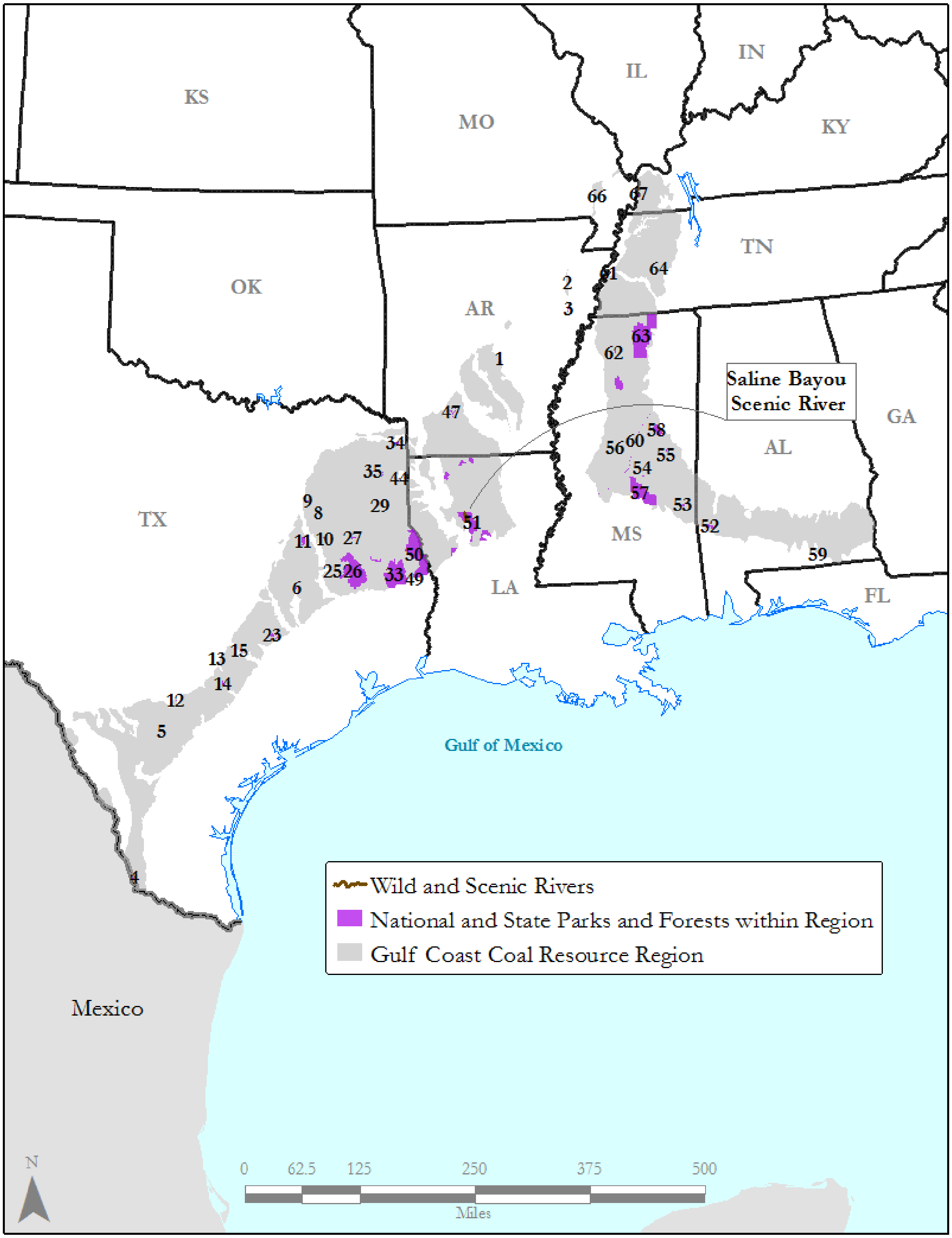
Approximately 4.4 million acres of national forest lands fall within the boundaries of the Gulf Coast coal-producing region. Table I-13 in Appendix I provides information on the national forests in this region. The USFS-managed Saline Bayou Wild and Scenic River, the only designated wild and scenic river in this region, is located in Louisiana's Kisatchie National Forest. Eight NPS-managed facilities encompassing 155,000 acres are located within the boundaries of the Gulf Coast coal-producing region. Park specific information is displayed in Table I-14 of Appendix I. A review of Table I-15 in Appendix I shows that 112 state-managed recreational facilities are located within this coal-producing region, totaling approximately

188,000 acres. Figure 3.10-3 locates the only designated wild and scenic river in this region and depicts where the coal-producing areas of the region overlap national and state parks and forests. Each national or state park or forest in Figure 3.10-3 has been assigned a number; the corresponding place names are identified in Tables I-13, I-14, and I-15 of Appendix I.

Relevant data from the U.S. FWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-16 of Appendix I. The table also includes total expenditure data by state. For the activities included in the 2006 survey, Texas had the most participants (7.9 million) while Mississippi had the least (1.6 million).

Although coal is present in all ten states in the Gulf Coast region, it is only mined in Gulf Coast areas of Texas, Louisiana, and Mississippi. For this reason, the following subsections focus on these three states.

Figure 3.10-3 Gulf Coast Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

3.10.4.1 Louisiana Tourism and Recreation

The Louisiana portion of the Gulf Coast coal-producing region is located in the tourism regions designated by the Louisiana Official Tour Guide (Louisiana DCRT, 2013) as the Sportsman's Paradise and Crossroads regions. The Sportsman's Paradise region covers the northern part of the state and offers a diversity of wildlife in the longleaf pine forests, sprawling meadows, marshes, and lakes. This region includes attractions such as Poverty Point National Monument, Kisatchie National Forest, and state parks such as Chicot, Lake Claiborne, Chemin-A-Haut, and South Toledo Bend. The Crossroads region encompasses the central part of Louisiana and is a haven for water sports, fishing, hunting, birding, and horseback riding. The Toledo Bend Reservoir is noted for its bass fishing, boating, and water sports.

3.10.4.2 Mississippi Tourism and Recreation

The Mississippi portion of the Gulf Coast coal-producing region intersects all five of the tourism regions defined in the Mississippi Official Tour Guide (Mississippi Development Authority, 2013) and covers most of the state except for the southern portion of the Coastal Region and the eastern portion of the Hills Region. Mississippi offers superb fishing (saltwater and freshwater), hunting, golfing, camping, horseback riding, and wildlife viewing. Major recreational attractions include the Mississippi River bordering the western edge of the state; Leroy Percy, Wall Doxey, Clarkco, Hugh White, and Roosevelt State Parks; and the Pearl River State Wildlife Management Area and Pearl River State Waterfowl Refuge. The Natchez Trace Parkway follows the frontier route from Natchez to Nashville offering natural trails, recreation areas, and historic sites along the way.

3.10.4.3 Texas Tourism and Recreation

The Gulf Coast coal-producing region in Texas stretches from the Mexico border northeasterly to the Arkansas border in the tourism regions designated as the South Texas Plains, Prairie and Lakes, and Piney Woods in the Texas Travel Guide (Texas OEDT, 2013). This region covers much of the eastern portion of Texas except for the coastal region. Recreational areas in this region include the Sabine National Forest, Angelina National Forest, Davy Crockett National Forest, and Sam Houston National Forest. Recreational opportunities abound through the 60 state parks located within the South Texas Plains, Prairie and Lakes, and Piney Woods tourism regions.

3.10.5 Illinois Basin Region

The Illinois Basin coal-producing region includes portions of the states of Illinois, Indiana, and western Kentucky. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodations-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists the 2007 data for visitation, acreage and revenue generated by state parks in coal mining states.

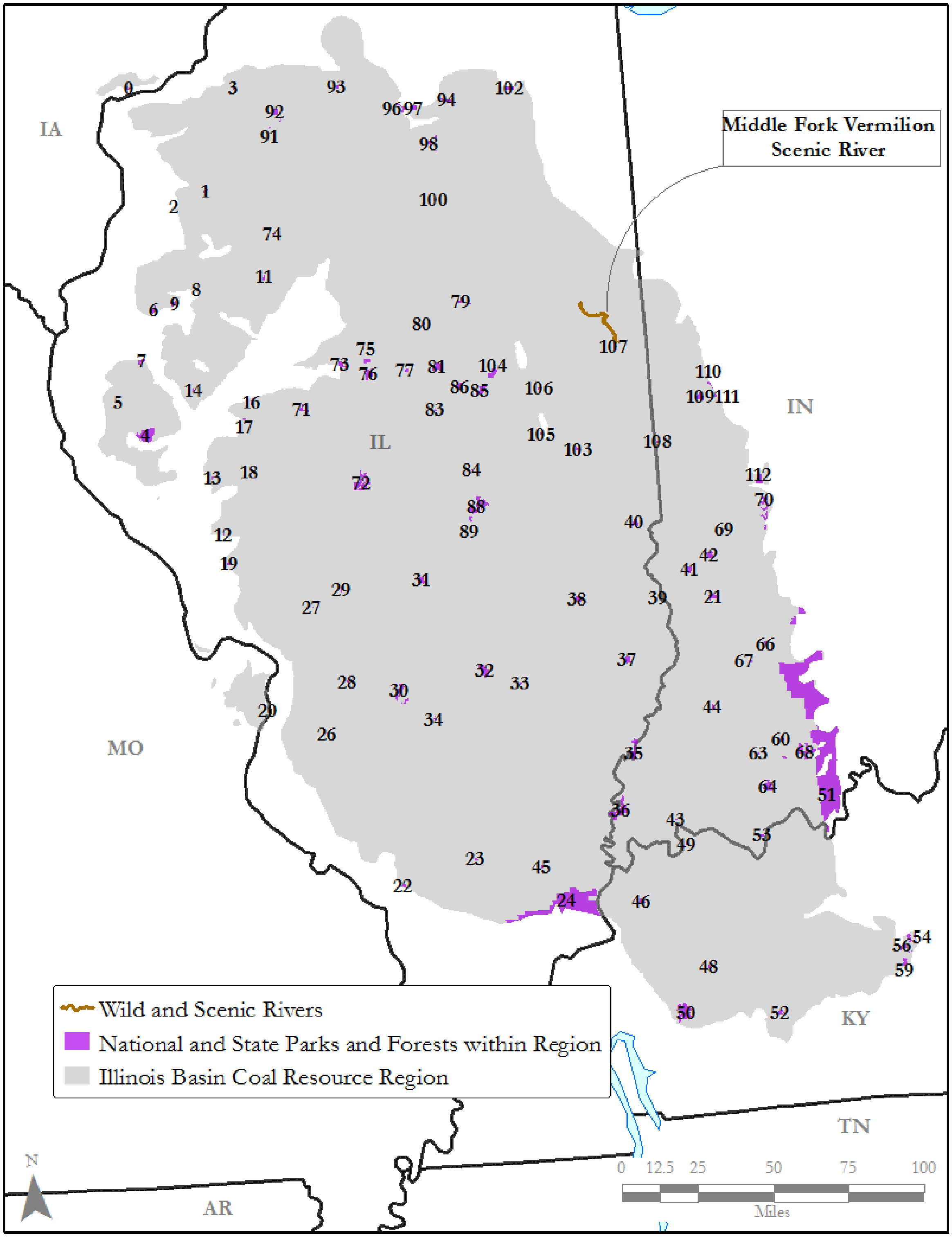
Approximately 686,000 acres of national forest lands fall within the boundaries of the Illinois Basin coal-producing region. Table I-17 in Appendix I provides information on the national forests in this region. The Middle Fork Vermilion Wild and Scenic River, the only designated wild and scenic river in this coal-producing region, is located in Illinois. Five NPS-managed facilities encompassing slightly more than 52,000 acres are located within the boundaries of the Illinois Basin coal-producing region. Park-specific information is displayed in Table I-18 of Appendix I. A review of Table I-19 in Appendix I shows that 56 state-managed recreational facilities are located within this coal-producing region, totaling approximately 84,000 acres. Figure 3.10-4 locates the only designated wild and scenic river in this region and depicts where the coal-producing region overlaps national and state parks and forests. Each national or state park or forest in Figure 3.10-4 has been assigned a number; the corresponding place names are identified in Tables I-17, I-18, and I-19 of Appendix I.

Relevant data from the FWS 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-20 of Appendix I. The table also includes total expenditure data by state. For the activities included in the 2006 survey, Illinois had the most participants (3.8 million) and Kentucky had the least (2.5 million).

3.10.5.1 Illinois Tourism and Recreation

The Illinois Basin coal-producing region covers much of the state with the exception of the northern quarter. The tourism areas within the coal-producing region, as designated by the Illinois Travel Guide (Illinois Office of Tourism, 2013), are Land of Lincoln (central-east), Great Rivers Country (west and southwest), and Trails to Adventure (southeast). The Southern region contains the expansive Shawnee National Forest, Ferne Clyffe State Park, and Giant City State Park, among other attractions. The Shawnee National Forest offers over 300 miles of hiking, biking, and equestrian trails. The Southwest region offers Jefferson National Expansion Memorial, Kaskaskia River Wildlife Area, and Pyramid State Park and Recreation Area at nearly 20,000 acres, the largest in Illinois, is made up almost entirely of formerly surface coal mined lands, as recreational opportunities. The Central region is home to Hazlet State Park, Ramsey Lake State Park, Stephen A. Forbes State Park, and Wayne Fitzgerrell State Park among several other recreation areas. The Western region is bounded on the west by the Mississippi River and on the east by the Illinois River. This region contains the Beaver Dam State Park and the Chautauqua National Wildlife Refuge.

Figure 3.10-4 Illinois Basin Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

3.10.5.2 Indiana Tourism and Recreation

The Indiana portion of the Illinois Basin coal-producing region includes the South and West tourism regions as designated by the Indiana Travel Guide (Indiana Office of Tourism Development (OTD), 2013). The South region offers boating, biking, camping, canoeing, caving, hiking, horseback riding, golfing, and water sports. The South region is bounded on the south by the Ohio River and includes Harmonie State Park, Angel Mounds State Memorial, Lincoln State Park, and the Hoosier National Forest among its recreational opportunities. The West region is home to Richard Lieber, Shades, Turkey Run, and Shakamak State Parks.

3.10.5.3 Kentucky Tourism and Recreation

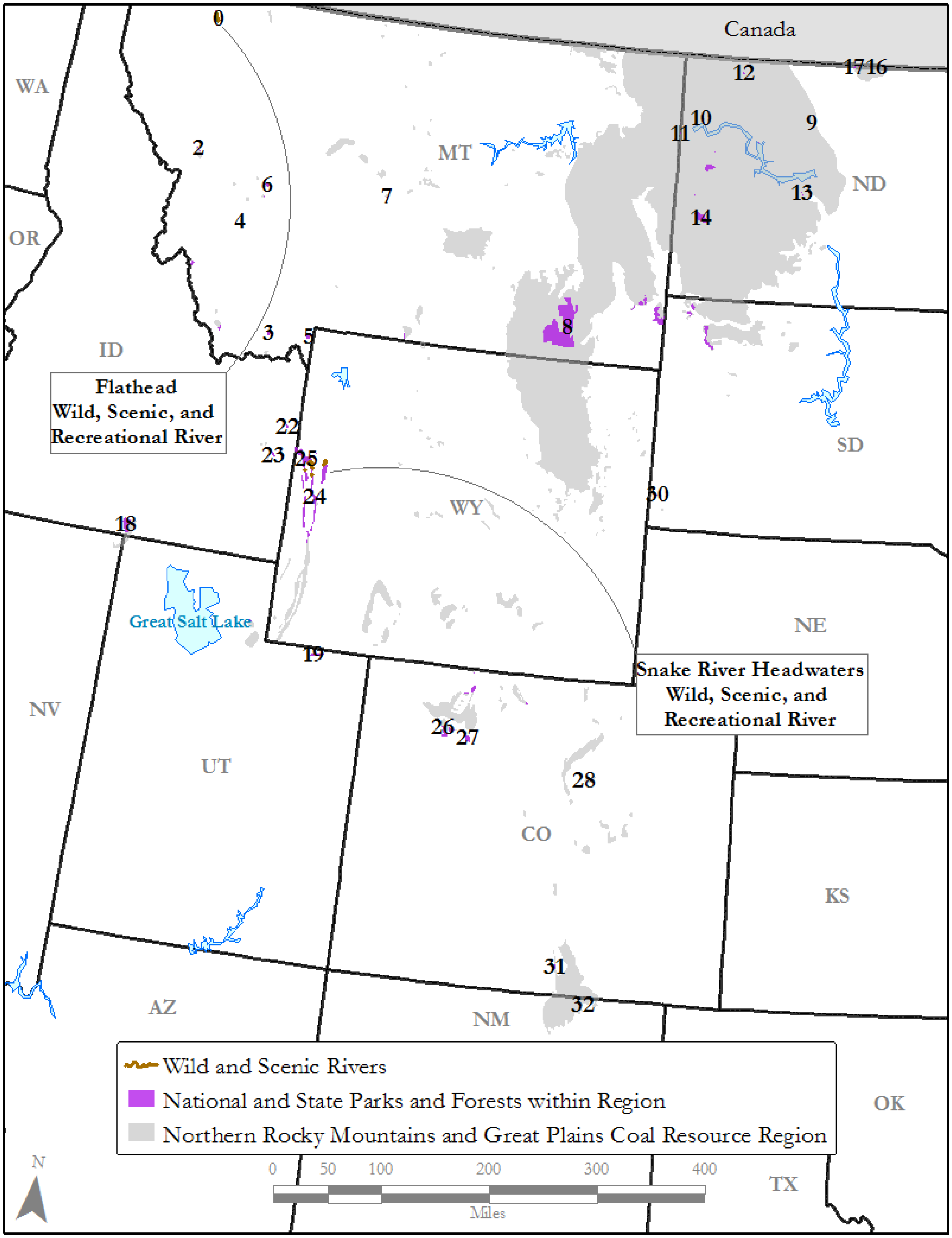
The Kentucky portion of the Illinois Basin coal-producing region is located in the tourism region designated by the Kentucky Official Visitor's Guide as the "Bluegrass Blues & BBQ Region" (Kentucky Department of Travel (DT), 2011). The area is bounded on the north by the Ohio River; the Green River splits the area, providing a source of recreational activities. Other outdoor recreational opportunities are available at Mammoth Cave National Park; several state parks (Pennyrile, John J. Audubon, Lake Malone, and Ben Hawes); and Sloughs Wildlife Management Area.

3.10.6 Northern Rocky Mountains and Great Plains Region

The Northern Rocky Mountains and Great Plains coal-producing region includes portions of the states of Colorado, Montana, North Dakota, Utah, and Wyoming. As discussed in Section 3.1, the vast majority of current coal production in the region occurs in Wyoming, with the remainder in Montana and North Dakota. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodations-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists the 2007 data for visitation, acreage, and revenue generated by state parks in coal mining states.

Approximately eight million acres of national forest lands fall within the boundaries of the Northern Rocky Mountains and Great Plains coal-producing region. Table I-21 in Appendix I provides information on the national forests in this region. Six national park managed facilities encompassing 3,577,000 acres are also located within the boundaries of this region. Park-specific information is displayed in Table I-22 of Appendix I. A review of Table I-23 in Appendix I shows that 41 state-managed recreational facilities are located within this coal-producing region, totaling approximately 101,000 acres. Figure 3.10-5 locates the designated wild and scenic rivers in this region and depicts where the coal-producing region overlaps national and state parks and forests. Each national or state park or forest in Figure 3.10-5 has been assigned a number; the corresponding place names are identified in Tables I – 21, I-22, and I-23 of Appendix I. Table I-24 in Appendix I provides information on each of the identified wild and scenic rivers located within the Northern Rocky Mountains and Great Plains coal-producing region.

Figure 3.10-5 Northern Rocky Mountains and Great Plains Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

Data from the U.S. FWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-25 of Appendix I. The table also includes total expenditure data by state. For the activities included in the 2006 survey, North Dakota had the most participants (5.4 million) within this region and Wyoming had the least (0.95 million).

Although coal is present in all five states included in the Northern Rocky Mountains and Great Plains coal-producing region, it is only mined in the states of Montana, North Dakota, and Wyoming. For this reason, the following discussions focus on these three states.

3.10.6.1 Montana Tourism and Recreation

The coal-producing region in Montana intersects the tourism regions designated by the 2011 Montana Travel Planner (Montana Office of Tourism (OT), 2013) as Southeast Montana, Missouri River Country (in the northeast), and Central Montana. Central Montana features many streams and lakes, and Lake Elwell offers excellent year-round fishing for walleye, northern pike, native trout, and more. Central Montana is also home to the Upper Missouri National Wild and Scenic River, Nez Perce National Historical Site, Ackley State Park, and Sluice Boxes State Park (Montana OT, 2013). Missouri River Country boasts Fort Peck Lake with over 1,500 miles of shoreline and excellent walleye, smallmouth bass, and Chinook salmon fishing. The surrounding Charles M. Russell National Wildlife Refuge is popular with anglers as well. Missouri River Country offers world class dinosaur fossil finds and is home to the Fort Belknap and Fort Peck Indian Reservations. Southeast Montana contains the Crow Indian and Northern Cheyenne Indian Reservations, Medicine Rocks, Pirogue Island, and Rosebud Battlefield State Parks, and the Custer National Forest. The Yellowstone River is the longest free-flowing river outside of Alaska.

3.10.6.2 North Dakota Tourism and Recreation

The Northern Rocky Mountains and Great Plains coal-producing region in North Dakota is located in the western third of the state. This region is home to the North Dakota Badlands, Theodore Roosevelt National Park, Little Missouri, Lake Sakakawea, and Sully Creek State Parks (NPS, 2013b; North Dakota Parks and Recreation Department (PRD), 2013). The west region offers hiking, biking, snowshoeing, cross country skiing, and horseback riding opportunities on its many trails. Fishing is available year-round, on both water and ice.

3.10.6.3 Wyoming Tourism and Recreation

The coal-producing region in Wyoming is spread throughout the state, although few reserves are located in the Southeast Wyoming. Northwest Wyoming is home to Yellowstone and Grand Teton National Parks. Northeast Wyoming is home to the Black Hills National Forest, Devil's Tower National Monument, and the Thunder Basin National Grassland. A major tourist attraction in the Southwest Wyoming is Flaming Gorge Reservoir and Flaming Gorge National Recreation Area (Wyoming OT, 2013).

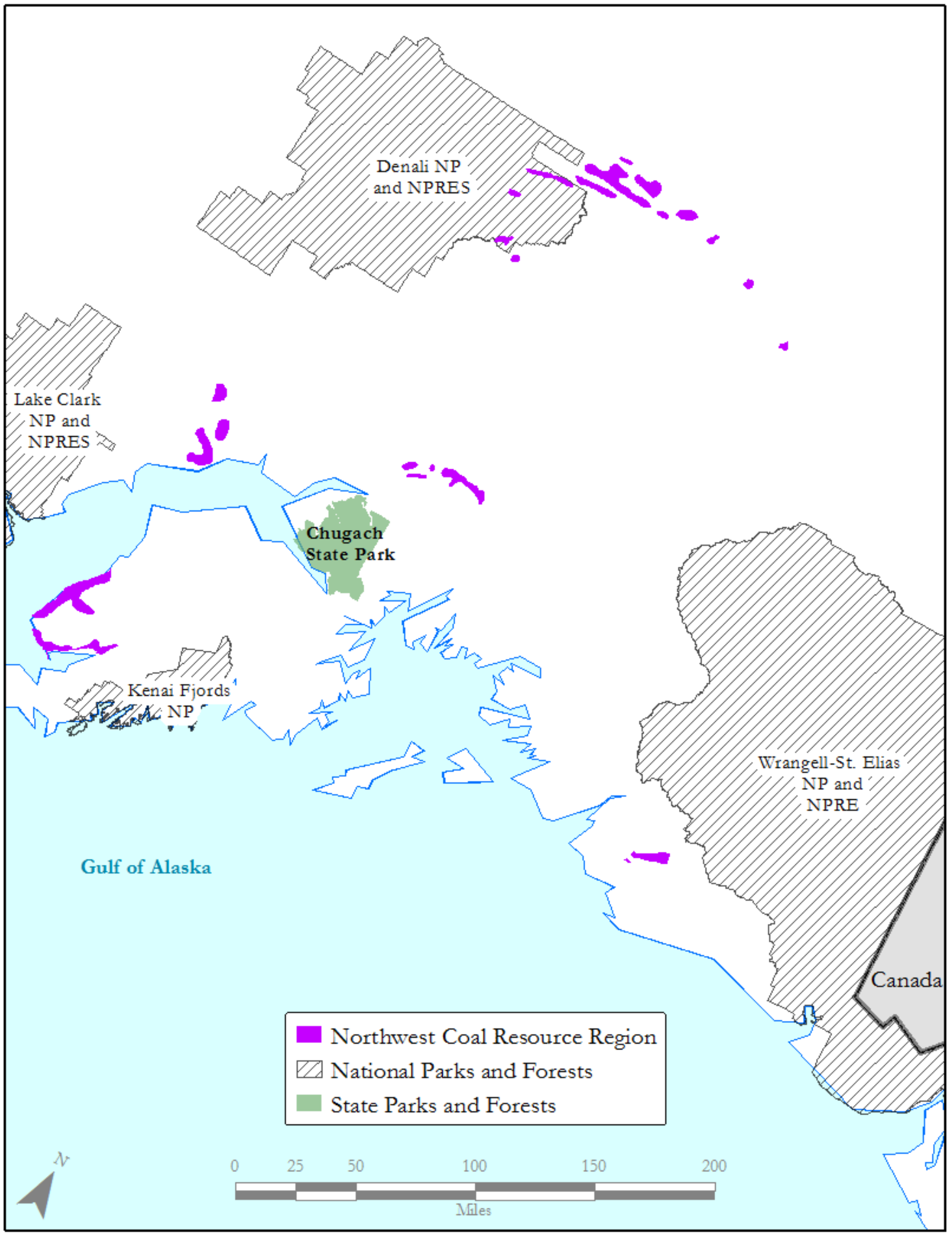
3.10.7 Northwest Region

The Northwest coal-producing region includes portions of the states of Alaska. Washington, and Oregon. Although coal is present in each of these states, the only reasonably foreseeable coal mining in the region is in the state of Alaska. For this reason, the following discussions focus only on Alaska. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodations-related jobs, payroll, and per capita expenditures for Alaska. Table I-3 in Appendix I lists the 2007 data for visitation, acreage, and revenue generated by Alaska state parks.

Approximately 562,000 acres of national forest lands fall within the boundaries of the Northwest (Alaska) coal-producing region. Table I-26 in Appendix I provides information on the national forests in this region. The Charley Wild and Scenic River is located in this region. Five NPS-managed facilities encompassing 16,400,000 acres are located within the boundaries of the Northwest region. Park-specific information is displayed in Table I-27 of Appendix I. A review of Table I-28 in Appendix I shows that one state-managed recreational facility is located within this coal-producing region, totaling approximately 1,600 acres. Figure 3.10-6 locates the designated wild and scenic river in this region and depicts where the coal-producing region overlaps national and state parks and forests. Each national or state park or forest in Figure 3.10-6 has been assigned a number; the corresponding place names are identified in Tables I-26, I-27, and I-28 of Appendix I.

Relevant data from the U.S. FWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-29 of Appendix I. The table also includes total expenditure data for Alaska. For the activities included in the 2006 survey, Alaska had 0.9 million participants.

Figure 3.10-6 Northwest Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

3.10.7.1 Alaska Tourism and Recreation

The Alaska coal-producing region occurs in the tourism regions designated by the TravelAlaska.com (State of Alaska, 2013) as the Southcentral, Interior, and Far North. The coal fields in the Southcentral region fall mostly on the Kenai Peninsula, just south of Anchorage, but are not currently active. The Kenai Peninsula is known as "Alaska's Playground" and offers wildlife, cultural attractions, and fishing. The peninsula spans the Chugach National Forest and is home to Kachemak State Park, Kenai Fjords National Park, Kenai National Wildlife Refuge, and the Exit Glacier. There are 433 miles of trails and 150 miles of canoe trails available for recreational use. The Interior region is home to the only active coal mining in Alaska. The Interior region features the Yukon-Charley Rivers National Preserve and Denali National Park and Preserve. Recreational opportunities include hiking, rock climbing, ice climbing, photography, wildlife viewing, nature walks, horseback riding, river excursions, hunting, and fishing. The North Slope coal fields, immense in size and located within the Far North Region, are also inactive. The Far North region offers backpacking and river excursions in the Kobuk Valley National Park, Noatak National Preserve, Selawik National Wildlife Refuge, Gates of the Arctic National Park and Preserve, and the Arctic National Wildlife Refuge.

3.10.8 Western Interior Region

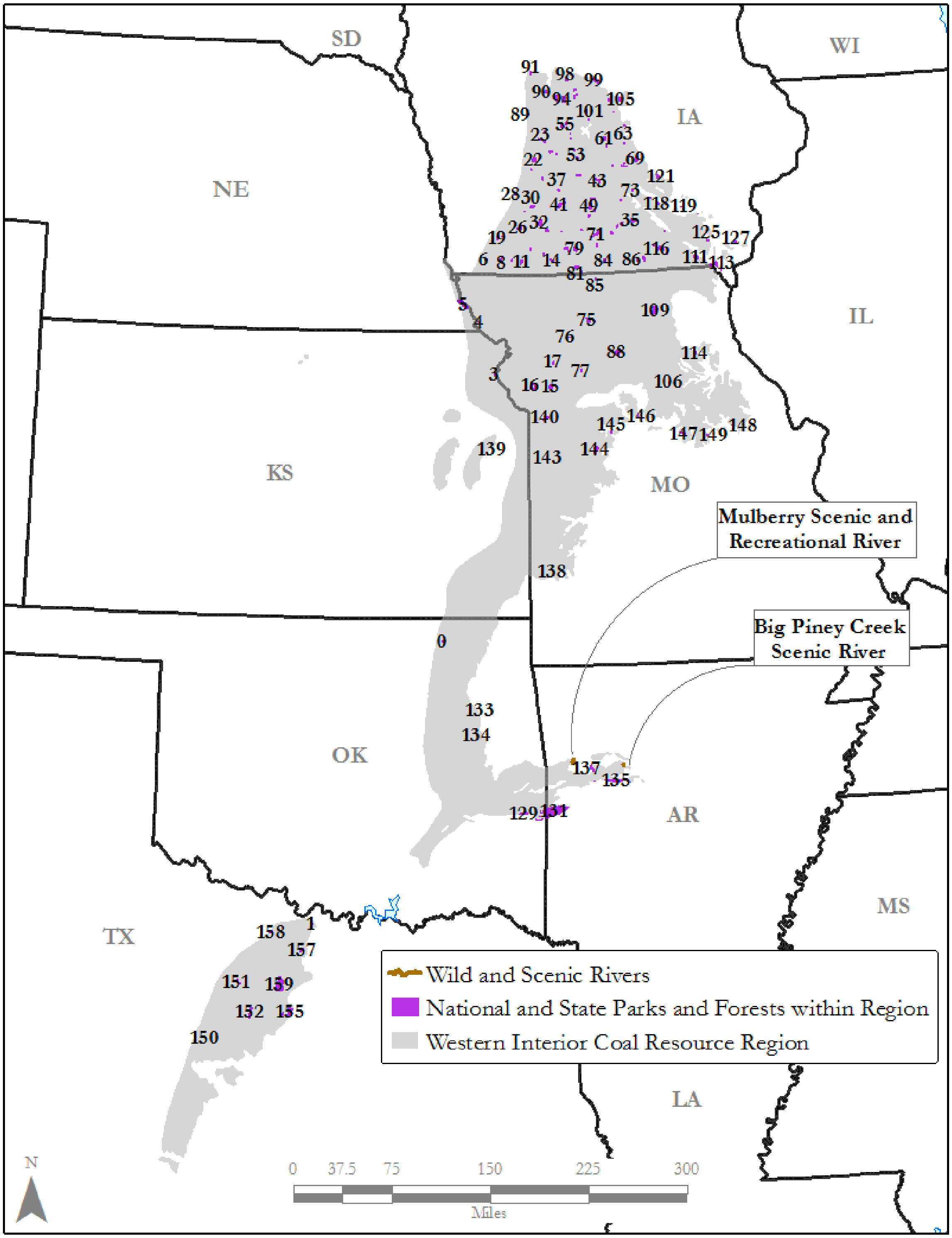
The Western Interior coal-producing region includes portions of the states of Arkansas, Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Texas. As discussed in Section 3.1, the vast majority of current coal production in the region occurs in Oklahoma, with the remainder in Arkansas, Kansas, and Missouri. Table I-2 in Appendix I lists the economic contribution of the tourism and recreation industry as well as food service and accommodations-related jobs, payroll, and per capita expenditures for each of these states. Table I-3 in Appendix I lists the 2007 data for visitation, acreage, and revenue generated by state parks in coal mining states.

Approximately 318,000 acres of national forest lands fall within the boundaries of the Western Interior coal-producing region. Table I-30 in Appendix I provides information on the national forests in this region. The USFS manages the two designated wild and scenic rivers in this region, both of which are located in Arkansas. Five national park managed facilities encompassing 775,000 acres are located within the boundaries of the Western Interior coal-producing region. Park-specific information is displayed in Table I-31 of Appendix I. A review of Table I-32 in Appendix I shows that 40 state-managed recreational facilities are located within this coal-producing region, totaling approximately 167,000 acres. Figure 3.10-7 locates the designated wild and scenic rivers in this region and depicts where the coal-producing region overlaps national and state parks and forests. Each national or state park or forest in Figure 3.10-7 has been assigned a number; the corresponding place names are identified in Tables I-30, I- 31, and I-32 of Appendix I. Table I-33 in Appendix I provides information on each of the identified wild and scenic rivers located within the Western Interior coal-producing region.

Relevant data from the U.S. FWS 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. FWS, 2011c) is provided in Table I-34 of Appendix I. The table also includes total expenditure data by state. For the activities included in the 2006 survey, Missouri had the most participants (3.9 million) and Kansas had the fewest (1.5 million).

Although coal is present in all seven states included in the Western Interior coal-producing region, it is only mined in four of these states: Arkansas, Kansas, Missouri, and Oklahoma. For this reason, the following discussion focuses on these four states.

Figure 3.10-7 Western Interior Region National and State Recreation Areas



Note: See Appendix I for numeric index of areas
Source: ESRI, 2015

3.10.8.1 Arkansas Tourism and Recreation

The Arkansas portion of the Western Interior coal-producing region lies within two recreational regions, the River Valley Region and the Ouachita Region, as designated by the Arkansas Tour guide (Arkansas Department of Parks and Tourism (DPT), 2013). The River Valley Region offers a number of recreational opportunities. This area is known as Arkansas's wine country. The Fort Smith National Historic Site offers a glimpse into the colorful history of the Old West. The Ouachita Region is a popular destination known for its beautiful scenery. Visitors to these regions of Arkansas can enjoy many outdoor recreational activities such as rafting, kayaking, boating, fishing, swimming, camping, and hiking.

3.10.8.2 Kansas Tourism and Recreation

The Kansas portion of the Western Interior coal-producing region covers most of the eastern quarter of the state, but represents a very low amount of production. This portion of Kansas lies in the recreational regions designated by the Kansas Official Travel Guide 2013 (Kansas Department of Wildlife, Parks & Tourism (DWPT), 2013) as the Eastern Wooded Hills and Flint Hills Regions. The Santa Fe and Oregon Trails traverse these regions. Recreational opportunities include fishing, hunting, golfing, and boating. Recreational areas located near Bourbon and Linn Counties include the Fort Scott National Historical Site, Crawford, and Massacre Memorial State Parks.

3.10.8.3 Missouri Tourism and Recreation

The Missouri portion of the Western Interior coal-producing region includes most of the northwestern portion of the state; however, coal production is very minimal. This area lies mostly within the recreational region designated by the Missouri Official Travel Guide (Missouri Department of Economic Development (DED), 2013) as the Northwest region. This area of the state offers superb hunting, with deer, turkey, quail, pheasant, and waterfowl in abundance. The Missouri River traverses the area, providing water-related recreational activities. Recreational areas in the coal-producing region include the Harry S. Truman National Historical Site and the Knob Noster State Park.

3.10.8.4 Oklahoma Tourism and Recreation

The Oklahoma portion of the Western Interior coal-producing region is located in the east/northeastern part of the state, mostly within the recreational region designated by TravelOK.com (Oklahoma Tourism and Recreation Department (TRD), 2013) as Green Country (northeast). It also extends into the regions designated as Frontier Country (central) and Kiamichi Country (southeast). Green Country represents 18 counties in northeastern Oklahoma and includes 16 major lakes, along with green rolling hills and tall grass prairie. The Cimarron and Arkansas Rivers join west of Tulsa to form a large, man-made lake. Recreation opportunities in Oklahoma are focused in state parks. Many man-made lakes support boating, swimming, fishing, camping, and picnicking. Rafting, kayaking, hiking, backpacking, and mountain biking are popular activities enjoyed on the rivers and in the natural areas of the state.

Recreation areas in the coal-producing region include the Fort Smith National Historical Site and Robbers Cave, Greenleaf Lake, and Fountainhead State Parks.

3.11 VISUAL RESOURCES AND NOISE

3.11.1 Visual Resources

NEPA requires that measures be taken to "assure for all Americans … aesthetically pleasing surroundings" (42 U.S.C. § 4331). Aesthetic or visual values are a matter of personal preference and are different for different observers. Visual resources include the physical characteristics that make up the visible and aesthetic landscape, including land, water, vegetation, and manmade features. Visual resources contribute to the feeling of community value and pride and can help to define the historic and cultural identity of a region. The natural and manmade visual resources of a region are often vital to tourism, and the aesthetic quality of a region can leave a lasting impression on visitors as well as residents.

In many of the coal-producing regions mining has resulted in altered visual landscapes. Substantial areas now have non-native or fragmented vegetation with modified landforms; exposed acidic soils and spoil piles are visible and are distinct from natural land contours; and mining related infrastructure such as buildings, rail spurs, and road systems are present in areas that otherwise are remote and have few structures. Coal mines dominate foreground and middle ground views in the affected viewsheds; background views generally depend on the status of reclamation activities and the perspective from a particular observation point.

Federal and state guidelines for visual resources concentrate on the quality of the physical landscape, public concern for scenic quality, and determining whether the affected land is visible from travel routes or observation points (U.S. BLM, 2012). These guidelines typically describe the affected visual environment by identifying key views, analyzing the resources and community responses. This then allows for characterization of visual impacts and development of mitigation measures.

While SMCRA does not explicitly require analysis of visual resources during the permitting process, there are provisions within SMCRA that identify specific circumstances in which visual resources are provided varying levels of protection and visual impacts must be considered. Under Section 522(e) unless a permit applicant demonstrates that they meet one of the specific exceptions, the applicant will not be permitted to conduct surface coal mining operations in any area designated by Congress as unsuitable for surface coal mining operations (30 U.S.C. § 1272(e)). Many of the designated areas are recognized as the Nation's preeminent visual resources. For example, subject to limited exceptions, surface coal mining operations are not permitted within the boundaries of units of the National Park System, the National Wildlife Refuge Systems, the National System of Trails, the National Wilderness Preservation System, the Wild and Scenic Rivers System (including study rivers designated under Section 5(a) of the Wild and Scenic Rivers Act), and National Recreation Areas designated by Act of Congress (30 U.S.C. § 1272(e)(1)). Likewise, SMCRA allows mining within national forests only under limited circumstances and prohibits mining that would adversely affect any publicly owned park or place on the National Register of Historic Places or within 300 feet of a public park (30 U.S.C. § 1272(e)(2), (3), and (5)). See also 30 CFR Part 761.

30 CFR 761.11(c) specifies that if a proposed surface coal mining operation would have an adverse impact on a publicly owned park or place in the National Register of Historic Places, the proposed operation cannot be authorized unless both the SMCRA regulatory authority and the agency with jurisdiction over the park or place jointly approve the operation. In essence, if adverse impacts are identified, under 30 CFR 780.31(a) or 784.17(a) the applicant must prepare a plan to prevent adverse impact, or (if approved by both agencies) to minimize adverse impacts.

Section 522 of SMCRA also establishes a process for the designation of areas as unsuitable for surface coal mining operations (30 U.S.C. § 1272). For example, areas may be designated unsuitable if the operations would "affect fragile or historic lands in which such operations could result in significant damage to important historic, cultural, scientific, and esthetic values and natural systems" (30 U.S.C. § 1272(a)(3)(B)). Such "fragile or historic lands" might include recreational resources (see also 30 CFR Part 762). Under Section 522(b) of SMCRA, all federal lands must be evaluated using the unsuitability criteria listed in that section (30 U.S.C. § 1272(b)). Finally, SMCRA allows anyone with an interest that is or may be adversely affected to petition the appropriate SMCRA regulatory authority to have certain lands, including fragile or historic lands, designated unsuitable for mining under the unsuitability criteria (30 U.S.C. § 1272(c); see also 30 CFR Parts 764 and 769).

Substantial BLM landholdings exist within some of the coal-producing regions. These BLM managed lands include lands subject to mineral leasing for coal, natural gas, or other minerals. The affected visual environment within these lands includes evidence of these activities interspersed with natural landscapes. However, BLM ensures that scenic values of these public lands are considered during the planning process through its visual resource management (VRM) system. The VRM system involves inventorying scenic values and establishing management objectives for those values through the resource management planning process, and then evaluating proposed activities to determine whether they conform to the management objectives (U.S. BLM, 2012).

3.11.2 Visual Resources by Region

3.11.2.1 Appalachian Basin Region

The Appalachian Basin coal-producing region includes parts of Pennsylvania, Ohio, Maryland, West Virginia, Virginia, eastern Kentucky, eastern Tennessee, and northern Alabama. The rugged terrain of the region is generally characterized by steep mountain slopes, confined river valleys, and narrow ridge tops. Mixed hardwood forests are prevalent throughout the region. Settlement patterns in the Appalachian Basin region were constrained by the dominant topographic features of the area such as rivers, streams, mountains, and valleys. Communities settled along rivers and within valleys primarily for transportation and agricultural purposes, and current road and rail transportation networks generally follow the network of streams. The natural environment is the key defining feature of the region (U.S. EPA et al., 2003). As described in Section 3.10 (Recreation), the tourism and recreation industries are highly dependent on the region's natural resources and scenic beauty.

Coal mining has had a pronounced influence on the visual resources within the region. Substantial areas now have non-native or fragmented vegetation with modified landforms; exposed acidic soils, and spoil piles are visible and are distinct from natural land contours. Both surface and underground mining have occurred in various locations throughout the region. Surface mining in the region has had temporary and permanent impacts on visual resources.

3.11.2.2 Colorado Plateau Region

The Colorado Plateau coal-producing region is located in the states of Arizona, Utah, Colorado, and New Mexico, encompassing approximately 150,000 square miles (388,500 square kilometers). The region is characterized by broad plateaus, volcanic intrusions and mountains at elevations of approximately 5,000 to 13,000 feet (1,520 to 3,960 meters), and deeply dissected canyons lined with sedimentary and volcanic rocks that provide striking visual vistas, including the Grand Canyon of the Colorado River (The Columbia Encyclopedia, 2013).

As discussed in Section 3.10, the region is popular with residents and tourists for its natural and historic recreational resources. Among the resources located within this region are numerous National Parks and monuments, and many ski resorts and destination resorts such as Aspen and Vail in Colorado and Park City in Utah. Resident and non-resident tourists are drawn to the many visual, cultural, and natural amenities found throughout the region.

Agricultural activity is a primary land use on the plains in the region, with agricultural lands consisting of croplands and grazing lands for livestock. In addition to coal, other diverse materials ranging from salt and gypsum to copper and gold are mined (USGS, 2013c). Communities within and around this coal-producing region were founded to support agriculture, mining, and transportation. These industries have become a part of the visual landscape of the region. The region also includes lands and resources owned and/or valued by Native American tribes.

Approximately 56.9 million acres of public lands in Colorado, Utah, New Mexico, and Arizona are managed under many different BLM offices and resource management plans (U.S. BLM, 2013d). Land is also managed by the U.S. Bureau of Reclamation (BOR) and the Bureau of Indian Affairs (BIA).

3.11.2.3 Gulf Coast Region

The Gulf Coast coal-producing region consists of lignite coal areas that spread from southern Texas eastward, primarily through the coal-producing areas of Louisiana and Mississippi. Extending into southern Alabama, the coal-producing region significantly diminishes in central Georgia and the Florida panhandle. This coal-producing region also extends northward up the Mississippi River embayment area to include much of eastern Arkansas into southeastern Missouri, extreme southern Illinois, and parts of far western Kentucky and Tennessee. While the southern edge of the coal region generally follows the arc of the coast, none of the region's operating mines are near the Gulf of Mexico or within visual distance of the coast. Although lignite is present in all 11 states included in this region, it is only mined in Texas, Louisiana, and Mississippi.

Visual resources within the region are varied. The landscape throughout Texas includes plains and prairies as well as oak and pine forests. Low, rolling hills exist within the coastal plains and are typical of the lignite mining areas of all three Gulf Coast mining states, with the mine areas of Louisiana and Mississippi being heavily forested.

3.11.2.4 Illinois Basin Region

The Illinois Basin coal-producing region includes 68 percent of Illinois as well as a portion of southwest Indiana and the bituminous coal area of western Kentucky. This region is a part of the Interior Plains of North America and is primarily flat, with expansive open crop and pastureland areas. In various parts of the basin, forest land is a significant part of the visual landscape, particularly in the southern portions of both Illinois and western Indiana, where areas of greater topographic relief are present. The region is traversed by the Kaskaskia, Wabash, and Ohio rivers. There are a few small national park properties in the region, including the Lincoln Boyhood Memorial in Indiana, Mammoth Cave in Kentucky, and the Lincoln Home Historical Site in Illinois. This region has a higher population density than other coal regions, though most of the population centers of Illinois are not within the coal region of the Illinois Basin.

3.11.2.5 Northern Rocky Mountains and Great Plains Region

This region includes coal-producing areas in the states of Montana, Wyoming, North Dakota, and parts of Colorado and Utah. The topography generally is of low to moderate relief, with occasional buttes and mesas. The underlying bedrock in some areas is very erodible, which may result in heavily dissected topography. The general topographic gradient slopes down gently (generally southwest to northeast) with elevations ranging from 5,000 to 6,000 feet above mean sea level (AMSL) on the southern and western portions of the basin, to less than 4,000 feet AMSL on the north and northeast along the Montana state line. The Wyoming portion of the basin is bounded on the west by the Big Horn Mountains and the Casper Arch, on the south by the Laramie Mountains, on the southeast by the Hartville Uplift, and on the east by the Black Hills (U.S. BLM, 2005).

The Powder River Basin landscape is characterized by prairie grasslands, shrublands, forested areas, and riparian areas. Prairie grassland accounts a major component of the region, while sagebrush shrubland vegetation is widely distributed and also occupies a large proportion of the region. The primary vegetation communities impacted as a result of coal mine development have included mixed-grass and short-grass prairie and sagebrush shrublands. The species composition on the reclaimed land is different than surrounding undisturbed lands, particularly in regard to the percent of woody shrub species present during the years immediately following reclamation (U.S. BLM, 2005).

The BLM’s Montana/Dakotas State Office manages 8.3 million acres of land and 47 million acres of mineral estate in Montana, North Dakota, and South Dakota (U.S. BLM, 2013a).

Because most of the coal in this region is managed by the BLM and subject to VRM requirements, visual resource assessment is included in environmental analysis in this region.

3.11.2.6 Northwest Region

While there is currently little mining activity ongoing in the region, the coal beds of this region are located in areas with high scenic value. Within the state of Washington coal beds exist in the Columbia Plateau, between the Cascade Range to the west and the Rocky Mountains in Idaho, to the east. There are also coal resources on the western and eastern flanks of the Cascade Range from Canada into northern Oregon. Oregon’s coal resources are primarily located in the west-central part of Coos County, a coastal area with an economy currently driven by forest products, tourism, fishing, and agriculture.

One mine is currently active in the state of Alaska. The mine is north of Denali National Park and Preserve (DNPP) in an area of remote, mountainous foothills near Healy, Alaska (Alaska DMLW, 2004; Alaska DMLW, 2013). The mine operation is approximately ten miles north of the DNPP entrance and the closest park borders and is not visible except from the highest elevations of DNPP. The topography in the area is ranges from lowland interior plains 2,000 feet in elevation to Mount McKinley’s southern peak at 20,320 feet, representing the highest point in North America. The coal operation is in the Nenana River valley, which is a sculpted U-shaped glacial valley with a broad floodplain. Scenic resources in the area are visible from multiple viewpoints including the George Parks Highway, the Alaska Railroad, and the Nenana River, all of which share the corridor through the Alaska Range. Transportation outside these established corridors is limited due to topographic constraints. Healy, Alaska is the largest town in the region, supporting a population of approximately 1,000 residents. Most residents are employed by activities connected to Usibelli coal mine, DNPP, and other recreation activities such as hiking, camping, fishing and hunting.

3.11.2.7 Western Interior Region

As a part of the Interior Plains of North America, this region includes the bituminous coal reserves of west-central Arkansas, central and southern Iowa, eastern Kansas, northwestern and central Missouri, southeastern Nebraska, eastern Oklahoma, and north-central Texas. Although coal is present in all seven states included in this region, it is not mined in Iowa and Nebraska. For this reason, further discussions focus on the Western Interior portions of the five coal-producing states.

Somewhat similar to the Illinois Basin coal-producing region, this region has a landscape that is primarily flat, with open crop and grass lands. The Oklahoma and Arkansas portions of this region have somewhat greater topographic relief, more extensive forest land cover, and may include greater visual resources. While historically this area was a large coal producer, coal mining has decreased significantly in the region. Most coal mining activities subject to SMCRA involve reclamation activities at inactive coal mining properties and the few scattered active mines remaining in this region.

3.11.3 Visual Resources by Region

The ambient, or background, noise of a particular area is part of the human environment. Both natural and human produced sounds contribute to the ambient noise level. Ambient noise is discussed in this document as a resource because the proposed action has the potential to cause localized effects on ambient noise levels (as discussed later in Chapter 4). In some circumstances noise can dictate land use; extremely noisy areas are not conducive to residential development or placement of noise sensitive facilities such as schools and hospitals. In other circumstances relatively low levels of introduced noise are potentially of concern, for example on public lands where the natural quiet is a part of the context of the park and unwanted or unexpected sounds detract from the experience. In addition to the effects on humans, noise may be an issue of concern related to wildlife and domesticated animals due to the potential for disturbance.

Noise is a unique topic in that the boundaries of the affected area would change continuously (from an identical noise source at a fixed location the area affected would vary due to weather related variables). In this DEIS, the extent of the affected environment is defined by the boundaries of the area that would potentially be affected by noise associated with mining activities, including transportation routes associated with the mining. Noise has a limited travel distance; the affected environment for this resource would not likely include large areas beyond the immediate area of the activity.

In general, existing land uses can provide an expectation of ambient noise conditions. In rural settings ambient noise levels are typically lower. Rural areas are more likely to have a soundscape dominated by natural sounds such as wind or surf with less frequent additions of human noise. Intermittent noise from vehicles is a component of the affected environment in most areas, from roadway traffic to farm equipment use. However, in these settings with relatively low ambient noise levels the addition of a human produced sound may be more noticeable than in an urban environment. In relatively urbanized areas the soundscape would be dominated by human produced sounds; the additional noise associated with coal mining activities may not produce a new affected area if the additional noise is masked by those already present.

As discussed in more detail in Section 3.11.2, SMCRA prohibits surface coal mining operations within the boundaries of many types of public lands, any publically owned park or place on the National Register of Historic Places, or within 300 feet of a public park. While these lands might be part of the affected environment for other resources, for example visual resources because mining activities might be visible from a long distance, these areas are unlikely to be part of the affected environment for noise from coal mining activity due to the characteristics of sound travel and the protections within SMCRA.

3.12 UTILITIES AND INFRASTRUCTURE

This section describes two key aspects of infrastructure that are important to coal mining operations: transportation and electrical utilities. The discussion first provides an overview of these infrastructure elements and reviews relevant regulations. The remaining subsections examine the transportation infrastructure of each coal-producing region in greater detail.

3.12.1 Overview

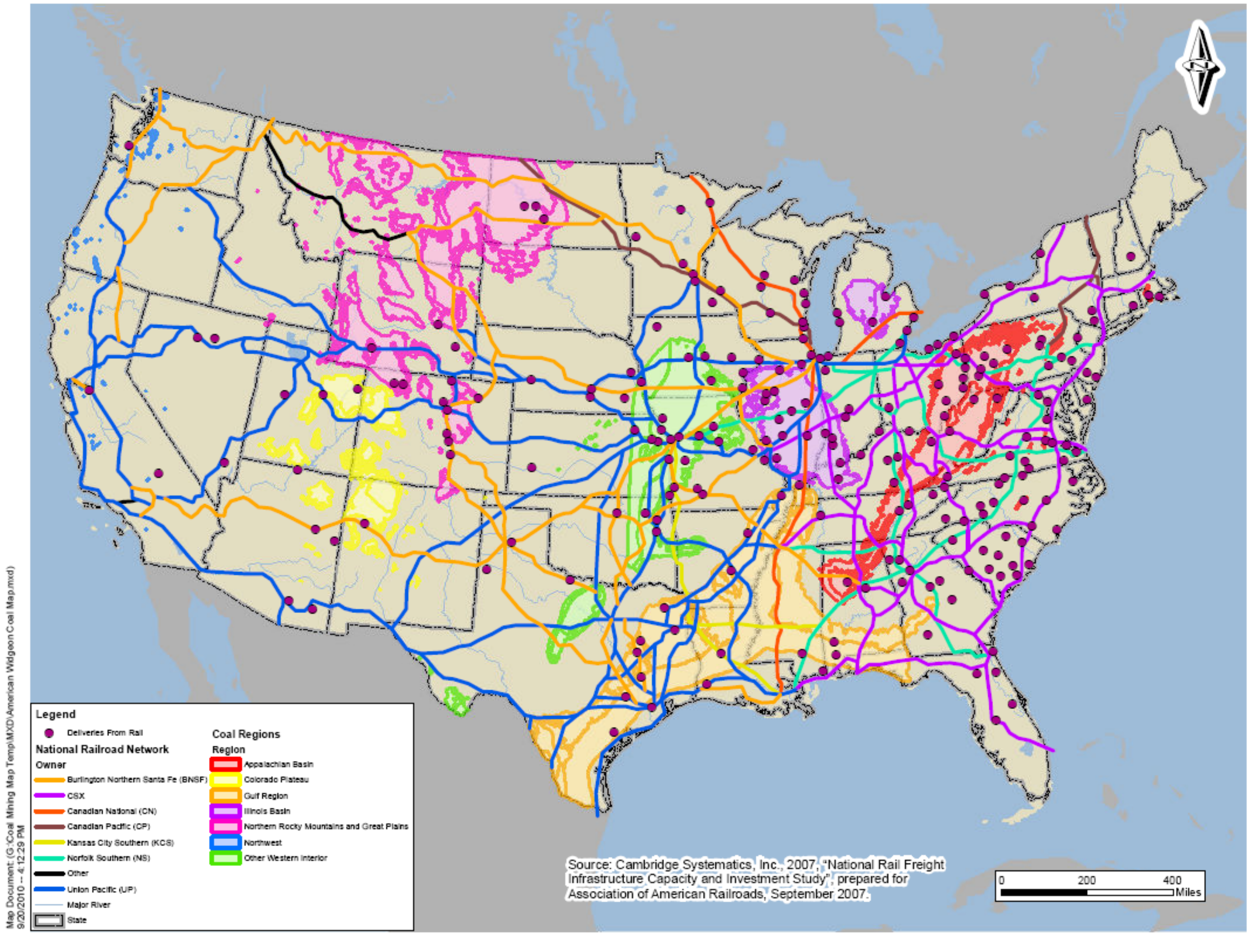
3.12.1.1 Transportation Infrastructure Overview

Both suppliers and users rely on a variety of freight transportation modes to move coal. Coal is traditionally transported by more than one mode of freight transportation because of cost considerations, the location of the mine site, and/or the location of the customer. Rail, truck, and/or barge are the most common modes of coal transport in the U.S. Customers located at or near coal mines may also use conveyor belts to transport the coal, but this method of transportation accounts for less than seven percent of coal transport (National Energy Technology Laboratory (NETL), 2010). In multimodal coal transportation, the initial transportation mode from the mine site is not always the primary mode of coal transportation. For example, coal shipments arriving by rail to a customer are normally hauled to or away from a railroad site by truck. Similarly, coal hauled by barge is transported to or away from river terminals by truck, rail, or conveyor. Approximately 70 percent of U.S. coal is transported to market by train for at least part of its trip; waterborne (river barge) deliveries account for 12 percent of shipments, and truck deliveries account for 11 percent of shipments (2012 estimates) (U.S. Energy Information Administration (EIA) *Domestic Distribution of U. S. Coal By Origin State*, *Consumer*, *Destination, and Method of Transport Quarterly Reports*, *2012*) (U.S. EIA, 2012d).

<u>Rail</u>

As shown in Figure 3.12-1, four principal coal hauling railroads currently operate in the U.S: Burlington Northern Santa Fe (BNSF), Union Pacific (UP), CSX, and Norfolk Southern (NS). BNSF and UP primarily operate west of the Mississippi River, while CSX and NS primarily provide service east of the Mississippi River (NETL, 2010). Growth in the volume and tonnage of rail traffic is expected to be considerable; the U.S. Department of Transportation (U.S. DOT) estimates that demand for rail freight transportation will increase by 88 percent over current tonnage by 2035. The *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) projects rail volumes both with and without infrastructure improvements and investments required for the railroads to carry the freight tonnage forecast by the U.S. DOT. Projected rail volumes from this study are discussed in this section.

Figure 3.12-1 National Rail Freight Network with Coal-Fired Power Plants

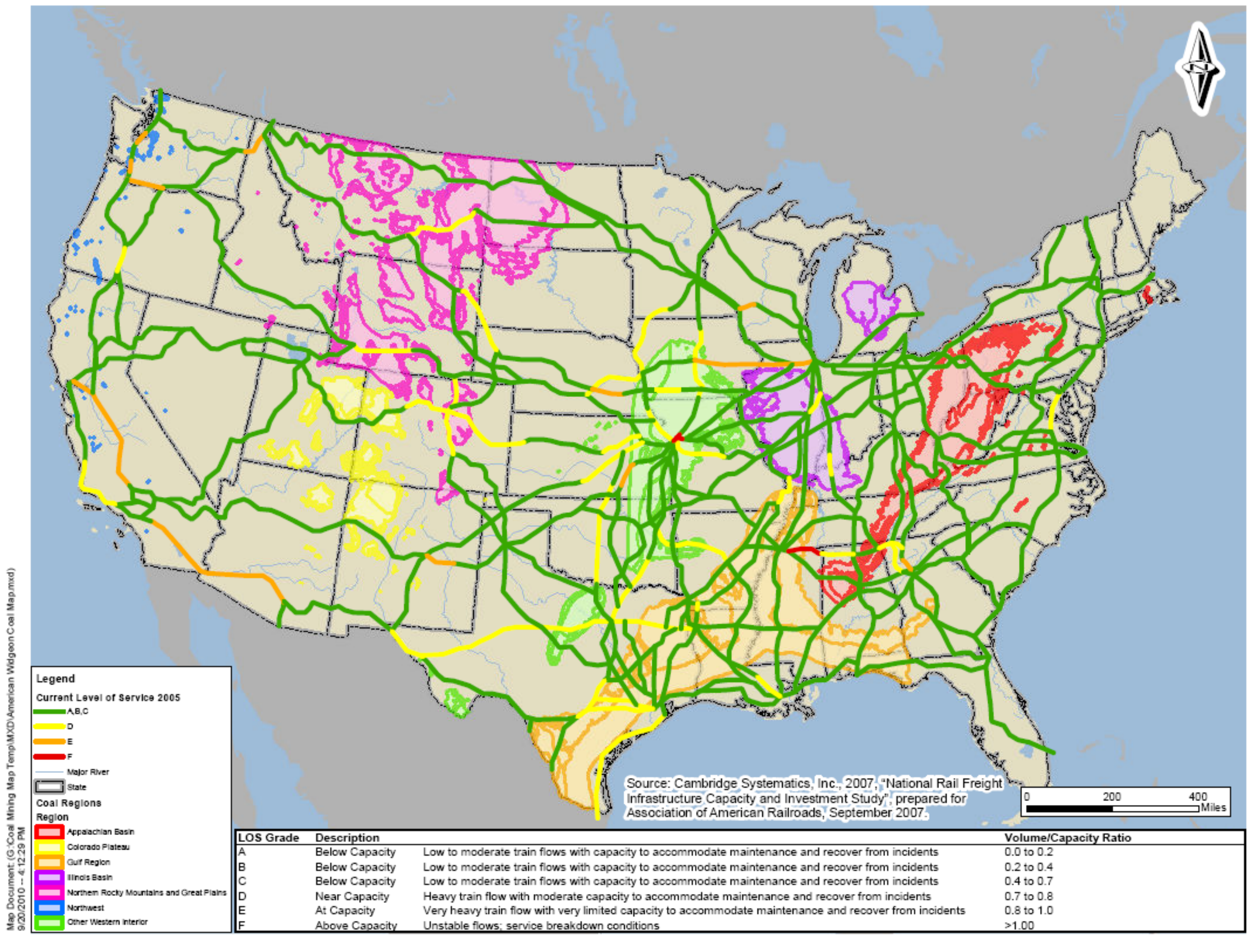


Sources: Cambridge Systematics, 2007. Figure 4.1: National Rail Freight Network and Primary Rail Freight Corridors. http://www.camsys.com/pubs/AAR_Nat_%20Rail_Cap_Study.pdf
NETL, 2010. Figure 12: U.S. Coal Fired Power Plants with Rail Delivery of Coal, 2008. U.S. Department of Energy. http://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Publications/DOE-NETL-403-081709-OvervUSCoalSupplyandInfrastructure-071210.pdf
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

CSX is the largest coal hauling railroad in the eastern U.S., serving more than 130 mines in nine states. Primary markets for CSX coal shipments are power plants in the Northeast and Southeast (NETL, 2010).

Figures 3.12-2 and 3.12-3 depict the regional areas of constraint within the current and future freight rail system. If railroads cannot meet transportation needs in 2035, then freight will be shed to trucks and an already heavily congested highway system. Conversely, if trucks cannot carry their share in 2035, then freight would be shifted to rail.

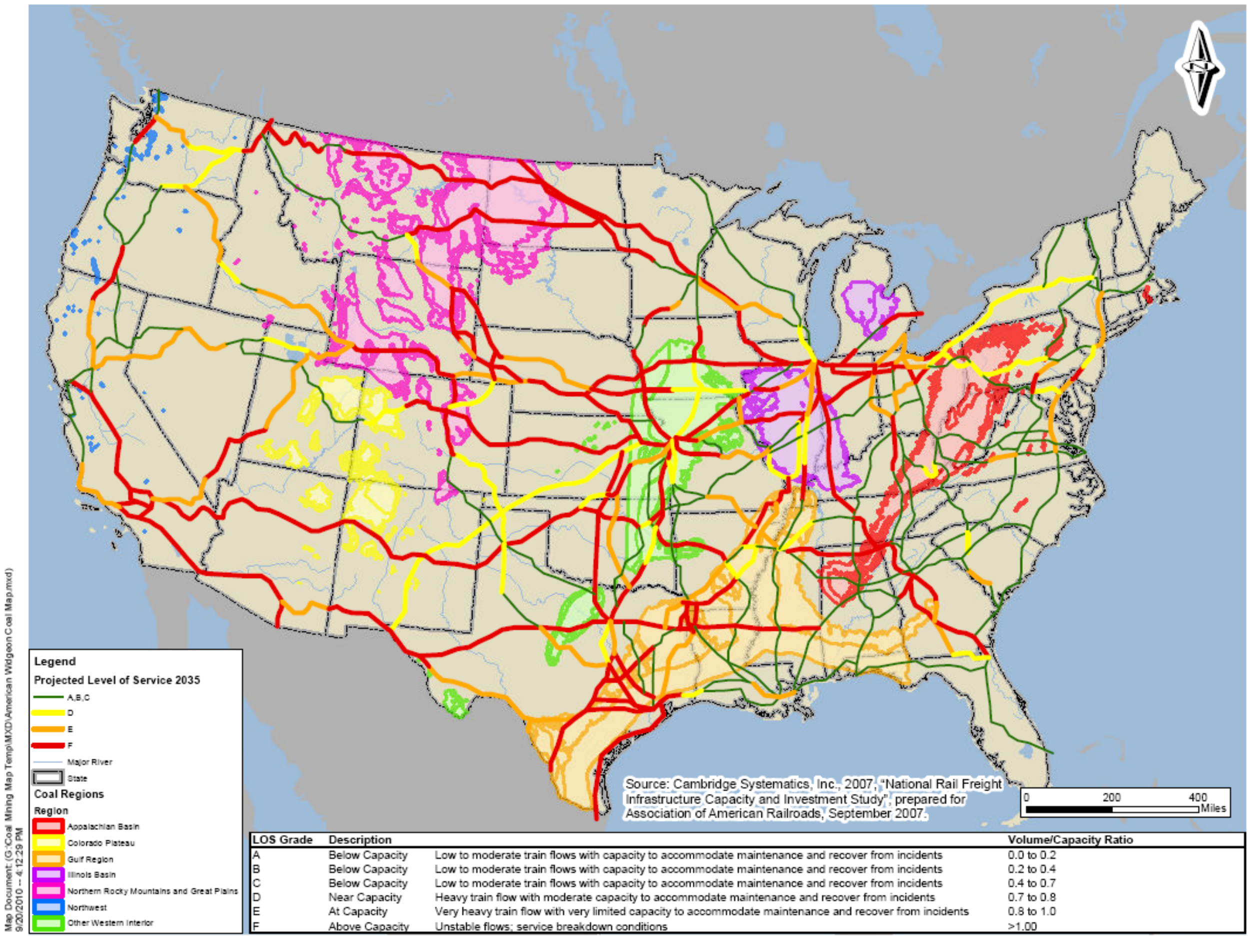
Figure 3.12-2 Current Level of Rail Service, 2005



LOS Grade	Description		Volume/Capacity Ratio
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2
B	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.2 to 0.4
C	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service breakdown conditions	>1.00

Source: Cambridge Systematics, 2007. Figure A.2: 2005 and 2035 Train Volumes Compared to Current Train Capacity. http://www.camsys.com/pubs/AAR_Nat_%20Rail_Cap_Study.pdf
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Figure 3.12-3 Projected Level of Rail Service, 2035



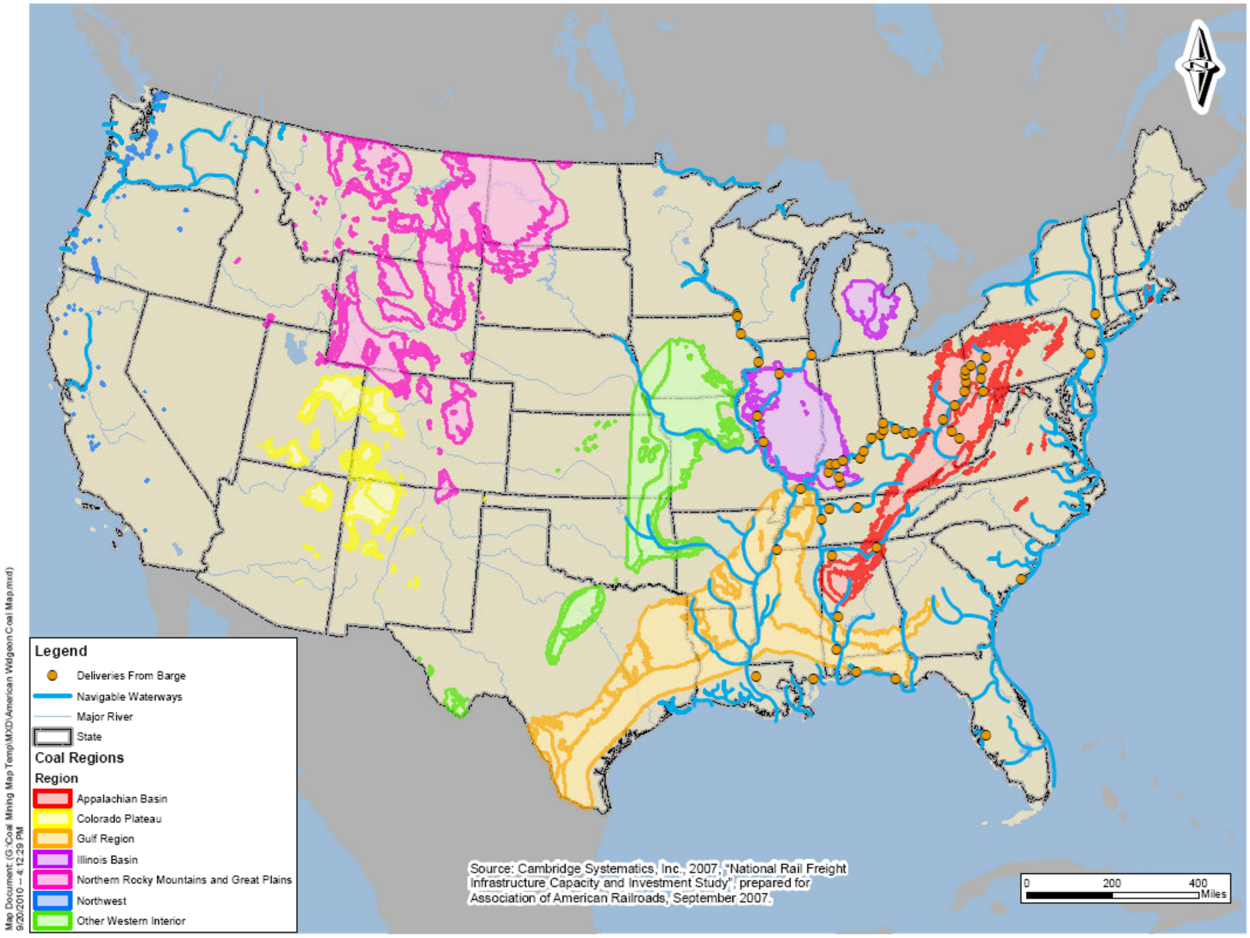
LOS Grade	Description		Volume/Capacity Ratio
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2
B	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.2 to 0.4
C	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service breakdown conditions	>1.00

Source: Cambridge Systematics, 2007. Figure A.2: 2005 and 2035 Train Volumes Compared to Current Train Capacity. http://www.camsys.com/pubs/AAR_Nat_%20Rail_Cap_Study.pdf
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Barge

According to the 2010 National Energy Technology Laboratory report (NETL, 2010), approximately 70 electric power plants are located along the U.S. inland water system. These locations are accessible by barge, which can be an efficient and inexpensive method of transportation. Most of these plants are located along the Ohio River and its tributaries, or the Mississippi River, while a few plants are located along the Gulf or Atlantic coasts. Figure 3.12-4 shows the location of coal-fired power plants with barge access.

Figure 3.12-4 Coal-Fired Power Plants with Barge Access

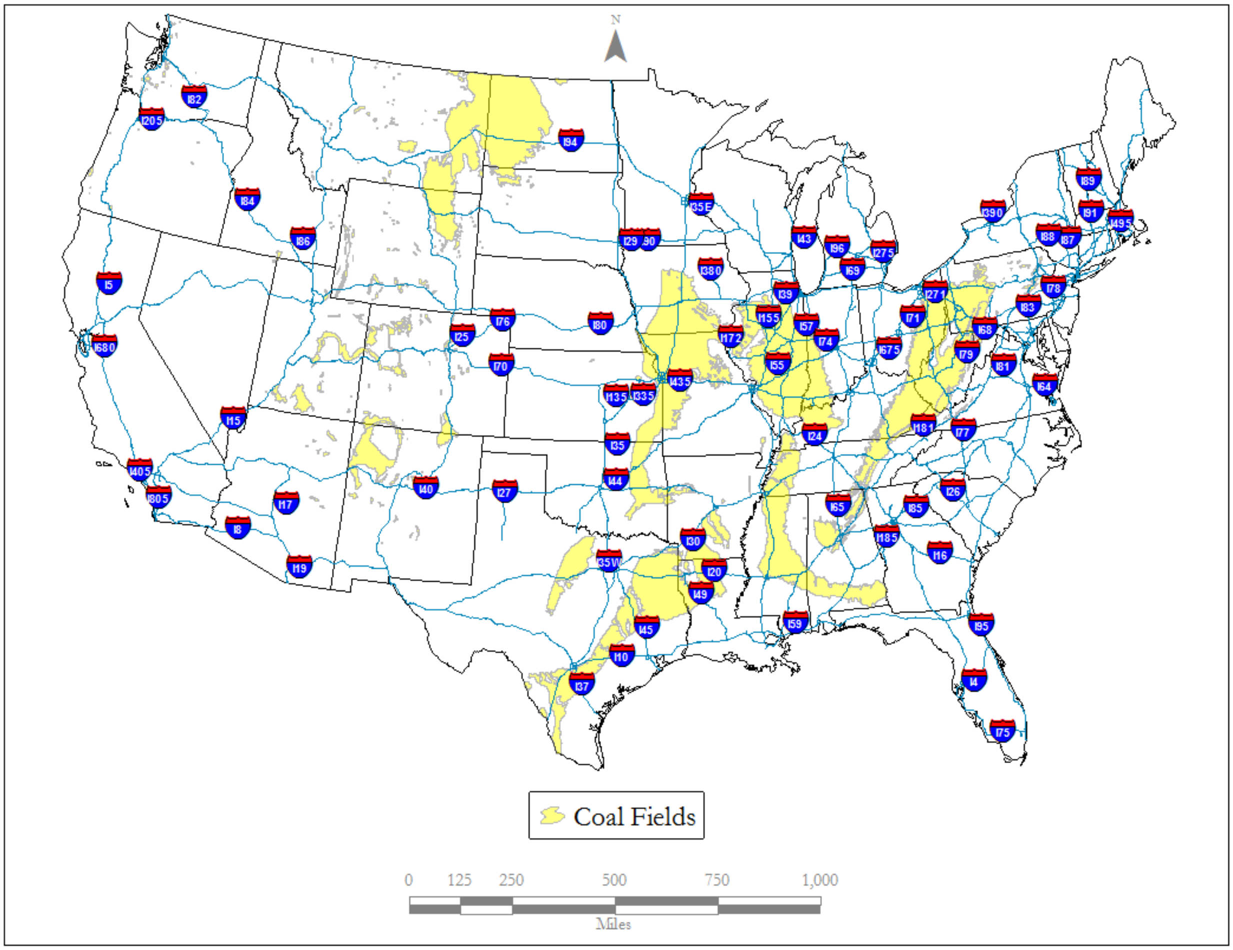


Source: NETL, 2010. Figure 15: U.S. Coal Fired Power Plants with Barge Delivery of Coal, 2008, U.S. Department of Energy. http://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Publications/DOE-NETL-403-081709-OvervUSCoalSupplyandInfrastructure-071210.pdf
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Roadways

Public highways and roads are frequently used to transport coal for a portion of the trip. Figure 3.12-5 depicts the major interstate highway system. The distance travelled by coal haul trucks varies based upon overall transport distance and the ultimate destination. Longer distances are frequently combined with other transport modes to minimize costs. Bridges and pavement in the Interstate Highway System are typically designed to allow 80,000 pounds gross vehicle weight (GVW) to travel long distances without reconfiguring. State and local authorities frequently monitor the weight of the freight vehicles, particularly with respect to the equivalent single axle load (ESAL). Kentucky and West Virginia have designated coal haul routes for which the weight of permitted vehicles is greater, typically 120,000 pounds GVW (West Virginia DOH, 2012).

Figure 3.12-5 Map of U.S. Interstate Highway System



Source: Environmental Systems Research Institute (ESRI), 2009. ESRI StreetMap Premium, ArcGIS Resource Center. http://www.esri.com/data/streetmap
USGS, 2011a, *Coal Fields*, U.S. DOI, http://nationalatlas.gov/atlasftp.html?openChapters=chpgeol#chpgeol

Other Modes

Less predominant means of coal transport also are used, including, but not limited to, the Great Lakes, Tidewater Piers, and Tramway/Conveyor/Slurry Pipelines. These other modes of transport are typically limited to a specific site or region but accounted for approximately seven percent of coal transport during 2012 (U.S. EIA, 2012d).

3.12.1.2 Electric Utilities Overview

Electricity in the U.S. is produced from a number of sources. The EIA's Electric Power Monthly 2013 (U.S. EIA, 2013f) data identifies fifteen different sources for production of electricity. Electricity produced from coal is the largest single production source in the country. In July, 2013, 38.9 percent (153,330 thousand megawatt hours) of the Nation's electricity was produced from coal. A total of 83,466,000 tons of coal were used to produce this electricity (U.S. EIA, 2013f). According to the EIA, in July 2013, the national average retail price across all sectors of the economy for electricity was 10.71 cents per kilowatt hour. In June of 2011, an estimated 93 percent of the coal mined in this country was used to produce electricity (U.S. EIA, 2013f).

The EIA's Annual Energy Outlook 2013 (U.S. EIA, 2013c) data includes projections for electricity demand and cost through 2040. The EIA predictions show that between 2011 and 2040, the production of electricity will increase at approximately 0.9 percent per year. In 2035, when adjusted to remove the effects of inflation, the national average retail price across all sectors of the economy for electricity is predicted to be between 10.1 and 11.9 cents per kilowatt hour.

Coal production, mining methods and cost of electricity to the consumer can vary greatly between regions. Variations in coal production and mining methods are discussed at length in Section 3.1 of this chapter. As production of coal from the 25 states within the coal-producing regions contributes over 38 percent of the energy required for the production of electricity in the Nation, the scope of the discussion of costs of electricity must include all regions within the U.S.

<u>Regional Electricity Production and Costs</u>

Given that coal is the dominant energy source for the production of electricity in the U.S., the scope of analysis of this issue must extend beyond the coal-producing states to include the country at large. This section will draw on the regional census division and state-specific information presented in the EIA's Electric Power Monthly for July 2013, released in September 2013. Table 3.12-1 shows the total electricity production by state, total electricity production from coal by state, and average retail price of electricity across all sectors of the economy as of July 2013.

Table 3.12-1
Electricity Production and Costs by Region and by State

Census Division and State	Net Electricity Production by State - All Sectors (Thousand Megawatt hours)	Net Electricity Production From Coal by State - All Sectors (Thousand Megawatt hours)	Average Retail Price of Electricity - Al Sectors (Cents per Kilowatt hour)
	July 2013	**July 2013**	**July 2013**
New England	**12,545**	**857**	**14.25**
Connecticut	3,488	96	15.55
Maine	1,267	2	11.90
Massachusetts	4,388	587	14.54
New Hampshire	1,961	172	14.14
Rhode Island	805	--	10.78
Vermont	637	--	14.46
Middle Atlantic	**43,188**	**10,041**	**13.94**
New Jersey	6,848	263	14.85
New York	14,329	613	17.08
Pennsylvania	22,010	9,165	10.08
East North Central	**57,687**	**35,208**	**9.74**
Illinois	18,075	7,812	8.12

Census Division and State	**Net Electricity Production by State - All Sectors (Thousand Megawatt hours)**	**Net Electricity Production From Coal by State - All Sectors (Thousand Megawatt hours)**	**Average Retail Price of Electricity - Al Sectors (Cents per Kilowatt hour)**
	July 2013	**July 2013**	**July 2013**
Indiana	10,669	9,091	8.81
Michigan	9,906	5,371	11.99
Ohio	12,435	8,631	9.72
Wisconsin	6,602	4,302	11.13
West North Central	**30,975**	**21,671**	**10.03**
Iowa	5,195	3,509	9.10
Kansas	4,882	3,038	10.13
Minnesota	4,427	2,103	10.18
Missouri	8,922	7,467	10.77
Nebraska	3,480	2,581	9.79
North Dakota	3,131	2,627	8.61
South Dakota	939	256	9.40
South Atlantic	**73,992**	**27,175**	**10.08**
Delaware	977	220	10.80
District of Columbia	NM	0	12.01
Florida	21,014	4,701	10.36
Georgia	11,821	4,475	10.30
Maryland	3,923	1,865	12.02
North Carolina	12,394	4,974	9.56
South Carolina	9,088	2,178	9.57
Virginia	8,149	2,442	9.37
West Virginia	6,619	6,319	7.94
East South Central	**34,191**	**15,395**	**9.21**
Alabama	13,705	4,268	9.51
Kentucky	7,851	7,085	7.99
Mississippi	5,418	1,059	9.51
Tennessee	7,218	2,984	9.80
West South Central	**66,300**	**23,589**	**8.94**
Arkansas	5,671	3,207	8.31
Louisiana	9,747	1,957	8.43
Oklahoma	7,537	3,030	8.38
Texas	43,345	15,395	9.23
Mountain	**37,007**	**18,329**	**10.02**
Arizona	11,919	3,911	11.21
Colorado	5,127	3,136	10.40
Idaho	1,736	NM	8.22
Montana	2,327	1,083	8.85
Nevada	4,046	636	10.29
New Mexico	3,323	2,205	10.12
Utah	3,905	3,108	8.88
Wyoming	4,623	4,242	7.40
Pacific Contiguous	**36,521**	**888**	**13.33**

Census Division and State	Net Electricity Production by State - All Sectors (Thousand Megawatt hours)	Net Electricity Production From Coal by State - All Sectors (Thousand Megawatt hours)	Average Retail Price of Electricity - Al Sectors (Cents per Kilowatt hour)
	July 2013	**July 2013**	**July 2013**
California	20,425	159	15.98
Oregon	4,819	6	8.43
Washington	11,277	723	6.98
Pacific Noncontiguous	**1,349**	**178**	**26.87**
Alaska	487	46	17.06
Hawaii	861	131	32.49
U.S. Total	**393,753**	**153,330**	**10.71**

NM = Not meaningful due to large relative standard error or excessive percentage change.
Notes: Values for 2013 are preliminary. Totals may not equal sum of components because of independent rounding.

Source: U.S. EIA, 2013g. Tables 1.6.A, 1.7.A, and 5.6.A; Electric Power Monthly, September 2013, with data for July 2013, U.S. Department of Energy.

A review of data in Table 3.12-1 (above) shows that while the average retail price for electricity across all sectors of the U.S. economy was 10.71 cents per kilowatt hour, the regional and state variations in this price are quite wide. Washington is at the low end of the spectrum at 6.98 cents per kilowatt hour and Hawaii is at the high end at 32.49 cents per kilowatt hour. The data further reveals that on a state-by-state basis, coal is of widely varying importance to the production of electricity. On the low end of the spectrum, coal is not used to produce electricity in Vermont or Rhode Island while, on the high end of the spectrum, coal is used to produce 95 percent of the electricity generated in West Virginia.

3.12.2 Appalachian Basin Coal Region Transportation

The Appalachian Basin spans eight states: Maryland, Ohio, Pennsylvania, West Virginia, Kentucky, Virginia, Alabama, and Tennessee. It is subdivided into smaller coal regions: North, Central, and South, the distinguishing factor primarily being the sulfur content of the coal. Table 3.12-2 shows the number of short tons of coal originating in each of these states in the year 2012 (U.S. EIA, 2012d).

Table 3.12-2
Short Tons of Coal Originating in Appalachian Basin States in 2012

Short Tons by State (All Modes)	Total
Alabama	8,974,000
Kentucky (East)	35,598,000
Maryland	2,165,000
Ohio	28,702,000
Pennsylvania	39,071,000
Tennessee	1,276,000
Virginia	10,882,000
West Virginia	74,066,000
Total Short Tons Appalachian Basin	**200,734,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-3 identifies the primary modes of coal transport and historic use of those modes within the Appalachian Basin, based on where the coal originates (U.S. EIA, 2012d).

Table 3.12-3
Primary Modes of Coal Transport by State – Appalachian Basin

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
Appalachian Basin North		
Maryland	Rail	None
	Barge	None
	Road	100
	Other	None
Ohio	Rail	12
	Barge	70
	Road	18
	Other	0
Pennsylvania	Rail	54
	Barge	20
	Road	20
	Other	6
West Virginia	Rail	48
	Barge	39
	Road	5
	Other	8
Appalachian Basin Central		
Kentucky (east)	Rail	85
	Barge	6
	Road	8

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
	Other	1
Virginia	Rail	75
	Barge	5
	Road	11
	Other	9
	Appalachian Basin South	
Alabama	Rail	52
	Barge	28
	Road	20
	Other	None
Tennessee	Rail	97
	Barge	< 1
	Road	3
	Other	None

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

The eastern portion of Kentucky is considered to be part of the Appalachian Basin, while the western portion of Kentucky is considered to be part of the Illinois Basin (and the far western portion is in the Gulf region but no coal is mined in that part of the state). For purposes of this report, transportation statistics have been generated by county. Statistics for Kentucky counties located within the Appalachian Basin are presented in this section, and statistics for Kentucky counties located within the Illinois Basin are presented below.

The transportation requirements of each mode within the Appalachian Basin are summarized below.

3.12.2.1 Rail Requirements

The *National Rail Freight Infrastructure Capacity and Investment Report* prepared for the Association of American Railroads by Cambridge Systematics (2007) provided an assessment of the long-term capacity expansion needs for continental U.S. freight railroads. The report included assessments of current and future demand for rail freight transportation through 2035. For the Appalachian Basin as a whole, train volumes from the year 2005 were below practical capacity (Level of Service (LOS) A, B, and C), with the exception of a small section of rail in northeastern Alabama/southern Tennessee that was near capacity (LOS D).

Without capital improvements, by 2035, it is estimated that the Appalachian Basin as a whole would be composed primarily of rail operating at LOS of A, B, and C (Cambridge Systematics, 2007). Without improvements, by 2035 some areas of west-central Pennsylvania and south-central Kentucky would be downgraded to LOS D (near capacity), and some areas in south-central Tennessee/northern Alabama would be downgraded to LOS F (over capacity). The study concluded that with improvements, the entire Appalachian Basin would be composed of rail operating at LOS A, B, and C, with the exception of a small section of rail in northeastern Alabama/southern Tennessee that would be operating at capacity (LOS E) (Cambridge Systematics, 2007).

The previously referenced the EIA's Quarterly Reports provide details of domestic distribution of U.S. coal by origin state, consumer, destination, and method of transport for the year 2012. Information provided in these reports included that quoted herein regarding usage of rail, barge, and roadway infrastructure for coal transportation in coal-producing regions. The information indicated that mines located in the eight states within the Appalachian Basin shipped nearly 105 million short tons of coal by rail in 2012. This represents approximately 17 percent of the total tonnage of coal shipped by rail nationwide in 2012.

3.12.2.2 Barge Requirements

Mines located in the eight states within the Appalachian Basin shipped nearly 62 million short tons of coal by river in 2012. This represents approximately 59 percent of the total short tons of coal shipped by river nationwide in 2012, making the Appalachian Basin the predominant user of river transportation.

3.12.2.3 Roadway Requirements

Mines located in the eight states within the Appalachian Basin shipped over 24 million short tons of coal by truck in 2012. This represents approximately 36 percent of the total short tons of coal shipped by truck nationwide in 2012.

3.12.3 Colorado Plateau Region Transportation

The Colorado Plateau spans four states: Arizona, Colorado, New Mexico, and Utah. Table 3.12-4 shows the number of short tons of coal originating in each of these states in the year 2012 (U.S. EIA, 2012d).

Table 3.12-4
Short Tons of Coal Originating in Colorado Plateau States in 2012

Short Tons by State (All Modes)	Total
Arizona	7,460,000
Colorado	20,595,000
New Mexico	22,941,000
Utah	15,264,000
Total Short Tons Colorado Plateau	**66,260,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-5 identifies the primary modes of coal transport and historic use of those modes within the Colorado Plateau, based on where the coal originates (U.S. EIA, 2012d).

Table 3.12-5
Primary Modes of Coal Transport by State – Colorado Plateau

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
Colorado Plateau		
Arizona	Rail	91
	Barge	None
	Road	9
	Other	None
Colorado	Rail	85
	Barge	0
	Road	14
	Other	1
New Mexico	Rail	40
	Barge	None
	Road	60
	Other	None
Utah	Rail	42
	Barge	None
	Road	44
	Other	14

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

The transportation requirements of each mode within the Colorado Plateau are summarized as follows.

3.12.3.1 Rail Requirements

Data within the *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) showed that within the Colorado Plateau as whole, train volumes for the year 2005 were below practical capacity (LOS A, B, and C) with the exception of northeastern Colorado, where rail was near capacity (LOS D).

Without capital improvements, it is estimated that the rail corridors bisecting New Mexico and Arizona and in northeastern Colorado and southwestern Utah will be operating at LOS F (over capacity) by 2035 (Cambridge Systematics, 2007). The study concluded that with improvements, the entire Colorado Plateau rail system would operate at LOS A, B, and C, with the exception of a small section of rail in southwestern New Mexico (outside the coal-producing region of New Mexico) that would be operating near capacity (LOS D).

Mines located in the four states within the Colorado Plateau shipped nearly 40 million short tons of coal by rail in 2012. This represents approximately seven percent of the total tonnage of coal shipped by rail nationwide in 2012. Within the Colorado Plateau, rail is the predominant mode of coal transport; more than 50 percent more coal is shipped by rail (40 million short tons) than by all other modes of transport in this region (26 million short tons).

3.12.3.2 Barge Requirements

Mines located in the four states within the Colorado Plateau did not record shipments of coal by river in 2012.

3.12.3.3 Roadway Requirements

Mines located in the four states within the Colorado Plateau shipped over 23 million short tons of coal by truck in 2012. This represents approximately 23 percent of the total short tons of coal shipped by truck nationwide in 2012.

3.12.4 Gulf Coast Region Transportation

Over 99 percent of current mining in the Gulf Coast region occurs within the states of Louisiana, Mississippi, and Texas. Table 3.12-6 shows the number of short tons of coal originating in each of these states in 2012.

Table 3.12-6
Short Tons of Coal Originating in Gulf Coast States in 2012

Short Tons by State (All Modes)	Total
Louisiana	3,961,000
Mississippi	3,185,000
Texas	43,215,000
Total Short Tons Gulf Coast	**50,361,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-7 identifies the primary modes of coal transport and historic use of those modes within the Gulf Coast, based on where the coal originates (U.S. EIA, 2012d).

The transportation requirements of each mode within the Gulf Coast are summarized as follows.

Table 3.12-7
Primary Modes of Coal Transport by State – Gulf Coast

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
Louisiana	Rail	None
	Barge	None
	Road	16
	Other	84
Mississippi	Rail	4
	Barge	None
	Road	96
	Other	None
Texas	Rail	35
	Barge	None
	Road	36
	Other	294

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

3.12.4.1 Rail Requirements

Data within the *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) showed that within the Gulf Coast, as a whole, train volumes from the year 2005 were already at capacity (LOS A, B, and C) or near capacity (LOS D). Areas of southwestern Texas and southwestern Louisiana contain the bulk of lines nearing capacity (LOS D). Areas in northern Mississippi/ southwestern Tennessee are above capacity (LOS F).

Without capital improvements, it is estimated that most of the rail corridors along the Gulf Coast will be operating at LOS F (over capacity) by 2035 (Cambridge Systematics, 2007). The study concluded that with improvements, the entire Gulf Coast would be composed of rail operating at LOS A, B, and C (Cambridge Systematics, 2007).

Mines located in the three states top producing states within the Gulf Coast shipped over 15 million short tons of coal by rail in 2012, most of which originated in Texas. Approximately 120 thousand tons originated in Mississippi. This represents approximately two percent of the total tonnage of coal shipped by rail nationwide in 2012.

3.12.4.2 Barge Requirements

Mines located in the three top producing states within the Gulf Coast coal region did not record shipments of coal by river in 2012.

3.12.4.3 Roadway Requirements

Mines located in the three top producing Gulf Coast states shipped over 19 million short tons of coal by truck in 2012. This represents approximately 20 percent of the total short tons of coal shipped by truck nationwide in 2012. This is the preferred method of coal transportation in the Gulf Coast region.

3.12.5 Illinois Basin Region Transportation

The Illinois Basin spans three states: Illinois, Indiana, and western Kentucky. Table 3.12-8 shows the number of short tons of coal originating in each of these states in the year 2012.

Table 3.12-8
Short Tons of Coal Originating in Illinois Basin States in 2012

Short Tons by State (All Modes)	Total
Illinois	32,856,000
Indiana	34,983,000
Kentucky (West)	39,052,000
Total Short Tons Illinois Basin	**106,891,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-9 identifies the primary modes of coal transport and historic use of those modes within the Illinois Basin, based on where the coal originates (U.S. EIA, 2012d).

The transportation requirements of each mode within the Illinois Basin are summarized as follows.

Table 3.12-9
Primary Modes of Coal Transport by State – Illinois Basin

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (Approximate percentage of coal transported by rail, barge, or road-sorted by state of origin)
Illinois	Rail	33
	Barge	47
	Road	10
	Other	10
Indiana	Rail	69
	Barge	13
	Road	19
	Other	<1
Kentucky (West)	Rail	35

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (Approximate percentage of coal transported by rail, barge, or road-sorted by state of origin)
	Barge	48
	Road	18
	Other	< 1

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

3.12.5.1 Rail Requirements

Data within the *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) showed that within the Illinois Basin as a whole, train volumes from the year 2005 were below capacity (LOS A, B, and C), with the exception of notable river crossings where they were near or at capacity (LOS D and E). Rail transport within the northeast Illinois region was at capacity (LOS E).

Without capital improvements, by 2035 the study estimates that most of the Illinois Basin will be downgraded to at or above capacity (LOS E and F) (Cambridge Systematics, 2007). The study concluded that, with improvements, the entire Illinois Basin would be composed of rail operating at LOS A, B, and C (Cambridge Systematics, 2007).

Mines located in the three states within the Illinois Basin shipped over 48 million short tons of coal by rail in 2012. This represents approximately eight percent of the total tonnage of coal shipped by rail nationwide in 2012. Rail is the predominant mode of coal haul from Indiana.

3.12.5.2 Barge Requirements

Mines located in the three states within the Illinois Basin shipped slightly more than 38 million short tons of coal by river in 2012. This represents approximately 37 percent of the total short tons of coal shipped by river nationwide in 2012. Barge is the predominant mode of coal haul from Illinois and western Kentucky.

3.12.5.3 Roadway Requirements

Mines located in the three states within the Illinois Basin shipped slightly less than 17 million short tons of coal by truck in 2012. This represents approximately 17 percent of the total short tons of coal shipped by truck nationwide in 2012. In Illinois, approximately ten percent of the coal produced in the state is shipped over public roadways.

3.12.6 Northern Rocky Mountains and Great Plains Region Transportation

The Northern Rocky Mountains and Great Plains region spans Montana, North Dakota, and Wyoming. Table 3.12-10 shows the number of short tons of coal originating in each of these states in the year 2012.

Table 3.12-10
Short Tons of Coal Originating in Northern Rocky Mountains and Great Plains States in 2012

Short Tons by State (All Modes)	Total
Montana	20,147,000
North Dakota	27,720,000
Wyoming	402,671,000
Total Short Tons Northern Rocky Mountains and Great Plains	**450,538,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-11 identifies the primary modes of coal transport and historic use of those modes within the Northern Rocky Mountains and Great Plains, based on where the coal originates (U.S. EIA, 2012d).

Table 3.12-11
Primary Modes of Coal Transport by State – Northern Rocky Mountains and Great Plains

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
Montana	Rail	59
	Barge	0
	Road	2
	Other	39
North Dakota	Rail	10
	Barge	None
	Road	41
	Other	49
Wyoming	Rail	96
	Barge	1
	Road	< 1
	Other	3

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

The transportation requirements of each mode within the Northern Rocky Mountains and Great Plains are summarized as follows.

3.12.6.1 Rail Requirements

Data within the *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) showed that within the Northern Rocky Mountains and Great Plains region as a whole, train volumes from the year 2005 were below practical capacity (LOS A, B, and C), with the exception of a small section of rail in southeastern Montana that was near capacity (LOS D).

Without capital improvements, by 2035 it is estimated that the Northern Rocky Mountains and Great Plains will experience rail operations at or above capacity (LOS E and F) for much of the region (Cambridge Systematics, 2007). The 2007 study concluded that, with improvements, the entire Northern Rocky Mountains and Great Plains area would be composed of rail operating at LOS A, B, and C, with the exception of a portion of northeastern Wyoming that would operate near capacity (LOS D) (Cambridge Systematics, 2007).

Mines located in the three states within the Northern Rocky Mountains and Great Plains shipped over 401 million short tons of coal by rail in 2012. This represents approximately 66 percent of the total tonnage of coal shipped by rail nationwide in 2012. Wyoming is the predominant source of coal within the region (and the U.S.), with over 95 percent of coal originating in Wyoming shipping by rail.

The Powder River Basin in the Northern Rocky Mountains and Great Plains is the principal source of coal originating on both the BNSF and UP railroads. More than 90 percent of all BNSF's coal tons originate from the Powder River Basin. UP also ships coal from other coal regions, including the Colorado Plateau (Colorado and Utah) and the Illinois Basin (Illinois) (NETL, 2010).

3.12.6.2 Barge Requirements

Mines located in two of the three states within the Northern Rocky Mountains and Great Plains use barge transportation. Montana and Wyoming shipped coal by barge (4.1 million short tons). This represents approximately four percent of the total short tons of coal shipped by river nationwide in 2012.

3.12.6.3 Roadway Requirements

Mines located in the three states within the Northern Rocky Mountains and Great Plains shipped slightly less than 13 million short tons of coal by truck in 2012. This represents approximately 13 percent of the total short tons of coal shipped by truck nationwide in 2012.

3.12.7 Northwest Region Transportation

Although the Northwest region includes the states of Oregon, Washington, and Alaska, there are no currently producing mines in Oregon or Washington. Consequently, this discussion will focus on the state of Alaska. There is currently one coal-producing area in this region, which is located in Alaska. Table 3.12-12 shows the number of short tons of coal originating from the region in 2012.

Table 3.12-12
Short Tons of Coal Originating in Northwest Region in 2012

Short Tons by State (All modes)	Total
Alaska	956,000
Total Short Tons Northwest	**956,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-13 identifies the primary modes of coal transport and historic use of those modes within the Northwest, based on where the coal originates (U.S. EIA, 2012d).

Table 3.12-13
Primary Modes of Coal Transport by State – Northwest

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (Approximate percentage of coal transported by mode by state of origin)
Alaska	Rail	87
	Barge	None
	Road	13
	Other	None

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

The transportation requirements of each mode within the Northwest region are summarized as follows.

3.12.7.1 Rail Requirements

Rail was the predominant mode of coal haul within the Northwest region. Mines located in the Northwest shipped 828,000 short tons of coal by rail in 2012. Coal was shipped by the Alaska Railroad Corporation to the coal loading facility in Seward, Alaska. Coal produced in this region represents less than 0.1 percent of the total short tons of coal shipped by rail nationwide in 2012. Rail congestion data for Alaska were not available in the Cambridge Systematics 2007 report, which covers only the lower 48 states.

3.12.7.2 Barge Requirements

Mines located within the Northwest region did not record shipments of coal by river in 2012.

3.12.7.3 Roadway Requirements

Mines located in the Northwest shipped 128,000 short tons of coal by truck in 2012. This represents less than 0.5 percent of the total short tons of coal shipped by truck nationwide in 2012.

The interstate shipment of coal produced in Yukon-Koyukuk County, Alaska, is limited by huge distances, difficult climate and topography, and numerous environmental, socioeconomic, and economic limitations. Yukon-Koyukuk County is roughly the same size as the relatively large state of Montana, and the population density is less than one person per 20 square miles. The only road connecting to the remainder of the state is State Route 11, with 40.6 miles of interstate and arterial road in the census area connecting south to Fairbanks and the Dalton Highway. Roads are gradually being built throughout Alaska, and coal extraction and truck transport is expected to be made more viable as road resources increase.

3.12.8 Western Interior Region Transportation

The Western Interior region spans four states: Arkansas, Kansas, Missouri, and Oklahoma. The region is subdivided into smaller coal regions, the distinguishing factor primarily being sulfur content of the coal. Table 3.12-14 shows the number of short tons of coal originating in each of these states in the year 2012.

Table 3.12-14
Short Tons of Coal Originating in Western Interior States in 2012

Short Tons by State (All Modes)	Total
Arkansas	106,000
Kansas	18,000
Missouri	310,000
Oklahoma	755,000
Total Short Tons Other Western Interior	**1,189,000**

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

Table 3.12-15 identifies the primary modes of coal transport and historic use of those modes within the Western Interior region, based on where the coal originates (U.S. EIA, 2012d).

Table 3.12-15
Primary Modes of Coal Transport by State – Other Western Interior

Originating Coal Haul State	Originating Mode of Transport	Statistics for Primary Modes of Coal Transport (approximate percentage of coal transported by mode by state of origin)
Arkansas	Rail	None
	Barge	None
	Road	100
	Other	None
Kansas	Rail	None
	Barge	None
	Road	100
	Other	None
Missouri	Rail	None
	Barge	None
	Road	100
	Other	None
Oklahoma	Rail	35
	Barge	None
	Road	65
	Other	None

Source: U.S. EIA, 2012d. Domestic Distribution of U.S. Coal by Origin States, Consumer, Destination and Method of Transportation, 2012 Quarterly Reports.

The transportation requirements of each mode within the Other Western Interior region are summarized as follows.

3.12.8.1 Rail Requirements

The Western Interior serves as a major junction of freight rail. Central sections are currently near or at capacity (LOS D and E). Without capital improvements, the *National Rail Freight Infrastructure Capacity and Investment Study* (Cambridge Systematics, 2007) has estimated that rail conditions in the Other Western Interior will continue to degrade, with central sections being downgraded to at or above capacity (LOS E and F) by 2035. The study concluded that, with improvements, Western Interior would operate at levels similar to those of the present day (Cambridge Systematics, 2007).

Mines located in the four states within the Western Interior shipped approximately 261,000 short tons of coal by rail in 2012. This represents less than 0.05 percent of the total tonnage of coal shipped by rail nationwide in 2012.

3.12.8.2 Barge Requirements

Mines located within the Western Interior region did not record shipments of coal by river in 2012.

3.12.8.3 Roadway Requirements

Mines located in the four states within the Western Interior shipped slightly less than one million short tons of coal by truck in 2012. This represents approximately one percent of the total short tons of coal shipped by truck nationwide in 2012. Truck transport was the predominant mode of coal haul with the region.

3.13 ARCHAEOLOGY, PALEONTOLOGY AND CULTURAL RESOURCES

Historic and archaeological resources are sometimes broadly categorized as "cultural resources." Cultural resources consist of prehistoric and historic districts, sites, structures, artifacts, and other physical evidence of human activities considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Prehistoric and historic archaeological resources are locations where human activity measurably altered the earth or left deposits of physical remains. Typical environments in which archaeological resources can be found include rock shelters, terraces, floodplains, and ridge tops. Architectural and historic period resources, which may include dams, bridges, and other structures having historic or aesthetic importance, generally must be older than 50 years to be considered for protection under existing federal cultural resource laws. Cultural resources that may be present within mine sites include cemeteries, historical sites and structures, archeological sites, public parks, Native American burial mounds, and other features of cultural significance to surrounding communities (U.S. EPA et al., 2003).

For the purposes of this discussion, "paleontological resources" are distinct from archaeological resources. Specifically, paleontological resources are "any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth" (NPS, 2009a).

3.13.1 Appalachian Basin Region

3.13.1.1 Paleontology

The potential for paleontological resources is almost entirely dependent on the type and age of geological formations present in a specific region. A more thorough discussion of regional geology is presented in Section 3.2. Though regional geologic trends occur, each state, and even specific areas within each state can contain significantly different paleontological resources. The preservation of plant and animal fossils depends on a variety of circumstances. However, the speed with which they were covered and the nature of the covering materials often determine the quality of preservation, if any. Generally, the types of fossils encountered by coal mining include plants (such as ferns and trees) in the coal seams and scattered fossils of Tertiary age in the overburden. The following information on paleontological resources in each Appalachian Basin state was compiled from the Paleontology Portal Website (National Science Foundation et al., 2003).

Alabama

Paleontological resources in Alabama range from Late Cambrian to Quaternary in age, with gaps during the Precambrian, Jurassic, and Triassic. The first fossils of note in Alabama are Late Cambrian in age. Fossils from these periods can be found throughout northern Alabama and reflect the marine environment of Alabama at the time. The Devonian is less represented in Alabama's fossil record. The Mississippian saw a return to life-filled seas, and crinoids and brachiopod fossils are common in rocks of this age. Broad coastal plains that developed during the Pennsylvanian resulted in a wealth of plant and terrestrial fossils that are found throughout the northern portion of the state.

Kentucky

Paleontological resources present in Kentucky range from Ordovician to Tertiary in age, with a gap from the Permian through the Jurassic. Shallow tropical seas covered most of Kentucky from the Ordovician to the Pennsylvanian. Pennsylvanian rocks are present in the Eastern and Western Coal fields and may have once covered much of the state. Peat deposits during this age are responsible for the coal beds, and the fluctuating sea levels resulted in a variety of both marine and terrestrial fossils.

Maryland

Paleontological resources in Maryland span nearly the entire known range for fossil remains, with the exception of the Precambrian and possibly the Permian. Beginning in the Cambrian and lasting through much of the Ordovician, much of Maryland was covered by a shallow warm sea. By the Late Paleozoic Mississippian and Pennsylvanian Periods, fluctuating sea levels and mountain building events had created extensive swamps, low coastal regions, and a continuation of shallow seas. Fossils from these ages are found predominantly in the extreme western edge of the panhandle, coincident with coal-bearing land. These fossils include brachiopods, bivalves, and bryozoans from the marine deposits and horsetail rushes and scale trees from the terrestrial deposits.

Ohio

The majority of paleontological resources from Ohio are Cambrian to Permian in age, with later Quaternary also known from the Ordovician through the Mississippian. Nearly the entire state was covered by a shallow sea, with fluctuating levels of mud as a result of mountain building to the east. Fossils from these periods are found in the eastern half of the state (including coal-bearing lands) and include a variety of marine organisms such as brachiopods, bryozoans, corals, crinoids, trilobites, gastropods, and cephalopods. Permian plant fossils in southern parts of the state commonly include horsetails and ferns.

Pennsylvania

Paleontological resources in Pennsylvania are similar to those in much of the Appalachian Basin. Paleozoic fossils are well represented, and include both marine and terrestrial plants and animals. Delta creation continued into the Pennsylvanian, and included the development of extensive swamps. Pennsylvanian age rocks are found extensively throughout the western half of the state and contain fossil deposits that include amphibians and plants such as scale trees, ferns, and horsetail rushes.

Tennessee

Tennessee's paleontological resources include fossils from Cambrian to Quaternary in age, with an erosional gap in the record in the Early Mesozoic. Devonian and Mississippian age rocks with a similar range of fossils are present in the western and central portions of the state, respectively. Beginning in the Pennsylvanian, mountain building to the east transformed the shallow seas that had covered most of the state into vast deltas and coastal swamps. Fossils from this period include scale trees, horsetail rushes, and other plants.

Virginia

The paleontological resources of Virginia are Cambrian through Quaternary in age, with a gap in the Permian due to the lack of sedimentary rocks from that period. Virginia was also covered by shallow seas and coastal swamps through much of the Mississippian and Pennsylvanian Periods.

West Virginia

The paleontological resources of West Virginia are almost exclusively Paleozoic and Quaternary in age.

Throughout the Carboniferous (Mississippian and Pennsylvanian), fluctuating sea levels and mountain building events to the east resulted in large deltas and swamps in addition to the shallow sea that covered much of West Virginia. Fossils from the Mississippian and Pennsylvanian are exposed over much of the state. They include marine brachiopods, gastropods, blastoids, and bryozoans, freshwater sharks, and terrestrial horsetail rushes and scale trees. Permian rocks are present across the western two-thirds of the state and indicate the development of extensive flood plains as a result of erosion during the mountain-building event that created the Appalachian Mountains. Permian fossils in West Virginia include *Calamites* (related to modern horsetail rushes), ferns, scale trees, amphibians, and tracks from the terrestrial reptile *Dimetrodon.*

3.13.1.2 Archaeology and Cultural Resources

Generally, the history of the various coal regions can be divided into broad categories or cultural manifestations. These divisions cut across state lines and in some cases cross-cut coal regions.

Prehistory

Within the Appalachian Basin, prehistoric peoples occupied various areas within the states of Alabama, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia since at least ca. 10,000 B.C. and as early as ca. 13,000 B.C. (Fagan, 1991). Archaeologists have generally divided the prehistoric period into three broad periods: Paleo-Indian, Archaic, and Woodland. The exact timing of each period differs within each state, but the material manifestations are similar enough to warrant treating the region as a single resource area.

Generally, archaeological resources dating to the Paleo-Indian Period indicate that prehistoric peoples during this period were highly mobile. These people have occupied areas near several large waterways (Fagan, 1991). For example, Paleo-Indian sites clustered in northern Alabama, along the Tennessee River (University of Alabama, 2005) while in Tennessee, artifacts of this time period are found in the Cumberland and Lower Tennessee River valleys (Anderson and Sullivan, n.d.). Sites dating to this period are identified through the presence of such projectile points as Clovis and Folsom points. Other resource associations include isolated finds, simple tool scatters, and rock shelters, as well as some association with large extinct mammals and the occasional camp features (West Virginia Division of Culture and History, 2013a). It is generally believed that subsistence activities included the hunting of large game and gathering of local resources.

The next 7,000 years (8000 to 1500 BC) are characterized by the Archaic Period, in which archaeological sites are more numerous, larger, and more developed. Spring and summer camp sites are located in river valleys (University of Alabama, 2005). Larger base camp sites are found at the fall lines of streams and at estuaries (Maryland ACL, 2009). Archaic Period archaeological resources represent a shift in subsistence practices. This appears to be partly due to climactic shifts. Prehistoric peoples of this period employed a more diversified tool-kit and exploited a larger suite of resources than Paleo-Indian. Adaptive strategies shifted to those focusing on forest resources as woodlands expanded. In addition, hunter-gatherer groups increased in size and in number (Lewis, 1996). In some areas, mounds with burials and grave goods become more elaborate over time. As populations grew, foraging ranges became more restricted and peoples were more sedentary. The bow and arrow was introduced in the area and true farming began to develop (Fagan, 1991; Ohio History Central, n.d.). Pottery use becomes more common.

Evidence of human occupation and activity during the Eastern Woodland Period, lasting from approximately 1000 B.C. to A.D. 1650 is evident in West Virginia and much of the eastern U.S. and Canada (Fagan, 1991). Woodland Period peoples continued the trend toward fidelitly to living in one place for a long time. Settlements were clustered along the banks of large and small rivers (University of Alabama, 2005; Fagan, 1991). Maize became the most important food crop, and most people lived in large, often stockaded settlements (Ohio History Central, n.d.). Village sites become common as did the use of bow and arrow and an increased reliance on agriculture. In addition, burials become more complex and earthen structures appeared. Woodland Period archaeological sites in Pennsylvania date from 1000 B.C. to A.D. 1550. From A.D. 1000 to 1600 in Tennessee, larger and more stable populations lived in organized villages and ruled through a strong structure of chiefdoms. They built large, flat-topped mounds, worked extensive agricultural fields, and completed other communal projects. Villages, frequently found on high ground on river and stream terraces, were large and included round, oval, and rectangular houses made of wooden post walls, with bark or mat roofing, and the settlements were sometimes palisaded (Pennsylvania Historical & Museum Commission, 2013a). These structures, in the form of mounds and effigies, become more complex and common with time. Grave goods associated with burials indicate expansive trade networks and complex social structures. This culminated in the Mississippian cultures in the Late Woodland Period. The Mississippian Period flourished from A.D. 1000 to 1600 in Virginia with larger and more stable populations living in permanent villages. During this period, social complexity reached the level of low-level chiefdoms. However, the initial exploration of the new world by Euro-Americans and subsequent colonization disrupted and displaced many Late Woodland groups.

Protohistoric-Historic

In general, during the late prehistoric period into the protohistoric, Native Americans came into indirect contact with European goods followed by direct contact with people. At contact, many Indian tribes were in conflict with one another and in turn with the French and English explorers and colonists in the eastern U.S.and the Spanish in the south and west.

The protohistoric contacts (early Native American contact with Europeans) and the historic period development can be considered unique to each state. Beginning in the early 1500s in the eastern portions of North America and later in the west, European influences directed the development of the country. Broad patterns of exploration, settlement development, transportation development, agricultural and industrial development, and western expansion occurred. The American Revolutionary and Civil wars (as well as other regional wars and conflicts) contributed to formulation of state boundaries and characteristics. State specific protohistory and history overview discussions are presented below.

Alabama

The Alabama territory was occupied by seven different Native American tribes at the time of contact, which was in 1540 when the Spaniard De Soto traveled through the area. These were the Alabama, Biloxi, Cherokee, Chickasaw, Choctaw, Koasati, and Musogee (Creek) tribes (Access Genealogy, 2013a). As of the mid-1500s, the Alabama tribe inhabited a large area in central Alabama, focused on the upper Alabama River (Native Languages of the Americas, 2011a; Access Genealogy, 2013b). The Choctaw Tribe temporarily inhabited southwestern Alabama and hunted there, while most of their territory was in middle and southern Mississippi (Access Genealogy, 2013c). The Koasati lived in north-central and northeastern Alabama, along the Tennessee River. On contact with Europeans, many of the Koasati moved south, to settle along the Coosa and upper Alabama River. The Muscogee (Creek) Tribe lived throughout the eastern one-third of Alabama from at least the 1500s through the early 1800s on the Coosa, Tallapoosa, Chattahoochee, and Ocmulgee rivers (Access Genealogy, 2013d).

When the Spanish expeditions began in the area in the 1500s, occasional battles with the resident Native American tribes occurred. In the early 1700s, the French arrived (Access Genealogy, 2013d; Jackson, 2010). British and American colonial settlement followed. Every historic-period archaeological resource imaginable might be found. Such cultural resources will be frequently located adjacent to streams (Gamble, 1990). Architectural resources in Alabama reflect its history, beginning in the early 1700s, and encompass the many building and structural types built since that time. These include vernacular dwellings such as dogtrot houses, I-houses, Creole cottages, and Spraddle Roof houses, as well as high style Victorian types, Arts and Crafts, modern, and other styles of residential, commercial, industrial, governmental, and military buildings constructed through the mid-twentieth century (Gamble, 1990). In addition, many historic bridges over streams and rivers still stand.

Kentucky

As Euro-American explorers entered the area from Virginia, in search of rivers, Shawnee and Iroquois tribes were the Kentucky area occupants. Shawnee had been established along the Cumberland River since some unknown time before 1770 (Access Genealogy, 2013e; Lazzerini, 2005a). Euro-Americans built their first settlements in Kentucky in the mid 1770s. Kentucky is known for its frontier history and sites, reflecting its early settlement. In settlements, retail shops, churches, public spaces, government buildings, streets, and roads existed. Grist and other kinds of mills driven by water wheels are a particular resource for which streams were integral parts. Their remains will be frequently located adjacent to streams. Architectural resources in the state reflect Kentucky's history, beginning in the late 1600s, and encompass the many building and structural types built since that time. These include single- and double-household log cabins, plantation houses, with associated slave quarters, smokehouses, outhouses, warehouses, packing houses, various kinds of mills, blacksmith shops, workshops, small and middle-sized farm houses, barns, and other outbuildings (Lewis, 1996). Military forts, with associated battlements, trenches, and bridges from the American Revolutionary and Civil Wars may also be present (Lewis, 1996).

Maryland

Maryland's architectural resources reflect its history, beginning in the mid-1600s, and encompass the many building and structural types built since that time. These include vernacular dwellings such as I-houses, tobacco sheds, one-room planter's houses, log cabins, plantation houses, slave cabins, and outbuildings. Maryland also has high-style Colonial, Victorian, Arts and Crafts, modern and other style residential, commercial, industrial, governmental, and military buildings from the eighteenth to the mid-twentieth century (Upton, 1986).

Ohio

Historical and other cultural resources may date back to 1650 in Ohio, at which time French exploration began, quickly followed by the British (Ohio History Central, n.d.). Throughout the 1800s, farms and factories developed, as did transportation systems such as turnpike roads, canals, and railroads. These, plus larger towns and cities established from the late 1800s through the mid-1900s, provide a large body of historic cultural resources in Ohio. Ohio's architectural resources reflect its settlement history, beginning in the mid-1700s, and encompass the many building and structural types built since that time.

Pennsylvania

First contact between the Europeans and the Native Americans of Pennsylvania occurred around 1550 (Pennsylvania Historical & Museum Commission, 2013b). More than six agricultural tribes lived in the region at the time including: Honniasont, Huron, Iroquois (especially Seneca and Oneida), Leni Lenape, Munsee, Shawnee, Susquehannock (Access Genealogy, 2013f). The lifestyles of all the Pennsylvania tribes were similar, as all were village and town dwellers who practiced agriculture, hunting, and trade for their livelihoods.

Pennsylvania's historic period began in 1608, with the visit of Captain John Smith to the Susquehannock tribe. Settlement followed in 1643, with the establishment of two Swedish forts near present-day Philadelphia (U.S. History, 2013). For the past 200 years, every historic-period archaeological resource imaginable might be found, including log cabin foundations and ruins, Native American villages and campsites, quarters, smokehouses, and outbuildings, small and middle-sized farm sites, barns, and towns, villages, roads, trails, bridges, industrial sites, fishing sites, canneries, military sites and battlegrounds from the French and Indian War, Revolutionary War, War of 1812, and Civil War. Such cultural resources will be frequently located adjacent to streams. Sites from the late 1700s to the mid-1900s will also include urban remains, coal- and iron-mining sites, and steel mills. Pennsylvania's architectural resources reflect its history, beginning in the mid-1600s, and encompass the many building and structural types built since that time.

Tennessee

Native Americans in Tennessee were first introduced to Europeans in 1540 (Tennessee4me, 2013). Six tribes occupied the area at the time of contact – the Cherokee, Chickasaw, Koasati, Quapaw, Shawnee, and Yuchi tribes (Native Languages of the Americas, 2011b). All Tennessee tribes were sedentary, farming groups. Archaeological resources from this period include remains of large, walled towns with or without mounds along major rivers. Tennessee's first permanent settlement by Euro-Americans occurred in the early 1770s (Thingstodo.com, 2012; Tennessee Department of State, 2011). Architectural resources reflect Tennessee's history, beginning in the late 1770s, and encompass the many building and structural types built since that time (Murray, 1995).

Virginia

In the late 1500s, Euro-American explorers entered the area in search of rivers, a route to the sea, and trade possibilities. Because most of the Indian tribes of Virginia were forced to leave during the Indian removals of the 1800s, there are currently no federally recognized tribes in Virginia today and very little is known about the tribes at the time of contact (Native Languages of the Americas, 2011c). Jamestown, Virginia, settled in 1607, is America's first permanent English settlement, though the western portions of Virginia, including areas of Virginia with coal, were not settled until the 1700s.

Architectural resources in the state reflect Virginia's history, beginning in the late 1600s, and encompass the many building and structural types built since.

West Virginia

During the Late Prehistoric Period, native tribes began to come into indirect contact with European goods and people. At the time of contact, the Shawnee and the Delaware moved into the Ohio River Valley within West Virginia. Much of the 1600s and 1700s in West Virginia were dominated by warfare between the Iroquois Confederacy and the Shawnee and Delaware tribes. Warfare also existed between the Indian tribes and British, French, and other Colonists. After the Revolutionary War, most Native Americans moved out of West Virginia (West Virginia Division of Culture and History, 2013b). Land grants in West Virginia were first given to loyal supporters of King Charles II in 1669. After the Proclamation of 1763, settlement of West Virginia rapidly increased. During the 1700s most of Euro-American settlers in West Virginia were farmers (West Virginia Division of Culture and History, 2013c).

Architectural resources in the state reflect West Virginia's history, including single-family houses, plantation houses, slave quarters, smokehouses, outhouses, warehouses, packing houses, various kinds of mills, blacksmith shops, workshops, small and middle-sized farmhouses, barns, and other outbuildings.

3.13.2 Colorado Plateau Region

3.13.2.1 Paleontology

Arizona

The fossil record for Arizona begins in the Precambrian with stromatolites found in limestones deposited under shallow marine conditions. Most of the state was covered by shallow seas throughout the Devonian, Mississippian, and Pennsylvanian, and, as a result, a diverse and abundant fossil record is present for these periods.

Fossils for this portion of the Paleozoic include placoderms (armored fish), corals, crinoids, bryozoans, brachiopods, gastropods, and bivalves. Rare plant fossils can also be found in some Devonian age rocks, indicating that some terrestrial environments were present as well.

Colorado

Colorado was covered by a shallow sea through much of the Early and Middle Paleozoic. These seas expanded during the Carboniferous, and mountain building events resulted in the rise of the Ancestral Rockies and the Uncompahgre Range. A rich array of paleontological resources are known from this time, including sharks, trilobites, brachiopods, crinoids, conifers, lycopods, and the huge horsetail *Calamites*. The end of the Paleozoic is marked by a retreat of sea levels; the development of Permian Age fossils can be found in the western half of the state and include track ways from insects and reptiles.

New Mexico

Fossil resources in New Mexico range in age from Cambrian to Quaternary. During the Carboniferous, portions of the state were still covered by shallow seas, but a significant portion of the state was above sea level as an archipelago. Clams, brachiopods, and pelecypods are common marine fossils from this time, while seed ferns and amphibians represent the terrestrial environments.

Utah

Paleontological resources within Utah span the entirety of geologic time since the Precambrian. The Mississippian shales and sandstones in Utah are the most fossiliferous in the state and contain foraminiferans, corals, brachiopods, conodonts, bryozoans, snails, clams, cephalopods, and, more rarely, fish.

3.13.2.2 Archaeology and Cultural Resources

The Colorado Plateau includes Arizona's northeast quarter, the north and west portions of New Mexico, the southwest corner of Colorado and the southeast portion of Utah.

Prehistory

Current archaeological evidence shows that the Paleo-Indian were the first humans to occupy the Colorado Plateau region sometime around 13,000 years ago until about 7,500 years ago (11,000 B.C. to 5500 B.C.). New Mexico is home to both the Clovis and Folsom Paleo-Indian type sites and dozens of these sites have been identified across the region. Cultural resources associated with this period may include open lithic scatters, rock shelters, lake shore camps, and large game butchering sites (Alexander, 2013; Grahame and Thomas, 2002; New Mexico Office of the State Historian, 2013).

The southwestern Archaic Period on the Colorado Plateau begins around 7,500 years ago (5500 B.C.) and is characterized by nomadic hunter-gathers who followed seasonal food sources across the landscape. The Archaic Period persisted for approximately 6,000 years or until about A.D. 400. Potential cultural resources that may be encountered from this period include open lithic scatters, rock shelters, small village sites, pinyon nut gathering sites, and rock art (Grahame and Thomas, 2002). Prehistoric cultural resources in Utah share many characteristics with the rest of the Colorado Plateau as summarized above, and include important caves (Danger Cave, Cowboy Cave, and Hogup Cave), cliff dwellings, and rock art sites.

Following the Archaic is the Late Prehistoric Period, which was dominated by the Anasazi culture on the Colorado Plateau. In Arizona, Hohokam peoples established an agricultural society complete with canals and other irrigation features, and numerous villages such as those at Pueblo Grande, Mesa Grande, and Casa Grande in Coolidge (The Arizona Republic, 2011; Native American Netroots, 2010). To the north, the Anasazi built cliff dwellings and large pueblos such as those at Montezuma's Castle and Navajo National Monument. Prehistoric cultural resources for the states include a wide variety of agricultural and village sites. The Anasazi occupied the Colorado Plateau area from about A.D. 400 to about 1300. Some of the most well-known examples of Anasazi ruins include Chaco Canyon in New Mexico, Pueblo Grande in Arizona, and Mesa Verde in Colorado. Some of the anticipated cultural resources associated with this period include cliff dwellings, kivas, pithouses, large administrative centers, small villages, camps, agricultural fields, rock art, open lithic scatters, and road systems connecting settlements (Hurst, 2013).

Within the Colorado Plateau, five major tribes of Native Americans have occupied the region since the collapse of the Anasazi culture in circa A.D. 1300 to present. Among these five are the Zuni and the Hopi. Both groups are Pueblo people and are considered to be direct descendants of the Anasazi. The Zuni are primarily located in the northwestern portion of New Mexico and have occupied parts of that area since A.D. 400. The Hopi are located in the northeastern portion of Arizona and have made this region their home since circa A.D. 500 (Grahame and Thomas, 2002; Hurst, 2013). The Navajo Indians have occupied most of northern New Mexico, portions of southern Utah, and part of northern Arizona since at least A.D. 1500. Anthropologists consider Navajos to be Apachean people who migrated into the area approximately 500 years ago. The Ute and the Southern Paiute tribes are Numic tribes who are said to have migrated from the southern California area between 500 and 1,000 years ago. At the time of contact with Europeans in the 1500s, the Utes occupied most of Utah and western Colorado. The Southern Paiutes entered the western Colorado Plateau region between 1100 and 1200 A.D. (Grahame and Thomas, 2002). Some of the cultural resources associated with the above ethnographic people include abandoned villages, pithouses, pueblos, agricultural fields, sheep herding camps (later period), pinyon nut gathering sites, resource use sites, and open lithic scatters.

Protohistoric – Historic

The Spanish were the first Europeans to make contact with native people on the Colorado Plateau, beginning in the mid-1500s. The Spanish were the dominant Euro-American influence of the area until the mid-1800s. Mormon settlement began in Utah in 1847. Mining booms gripped portions of southwestern Colorado from the 1870s through the 1890s. Sites expected from this period may include missions, forts, military camps, wagon roads, railroads, town sites, irrigation ditches, outhouse pits, abandoned houses, mill foundations, old mines, cemeteries, cowboy line camps, and telegraph lines (Bauman, 2013; Husband, 2006; Old and Sold, n.d.).

Chapter 4All manner of buildings associated with the history and prehistory of the area may be expected in the region. Architectural styles draw on the varied cultural influences of a given region, including the Spanish, Puebloan, and northern European influences.

Arizona

Spanish explorers, missionaries and settlers came into Arizona from Mexico throughout the sixteenth to nineteenth centuries, bringing with them missions, presidio, pueblos, and ranchos. Mexico controlled Arizona until the end of the Mexican-American War of 1846 to 1848. The railroad arrived in Arizona in 1881, and with it, mass settlement and development. The Roosevelt Dam completed in 1911, Hoover Dam completed in 1935, and the Glen Canyon Dam completed in 1966 typify the reclamation projects that helped develop Arizona desert lands for agricultural and urban uses. Historic age sites include the early missions and forts to more modern constructions.

Colorado

The historic period in Colorado begins with the first Spanish visitors in the late 1700s. Later they established the failed settlement of San Carlos in the south near the city of Pueblo (Ubbelohde et al., 2006). In 1803, the U.S. acquired the territory through the Louisiana Purchase; however, this conflicted with claims held by Spain (Ubbelohde et al., 2006). The early part of the 1800s saw the area that was to become Colorado explored and exploited by trappers and settlers. Trading forts were established near extant Native American populations. After defeating Mexico in the Mexican-American War of 1846 to 1848, the U.S. took control of the southern portion of the state, as well as portions of New Mexico and Arizona. In the late 1840s, gold discoveries fueled interest in the eastern slopes of Colorado. Colorado became a state in 1876. Mining continued to be of great import throughout the late 1800s and was the stimulus for multiple labor disputes and violent uprisings due to working conditions. These disputes were most apparent at coal mining operations where several massacres, such as the one at Ludlow, occurred (Ubbelohde et al., 2006; Whiteside, 1990). Historic age sites may include missions, forts, military camps, wagon roads, railroads, town sites, irrigation ditches, outhouse pits, abandoned houses, mill foundations, old mines, cemeteries, cowboy line camps, and telegraph lines.

New Mexico

The historical period in New Mexico began with the exploration of this region by Francisco Vasquez de Coronado from 1540 to 1542 (World Atlas, 2013; Smithsonian Magazine, 2007; National Humanities Center, 2006). Over 50 years later, Juan de Oñate founded the first permanent European settlement: the San Juan colony on the Rio Grande. As part of New Spain, settlements and towns continued to grow, and during the Mexican War of Independence, the province of New Mexico passed to now-independent Mexico. The Spanish Trail, an important trade route from Los Angeles, California to Santa Fe, New Mexico, was established in 1829. Following the Mexican-American War in 1846 to 1848, portions of what would become the modern state of New Mexico was ceded to the U.S., and for the next 50 years the region saw much conflict between Native Americans, the U.S. government, cattle ranchers, sheepherders, homesteaders, and other settlers. New Mexico became a state in 1912. More modern history includes the establishment of the Los Alamos Research center in 1943, high altitude experiments near Roswell in 1947, and the development of extensive nuclear, solar, and geothermal energy industries. Historical cultural resources in the state range from settlements from the time of Spanish exploration and settlement, to sites related to the nuclear industry.

Utah

Historic age cultural resources in Utah are associated with early exploration and cross-continental travel, Mormon settlement, mining, and other industries. Spanish exploration of Utah began in 1776 with Fathers Silvestre Velez de Escalante and Francisco Atanasio Dominguez, but Euro-American settlement did not begin in earnest until the 1820s through the 1840s when fur trappers and traders moved into the region, and overland routes such as the Old Spanish Trail were established (State of Utah, 2013). Mormon settlement began in Utah in 1847. Manti, Utah was the first of numerous Mormon settlements on the Colorado Plateau, settled in 1849. Silver and lead were discovered in Bingham Canyon in 1863, though open pit mining did not begin until 1906. In 1869, the Union Pacific and Central Pacific Railroad Lines met at Promontory, and, in 1896, Utah became the 45th state.

3.13.3 Gulf Coast Region

3.13.3.1 Paleontology

Louisiana

Carboniferous age fossils from mollusks, crinoids, brachiopods, and trilobites are known to exist in gravels that eroded and were deposited in rivers. Shallow seas and coastal plains dominated the Tertiary landscape, and fossil camels, mastodons, and other mammal fossils are known to exist throughout the state.

Mississippi

Paleontological resources in Mississippi are known from the Late Devonian through the Quaternary, with significant gaps in the Late Paleozoic and Early Mesozoic.

Fossils from the Tertiary can be found throughout the central portion of the state. Marine fossils from this time include mollusks, whales, sharks, bony fish, and dugongs. Fossils of shells of various terrestrial and freshwater snails and other mollusks, and fossil of manatees, hippos, and the short-faced bear have been recovered from Quaternary loess deposits throughout the state.

Texas

Paleontological resources from Texas are known from the Cambrian to the Quaternary. During the Paleozoic, Texas was covered by a shallow sea. Cambrian rocks contain trilobites, brachiopods, bivalves, sponges, gastropods and bryozoans. Late Carboniferous (Pennsylvanian) fossils are exposed in north-central Texas and commonly contain brachiopods, trilobites, gastropods, corals, and other marine organisms. Rocks from the Permian are also well exposed in the north-central portion of the state and contain fossil evidence of marine invertebrates such as brachiopods, and terrestrial vertebrates such as *Dimetrodon* and other reptiles, amphibians, and sharks.

Mammalian diversity exploded in the Tertiary, and this can be seen in the fossil record from this time.

3.13.3.2 Archaeology and Cultural Resources

Prehistory

The archaeological pattern within the Gulf Coast region can be characterized by an increase in sedentism and material complexity. Several archaeological periods have been identified within the states of Louisiana, Mississippi, and Texas. All three states have Paleo-Indian sites dating to ca. 10,000 B.C. Due to decay, erosion and the changing geography and environment, Paleo-Indian sites are not common (Neuman and Hawkins, 1993). Following the Paleo-Indian Period, the archaeological record reflects a more diversified subsistence strategy.

In Louisiana, the archaeological record links to three overlapping periods: (1) Paleo-Indian (12,000 to 6000 B.C.), (2) Meso-Indian (6500 to 2000 B.C.), and (3) Neo-Indian (2500 to 1500 A.D.). The Meso-Indian culture lived in small nomadic hunter gatherer groups. According to radiocarbon dating, samples from Louisiana Meso-Indian mound sites are the earliest mounds in North America (Neuman and Hawkins, 1993).

The Neo-Indian culture (2000 B.C. to 1100 A.D.) is distinguished by population expansion, a more sedentary lifestyle, stone and ceramic vessels, and many decorative ceremonial objects (Neuman and Hawkins, 1993; Gregory and Webb, 1990). They produced refuse piles called shell middens, which is a very valuable and informative resource in the archaeological record (Gibson, 1996). Around, 2,000 years ago during the Woodland Period, the Hopewell (Mound building) culture dominates in the Mississippi area. The Mississippian Period is characterized by large temple mounds denoting ceremonial sites that appear, along with extensive villages, multilevel societies called chiefdoms, agriculture, trade and gradually increasing warfare (Morgan, 2002; Mississippi Department of Archives and History, n.d.). Within Texas, complexity is not as great. The Late Prehistoric Period (A.D. 700 to 1500) is particularly noticeable in archaeological sites across the state, with the period more similar to the Plains Village site of the Western Interior region. Long distance trade, best reflected in the distribution of artifacts made of obsidian, a material that does not occur naturally in the region, is one distinctive aspect of the period (Thomas and Turner, 2013).

Protohistoric - Historic

Louisiana

The first descriptions of Louisiana Indians are contained in accounts kept by members of Hernando De Soto's Spanish expedition in the 1540s. The next recorders of Indian life were the French in the 1700s. Some of the historic tribes first encountered by Euro-Americans were the Caddo, the Tunica, the Natchez, the Houma, the Atakapa, the Choctaw, and the Chitimacha. Several of Louisiana's present-day Indian tribes, such as the Tunica-Biloxi, Choctaw, and Koasati entered the state in the second half of the eighteenth century (Gregory and Webb, 1990; KnowLA Encyclopedia of Louisiana, 2013).

In 1714, the town of Natchitoches (along the Red River in present-day northwest Louisiana) was established by Louis Juchereau de St. Denis, making it the oldest permanent European settlement in the Louisiana Purchase territory. Major historical conflicts affecting the development of the state of Louisiana include the War of 1812, the Seminole Indian War, the Mexican-American War (1846 to 1848) and the U.S. Civil War (1861 to 1865). These activities left a very rich historical archaeological record, including colonial French, English, and Spanish fortification and settlement, European/Native American trade (glass beads, salt, horses, etc.), Euro-American homesteading, railroading, logging, and petroleum activities (Gregory and Webb, 1990; KnowLA Encyclopedia of Louisiana, 2013). In Louisiana, historic buildings and examples of many classic and unusual architectural styles are abundant. Architectural styles throughout the state include French Creole, Spanish Colonial, Antebellum, Greek Revival, Gothic Revival, Italianate, East Lake, Queen Anne Revival, Beaux Arts, Neoclassical, Bungalow, Hispanic Revival, Empire and Art Deco. Some of the region's common house styles are the Planter's cottage, Dog Trot or Dog Run house, the Shotgun house, and wood plank or log cabins (Fricker et al., 1998; Reichard, 2013).

Mississippi

The first European contact with Native Americans in the present-day state of Mississippi occurred in 1540 when the Spanish explorer Hernando De Soto entered the region in a search for gold, wintering with the Chickasaw tribe. Next, in the late 1670s, French Canadians sailed down the Mississippi River and into the area from the north. By that time, disease had killed thousands of natives, and in the early 1700s the French encountered what may have been the last mound cultures in the Mississippi delta, the Natchez tribe (Lamendola, n.d.). High points in Mississippi history include the French and Indian War (1754 to 1763), the completion of Spanish withdrawal from Mississippi territory (1798), the War of 1812 (1812 to 1815), and statehood in 1817. This state has a rich historical archaeological context including Colonial French, Spanish, and English fortification and colonization, Euro-American homesteading (Territorial Period), railroading, and logging activities (Mississippi Department of Archives and History, 2010; Lamendola, n.d.; Mississippi Department of Archives and History, 2013). Mississippi architecture encompasses a wide spectrum of significant buildings ranging from pioneer log and plank cabins, Antebellum, to Art Deco skyscrapers (Lamendola, n.d.). The first permanent house form in Mississippi is the Creole Cottage. Some of the region's other historic house styles are the Planter's Cottage, the Dog Trot or Dog Run house, and the Shotgun house (Sanders, 2009).

Texas

First contact of Native American and European peoples in the present day region of Texas was the result of European exploration of the Gulf area. Spanish and French parties accessed the region from the Gulf of Mexico on mapping and military expeditions. Later, throughout the 18th century, Spain continuously established Catholic missions throughout the region, which in many cases resulted in first contact with many Indian tribes who occupied the region between the Rio Grande to the south and the Red River to the north (Lone Star Junction, 2009).

The earliest documented settlements in present day Texas are the Spanish mission Isleta (1681) in modern day El Paso, followed by the French Fort St. Louis (1685) on the Gulf Coast. Aproximately ten years after Texas won its independence from Mexico, it was annexed to the U.S. in 1846. The U.S.-Mexian war began shortly after because of disagreements about the definition of the boarder between Texas and Mexico. Two years later, the signing of the Treaty of Guadalupe-Hidalgo ended the war, and Mexico officially recognized Texas as part of the U.S. (Bullock Museam, 2015). Agriculture, logging, and ranching flourished throughout the 1800s, and oil was discovered in January of 1901 at the Spindletop field near Beaumont, adding considerably to the archaeological record (Lone Star Junction, 2009).

Historic Texas architecture reflects a variety of cultural influences from a long period of colonization and settlement, organized into six distinct periods from pre-colonial to modern (Robinson, 2013).

3.13.4 Illinois Basin Region

3.13.4.1 Paleontology

Illinois

Paleontological resources for Illinois range in age from Cambrian to Quaternary in age, with a gap in the fossil record of the Mesozoic. During the Mississippian, sea levels fluctuated across the state. In the Pennsylvanian, Illinois was covered by a large delta and extensive swamps. The fossils from this time include ferns, seed ferns, and extinct relatives of spiders, millipedes, giant dragonflies, jellyfish, shrimp, horseshoe crabs, clams, sharks, brachiopods, and bony fishes.

Indiana

Paleontological resources for much of the Paleozoic and Cenozoic are present within the state of Indiana. A shallow sea covered much of the state during the Early and Middle Paleozoic, with more terrestrial environments developing during the Carboniferous. Large reefs are common from the Silurian in Indiana. During the Carboniferous, swamps and deltas developed along with the shallow sea, allowing for the preservation of both marine and terrestrial fossils. These include crinoids, bryozoans, brachiopods, gastropods, bivalves, lycopods, Cordaites (conifer relatives), and seed ferns and are exposed in wide swaths across the northern and western portions of the state.

Kentucky

A description of the paleontological resources in Kentucky can be found in Section 3.13.2.1.

3.13.4.2 Archaeology and Cultural Resources

Prehistory

The prehistory of the Illinois Basin region can generally be separated into four major prehistoric traditions that are shared by much of the eastern U.S. These traditions are the Paleo-Indian Tradition, the Archaic Tradition, the Woodland Tradition, and the Mississippian Tradition. The oldest of these begins with the oldest human occupations in the area from at least 10,000 B.C., and lasts until about 8000 B.C. Sites in the Illinois Basin from this tradition are likely to be limited to isolated fluted points, often found on erosional surfaces and older landforms (Keller, 1993).

The Archaic Tradition (8000 B.C. to 1000 B.C.) is mostly characterized by widespread changes, particularly increased population, broadened subsistence strategies, increased technological sophistication, and greater residential stability (Keller, 1993). Sites from this period reflect these changes and commonly include rock shelters, shell mounds, cemetery areas, and residential campsites.

The greatest factors that distinguish the Archaic Tradition from the Woodland Tradition (1000 B.C. to A.D. 900) are the addition of pottery and the increase and spread of burial mounds and other ceremonial practices (Keller, 1993). Other important shifts during this period in the Illinois Basin region include the use of the bow and arrow by A.D. 700 and the emergence of agriculture, maize in particular, by A.D. 900 (Fowler and Hall, 1978). Most of the burial mounds in Indiana are associated with the Woodland Tradition (1000 B.C. to A.D. 900) (Kellar, 1998). Artifacts from this period reflect increased craft specialization and ceremonialism, as well as the expansion of trade networks (Keller, 1993).

The Mississippian Tradition (A.D. 900 to 1600) in the Illinois Basin is dominated by the influence of the Cahokia site in western Illinois, near St. Louis (Fowler and Hall, 1978; Keller, 1993). The Cahokia site was the cultural center for this area and dominated the development of the Mississippian Tradition (A.D. 900 to 1600) (Fowler and Hall, 1978; Keller, 1998). Cahokia covered nearly six square miles with population estimates ranging from 20,000 to 40,000. Many of the sites are confined to the broad floodplains of the Illinois Basin, possibly due to the presence of better farmland (Keller, 1993). In Indiana, the Mississippian Tradition includes settled town life in Indiana, expressed with the presence in some areas of flat-surfaced mounds on which were erected important structures. A distinctive pottery complex further defines this tradition (Kellar, 1998).

Protohistoric – Historic

The French were the first Europeans in the Illinois Basin in the late 1600s. The Illinois tribe's traditional territory included most of the state of Illinois, including a large area within the Mississippi River basin. The Chickasaw tribe occupied western Kentucky (Illinois State Museum, 2000). Rapid Euro-American population growth in the 1700s led to the establishment of Indiana territory in 1800 (which included Illinois and Indiana). Industries in the region included coal mining, railroads, steel manufacturing, and meat packing. Cultural resources expected from this period may include forts, houses, farmsteads, barns, trails/roads, canals, railroads, bridges, factories, mills, and mines (Center for History, 2010; Lazzerini, 2005a; Lazzerini, 2005b).

Architectural styles draw on the varied cultural influences of a given region. For this region those influences include the French and English on initial settlement. Later, a wide range of industries attracted German, Jewish, Irish, Scandinavian, and Slavic immigrants to the area. Their influences are also apparent in the architectural styles of the region. Architectural resources of this region will include forts, cabins, farm houses, barns, covered bridges, schools, churches, courthouses, hospitals, libraries, theaters, high-rises, gas stations, commercial buildings, railroad stations, factories, and mills (Center for History, 2010; Lazzerini, 2005a; Lazzerini, 2005b).

Illinois

The first European explorers to reach Illinois were the French Jacques Marquette and Louis Jolliet in 1673 (Lazzerini, 2005b). Settlement began in earnest with the erection of Fort Crevecoeur in 1680 by Rene-Robert Cavalier, sieur de La Salle, though the fort fell to mutiny later that year. After the French and Indian War, the land that would become Illinois came under English control. Early historic-age sites in Illinois are related to seventeenth and eighteenth century French and English exploration and occupation of the region. They include forts, cabins and homesteads, trading posts, and other sites associated with exploration and the fur trade (Center for History, 2010; Lazzerini, 2005b). After the American Revolution, Illinois became a U.S. territory, and achieved statehood in 1818 (History, 2015).

Indiana

The first European explorer to reach Indiana was Rene-Robert Cavalier, sieur de La Salle in December 1679 (Center for History, 2010). The fur trade became important in Indiana throughout the eighteenth century, and forts and trading posts soon were constructed across the landscape. The end of the French and Indian War (1754 to 1763) resulted in Indiana being turned over to the English. By the end of the American Revolution in 1783, the Ohio Valley was part of the U.S. Historic-age sites in Indiana include forts and trading posts related to both the fur trade and the various wars associated with early American history. Other sites include cabins, schools, churches, homesteads and towns related to early and continued settlement, as well as a full range of more modern industrial and mining related activities (Center for History, 2010).

Kentucky

A description of the archaeological and architectural resources in Kentucky can be found in Section 3.13.2.2.

3.13.5 Northern Rocky Mountains and Great Plains Region

The coal-bearing counties in the intermountain region are within Colorado, Wyoming, Montana, and North Dakota. Physiographically, the coal-bearing counties in the intermountain region are within the northern Great Plains (portions of Colorado and Wyoming, and all counties in Montana and North Dakota), and northeastern Colorado Plateau (portions of Colorado and Wyoming) (Mehls, 1984; Schmidt and Vermeer, 2002).

3.13.5.1 Paleontology

Colorado

Paleontological resources from Colorado are described in Section 3.13.3.1.

Montana

Paleontological resources in Montana are known from nearly all periods of geologic time. Shallow seas covered much of Montana from the Precambrian through the Early Paleozoic. Fossil evidence of these seas include stromatolites, algae, trilobites, crinoids, bryozoans, brachiopods, gastropods, mollusks, conodonts and, later in time, over a hundred species of fish. During the Cenozoic, the environment in Montana ranged from hot and arid to more humid with seas, including the Cretaceous Interior Western Seaway, covering the state for portions of this era. Important fossil resources from this time include a wide range of plants and animals. Dinosaur fossils are perhaps the best known and include *Deinonychus*, *Tyrannosaurus rex*, and the state fossil *Maiasaura peeblesorum* (including evidence of their nests, eggs, and young). Fossils from the Quaternary reflect variable climate conditions and include titanotheres, dogs, mammoths, dire wolves, and musk ox. Carboniferous fossils in Montana are known from exposures in the central portion of the state. Because shallow-to-deep seas again covered Montana during the Mississippian, the fossils from this time include algae, sponges, worms, arthropods, bivalves, cephalopods, brachiopods, and nearly 100 species of fish.

Wyoming

The oldest fossils in Wyoming are Precambrian in age and consist of stromatolites. Fluctuating sea levels and periods of uplift and erosion were present from the Cambrian through the Paleozoic, leaving a range of paleontological resources that include trilobites, brachiopods, corals, sponges, pelycopods, conodonts, crinoids, algae, fish and trace fossils. Mesozoic paleontological resources are known from both marine and terrestrial environments and include oysters, belemnites and other marine invertebrates, and theropod dinosaur trackways. The sediments of the world-famous Jurassic-age Morrison Formation are known to contain many dinosaurs, including *Apatosaurus*, *Stegosaurus*, *Allosaurus*, *Diplodocus*, *Camarasaurus*, as well as the fossils of fish, frogs, salamanders, lizards, crocodiles, pterosaurs, and small mammals. Cretaceous age fossils can be found in rock exposures throughout the state and include a wide variety of animals such as fish, frogs, salamanders, turtles, crocodiles, pterosaurs, mammals, and birds. Well known dinosaur finds include *Tyrannosaurus*, *Triceratops*, *Ankylosaurus*, *Troodon*, *Edmontosaurus*, *Pachycephalosaurus*, *Edmontonia*, *Dromaeosaurus*, and *Ornithomimus.* Tertiary rocks and sediments cover much of the state and contain evidence of lush forests, some of which are the source of coal deposits in the state. Fossils from this age include the state fossil, the fish *Knightia eocaena*, as well as flamingos, crocodiles, boas, and bats. Quaternary deposits include fossils of mammoth, horse, camel, bison, and Pronghorn antelope, as well as fossil pollens.

North Dakota

The oldest fossils in North Dakota are Precambrian in age and consist of stromatolites. During the Pennsylvanian and Permian, the sea levels started to recede. Rocks of this age can be found throughout the state and contain brachiopods, sponges, horn corals, bryozoans, pelecypods, gastropods, belemnites, ostracods, conodonts, and fish. Jurassic rocks are exposed throughout the state and are rich in fossils. These paleontological resources include oysters, belemnites and other marine invertebrates. Theropod dinosaur trackways are also known. Tertiary rocks and sediments cover much of the state and contain evidence of lush forests, some of which are the source of coal deposits in the state. Fossils from this age include the state fossil, the fish *Knightia eocaena*, and flamingos, crocodiles, boas, and bats.

3.13.5.2 Archaeology and Cultural Resources

Prehistory

This section draws primarily from the *Handbook of North American Indians, Volume 13* (DeMallie and Sturtevant, 2001) and various state preservation plans (Gregg et al., 2008; Wyoming State Preservation Office, 2007) and historic contexts (Fraserdesign, 2006; Grady, 1984).

Archaeology within the region has been divided between the Paleoindian (10,000 to 8000 B.C.) and Archaic (8000 to 500 B.C.). At this point archeological patterns in the Great Plains and Colorado Plateau differ. The archaeology of the plains has been divided into the Plains Woodland (500 B.C. to 1000 A.D.), Plains Village (1,000 A.D. to contact), and historic period (contact to 1950). The archeology of the Colorado Plateau consists of the Formative (A.D. 300 to 1300) and Protohistoric (A.D. 1300 to contact) Periods (DeMallie and Sturtevant, 2001*).*

During the Paleoindian Period, distinct artifact types are representative such as Clovis Points, Folsom Points, Hell Gap/Agate Basin, and Cody points. More ancient Paleoindian sites and isolated artifacts have been associated with river basins where Pleistocene glaciers released their outwash, and in areas where Pleistocene landforms have been preserved. As glaciers melted, Paleoindians expanded their territory to take advantage of new environments. Beginning around 5500 B.C., patterning within the archaeological record of the region shifts, both in the tools present and spatial patterning (Grady, 1984). Within the Great Plains, perishable artifacts such as basketry, dart shafts, and digging sticks have been recovered from caves in Wyoming. Other features common during this period are stone circles, or tepee rings, pictographs and petroglyphs, and occasionally burials.

Starting at the end of the Archaic Period, the archeology of the plains diverges from that of the Colorado Plateau. From 500 B.C. to contact, the archaeologists have adopted the Eastern Woodlands and Plains Village Traditions. Ceramics first appear during the Plains Woodlands Period. Plains Village archaeological sites have many similarities with Woodland sites. Villages became semi-permanent, with large, rectangular houses. Villages were placed in defensible positions and often had palisades. Large tracts of land on flood plains were used for crop production, and horticulture was equally as important as hunting and gathering. In addition, buffalo were hunted in large numbers.

Prehistoric cultural resources in Montana reflect those found throughout the Northern Rocky Mountains and Great Plains region, as summarized above. Prehistoric cultural resources in North Dakota reflect those found throughout the Northern Rocky Mountains and Great Plains region, as summarized above, and include isolate finds, small campsites, and kill sites as well as larger camps and the important Knife River flint source. Prehistoric cultural resources in Wyoming reflect those found throughout the Northern Rocky Mountains and Great Plains region, as summarized above, and include perishable artifacts such as basketry, dart shafts, and digging sticks that have been recovered from caves within the state.

For Colorado, from A.D. 300 to contact, archaeologists have identified the Formative and Protohistoric Periods. The Formative Period is confined to the western portion of Colorado and southwestern Wyoming. Archaeological sites dating to this period indicate native peoples were more sedentary than during the Archaic Period. These groups are generally ascribed the term Fremont. As early as A.D. 900 the archaeological pattern of the Formative Period begins to be replaced by more mobile hunter-gatherers.

With the exploration of North America and its subsequent colonization, several old-world diseases were introduced to Native populations. This, along with encroachment by settlers, has resulted in the displacement of many Native American groups indigenous to the Great Plains and Colorado Plateau. Within the Intermountain region of the Great Plains, eight Native American groups have been identified. These are the Assinibonie, Blackfoot, Crow, Gros Venture, Hidatsa, Mandan, Cheyenne, and Arapaho. Two Native American groups are present in the Colorado Plateau portion of the study area. These are the Eastern Shoshone and the Ute. Within Wyoming, the Eastern Shoshone occupied a territory which stretched the entire length of the state. The Ute occupied the western half of Colorado.

<u>Protohistoric – Historic</u>

<u>Colorado</u>

Archaeological and Cultural resources from Colorado are described in Section 3.13.3.2.

<u>Montana</u>

Historic resources reflect exploration, cattle ranching, railroads, and mining. The Lewis and Clark Expedition of 1804 to 1806 was the first group of American explorers to cross Montana. Fur trappers, traders, and Roman Catholic missionaries soon followed, as did the establishment of Saint Mary's Mission in the Bitterroot Valley, thought to be the first permanent settlement in Montana. Gold brought many prospectors into the area in the 1860s, and Montana became a territory in 1864. The rapid influx of people led to boomtowns that grew rapidly and declined just as quickly when the gold ran out. Cattle ranches flourished in the 1860s and 1870s, leading to conflicts with Native Americans, culminating in the 1876 Battle of the Little Bighorn. During the 1880s, railroads crossed Montana and the territory became a state in 1889. Hardrock mining also began at this time. Butte became famous when silver and copper were discovered. The Anaconda Copper Company, owned by Marcus Daly, became one of the world's largest copper mining companies and exercised inordinate influence in the state (State of Montana, 2010).

North Dakota

North Dakota was first visited by the French in 1738. In 1803, the territory was transferred to the U.S. through the Louisiana Purchase. Lewis and Clark explored this area in 1804 and 1806, and several Roman Catholic missions were established in the territory during the 1810s. Several trading posts were established in the subsequent years, and, in 1832, the first steam ship arrived in the territory, bringing settlers and trappers. In 1889, North Dakota was admitted into the union. Since statehood, North Dakota has been the scene of ranching and farming. Historic sites found in the state include ranches, homesteads, trading posts, and battle fields, among others.

Wyoming

Historic age resources are related to exploration, mining, and westward expansion. Wyoming was first visited by Europeans during the mid-1700s, but it was not until 1807 that the first American, John Colter, entered Wyoming. During the 1800s, settlers began crossing the area via the Oregon Trail, and by 1825, fur trapping and trading was a significant activity in the area. The first town, Ft. Supply, was established in 1853, and the construction of the transcontinental Telegraph in 1861 led to the establishment of several army forts and trading posts. In 1868, the Wyoming territory was created, and in 1872, Yellowstone National Park was established. Gold discoveries in the late 1860s also brought more settlers into the territory. In 1890, Wyoming became a state. In the early 1900s, mining operations began extracting uranium and other minerals.

3.13.6 Northwest Region

Although the Northwest region includes the States of Oregon, Washington, and Alaska, there are no active or proposed mines in Oregon or Washington. Consequently, this discussion is limited to the State of Alaska.

3.13.6.1 Paleontology

Alaska

Paleontological resources in Alaska begin with finds from the Precambrian. Fossils from the Permian are entirely marine in nature and include brachiopods, ammonoids, and snails. Volcanic activity in the Triassic resulted in the formation of volcanic island arcs, around which reefs formed. Fossil evidence of these reefs can be found in the southern portion of the state, as can fossils of mollusks, ichthyosaurs, and early bony fish. Coastal swamps and shallow marine conditions during the Cretaceous resulted in a fossil record that includes dinosaurs and marine organisms. The Alaska state fossil, *Mammuthus primigenius*, is also from the Quaternary.

3.13.6.2 Archaeology and Cultural Resources

Prehistoric

Alaska

The Paleo Arctic Tradition (8000 to 6000 B.C.) is widespread throughout the state and is characterized by lithic artifact assemblages based on a core and blade/micro-blade technology, distinctive micro-cores, and burins (small engraving tools) (NPS, 2013c; Sturtevant and Damas, 1985). Numerous other cultural sequences followed, including traditions from the Pacific Coast, the Aleutian Region, the Pacific Eskimo Stages, Southwest Alaska Coastal, and Mainland (Totem and Potlatch People) (Alaska Native Heritage Center, 2013; Athropolis, 2005; Sturevant and Damas, 1985).

Protohistoric - Historic

The known history of modern Alaska is short due to its relatively recent dcovery by the developed world halfway through the 18th century (Alaska Public Lands Information Center, 2015). The first historic contact with Alaskan Native Americans was made by the fur trade expedition of the Russians Aleksei Chirikov and Vitus Bering in 1741. The major Alaskan Indian groups at the time consisted of the Athabascan, Yup'ik, Cup'ik, Inupiaq, Aleut, Alutiiq, Eyak, Tlingit, Haida, and Tsimshian tribes (History Timelines, 2012; Athropolis, 2005; Sturevant and Damas, 1985).

Other significant milestones in Alaskan history include the beginning of coal mining activities in 1857, the U.S. purchase of Alaska from Russia in 1867, construction of the Alaskan Rail Road from 1914 to 1923, salmon and other fish canneries beginning around 1882, and the influx of prospective miners in search of gold such as during the Klondike Gold Rush of 1897-1900.

All manner of buildings associated with the history and prehistory of the area may be expected in the region. Architectural styles draw on the varied cultural influences of a given region. More notable influences include the Russian American, Victorian, and later the Craftsman Movement (NPS, 2009b).

3.13.7 Western Interior Region

3.13.7.1 Paleontology

Arkansas

The fossil record in Arkansas begins in the Early Paleozoic. During this time, the state was covered by a shallow sea. The extensive seas of the Mesozoic were still present, but less extensive during the Cenozoic. As sea levels fell throughout the Tertiary, swamps formed throughout southern Arkansas. Fossils from this period are present in rocks in the southern and eastern portions of the state and include oysters and shark teeth.

Kansas

Paleontological resources in Kansas are absent for the Precambrian, the Early Paleozoic and the Early Mesozoic. However, the Carboniferous, Permian, Cretaceous, Tertiary, and Quaternary are well represented in the fossil record for the state. Shallow seas that likely covered much of the state during the Paleozoic experienced fluctuating levels during the Carboniferous, resulting in the formation of swamps along the coasts. Fossils from this period are exposed in a broad band of rocks covering the eastern edge of the state, and include crinoids, brachiopods, bryozoans, echinoids, bivalves, gastropods, corals, trilobites, amphibians, early reptiles, and many primitive plants. Sea levels continued to fluctuate during the Permian, and similar life forms persisted. The Tertiary in Kansas was marked by a wetter and milder climate than today, and a more savannah-like environment. Tertiary fossils are present in rocks in the western portion of the state and include rhinoceros, camel, and tortoise species.

Missouri

Paleontological resources in Missouri range from Paleozoic marine invertebrates to Quaternary mastodons. The most extensive fossil deposits from the Paleozoic are from the Carboniferous. Rocks of this age cover nearly the entirety of the northern and western portion of the state and include both marine and terrestrial fossils. The Missouri state fossil, the crinoid *Delocrinus missouriensis*, is from the early Carboniferous.

Oklahoma

The earliest fossils in Oklahoma are Cambrian in age. During most of the Paleozoic, a shallow sea covered much of the state, and the fossil resources for this period reflect that environment. Mississippian fossils are known from the northeastern portion of the state and include blastoids, brachiopods, echinoids, corals, trilobites, and other tropical marine invertebrates. Permian rocks cover much of the state and reflect a retreat of the shallow sea that had covered the state for much of the Paleozoic. Fossils from these rocks include rare amphibians and reptiles, and vertebrate footprints.

Texas

A description of the paleontological resources in Texas can be found in Section 3.13.4.1.

3.13.7.2 Archaeology and Cultural Resources

Prehistoric

The Western Interior region is in a transition zone between the Great Plains and the Eastern Woodlands called the Osage Plains. The Western Interior region includes the western edge of Arkansas, the eastern edge of Kansas, northwestern Missouri. In this region, the Paleo-Indian period begins roughly 13,500 years ago (11,500 B.C.) and transitions into the Archaic pPeriod around 7500 B.C. The people of this period practiced a hunter-gatherer subsistence pattern that emphasized a high degree of mobility and hunting of Pleistocene Mega Fauna and, later in the period, large game. Clovis, Folsom, and Dalton points are three of the projectile point types most closely associated with this period in this region. Because Paleo-Indian groups were highly mobile, isolated finds, small campsites, and kill sites are present in a variety of physiographic contexts throughout the larger Plains region, including the Osage Plains (Brown et al., 1987; Marchand, 1993). Paleo-Indian Period resources are present in Missouri in the form of isolated finds and cave sites. Sites such as Arnold Research Cave are located along near drainages. In Arkansas, temporary camps such as at La Crosse, and rock art sites such as at Rock House Cave evidence Paleo-Indian occupations. Sites such as La Crosse are located along river drainages. Paleo-Indian Period resources are present in Oklahoma in the form of isolated finds, open camps, and kill sites. Sites such as Jakes Bluff and the Domebo Canyon Site are located along rolling hills near drainages.

The Archaic Period begins approximately 9,500 years ago (7500 B.C.). Cultural materials from this period may include stone bowls, groundstone, dart-sized projectile points, knife blades, stone scrapers, drills, fish-hooks, stone sinkers, awls, and atlatls (Alex, 2002; Trubitt, 2010). Towards the end of the Archaic, some sites might include base camps, village sites, and mound sites (Alex, 2002; Trubitt, 2010).

The transition into the Woodland Period begins around 2,600 years ago (600 B.C.) and persists until about A.D. 1000. The construction and use of burial mounds and ceremonial complexes, the production and use of ceramic vessels, the development of exchange networks (i.e., importation of copper) and intensified use of agriculture are considered Woodland developments. Expected sites from this period include villages, lodges, smaller structures, burial mounds, ceremonial mounds, and small non-mound villages (Mainfort, 2011). Some of the more notable Arkansas Woodland sites include Nodena and Toltec Mound; while in Missouri, Fairfield Mound is a notable site.

Archaeologists designate the period from about A.D. 900 to 1600 as the Plains Village Tradition. This period is marked by extensive maize (corn) farming. After about A.D. 900, sites containing features such as earthen lodges, village sites, stockades, farmsteads, temples, platform mounds, and storage pits become common (Nebraskastudies.org, 2011; Nebraska State Historical Society, 1998). The Mississippian people lived in chiefdoms, traded for copper and marine shell, lived a sedentary lifestyle, built mounds, and conducted warfare. An example is the Duncan Site in Oklahoma.

Protohistoric – Historic

Native American groups from the contact period to the historic period in this region include at least ten different tribes. The Osage tribal territory encompasses most of the Western Interior region. The Quapaw is on at the southeastern edge of the region. The Wichita and Kiowa are just along the western edge of the region. The Kansa, Missouria, Otoe, and Iowa are clustered at the northern portion of this region. The Omaha and Pawnee are located at the northwestern periphery of the region. At the time of European contact in the 1700s, these tribes and their neighbors were in a state of geographic flux.

Arkansas

Spanish explorer, Hernando De Soto was the first European to reach Arkansas in 1541. At the time its Native American population was peaking with thousands of people in villages along the Mississippi River. The first European settlement was established by the French in 1686.

Arkansas became part of the U.S. in 1803 with the Louisiana Purchase, and gained statehood in 1836 (Arkansas Department of Parks & Tourism, 2015).

Historic sites date to as early as A.D. 1540. Sites within Arkansas include the Pakin Site, a village that many suspect was visited by de Soto, grist mills, settlements, Civil War battle fields, Civil Conservation Corps camps and projects, and buildings important to the civil rights movement such as Little Rock High School.

Kansas

The first European explorer to travel to this region was Francisco de Coronada in 1541. This area was claimed by France in 1682, ceded to Spain in 1763, revereted to France in 1800, and finally became part of the U.S. as a result of the Louisiana Purchase in 1803. After disagreements over the practice of slavery in the area Kansas' statehood became a national debate, but in 1861 Kansas was granted statehood (Information Please Database, 2014).

Historic sites date to as early as the 1540s. Historic era sites within Kansas include settlements, trading outposts, forts, ranches, and travel routes.

Missouri

In 1673, the French explorers Jaques Marquette and Louis Joliet were the first Europeans to explore this region. In the same manner as Kansas, Missouri was claimed by both Spain and France throughout the 17th and 19th centuries (Missouri Office of the Secretary of State, 2015). This area was acquired by the U.S. as a result of the Louisina Purchase of 1803, and acquired statehood in 1821 as a result of the Missouri Compromise (History, 2015).

Historic sites date to as early as the early 1500s. Historic era sites within Missouri include settlements, trading outposts, forts, ranches, and travel routes.

Oklahoma

European explorer, Francisco Coronado, is believed to have reached Oklahoma in 1541 (History, 2015). Several Native American tribes populated the area but the Europeans did not settle in this region. Oklahoma became part of the U.S. as a result of the Louisina Purchas in 1803, and gained statehood in 1907 (Information Please Database, 2014).

Historic sites date to as early as A.D. 1450. Historic era sites within Oklahoma include settlements, trading outposts, forts, ranches, and travel routes.

Texas

A description of the Archaeology and Cultural resources in Texas can be found in Section 3.13.4.2.

3.14 SOCIOECONOMIC CONDITIONS

This section characterizes the socioeconomic features of the seven coal regions: the Appalachian Basin, the Colorado Plateau, the Gulf Coast, the Illinois Basin, the Northern Rocky Mountains and Great Plains, the Northwest, and the Western Interior. Within these geographic areas, a total of 285 counties were identified as coal-producing counties. This section describes the demography and regional economic profile of the coal-producing counties, organized by coal region. For context, the socioeconomic profiles of the coal regions are compared with those of the broader statewide and national economies.

Section 3.14.1 describes regional demography, including population, age, race, and ethnicity. Section 3.14.2 characterizes the regional economic environment, such as income and employment statistics by industry, including the coal mining industry, and coal-related severance tax rates and associated revenues. While this section contains some information on trends in coal production and related employment levels, a detailed description of recent trends in the coal mining industry is provided in Section 3.1. Section 3.14.3 focuses specifically on the economic profiles of potentially-affected Tribal populations. This information informs the socioeconomic impact analysis in Section 4.3.1, as well as the Environmental Justice analysis in Section 4.4, which evaluates the extent to which the regulatory alternatives may generate disproportionately high and adverse human health or environmental effects on minority and low-income populations. Section 4.3.1 includes a discussion of the coal industry’s contribution to the quality of life within mining-dependent regions.

3.14.1 Demography

Demographic information is broken down into three specific areas of interest: population trends, ethnic composition, and age composition. This DEIS evaluates trends in these demographic characteristics using 1990, 2000, and 2010 U.S. Census data.

As described in Table 3.14-1, the populations of coal-producing counties experienced relatively low population growth compared to the U.S. as a whole between 1990 and 2010. Specifically, the rate of population growth in coal-producing counties was roughly half the nationwide growth during that time period. Approximately 6.4 percent of the nationwide population lived within coal-producing counties in 2010.

As highlighted in Table 3.14-2, coal-producing counties are generally less racially diverse than the nationwide population. Approximately 83.9 percent of the population living in coal-producing counties self-identifies as “white.” With the exception of American Indians and Alaska Natives, every reported minority is underrepresented in coal-producing counties compared to the broader U.S.

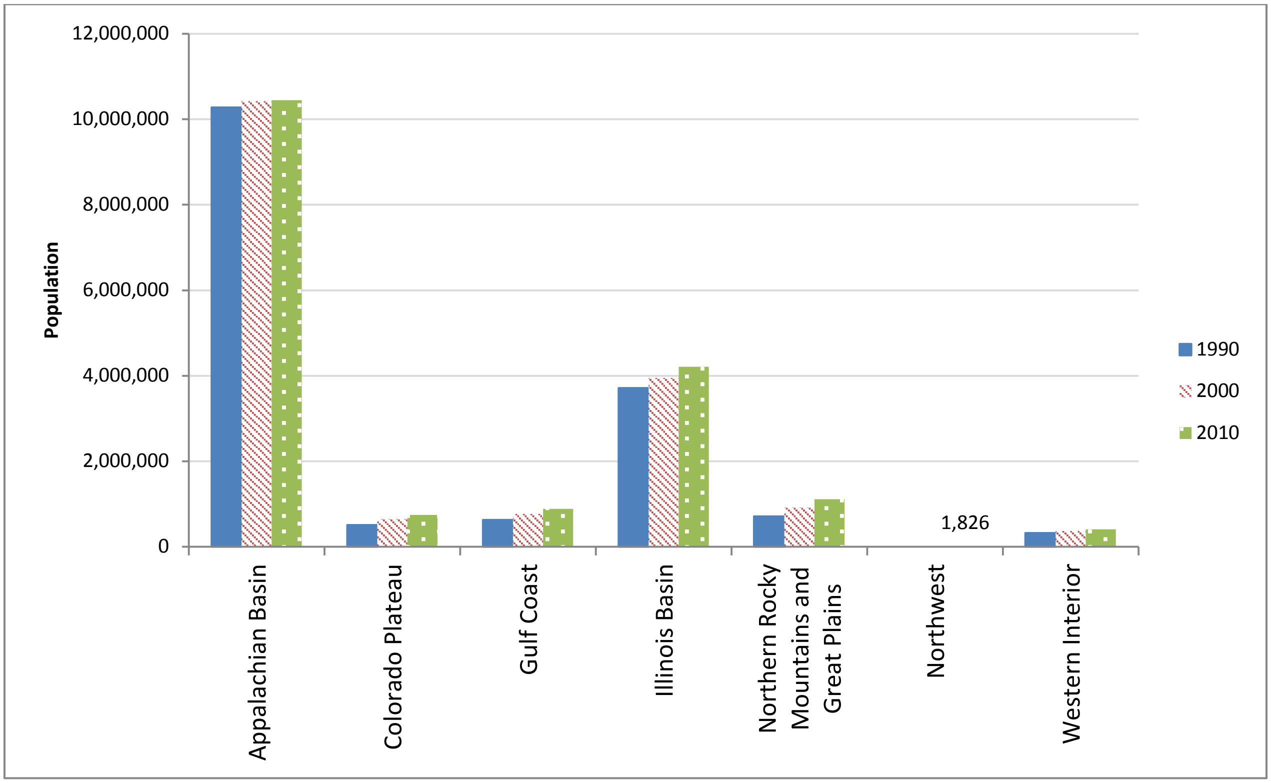
The age composition of coal-producing counties conforms closely to that of the broader country. Across the eight age groups described in Table 3.14-3, only one group (senior citizens) constitutes more than a single percentage-point difference from the age composition of the national population. The following sections provide more information on demography by coal region.

Table 3.14-1
Population Trends in Coal Regions, 1990 – 2010

Coal Region*	Geography	Population Growth 1990 - 2000 (%)	Population Growth 2000 - 2010 (%)	2010 Population
Appalachian Basin	Coal-producing Counties	1.4	0.1	10,437,566
	Statewide – all counties	8.1	6.4	55,331,661
Colorado Plateau	Coal-producing Counties	26.3	14.3	743,834
	Statewide– all counties	32.2	20.5	16,244,277
Gulf Coast	Coal-producing Counties	21.3	15.0	885,209
	Statewide– all counties	18.4	15.9	32,646,230
Illinois Basin	Coal-producing Counties	6.4	6.6	4,208,144
	Statewide– all counties	9.1	4.9	23,653,801
Northern Rocky Mountains and Great Plains	Coal-producing Counties	27.7	21.4	1,109,303
	Statewide– all counties	22.2	14.4	7,254,828
Northwest**	Coal-producing Counties	***	-3.5	1,826
	Statewide– all counties	14.0	13.3	710,231
Western Interior	Coal-producing Counties	14.1	8.5	404,473
	Statewide– all counties	10.1	7.6	15,509,314
Total U.S.	Within All Coal Counties	5.5	4.1	17,713,505
	Nationwide – Coal and Non coal states	13.2	9.7	308,745,538

* Counties within a state (such as certain counties in Kentucky and Colorado) that cross regional boundaries are counted in the region where they fall.
** Northwest data includes only Alaska; no population data exists for Denali County, AK from the 1990 Census.
Source: U.S. Census Bureau, Census 1990, Census 2000, and Census 2010.

Figure 3.14-1 Population in the Seven Coal Regions, 1990, 2000, and 2010



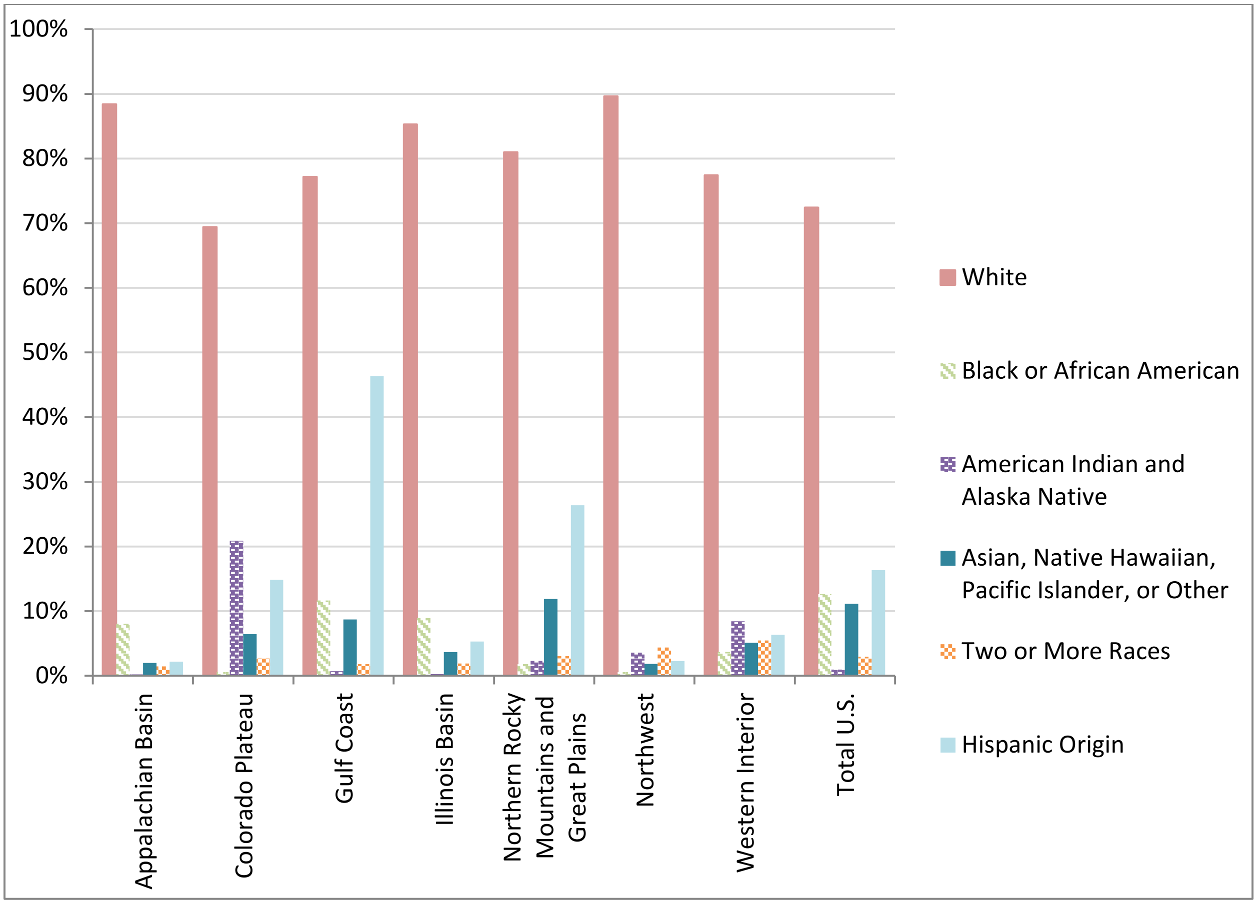
Source: U.S. Census Bureau, 2013. 1990 Census, Census 2000 Gateway, and Census 2010. U.S. Department of Commerce.

Table 3.14-2
Race and Ethnicity in Coal Regions (Percent of Population), 2010

Coal Region*	Geography	White	Black or African American	American Indian and Alaska Native	Asian, Native Hawaiian, Pacific Islander, or Other	Two or More Races	Hispanic Origin***
Appalachian Basin	Coal-producing Counties	88.4	8.0	0.2	2.0	1.4	2.2
	Statewide – All counties	76.9	15.8	0.3	4.9	2.1	5.1
Colorado Plateau	Coal-producing Counties	69.4	0.6	20.9	6.4	2.7	14.8
	Statewide– all counties	77.2	3.3	3.6	12.6	3.3	26.1
Gulf Coast	Coal-producing Counties	77.2	11.6	0.7	8.7	1.8	46.4
	Statewide– all counties	68.3	16.9	0.7	11.7	2.4	29.8
Illinois Basin	Coal-producing Counties	85.3	8.9	0.2	3.7	1.9	5.3
	Statewide– all counties	78.0	11.8	0.3	7.8	2.1	10.8
Northern Rocky Mountains and Great Plains	Coal-producing Counties	81.0	1.8	2.3	11.9	3.0	26.3
	Statewide– all counties	84.0	3.0	2.3	7.7	3.1	15.6
Northwest**	Coal-producing Counties	89.6	0.5	3.6	1.9	4.4	2.3
	Statewide– all counties	66.7	3.3	14.8	8.0	7.3	5.5
Western Interior	Coal-producing Counties	77.4	3.7	8.4	5.1	5.4	6.3
	Statewide– all counties	79.3	10.2	2.6	4.7	3.2	6.6
Total U.S.	Within All Regions	83.9	7.4	1.4	5.1	2.1	7.4
	Nationwide – Coal and Non coal states	72.4	12.6	0.9	11.1	2.9	16.3

Source: U.S. Census Bureau, 2013. Census 2010. U.S. Department of Commerce.
* Counties within a state (such as certain counties in Kentucky and Colorado) that cross regional boundaries are counted in the region where they fall.
** Northwest data includes only Alaska; no population data exists for Denali County, AK from the 1990 Census.
Source: U.S. Census Bureau, Census 1990, Census 2000, and Census 2010.
*** Hispanic origin is an ethnicity and not a race. Thus, an individual may self-identify as being both within a certain race and of Hispanic origin. The "Hispanic Origin" column of this table is, therefore, not additive with the other columns defining race.

Figure 3.14-2 Race and Ethnic Composition in the Seven Coal Regions, 2010



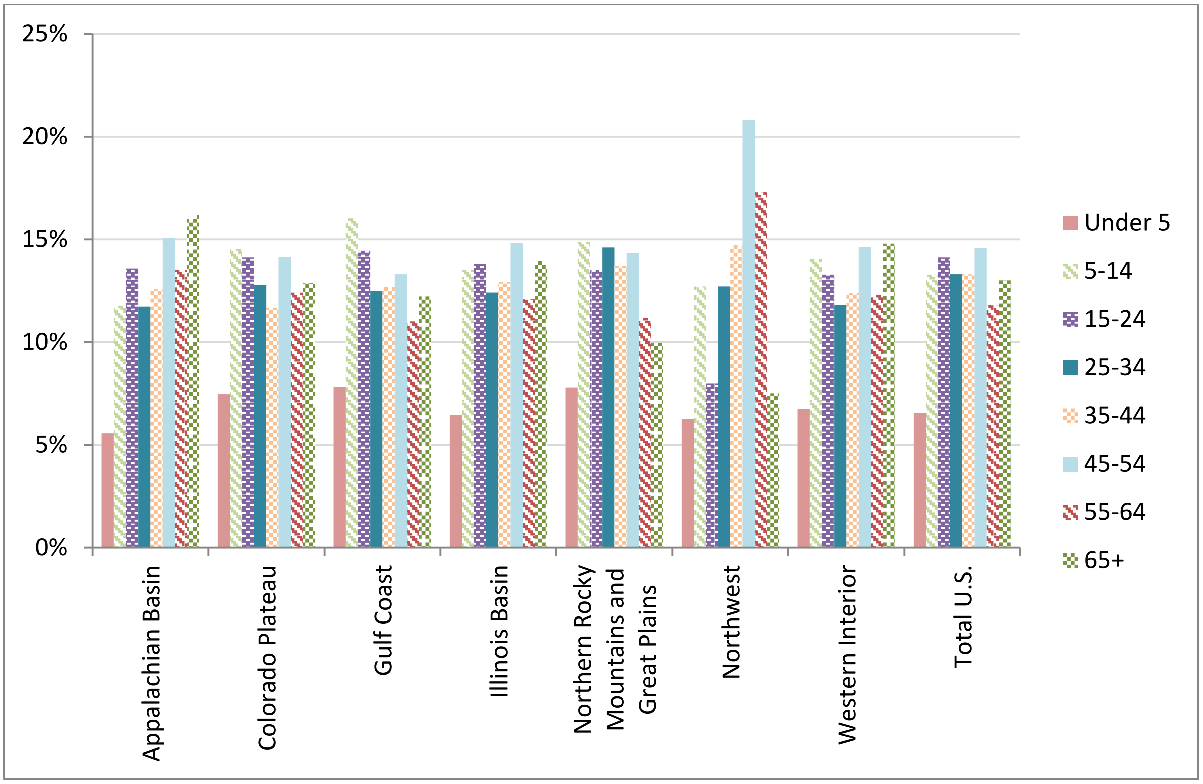
Source: U.S. Census Bureau, 2013. Census 2010. U.S. Department of Commerce.

Table 3.14-3
Age Composition in Coal Regions (Percent of Population), 2010

Coal Region*	Geography	Under 5	5-14	15-24	25-34	35-44	45-54	55-64	65+
Appalachian Basin	Coal-producing Counties	5.6	11.8	13.6	11.7	12.6	15.1	13.5	16.2
	Statewide– all counties	6.2	12.8	13.8	12.6	13.2	15.1	12.5	13.8
Colorado Plateau	Coal-producing Counties	7.5	14.6	14.1	12.8	11.7	14.1	12.4	12.9
	Statewide– all counties	7.4	14.4	14.4	14.1	12.9	13.4	11.2	12.0
Gulf Coast	Coal-producing Counties	7.8	16.0	14.5	12.5	12.7	13.3	11.0	12.2
	Statewide– all counties	7.5	14.8	14.7	14.2	13.5	13.8	10.7	10.8
Illinois Basin	Coal-producing Counties	6.5	13.5	13.8	12.4	12.9	14.8	12.1	13.9
	Statewide– all counties	6.6	13.5	14.0	13.4	13.3	14.6	11.8	12.8
Northern Rocky Mountains and Great Plains	Coal-producing Counties	7.8	14.9	13.5	14.6	13.7	14.3	11.2	10.0
	Statewide– all counties	6.8	13.2	13.9	14.0	13.2	14.8	12.3	11.9
Northwest**	Coal-producing Counties	6.2	12.7	8.0	12.7	14.7	20.8	17.3	7.5
	Statewide– all counties	7.6	14.3	15.0	14.5	13.1	15.6	12.1	7.7
Western Interior	Coal-producing Counties	6.8	14.1	13.3	11.8	12.4	14.6	12.3	14.8
	Statewide– all counties	6.8	13.5	14.1	13.1	12.4	14.4	11.9	13.8
Total U.S.	Within All Regions	6.1	12.6	13.6	12.6	13.0	14.9	12.7	14.5
	Nationwide – Coal and Non coal states	6.5	13.3	14.1	13.3	13.3	14.6	11.8	13.0

Source: U.S. Census Bureau, 2013. Census 2010. U.S. Department of Commerce.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions.
** Northwest data includes only Alaska; no population data exists for Denali County, AK from the 1990 Census.
Source: U.S. Census Bureau, Census 1990, Census 2000, and Census 2010.

Figure 3.14-3 Age Distribution in the Seven Coal Regions, 2010



Source: U.S. Census Bureau, 2013. Census 2010. U.S. Department of Commerce.

3.14.1.1 Appalachian Basin

There are 145 coal-producing counties in the eight states that make up the Appalachian Basin region. More than half of the people living in coal-producing counties nationwide are located in the Appalachian Basin region. The population in these counties accounts for 18.9 percent of the population within the eight Appalachian Basin states. Among the seven coal regions, coal-producing counties within the Appalachian Basin experienced the lowest positive rates of population growth between 1990 and 2010 (Table 3.14-1). Population within these counties remained stable, growing by less than two percent between 1990 and 2000 and less than one percent between 2000 and 2010. The eight Appalachian Basin states likewise experienced less growth than the nationwide population; however, statewide growth rates are greater than those of coal-producing counties in the region.

The Appalachian Basin is the least racially diverse of the seven coal regions. Approximately 88.4 percent of the regional population is white. The largest minority population in the region is black or African-American, making up 8.0 percent of the total population. Statewide estimates more closely resemble the national racial composition, with greater percentages for every reported minority population. While 16.3 percent of the national population is of Hispanic origin, only 2.2 percent of people within coal-producing counties in the Appalachian Basin self-identify as Hispanic.

The Appalachian Basin population is older on average than the statewide and nationwide populations. Approximately 16.2 percent of the population in coal-producing counties is over 65 years of age. Age groups below 45 years of age are all underrepresented when compared with statewide and national age distributions.

3.14.1.2 Colorado Plateau

There are 16 coal-producing counties in the 4 states that make up the Colorado Plateau coal region. Within these states, 4.6 percent of the population lives within a coal-producing county. The Colorado Plateau demonstrated the greatest rates of population growth among the seven coal regions. Population within these counties grew by 26.3 percent between 1990 and 2000, and by 14.3 percent between 2000 and 2010. This growth was greater than national population growth over the same time periods. The states encompassing the Colorado Plateau were subject to even greater rates of population growth than the coal-producing counties within this region.

Coal-producing counties in this region include a significant Hispanic population, approximately 14.8 percent. In addition, 20.9 percent of the population self-identifies as American Indian or Alaska Native, the greatest proportion among all seven coal regions. The black or African American population, both in coal-producing counties (0.6 percent) and in the states encompassing this region (3.3 percent), is disproportionately small when compared with the Nation as a whole (12.6 percent).

The Colorado Plateau population is slightly younger on average than the national population, with only 12.9 percent of the population over 65 years of age, as opposed to 13 percent nationwide. The population under 14 years of age is relatively great in coal-producing counties (22.1 percent), mirroring statewide age composition for the states encompassing the region (21.8 percent); in comparison, 19.8 percent of the national population is under 14.

3.14.1.3 Gulf Coast

There are 22 coal-producing counties in the three states that make up the Gulf Coast region. Coal-producing counties account for 2.7 percent of the population in the three states. States within the Gulf Coast region experienced high growth rates during the 1990 to 2000 timeframe and again from 2000- to 2010; the coal-producing counties experienced similar growth rates of 21.3 percent between 1990 and 2000 and 15.0 percent between 2000 and 2010. These rates were much higher than the nationwide rates over the same time periods.

The Gulf Coast region supports a significant Hispanic population, approximately 46.4 percent. This estimate is considerably greater than the corresponding statewide statistic (29.8 percent). Coal-producing counties in the Gulf Coast are also more predominantly white (77.2 percent) than the broader Gulf Coast states (68.3 percent).

The Gulf Coast population is younger on average than the national population; 23.8 percent of the population in the region is under 14 years of age, while 19.8 percent of the Nation as a whole is under 14.

3.14.1.4 Illinois Basin

There are 67 coal-producing counties in the three states that make up the Illinois Basin region. The population within coal-producing counties constitutes 17.8 percent of the total population of these three states. Coal-producing counties experienced stable but low growth, with growth rates of six to seven percent both between 1990 and 2000, as well as between 2000 and 2010. The coal-producing counties in this region did not experience the slowdown in population growth experienced by both the Illinois Basin states and the country as a whole.

The Illinois Basin is less racially diverse than the country as a whole, with 85.3 percent of the population self-identifying as white. The largest minority group in the region is black or African-American (8.9 percent). As a whole, the three Illinois Basin states are more racially diverse than the coal-producing counties within them, with greater representation across all reported minority groups.

The age composition of the Illinois Basin population closely conforms to both statewide and national statistics.

3.14.1.5 Northern Rocky Mountains and Great Plains

There are 24 coal-producing counties in the four states that make up the Northern Rocky Mountains and Great Plains coal region. Within the four states, 15.3 percent of the population lives in coal-producing counties. The rate of population growth in this region was considerable between 1990 and 2010, growing 27.7 percent between 1990 and 2000 and 21.4 percent between 2000 and 2010. To a lesser degree, statewide populations also experienced an increase in population growth.

The Northern Rocky Mountains and Great Plains region is less racially diverse than the rest of the country. Approximately 81.0 percent of the population within coal-producing counties is white, and the region had the lowest percentage of black or African-American citizens (1.8 percent) within all seven coal regions. The region includes a relatively large population self-identifying as an Asian, Native Hawaiian, Pacific Islander, or "Other"; these groups make up 11.9 percent of the larger population.

The population of the Northern Rocky Mountains and Great Plains region is slightly younger on average than the national population. Coal-producing counties have a relatively great percentage of children under 14 years of age (22.7 percent compared to 19.8 percent nationally) and a relatively small percentage of senior citizens 65 years of age or older (10.0 percent compared to 13 percent nationally).

3.14.1.6 Northwest

The Northwest region includes one coal-producing county in Alaska (see Section 3.0.2 of this DEIS which discusses Northwest region). Denali County accounts for less than one percent of the population in the state. The population in this county experienced a decrease in population over the past ten years of negative 3.5 percent, while the rest of the country experienced population growth. Population growth calculated on a statewide basis in the northwest region was also greater than the growth in the region's coal-producing counties. The Northwest region is the only coal region with a lesser percentage of the population self-identifying as white (66.7 percent) than the broader U.S. (72.4 percent). However, in the coal-producing county, an overwhelming majority identify as white (89.6 percent). The two other largest racial and ethnicity groups are either self-identified two or more races (4.4 percent) or American Indian and Alaska Native (3.6 percent). This racial distribution is not reflected in the statewide estimates for Alaska, which identify a greater percentage of people self-identifying as "white" or "American Indian and Alaska Native" than the coal-producing counties.

The middle-aged population in the Northwest coal region is relatively large, with age groups between 25 and 54 accounting for a greater portion of the population (43.2 percent) than in the broader U.S. (41.2 percent). Both the coal-producing county and the state encompassing the region support relatively small populations 65 years of age or older.

3.14.1.7 Western Interior

There are 11 coal-producing counties in the four states that make up the Western Interior region. Within these states, coal-producing counties support 2.6 percent of the population. Population growth in coal-producing counties was greater than that of the Western Interior states, but similar to the national trend, with 14.1 percent growth between 1990 and 2000, and 8.5 percent growth between 2000 and 2010.

The Western Interior region includes a significant population self-identifying as American Indian or Alaska Native (approximately 8.4 percent). Compared with the national racial composition, all other reported minority groups are underrepresented in the Western Interior, with the white population accounting for 77.4 percent of the total population. Coal-producing counties have relatively smaller white and black or African-American populations than the states encompassing the region.

The senior population (65 years or older) of the Western Interior region represents 14.8 percent of the total population (compared with a slightly less 13 percent nationwide). The age composition of this region generally conforms closely to that of the broader statewide and national populations.

3.14.2 Economic Conditions

This section describes per capita income, median household income, median home value, unemployment, employment and payroll by industry, severance tax rates, and severance tax revenues for each of the seven coal regions. The data are from the American Community Survey 2007-2011 Five-Year Estimates; the Bureau of Labor Statistics 2012 Annual Averages; the U.S. Census Bureau County Business Patterns 2001 and 2011 data releases; individual state tax codes and revenue reports; and the U.S. Census Bureau 2010 Annual Survey of State Government Tax Collections.

In general, the population in coal-producing counties is slightly less affluent than the broader U.S. population (Table 3.14-4). Per capita income and median household income are both slightly less in coal-producing counties than in the national population except in the Northwest region. Median home value in coal-producing counties, however, is 18.6 percent less than the national average. Table 3.14-5 provides statistics on poverty and unemployment. Poverty rates in coal-producing counties are generally comparable to poverty rates for the country as a whole, with 14.9 percent of the population in these counties living below the poverty line compared with 14.3 percent nationally. The unemployment rate across coal-producing countries was slightly below the national rate in 2011 (7.9 percent compared with 8.1 percent nationwide).

Figure 3.14-6 highlights 15-year trends in coal production within the seven coal regions. Most prominent among these trends are the long-term shifts away from production in the Appalachian Basin region and toward production in the Northern Rocky Mountains and Great Plains region. Table 3.14-6 describes employment and annual payroll in the coal mining industry for states with active mining. Coal mining accounts for 0.1 percent of national employment and 0.1 percent of national income. Although nine states experienced a reduction in employment between 2001 and 2011 in the coal mining sector, both national scale coal mining sector employment and annual payroll grew at the national level (20.6 percent (employment); 20.0 percent (payroll)) during this time period. Coal mining employment trends, described in Figure 3.14-7, generally corresponded with regional shifts in production, with the exception of the recent rise in coal mining employment in the Appalachian Basin. As discussed below, a shift toward the more labor-intensive underground mining in the Appalachian region, combined with an overall depletion of the most readily accessible surface reserves, has led to an offsetting increase in coal mining employment in recent years. Figure 3.14-7 highlights that coal mining-related employment levels are significantly higher in the Appalachian Basin than in the other coal regions. As discussed in Table 3.14-6 this result is driven by the relatively high level of coal mining employment in West Virginia and Kentucky (these states account for approximately 26 percent and 13 percent of total nationwide coal mining employment, respectively). A detailed discussion of trends and existing conditions in the coal mining industry is provided in Section 3.1.

Tables 3.14-7 and 3.14-8 describe tax rates and revenues by source for coal-producing states. Policies on taxing the coal mining industry vary from state to state. Many states levy a direct severance tax on extracted minerals. These are excise taxes on the present and continuing activity of removing, extracting, severing, or producing minerals. Severance taxes are generally levied in the form of a percent of the value of the resources removed or sold. Severance tax rates for various states are listed in Table 3.14-7. State governments collected over $1.1 billion in coal severance tax revenues across the U.S. in 2012, making up 0.33 percent of total state tax revenue (Table 3.14-8). For most states that levy a severance tax on coal, coal severance taxes contributed less than 1.0 percent to total state tax revenues. In four states, however, coal severance taxes contributed more than 1.0 percent to total state tax revenues. Specifically, in Wyoming the contribution of coal severance taxes was greatest at 11.3 percent of total state tax revenues in 2012. In West Virginia, the contribution was 8.6 percent. In Kentucky and Montana, coal severance taxes contributed 2.7 percent and 2.1 percent to total state tax revenues, respectively. Outside of state taxes, two excise taxes are imposed by the federal government: The Abandoned Mine Lands Reclamation Tax (also known as the reclamation fee or AML fee) and the Black Lung Excise Tax. Whether these taxes will continue to be imposed prior to and during the study period is uncertain.[6] These taxes are further discussed in Section 4.3.1.6.

The following sections provide more information on the affected environment in terms of economic conditions for each of the seven coal regions.

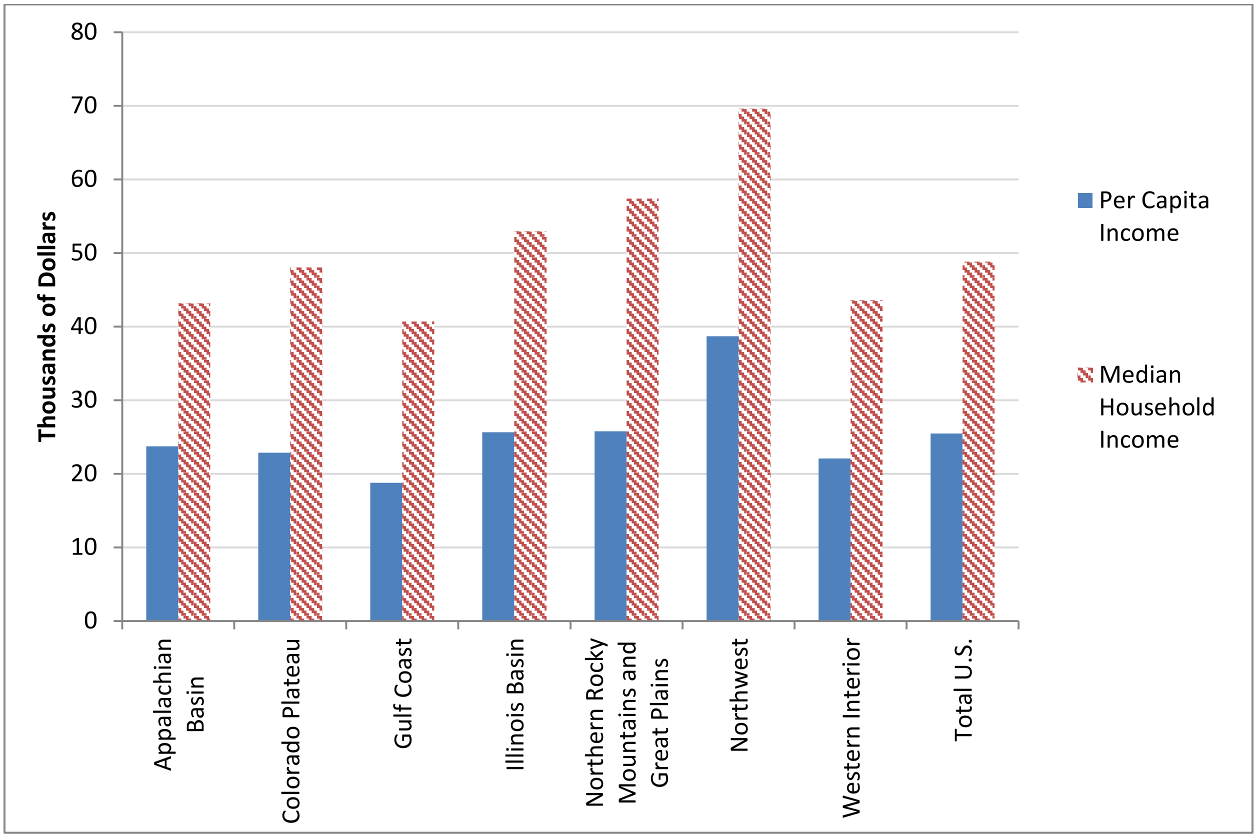
6 Collection of the reclamation fee is scheduled to end September 30, 2021 (30 U.S.C. § 1232(a)).

Table 3.14-4
Per Capita Income, Median Household Income, and Median Home Value in Coal Regions, 2011

Coal Region*	Geography	Per Capita Income***	Median Household Income***	Median Home Value****
Appalachian Basin	Coal-producing Counties	$23,702	$43,161	$112,413
	Statewide– all counties	$27,578	$51,971	$174,551
Colorado Plateau	Coal-producing Counties	$22,854	$48,050	$193,367
	Statewide– all counties	$26,690	$53,311	$209,077
Gulf Coast	Coal-producing Counties	$18,756	$40,660	$96,084
	Statewide– all counties	$24,855	$48,860	$125,170
Illinois Basin	Coal-producing Counties	$25,648	$52,951	$130,478
	Statewide– all counties	$26,887	$51,728	$163,414
Northern Rocky Mountains and Great Plains	Coal-producing Counties	$25,781	$57,375	$199,665
	Statewide– all counties	$29,502	$55,129	$213,776
Northwest**	Coal-producing Counties	$38,669	$69,587	$394,197
	Statewide– all counties	$31,944	$69,014	$235,100
Western Interior	Coal-producing Counties	$22,050	$43,566	$104,353
	Statewide– all counties	$24,534	$45,794	$122,718
Total U.S.	Within All Regions	$25,469	$48,760	$151,493
	Nationwide – Coal and Non coal states	$27,915	$52,762	$186,200

Source: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions and therefore the populations of each coal region do not sum to the total population within all coal regions.
** Northwest data includes only Alaska; no population data exists for Denali County, AK from the 1990 Census.
Source: U.S. Census Bureau, Census 1990, Census 2000, and Census 2010.
*** Per capita income and median household income are reported in 2011 inflation adjusted dollars.
**** Median reported value of owner occupied housing units.

Figure 3.14-4 Income Levels in the Seven Coal Regions, 2011



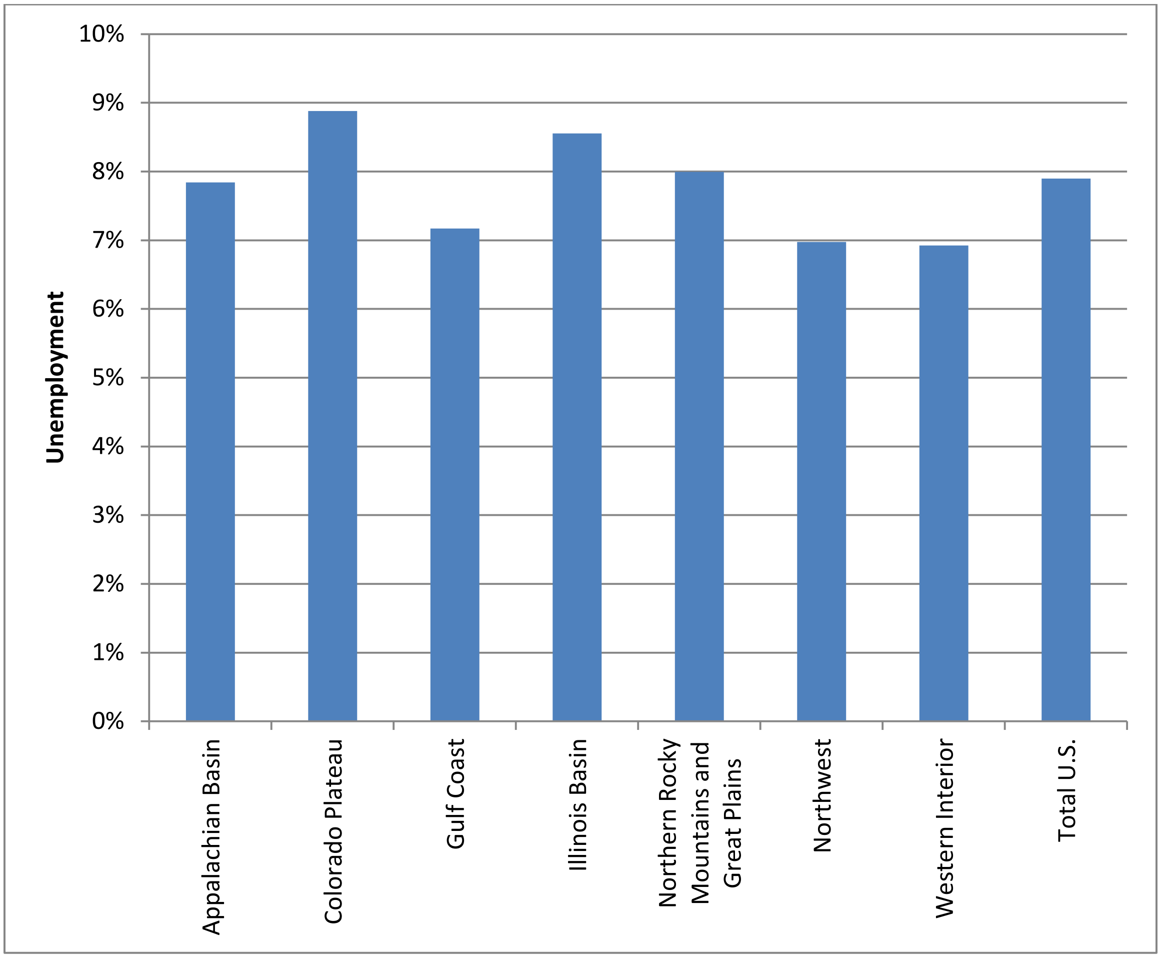
Source: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce.

Table 3.14-5
Poverty and Unemployment in Coal Regions, 2011

Coal Region*		**Population Below the Poverty Line**	**Percent of Population Below the Poverty Line (%)**	**Unemployment Rate in 2012 (%)**
Appalachian Basin	Coal-producing Counties	1,599,873	15.9	7.8
	Statewide– all counties	7,443,988	13.9	7.3
Colorado Plateau	Coal-producing Counties	124,242	17.3	8.9
	Statewide– all counties	2,293,728	14.6	7.6
Gulf Coast	Coal-producing Counties	186,470	22.0	7.2
	Statewide– all counties	5,538,611	17.6	6.9
Illinois Basin	Coal-producing Counties	527,257	13.0	8.6
	Statewide– all counties	3,282,525	14.3	8.6
Northern Rocky Mountains and Great Plains	Coal-producing Counties	136,505	12.8	8.0
	Statewide– all counties	881,419	12.6	7.1
Northwest**	Coal-producing Counties	208,299	10.7	7.0
	Statewide– all counties	65,111	9.5	7.0
Western Interior	Coal-producing Counties	66,021	16.8	6.9
	Statewide– all counties	2,278,667	15.3	6.4
Total U.S.	Within All Regions	2,840,397	14.9	7.9
	Nationwide – Coal and Non coal states	42,739,924	14.3	8.1

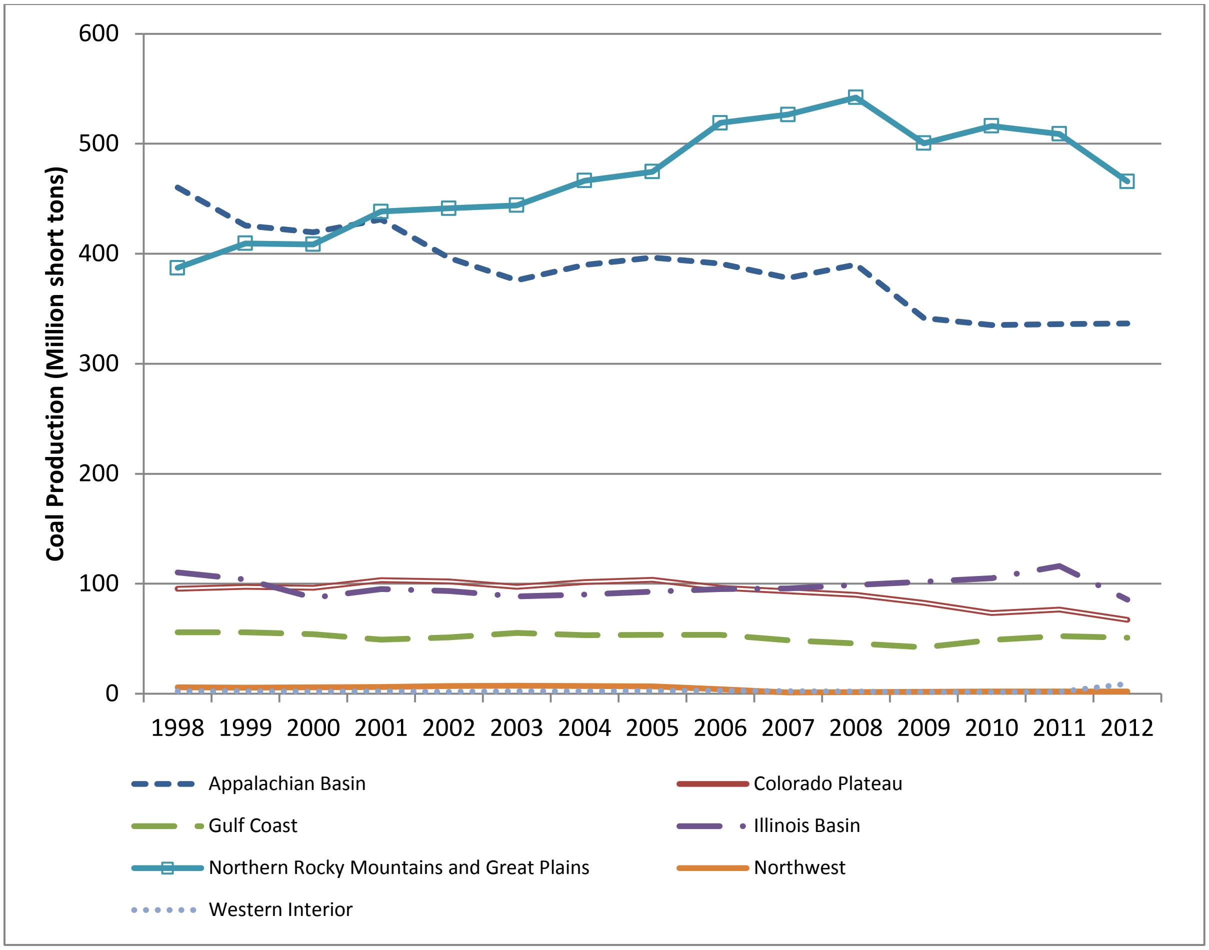
Sources: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce.; U.S. Bureau of Labor Statistics, 2012. Local Area Unemployment Statistics 2012 Annual Averages.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions and therefore the populations of each coal region do not sum to the total population within all coal regions.
** Northwest data includes only Alaska; no population data exists for Denali County, AK from the 1990 Census.
Source: U.S. Census Bureau, Census 1990, Census 2000, and Census 2010.

Figure 3.14-5 Unemployment Rates in the Seven Coal Regions, 2012



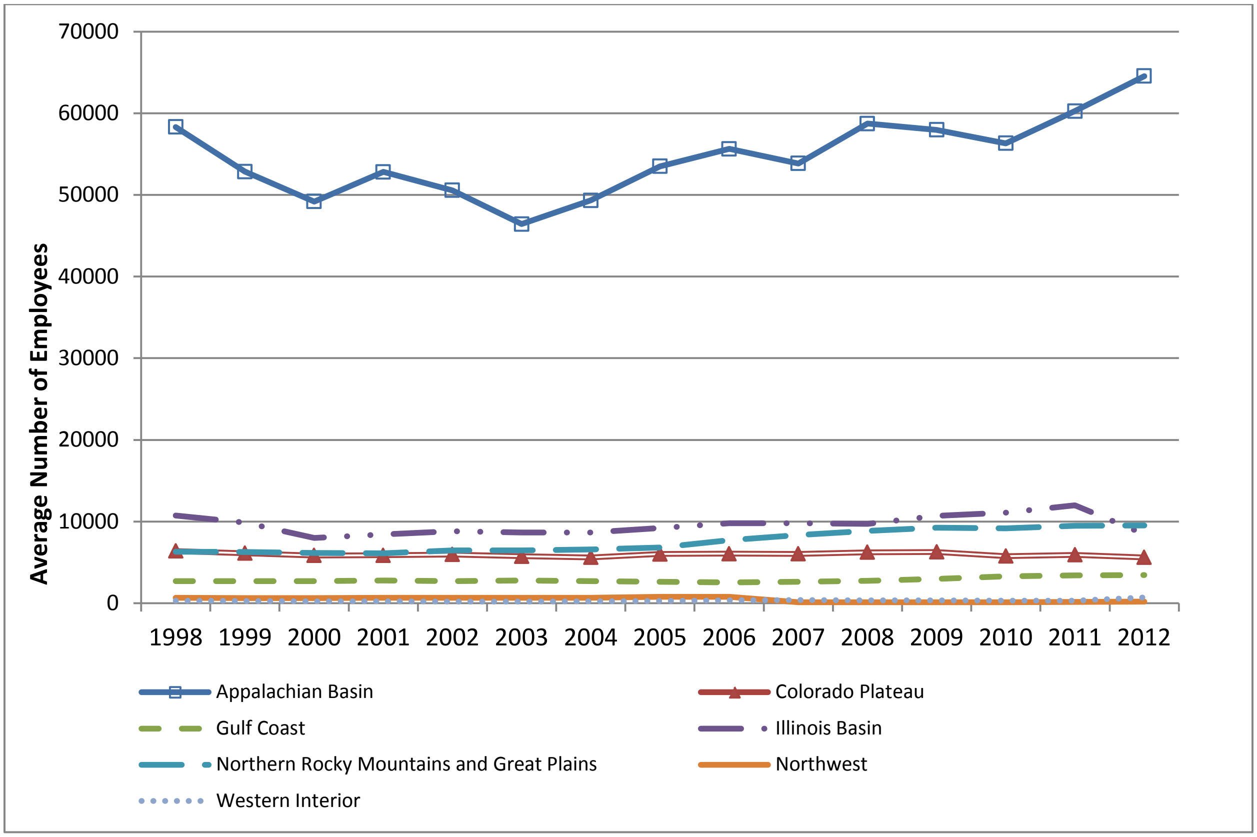
Source: U.S. Bureau of Labor Statistics, 2012. Local Area Unemployment Statistics 2012 Annual Averages.

Figure 3.14-6 Coal Production Trends in the Seven Coal Regions, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).

Figure 3.14-7 Coal Mining Employment Trends in the Seven Coal Regions, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers.

Table 3.14-6
Coal Mining Employment and Annual Payroll by State, 2011

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Appalachian Basin						
West Virginia	23,307	4.1%	41.9%	$1,867	8.5%	49.3%
Kentucky[b]	14,281	1.0%	-3.1%	$1,221	2.1%	21.2%
Pennsylvania	8,665	0.2%	6.1%	$746	0.3%	21.9%
Virginia	5,261	0.2%	-1.3%	$454	0.3%	-3.8%
Alabama	4,756	0.3%	43.0%	$330	0.5%	35.1%
Ohio	3,006	0.1%	5.1%	$264	0.1%	-25.5%
Tennessee	505	0.0%	-9.8%	*	*	*
Maryland	488	0.0%	6.1%	$21	0.0%	N/A
Colorado Plateau						
Colorado[c]	2,405	0.1%	23.7%	$182	0.2%	7.7%
Utah*	1,797	0.2%	20.8%	$145	0.3%	4.2%
New Mexico	1,292	0.2%	-25.2%	$147	0.6%	-16.2%
Arizona	419	0.0%	-40.0%	*	*	*
Gulf Coast						
Texas	2,936	0.0%	424.3%	$199	0.0%	12.0%
Louisiana	259	0.0%	39.2%	*	*	*
Mississippi	224	0.0%	75.0%	*	*	*
Illinois Basin						
Kentucky[b]	4,353	0.3%	81.2%	$1,221	2.1%	21.2%
Illinois	4,105	0.1%	19.1%	$240	0.1%	-18.1%
Indiana	3,540	0.1%	40.0%	$288	0.3%	64.8%
Northern Rocky Mountains and Great Plains						
Wyoming	7,039	3.4%	61.3%	$632	6.5%	51.5%
Colorado[c]	2,405	0.1%	23.7%	$182	0.2%	7.7%
Montana	1,251	0.4%	48.4%	*	*	*
North Dakota	1,169	0.4%	28.2%	*	*	*
Northwest						
Alaska	136	0.1%	14.3%	*	*	*
Western Interior						
Oklahoma	184	0.0%	21.9%	$16	0.0%	N/A
Kansas	8	0.0%	-11.1%	*	*	*
Missouri	26	0.0%	-31.6%	*	*	*
Arkansas	70	0.0%	-41.2%	*	*	*
Total U.S.	91,482	0.1%	20.6%	$7,091*	0.1%	20.0%

Sources: [1] U.S. Energy Information Administration (EIA), 2001 and 2011 Annual Coal Reports (EIA-0584);
[2] 2011 Employment from U.S. EIA, 2011 Annual Coal Report (EIA-0584); Total Employment from U.S. Census Bureau, County Business Patterns (CBP) 2011 Data Release.
[3] Payroll figures for 2011 are adjusted to 2013 dollars using U.S. Bureau of Economic Analysis GDP Deflator.
[4] U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases
[a] Growth not listed because annual payroll data were not released in 2001 for these states.
[b] Employee data for Kentucky is broken down by Eastern (Appalachia) and Western (Illinois Basin). Regional payroll data was unavailable from the CBP and are presented in aggregate for the entire state.
[c] Both regional employment and payroll data for Colorado was unavailable from the EIA and CBP, respectively, and are presented in aggregate for the entire state.
*****Annual payroll data were suppressed for states with low coal production in order to avoid disclosure of information about individual employers.

Table 3.14-6a
Coal Mining Employment and Annual Payroll by State, 2011 – Appalachian Basin

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
West Virginia	23,307	4.1%	41.9%	$1,867	8.5%	49.3%
Kentucky[b]	14,281	1.0%	-3.1%	$1,221	2.1%	21.2%
Pennsylvania	8,665	0.2%	6.1%	$746	0.3%	21.9%
Virginia	5,261	0.2%	-1.3%	$454	0.3%	-3.8%
Alabama	4,756	0.3%	43.0%	$330	0.5%	35.1%
Ohio	3,006	0.1%	5.1%	$264	0.1%	-25.5%
Tennessee	505	0.0%	-9.8%	*	*	*
Maryland	488	0.0%	6.1%	$21	0.0%	N/A

Table 3.14-6b
Coal Mining Employment and Annual Payroll by State, 2011 – Colorado Plateau

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Colorado[c]	2,405	0.1%	23.7%	$182	0.2%	7.7%
Utah*	1,797	0.2%	20.8%	$145	0.3%	4.2%
New Mexico	1,292	0.2%	-25.2%	$147	0.6%	-16.2%
Arizona	419	0.0%	-40.0%	*	*	*

Table 3.14-6c
Coal Mining Employment and Annual Payroll by State, 2011 – Gulf Coast

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Texas	2,936	0.0%	424.3%	$199	0.0%	12.0%
Louisiana	259	0.0%	39.2%	*	*	*
Mississippi	224	0.0%	75.0%	*	*	*

Table 3.14-6d
Coal Mining Employment and Annual Payroll by State, 2011 – Illinois Basin

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Kentucky[b]	4,353	0.3%	81.2%	$1,221	2.1%	21.2%
Illinois	4,105	0.1%	19.1%	$240	0.1%	-18.1%
Indiana	3,540	0.1%	40.0%	$288	0.3%	64.8%

Table 3.14-6e
Coal Mining Employment and Annual Payroll by State, 2011 – Northern Rocky Mountains and Great Plains

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Wyoming	7,039	3.4%	61.3%	$632	6.5%	51.5%
Colorado[c]	2,405	0.1%	23.7%	$182	0.2%	7.7%
Montana	1,251	0.4%	48.4%	*	*	*
North Dakota	1,169	0.4%	28.2%	*	*	*

Table 3.14-6f
Coal Mining Employment and Annual Payroll by State, 2011 – Northwest

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Alaska	136	0.1%	14.3%	*	*	*

Table 3.14-6g
Coal Mining Employment and Annual Payroll by State, 2011 – Western Interior

Geography	Number of Coal Industry Employees [1]	Contribution of Coal Industry Employees to Total Employment (%)[2]	Coal Industry Employment Growth 2001 - 2011 (%)[1]	Coal Industry Annual Payroll 2011 ($ Millions, 2013$)[3]	Coal Industry Contribution to Total State Annual Payroll (%)[4]	Coal Industry Payroll Growth 2001 - 2011 (%)[4]
Oklahoma	184	0.0%	21.9%	$16	0.0%	N/A
Kansas	8	0.0%	-11.1%	*	*	*
Missouri	26	0.0%	-31.6%	*	*	*
Arkansas	70	0.0%	-41.2%	*	*	*

Sources and Notes for Tables 3.14-6a-g:
[1] U.S. Energy Information Administration (EIA), 2001 and 2011 Annual Coal Reports (EIA-0584);
[2] 2011 Employment from U.S. EIA, 2011 Annual Coal Report (EIA-0584); Total Employment from U.S. Census Bureau, County Business Patterns (CBP) 2011 Data Release.
[3] Payroll figures for 2011 are adjusted to 2013 dollars using U.S. Bureau of Economic Analysis GDP Deflator.
[4] U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases
[a] Growth not listed because annual payroll data were not released in 2001 for these states.
[b] Employee data for Kentucky is broken down by Eastern (Appalachia) and Western (Illinois Basin). Regional payroll data was unavailable from the CBP and are presented in aggregate for the entire state.
[c] Both regional employment and payroll data for Colorado was unavailable from the EIA and CBP, respectively, and are presented in aggregate for the entire state.
*****Annual payroll data were suppressed for states with low coal production in order to avoid disclosure of information about individual employers.

Table 3.14-7a
Coal Severance Tax Rates by State, 2012 – Applachian Basin

State	Severance Tax Type	Rate
Alabama (a)	State Coal Severance Tax	$0.335 per ton for the state.
	Local Coal Severance Tax	$0.20 per ton in Jackson and Marshall County.
Kentucky (b)	Coal Severance and Processing Tax	4.5% of gross value with a minimum tax of $0.50 per ton. A credit is given to thin seam coal extraction on a scale from 2.25% to 3.75% of the coal value.
Maryland (c)	No Coal Severance Tax	N/A
Ohio (d)	Coal Severance Tax	Base rate of $0.10 per ton, plus an additional $0.012 per ton on surface mined coal. An additional $0.12 to $0.16 per ton is levied on operations without a full cost bond and changes based on the amount remaining in the state Reclamation Forfeiture Fund at the end of each state budget biennium.
Pennsylvania	No Coal Severance Tax	N/A
Tennessee (e)	Coal Severance Tax	$0.75 per ton on entire production of coal products in the state, regardless of place of sale or outside-of-state delivery.
Virginia (f)	Local Coal Reclamation Tax	Any county or city may impose a severance tax on all coal within its jurisdiction. The rate of tax shall not exceed 1% of the gross receipts from such coal or gases.
West Virginia (g)	Natural Resources Severance Tax	5% of gross value, with the following reduced rates for thin seam underground mining: 2% of gross value for seams with thickness between 37 and 45 inches and 1% of gross value for seams with thickness less than 37 inches.

Table 3.14-7b
Coal Severance Tax Rates by State, 2012 – Colorado Plateau

State	Severance Tax Type	Rate
Arizona	No Coal Severance Tax	N/A
Colorado (h)	Coal Severance Tax	$0.842 per ton.
New Mexico (i)	Coal Severance Tax	$0.57 per ton on surface coal and $0.55 per ton on underground coal. The state also imposes a surtax on coal, which is increased on July 1 each year. The surtax in effect in Fiscal Year (FY) 2009 was $0.83 per ton. Post-2011 renegotiated contracts are not subject to the surtax.
Utah	No Coal Severance Tax	N/A

Table 3.14-7c
Coal Severance Tax Rates by State, 2012 – Gulf Coast

State	Severance Tax Type	Rate
Louisiana (j)	Natural Resources Severance Tax	$0.12 per ton of lignite.
Mississippi	No Coal Severance Tax	N/A
Texas	No Coal Severance Tax	N/A

Table 3.14-7d
Coal Severance Tax Rates by State, 2012 – Illinois Basin

State	Severance Tax Type	Rate
Illinois	No Coal Severance Tax	N/A
Indiana	No Coal Severance Tax	N/A
Kentucky (b)	Coal Severance and Processing Tax	4.5% of gross value with a minimum tax of $0.50 per ton. A credit is given to thin seam coal extraction on a scale from 2.25% to 3.75% of the coal value.

Table 3.14-7e
Coal Severance Tax Rates by State, 2012 – Northern Rocky Mountains and Great Plains

State	Severance Tax Type	Rate			
Colorado (h)	Coal Severance Tax	$0.842 per ton			
Montana (k)	Coal Severance Tax	Heat Content	Surface	Auger	Underground
		<7,000 BTU	10% of value	3.75% of value	3% of value
		7,000+ BTU	15% of value	5% of value	4% of value
North Dakota (l)	Coal Severance Tax	$0.375 per ton plus $0.02 per ton for the Lignite Research Fund. Reduced rates apply to coal used in cogeneration facilities. No tax on coal used for the following: (1) to heat state buildings; (2) used by the state or political subdivision of the state; or (3) agricultural processing. Counties may also grant a partial or complete exemption from the counties' 70% portion of the $0.375 tax for coal shipped out of state.			
Wyoming (m)	Coal Severance Tax	7% of taxable valuation of surface coal and 3.75% of taxable valuation of underground coal, with a maximum tax of $0.60 per ton of surface coal and $0.30 per ton of underground coal.			

Table 3.14-7f
Coal Severance Tax Rates by State, 2012 – Northwest

State	Severance Tax Type	Rate
Alaska (n)	Mining License Tax on Net Income	No tax if net income is $40,000 or less; $1,200 plus 3% of net income over $40,000; $1,500 plus 5% of net income over $50,000; and $4,000 plus 7% of net income over $100,000.
	Production Royalty on State Lands	3% on same net profits as license tax is based on.

Table 3.14-7g
Coal Severance Tax Rates by State, 2012 – Western Interior

State	Severance Tax Type	Rate
Arkansas (o)	Natural Resources Severance Tax	$0.02 per ton of coal, lignite and iron ore plus an additional $0.08 per ton on coal.
Kansas (p)	Minerals Severance Tax	$1.00 per ton coal produced. Severance or production of the first 350,000 tons of coal at any mine is exempt from taxation.
Missouri	No Coal Severance Tax	N/A
Oklahoma	No Coal Severance Tax	N/A

Sources for Tables 3.14-7a-g:
(a) Alabama - §§40-13-50, 40-13-61, Code of Alabama, 1975
(b) Kentucky – Kentucky Revised Statutes (KRS) §143.020; KRS §143.010(13); KRS §143.010(14); KRS §143.021(3)
(c) Maryland - Annotated Code of Maryland §15-509 (Environment Article). Annotated Code of Maryland §15-615 (Environment Article)
(d) Ohio - Ohio Revised Code (ORC) §5749.02(A)(1); ORC §5749.02(A)(8); ORC §5749.02(A)(9)
(e) Tennessee – Tennessee Code 67-7-104
(f) Virginia - Virginia Code §58.1-3286
(g) West Virginia - West Virginia Code §11-13A; West Virginia Code §11-13V-4
(h) Colorado – Quarterly Final Tax Rate for most recent reported quarter, December 2012. Severance tax rate is adjusted quarterly and is based on the chance in producer price index as published by Bureau of Land Statistics. Colorado Revised Statutes 39-29-106
(i) New Mexico – 2012 The State of New Mexico Continuing Disclosure: Annual Financial Information Filing for Fiscal Year 2012, p. 12.; 2010 New Mexico Statutes Annotated 1978 7-26-6; “Taxation of Coal and Other Energy Resources.” January 2009. New Mexico Taxation and Revenue Department.
(j) Louisiana – Revised Statutes 47:633
(k) Montana – Montana Code Annotated 15-35-103
(l) North Dakota - North Dakota Century Code §57-61-01.1
(m) Wyoming - Wyoming State Statutes §39-14-104
(n) Alaska - Mining License Tax Law: Alaska Statute 43.65; Alaska Statute 38.05.212
(o) Arkansas - Arkansas Code Annotated §26-58-101 et. seq.
(p) Kansas – Kansas Statutes Annotated 79-42
These collections do not include revenues collected by Tribal governments.

Table 3.14-8a – Applachian Basin
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Alabama*	$3,453	$9,052,880	0.04%
Kentucky**	$277,821	$10,472,861	2.65%
Maryland	$0	$17,064,468	0.00%
Ohio**	$5,627	$25,924,024	0.02%
Pennsylvania	$0	$32,949,917	0.00%
Tennessee**	$955	$11,982,345	0.01%
Virginia	$0	$17,137,586	0.00%
West Virginia**	$460,077	$5,355,809	8.59%

Table 3.14-8b – Colorado Plateau
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Arizona	$0	$12,973,265	0.00%
Colorado**	$9,747	$10,250,628	0.10%
New Mexico	$10,879	$5,088,335	0.21%
Utah**	$0	$5,809,953	0.00%

Table 3.14-8c – Gulf Coast
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Louisiana	$484	$8,994,053	0.01%
Mississippi**	$0	$6,953,362	0.00%
Texas	$0	$48,596,548	0.00%

Table 3.14-8d – Illinois Basin
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Illinois	$0	$36,437,803	0.00%
Indiana	$0	$15,704,680	0.00%
Kentucky**	$277,821	$10,472,861	2.65%

Table 3.14-8e – Northern Rocky Mountains and Great Plains
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Colorado**	$9,747	$10,250,628	0.10%
Montana**	$52,743	$2,459,324	2.14%
North Dakota	$10,898	$5,620,036	0.19%
Wyoming	$287,532	$2,550,991	11.27%

Table 3.14-8f – Northwest
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Northwest			
Alaska**	$40,696	$7,049,398	0.58%

Table 3.14-8g – Western Interior
Coal Severance Tax Revenues in Coal-producing States, 2012

State	State Coal Severance Tax Revenues ($1,000s)	Total State Tax Revenues ($1,000s)	Contribution of Coal Severance to Total Taxes
Arkansas	$13	$8,287,744	0.00%
Kansas**	$8,745	$7,418,341	0.12%
Missouri	$0	$10,800,741	0.00%
Oklahoma	$0	$8,826,132	0.00%
Total U.S.	**$1,169,670**	**$351,385,939**	**0.33%**

Sources for Tables 3.14.8a-g: U.S. Census Bureau, 2012. 2012 Annual Survey of State Government Tax Collections; Individual state revenue reports.
* Severance tax revenues are reported for the FY ending September 30, 2012. Total state tax revenues are reported for the calendar year ending December 31, 2012. The contribution of coal severance to total taxes is calculated using data from varying timeframes. These collections do not include revenues collected by Tribal governments.
** Severance tax revenues are reported for the FY ending June 30, 2012. Total state tax revenues are reported for the calendar year ending December 31, 2012. The contribution of coal severance to total taxes is calculated using data from varying timeframes.
Notes for Tables 3.14.8a-g: Severance tax revenues listed for New Mexico are net of the Intergovernmental Tax Credits (ITC) afforded to taxed coal entities. Severance tax revenues listed for Alaska consist of revenue from Alaska's mining license tax. The value of severance tax revenues for the two regions in Kentucky (Illinois Basin and Appalachia) and Colorado (Northern Rocky Mountains and Great Plains and Colorado Plateau) could not be separated. The table shows the total value for the entire state. While local areas may impose taxes on coal extracted in Virginia, no revenues were reported in 2012. Severance taxes for West Virginia are calculated as General Revenue Fund, Infrastructure Fund, and Local Dedication from Coal Severance tax figures provided for FY 2012 by the West Virginia Department of Revenue.

3.14.2.1 Appalachian Basin

Both per capita income and median household income are relatively low in the Appalachian Basin. Under both measures of income, 2011 data for coal-producing counties in this region demonstrates slightly lesser income levels than the respective statewide and the national populations. The Appalachian Basin had a relatively low median home value of $112,413 in 2011, which was 39.6 percent lower than the national median home value. Similarly, in 2011, 15.9 percent of the population of coal-producing counties was living below the poverty line. Poverty in this region was slightly more prevalent than in the broader statewide and national populations. The 2011 unemployment rate was comparable in this region with the broader U.S. (7.8 percent compared with 8.1 percent nationally).

Table 3.14-9 lists the industries contributing the most to employment and annual payroll in the Appalachian Basin. Healthcare and Social Assistance, Manufacturing, and Retail Trade are the top industries in this region. Mining (including but not limited to coal mining), Quarrying, and Oil and Gas Extraction made up 1.9 percent of employment in the region and 3.7 percent of regional income in 2011, significantly greater than statewide and national percentages. Employment and annual payroll increased in these industries between 2001 and 2011. As described in Table 3.14-6, of the Appalachian Basin states, coal mining contributes most to employment and annual payroll in West Virginia and Kentucky. In 2011 coal mining accounted for 4.1 percent of total employment and 8.5 percent of statewide annual payroll in West Virginia. In 2011 in Kentucky, employment related to coal mining accounted for 1.0 percent of statewide employment and 2.1 percent of statewide annual payroll. Coal mining contributed less than one percent to employment and annual payroll in all other Appalachian Basin states in this same year. Between 1998 and 2012, coal production fell dramatically in the Appalachian Basin (Figure 3.14-8). Over this 15 year span, employment in the coal industry initially decreased due to less coal production. A shift toward underground mining has led to an offsetting increase in coal mining employment in recent years.

State governments in Alabama, Kentucky, Ohio, Tennessee, West Virginia, and Virginia require that direct severance taxes be paid on extracted coal. Severance tax rates are listed in Table 3.14-7. Table 3.14-8 shows severance tax revenue for state governments in 2012. In the Appalachian Basin, severance tax revenue as a fraction of total tax revenue was greatest in West Virginia and Kentucky, at 8.6 percent and 2.7 percent respectively. Maryland and Pennsylvania do not levy severance taxes on coal.

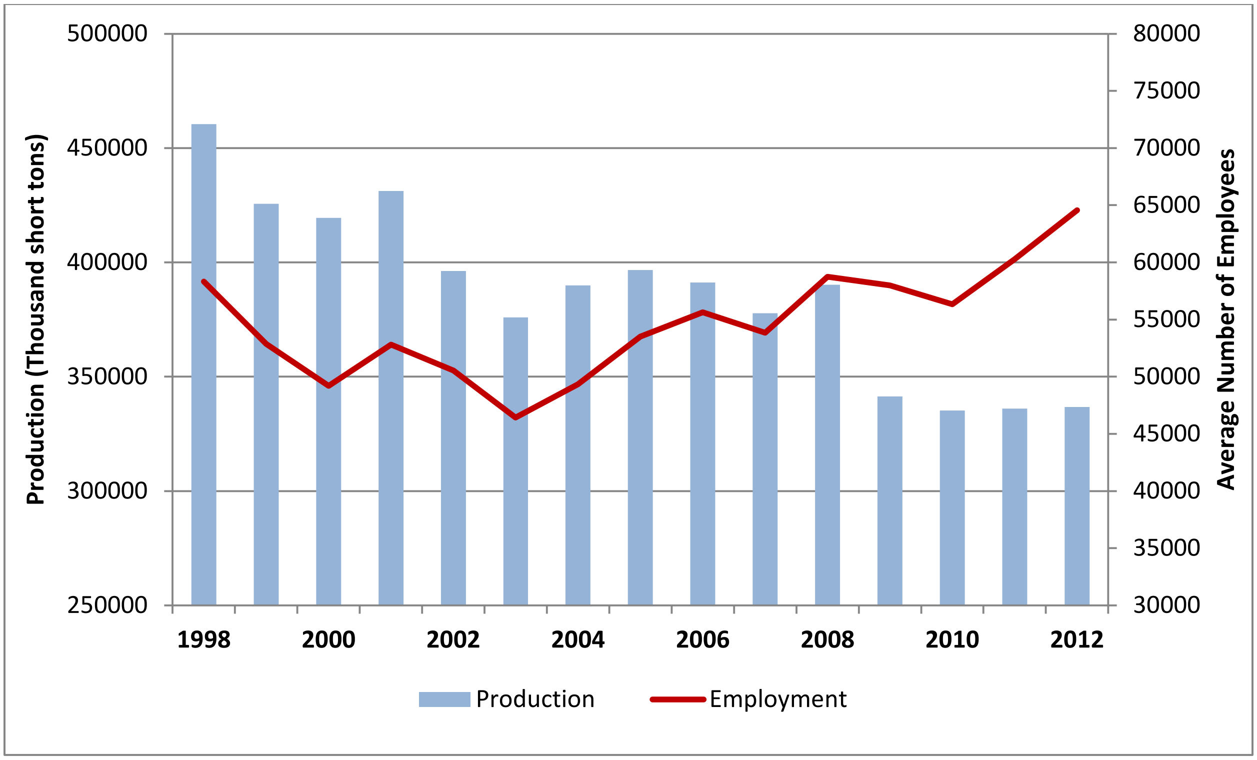
Table 3.14-9
Employment and Annual Payroll by Industry in the Appalachian Basin, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Health Care and Social Assistance	Coal-producing Counties:	694,916	18.9	15.5	28,808	19.8	5.1
	Statewide– all counties:	3,453,325	16.8	22.3	154,448	16.5	13.0
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Manufacturing	Coal-producing Counties:	408,526	11.1	-30.6	20,398	14.0	-33.8
	Statewide– all counties:	2,270,742	11.1	-31.8	121,338	13.0	-37.5
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3
Retail Trade	Coal-producing Counties:	518,210	14.1	-4.8	12,603	8.7	-17.4
	Statewide– all counties:	2,715,065	13.2	-4.4	70,258	7.5	-19.3
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Professional, Scientific, and Technical Services	Coal-producing Counties:	185,848	5.0	5.3	11,629	8.0	-2.0
	Statewide– all counties:	1,493,331	7.3	14.6	114,132	12.2	12.2
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8
Finance and Insurance	Coal-producing Counties:	164,582	4.5	-9.3	10,309	7.1	-8.8
	Statewide– all counties:	1,004,872	4.9	-9.3	72,550	7.7	-7.8
	Total U.S.:	5,886,602	5.2	-5.8	526,964	9.6	-9.6
Construction	Coal-producing Counties:	172,074	4.7	-14.4	9,035	6.2	-16.7
	Statewide– all counties:	947,260	4.6	-19.1	50,253	5.4	-23.7
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Wholesale Trade	Coal-producing Counties:	145,502	3.9	-17.1	7,955	5.5	-21.5
	Statewide– all counties:	903,489	4.4	-11.4	56,554	6.0	-13.9
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Management of Companies and Enterprises	Coal-producing Counties:	72,263	2.0	12.2	7,271	5.0	14.1
	Statewide– all counties:	533,930	2.6	4.1	52,329	5.6	4.5
	Total U.S.:	2,921,669	2.6	1.5	319,028	5.8	-4.1

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Administrative and Support and Waste Management and Remediation Services	Coal-producing Counties:	197,836	5.4	-3.6	6,236	4.3	-6.9
	Statewide– all counties:	1,510,662	7.4	5.2	51,273	5.5	2.6
	Total U.S.:	9,389,950	8.3	3.6	348,329	6.3	0.8
Mining, Quarrying, and Oil and Gas Extraction	Coal-producing Counties:	68,589	1.9	28.4	5,423	3.7	39.5
	Statewide– all counties:	115,970	0.6	26.3	8,934	1.0	36.0
	Total U.S.:	651,204	0.6	34.1	58,990	1.1	51.1

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions and therefore the populations of each coal region do not sum to the total population within all coal regions.

Figure 3.14-8 Coal Production and Employment Trends in the Appalachian Basin Region, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.2 Colorado Plateau

Income levels are slightly less in the Colorado Plateau than in the U.S. as a whole. The median household income for coal-producing counties in the region is about 1.5 percent less than the national average. Median home value is in these counties ($193,367) is on par with the broader U.S. ($186,200), but less than in the four Colorado Plateau states ($209,077). The Colorado Plateau has the greatest level of unemployment of all seven coal regions, with an unemployment rate of 8.9 percent. Poverty is also slightly more prevalent within coal-producing counties (17.3 percent below the poverty line) than in both the states encompassing the region (14.6 percent) and the broader U.S. (14.3 percent).

Table 3.14-10 lists the top industries in the Colorado Plateau. Healthcare and Social Assistance, Construction, and Retail Trade account for the highest contributions to annual payroll in this region; Healthcare and Social Assistance, Retail Trade, and Accommodation and Food Services account for the greatest employment levels. Employment and annual payroll in Mining, Quarrying, and Oil and Gas Extraction grew in this region between 2001 and 2011. These industries account for 4.2 percent of employment and 10.1 percent of annual payroll within coal-producing counties, more than double the statewide percentages and four times the national contribution for employment from the same industries. Coal mining constitutes between 1.0 percent and 2.0 percent of statewide employment and income in each state within the region

(Table 3.14-6). Both coal production and employment in the coal mining industry remained relatively stable between 1998 and 2008 but production declined since 2009 in the Colorado Plateau (Figure 3.14-9).

In Colorado and New Mexico, direct severance taxes are levied on extracted coal. Table 3.14-7 lists severance tax rates. Table 3.14-8 describes state severance tax revenues in 2012. Tax revenue from coal severance makes up 0.21 percent of total tax revenue in New Mexico. Colorado reports approximately 0.1 percent of total tax revenue from coal severance taxes. Arizona and Utah do not collect severance taxes on extracted coal.

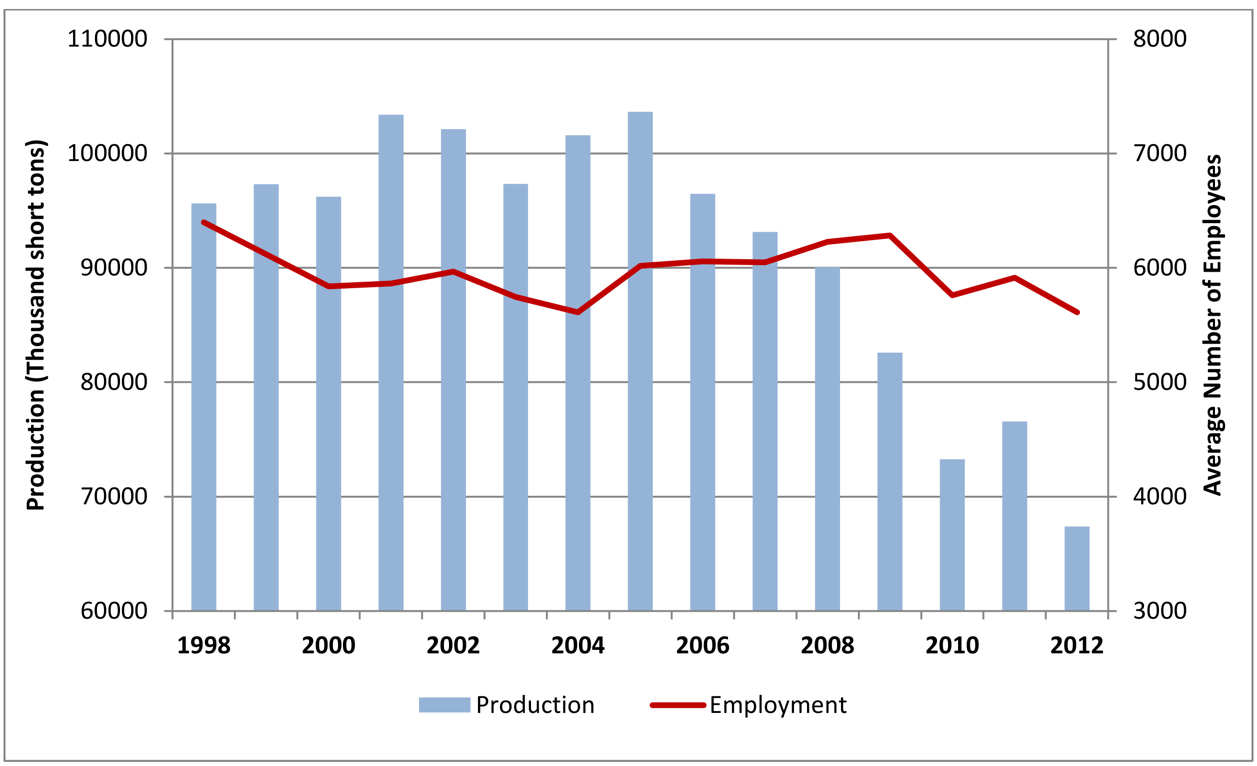
Table 3.14-10
Employment and Annual Payroll by Industry in the Colorado Plateau, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Health Care and Social Assistance	Within Coal Counties:	36,325	17.7	37.8	1,603	21.5	29.9
	Statewide– all counties:	803,298	14.1	40.9	37,838	14.7	31.7
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Retail Trade	Coal-producing Counties:	37,510	18.2	1.1	987	13.3	-13.3
	Statewide– all counties:	779,287	13.7	5.1	20,841	8.1	-18.3
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Construction	Coal-producing Counties:	14,737	7.2	-25.7	768	10.3	-20.1
	Statewide– all counties:	328,078	5.7	-25.0	16,236	6.3	-31.7
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Mining, Quarrying, and Oil and Gas Extraction	Coal-producing Counties:	8,624	4.2	60.7	751	10.1	71.5
	Statewide– all counties:	63,564	1.1	41.5	5,768	2.2	63.8
	Total U.S.:	651,204	0.6	34.1	58,990	1.1	51.1
Accommodation and Food Services	Coal-producing Counties:	29,848	14.5	13.1	475	6.4	7.0
	Statewide– all counties:	647,190	11.3	15.0	11,166	4.3	4.5
	Total U.S.:	11,556,285	10.2	15.9	207,349	3.8	3.3
Professional, Scientific, and Technical Services	Coal-producing Counties:	8,430	4.1	20.6	409	5.5	19.9
	Statewide– all counties:	415,659	7.3	16.8	29,044	11.3	12.9
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8
Transportation and Warehousing	Coal-producing Counties:	7,910	3.8	56.6	383	5.1	61.7
	Statewide– all counties:	197,796	3.5	7.1	8,863	3.4	-8.6
	Total U.S.:	4,106,359	3.6	9.5	187,874	3.4	-7.1
Wholesale Trade	Coal-producing Counties:	7,065	3.4	2.3	364	4.9	-0.7
	Statewide– all counties:	254,215	4.5	0.5	16,631	6.5	-5.4

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Finance and Insurance	Coal-producing Counties:	6,581	3.2	18.9	317	4.3	14.8
	Statewide– all counties:	302,312	5.3	4.9	19,423	7.5	-3.0
	Total U.S.:	5,886,602	5.2	-5.8	526,964	9.6	-9.6
Manufacturing	Coal-producing Counties:	6,882	3.3	-38.8	298	4.0	-38.0
	Statewide– all counties:	389,641	6.8	-24.2	22,650	8.8	-27.5
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions and therefore the populations of each coal region do not sum to the total population within all coal regions.

Figure 3.14-9 Coal Production and Employment Trends in the Colorado Plateau Region, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).

Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.3 Gulf Coast

The Gulf Coast region has the lowest income levels among all seven coal regions. Per capita income within coal-producing counties is $18,756, approximately 33 percent less than per capita income of the broader U.S. Median household income ($40,660) and median home value ($96,084) in the coal-producing counties are also significantly lesser than the corresponding national estimates ($52,762 and $186,200, respectively). With 22.0 percent of the population in coal-producing counties living below the poverty line, the Gulf Coast has the highest prevalence of poverty among all seven coal regions. Despite these statistics, there is slightly less unemployment (7.2 percent) in the Gulf Coast region than in the U.S. as a whole (8.1 percent).

The top three industries contributing to annual payroll in the region are Manufacturing, Healthcare and Social assistance, and Mining, Quarrying, and Oil and Gas Extraction (Table 3.14-11). In coal-producing counties, Mining, Quarrying, and Oil and Gas Extraction make up 5.1 percent of total employment and 12.7 percent of annual payroll, considerably more than statewide and national percentage contributions from coal mining. Employment and annual payroll in these industries grew between 2001 and 2011. As described in Table 3.14-6, the coal mining industry does not measurably contribute to statewide employment or annual payroll in any of the three states. Employment in the coal mining industry remained relatively stable between 1998 and 2005, but decreased in regional coal production toward the end of the 15 year span (Figure 3.14-10).

Louisiana levies a natural resource severance tax of $0.12 per ton of extracted lignite coal (Table 3.14-7). Tax revenue on coal severance makes up approximately one hundredth of one percent of total tax revenue in Louisiana (Table 3.14-8). Mississippi and Texas do not levy severance taxes on coal.

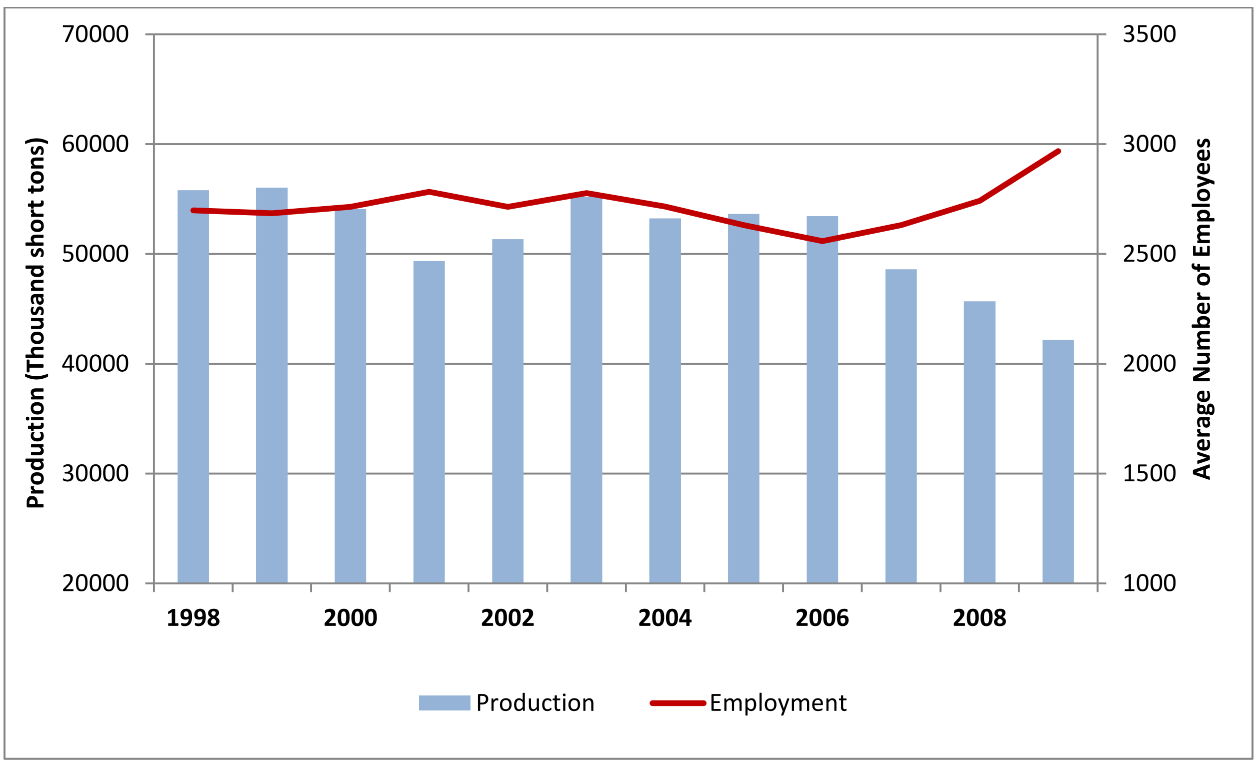
Table 3.14-11
Employment and Annual Payroll by Industry in the Gulf Coast, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Health Care and Social Assistance	Coal-producing Counties:	36,073	17.3	49.8	1,078	16.3	32.1
	Statewide– all counties:	1,471,764	14.9	12.2	63,877	13.5	3.3
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Manufacturing	Coal-producing Counties:	21,040	10.1	-20.9	904	13.7	-27.4
	Statewide– all counties:	872,091	8.8	-33.3	50,226	10.6	-35.0
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3
Mining, Quarrying, and Oil and Gas Extraction	Coal-producing Counties:	10,555	5.1	148.6	839	12.7	176.6
	Statewide– all counties:	192,317	1.9	15.2	20,234	4.3	36.3
	Total U.S.:	651,204	0.6	34.1	58,990	1.1	51.1
Retail Trade	Coal-producing Counties:	34,331	16.5	11.1	818	12.4	-1.7
	Statewide– all counties:	1,291,050	13.1	-8.9	33,998	7.2	-25.9
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Transportation and Warehousing	Coal-producing Counties:	16,901	8.1	12.1	656	9.9	19.0
	Statewide– all counties:	390,634	4.0	-3.0	20,043	4.2	-15.9
	Total U.S.:	4,106,359	3.6	9.5	187,874	3.4	-7.1
Construction	Coal-producing Counties:	9,830	4.7	7.7	420	6.4	21.3
	Statewide– all counties:	574,588	5.8	-17.2	29,395	6.2	-19.5
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Wholesale Trade	Coal-producing Counties:	7,358	3.5	-14.6	329	5.0	-2.5
	Statewide– all counties:	492,473	5.0	-13.9	33,422	7.1	-12.7
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Accommodation and Food Services	Coal-producing Counties:	22,088	10.6	40.5	319	4.8	30.4
	Statewide– all counties:	1,052,370	10.7	7.3	17,338	3.7	-7.3

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
	Total U.S.:	11,556,285	10.2	15.9	207,349	3.8	3.3
Finance and Insurance	Coal-producing Counties:	5,931	2.8	-20.7	282	4.3	-11.5
	Statewide– all counties:	498,272	5.0	-1.7	35,034	7.4	-3.7
	Total U.S.:	5,886,602	5.2	-5.8	526,964	9.6	-9.6
Professional, Scientific, and Technical Services	Coal-producing Counties:	5,536	2.7	20.9	248	3.8	22.4
	Statewide– all counties:	608,478	6.2	3.5	47,262	10.0	1.8
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.

Figure 3.14-10 Coal Production and Employment Trends in the Gulf Coast Region, 1998-2009



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2009 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.4 Illinois Basin

Income levels are relatively low in the Illinois Basin coal region. Per capita income and median home value are lower in coal-producing counties than in the broader Illinois Basin states (Table 3.14-4). Per capita income and median home value are all slightly less in coal-producing counties than in the country as a whole. The poverty rate is the same in coal-producing counties (8.6 percent) and Illinois Basin states (8.6 percent) and slightly greater than the rest of the country as a whole (8.1 percent). Unemployment is slightly more prevalent in this region than in the broader U.S. (8.6 percent compared with 8.1 percent).

Table 3.14-12 lists the top industries in the Illinois Basin. Healthcare and Social Assistance, Manufacturing, and Retail Trade contribute most to employment and annual payroll in this region. The Mining, Quarrying, and Oil and Gas Extraction industries account for 0.5 percent of employment and 1.2 percent of annual payroll in coal-producing counties. In Kentucky, coal mining constitutes 0.3 percent of statewide employment and 2.1 percent of statewide annual payroll (Table 3.14-6). Coal mining makes up less than 0.2 percent of employment and less than 0.3 percent of annual payroll in Indiana and Illinois. As shown in Figure 3.14-11, employment in the Illinois Basin coal mining industry decreased between 1998 and 2000 but increased steadily between 2000 and 2011, in response to a similar trend in regional coal production. Production and employment dropped again in 2012.

Kentucky levies a coal severance tax, collecting 4.5 percent of the gross value of extracted coal with a minimum of $0.50 per ton (Table 3.14-7). As shown in Table 3.14-8, severance tax revenue makes up 2.65 percent of the total tax revenue collected by the state of Kentucky. Illinois and Indiana do not levy coal severance taxes.

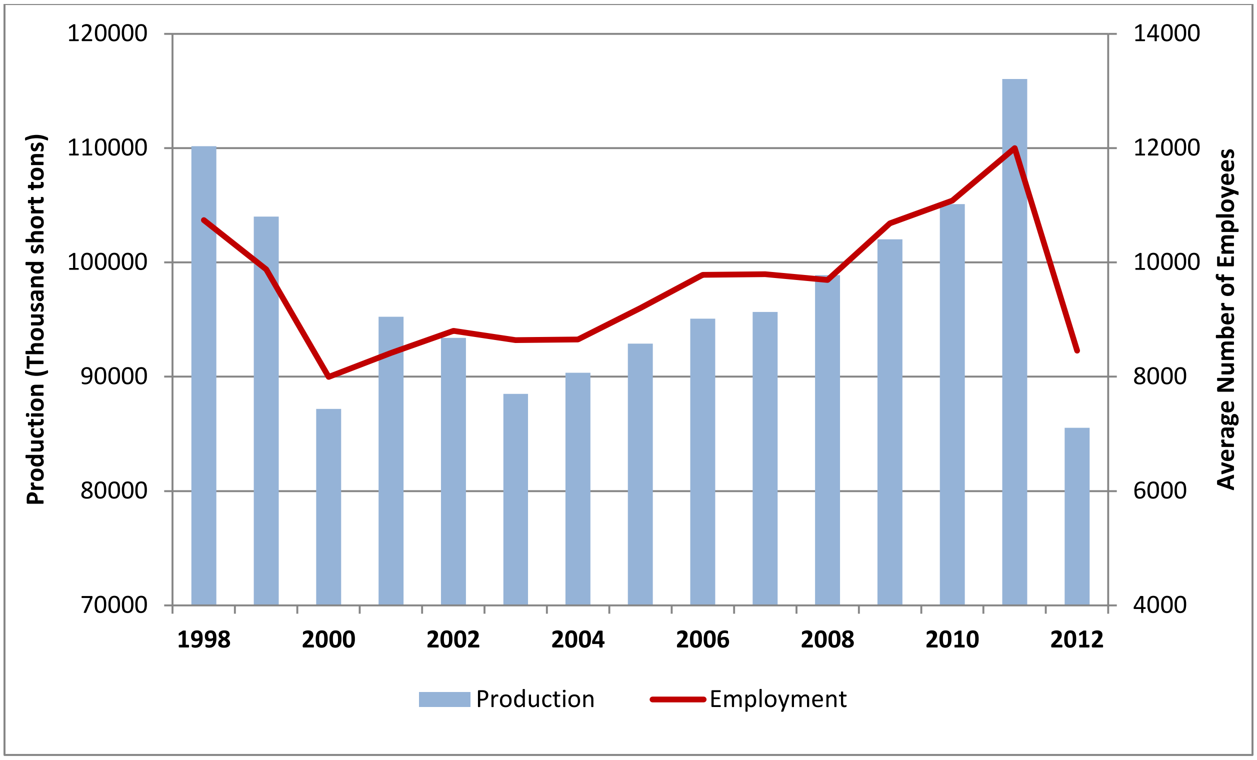
Table 3.14-12
Employment and Annual Payroll by Industry in the Illinois Basin, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Health Care and Social Assistance	Coal-producing Counties:	234,715	17.0	14.1	9,488	18.7	5.0
	Statewide– all counties:	1,146,975	15.3	18.0	51,087	14.1	6.2
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Manufacturing	Coal-producing Counties:	178,089	12.9	-24.7	9,407	18.6	-32.9
	Statewide– all counties:	976,188	13.1	-31.5	54,468	15.0	-38.0
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3
Retail Trade	Coal-producing Counties:	199,194	14.4	-0.9	4,892	9.7	-16.0
	Statewide– all counties:	904,846	12.1	-5.7	23,620	6.5	-22.7
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Finance and Insurance	Coal-producing Counties:	70,767	5.1	-3.9	4,287	8.5	-6.5
	Statewide– all counties:	393,020	5.3	-12.5	35,066	9.7	-14.3
	Total U.S.:	5,886,602	5.2	-5.8	526,964	9.6	-9.6
Construction	Coal-producing Counties:	63,674	4.6	-19.2	3,658	7.2	-26.0
	Statewide– all counties:	287,545	3.8	-28.2	18,151	5.0	-35.3
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Wholesale Trade	Coal-producing Counties:	63,264	4.6	0.6	3,493	6.9	0.6
	Statewide– all counties:	410,544	5.5	-11.3	27,359	7.5	-16.9
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Professional, Scientific, and Technical Services	Coal-producing Counties:	51,463	3.7	16.5	2,710	5.4	11.0
	Statewide– all counties:	447,879	6.0	0.8	34,819	9.6	-7.2
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8
Transportation and Warehousing	Coal-producing Counties:	56,845	4.1	25.9	2,368	4.7	6.8
	Statewide– all counties:	333,083	4.5	8.6	15,116	4.2	-10.1
	Total U.S.:	4,106,359	3.6	9.5	187,874	3.4	-7.1

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Administrative and Support and Waste Management and Remediation Services	Coal-producing Counties:	69,559	5.0	2.4	2,082	4.1	3.7
	Statewide– all counties:	635,960	8.5	2.1	20,127	5.5	-12.1
	Total U.S.:	9,389,950	8.3	3.6	348,329	6.3	0.8
Accommodation and Food Services	Coal-producing Counties:	138,638	10.0	9.7	1,974	3.9	3.8
	Statewide– all counties:	704,087	9.4	10.3	11,919	3.3	0.5
	Total U.S.:	11,556,285	10.2	15.9	207,349	3.8	3.3

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries (such as in KY) are counted in the region where they fall.

Figure 3.14-11 Coal Production and Employment Trends in the Illinois Basin Region, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.5 Northern Rocky Mountains and Great Plains

In the Northern Rocky Mountains and Great Plains region, per capita income in coal-producing counties is less than that of the states encompassing the region and national per capita income (Table 3.14-4). Median household income is greater in the coal-producing counties ($57,375) than in the broader Northern Rocky Mountains and Great Plains states ($55,129) and the U.S. as a whole ($52,762). Median home value is less in this region ($199,665) than in the states encompassing the region ($213,776) and greater than the broader U.S. ($186,200). Unemployment in this coal region is in line with the broader U.S. (Table 3.14-5). Poverty in the region and statewide (12.8 percent and12.6 percent, respectively) are less than in the greater U.S.

Construction, Retail Trade, and Mining, Quarrying, and Oil and Gas Extraction are the major industries in the region (Table 3.14-13). Mining, Quarrying, and Oil and Gas Extraction in this region contributes a greater share of employment and annual payroll than in any other coal region, accounting for 5.7 percent of employment and 10.9 percent of total annual payroll in coal-producing counties. In Wyoming, employment related to coal mining makes up 3.4 percent of statewide employment and 6.5 percent of statewide annual payroll (Table 3.14-6). Coal mining employment accounted for less than 0.4 percent of statewide employment in Montana and North Dakota; coal mining related payroll data are not available for these states. Between 1998 and 2012, mining related employment grew by more than 60 percent in the Northern Rocky

Mountains and Great Plains region, corresponding with considerable growth in regional coal production (Figure 3.14-12).

All four states in the Northern Rocky Mountains and Great Plains region levy severance taxes on coal (see Table 3.14-7). Coal severance tax revenues make up a relatively great share of total tax revenue in this region, accounting for 11.3 percent of Wyoming tax revenue, 2.1 percent of Montana tax revenue, 0.2 percent of North Dakota tax revenue, and 0.1 percent of Colorado tax revenue (Table 3.14-8).

Table 3.14-13
Employment and Annual Payroll by Industry in the Northern Rocky Mountains and Great Plains, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Construction	Coal-producing Counties:	33,769	11.0	-9.3	1,932	14.3	-15.2
	Statewide– all counties:	55,438	6.5	18.3	3,111	8.9	22.3
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Health Care and Social Assistance	Coal-producing Counties:	38,046	12.4	50.2	1,833	13.6	63.4
	Statewide– all counties:	152,584	17.9	24.7	6,433	18.4	25.3
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Mining, Quarrying, and Oil and Gas Extraction	Coal-producing Counties:	17,361	5.7	39.1	1,468	10.9	36.9
	Statewide– all counties:	48,385	5.7	81.8	4,289	12.3	98.3
	Total U.S.:	651,204	0.6	34.1	58,990	1.1	51.1
Wholesale Trade	Coal-producing Counties:	22,121	7.2	7.4	1,331	9.8	-4.9
	Statewide– all counties:	42,037	4.9	8.0	2,315	6.6	19.0
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Manufacturing	Coal-producing Counties:	25,127	8.2	-7.9	1,291	9.5	-15.9
	Statewide– all counties:	49,459	5.8	-9.0	2,449	7.0	-9.3
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3
Retail Trade	Coal-producing Counties:	39,827	12.9	2.7	1,137	8.4	-13.8
	Statewide– all counties:	130,975	15.4	5.8	3,467	9.9	-2.0
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Transportation and Warehousing	Coal-producing Counties:	19,562	6.4	8.1	1,050	7.8	8.6
	Statewide– all counties:	34,695	4.1	48.2	1,677	4.8	59.9
	Total U.S.:	4,106,359	3.6	9.5	187,874	3.4	-7.1
Professional, Scientific, and Technical Services	Coal-producing Counties:	10,629	3.5	38.5	620	4.6	53.0
	Statewide– all counties:	36,793	4.3	15.1	1,896	5.4	22.8
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Administrative and Support and Waste Management and Remediation Services	Coal-producing Counties:	14,920	4.8	-5.4	559	4.1	-2.4
	Statewide– all counties:	37,382	4.4	26.5	1,112	3.2	32.5
	Total U.S.:	9,389,950	8.3	3.6	348,329	6.3	0.8
Accommodation and Food Services	Coal-producing Counties:	31,902	10.4	17.0	498	3.7	12.5
	Statewide– all counties:	102,170	12.0	12.9	1,636	4.7	13.8
	Total U.S.:	11,556,285	10.2	15.9	207,349	3.8	3.3

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries are counted in the region where they fall. Three Colorado counties overlap both the Colorado Plateau and Northern Rocky Mountains and Great Plains regions. The data for these counties is therefore included in both regions and therefore the populations of each coal region do not sum to the total population within all coal regions.
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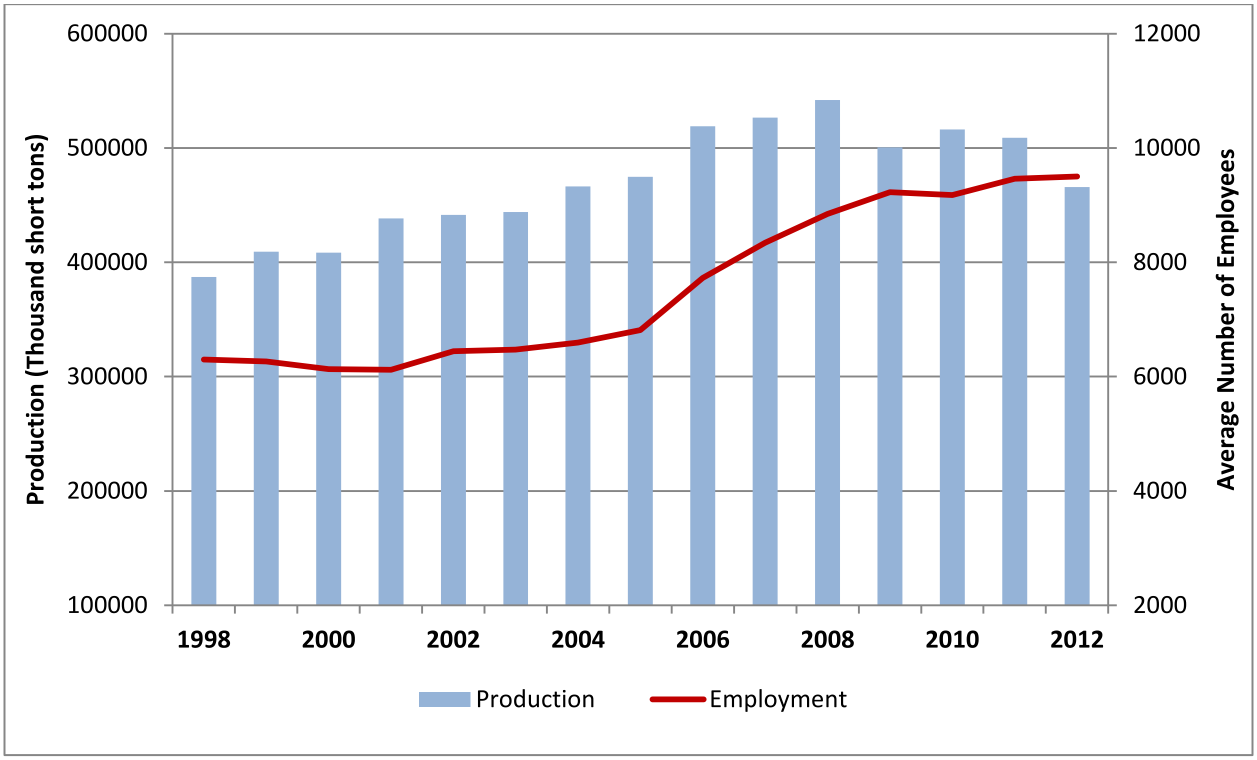
Figure 3.14-12 Coal Production and Employment Trends in the Northern Rocky Mountains and Great Plains Region, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.6 Northwest

This section describes the socioeconomic conditions of the current and reasonably foreseeable future coal mining activity in the region (i.e., Alaska). The socioeconomic metrics described in Tables 3.14-4 and 3.14-5 indicate that people living in the Northwest coal region are, on average, more affluent than the general population. Alaska is better off than the general population in terms of average income, home values, unemployment, and poverty rates. Per capita income in coal-producing counties is $38,669, the greatest among all coal regions and more than 38 percent greater than national per capita income. Median household income is also the greatest in the Northwest coal region. Median home value in coal-producing counties is $394,197, more than double the national median home value. These counties have a lower prevalence of poverty and unemployment than the rest of the country (Table 3.14-5).

Table 3.14-14 demonstrates that due to the small area in Alaska where coal operations take place, minimal data is available related to the employment and annual payroll of the region. Of available and reported data, Accommodations and Food Services, Transportation and Warehousing, and Retail Trade are the top contributors to annual payroll in the Northwest coal region. Transportation and Warehousing, Retail Trade and construction are the top industries contributing to employment in the region. The Mining, Quarrying, and Oil and Gas Extraction industries did not report figures for the 2001 to 2011 time period in this region (Table 3.14-6). Additionally, as shown in Figure 3.14-13, regional coal production and employment dropped precipitously between 2006 and 2007, reflecting the termination of coal production in Washington.

Alaska levies a license tax on net income earned from mining. The tax rate varies based on the amount of income earned. Alaska also collects royalties from production on state land (Table 3.14-7). Approximately 0.6 percent of total tax revenue collected by the state of Alaska comes from the mining license tax (Table 3.14-8).

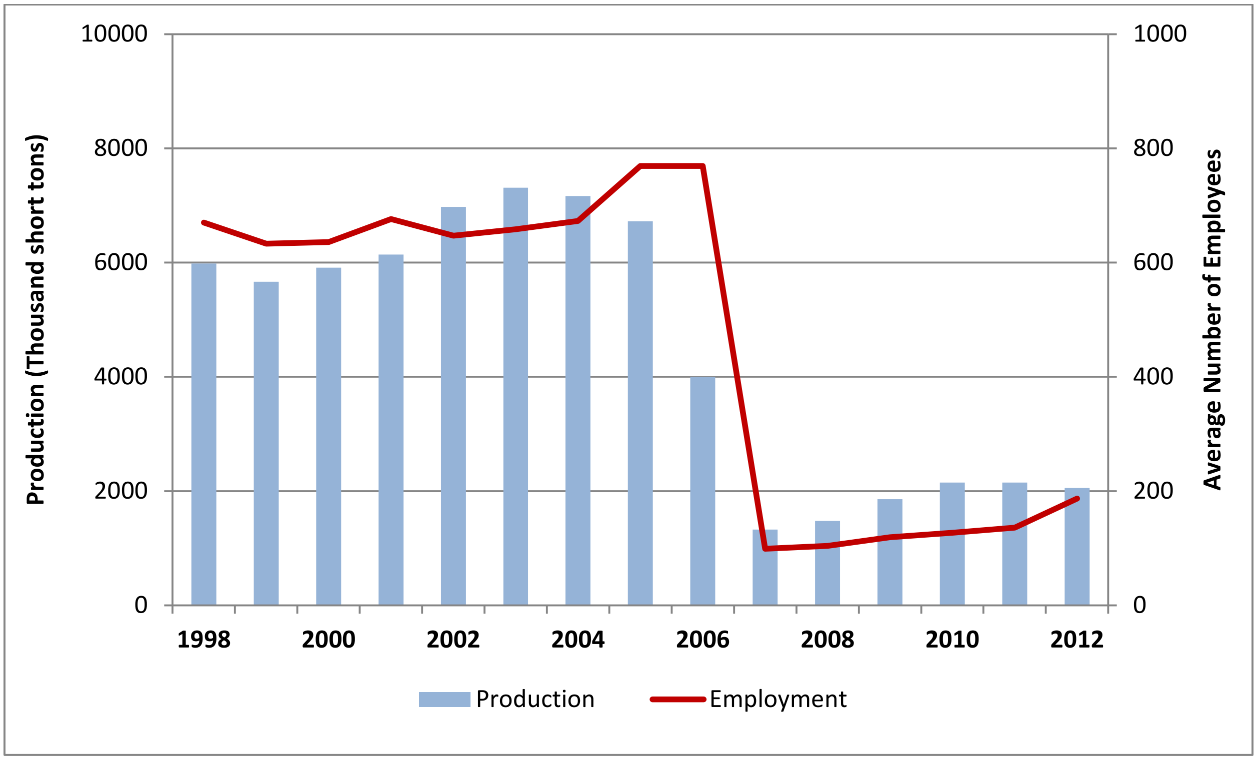
Table 3.14-14
Employment and Annual Payroll by Industry in the Northwest, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Accommodation and Food Services	Coal-producing Counties:	**	**	**	25	**	**
	Statewide– all counties:	26,132	1.0	19.2	655	0.5	4.3
	Total U.S.:	11,556,285	10.2	15.9	207,349	3.8	3.3
Transportation and Warehousing	Coal-producing Counties:	23	**	130.0	2	0.0	72.4
	Statewide– all counties:	17,713	0.7	-2.2	1,245	0.9	-4.3
	Total U.S.:	4,106,359	3.6	9.5	187,874	3.4	-7.1
Retail Trade	Coal-producing Counties:	22	**	-8.3	1	0.0	45.8
	Statewide– all counties:	32,548	1.2	-2.6	1,043	0.7	-19.0
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Construction	Coal-producing Counties:	18	**	**	1	0.0	**
	Statewide– all counties:	16,923	0.6	11.5	1,565	1.1	15.9
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Arts, Entertainment, and Recreation	Coal-producing Counties:	**	**	**	1	0.0	**
	Statewide– all counties:	4,906	0.2	*	96	0.1	**
	Total U.S.:	2,003,129	1.8	12.5	67,871	1.2	-5.7
Health Care and Social Assistance	Coal-producing Counties:	**	**	**	1	0.0	**
	Statewide– all counties:	44,084	1.7	35.2	2,417	1.7	16.2
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Professional, Scientific, and Technical Services	Coal-producing Counties:	**	**	**	0	0.0	**
	Statewide– all counties:	17,417	0.7	52.7	1,219	0.9	32.8
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8
Administrative and Support and Waste Management and Remediation Services	Coal-producing Counties:	**	**	**	**	**	**

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
	Statewide– all counties:	20,335	0.8	80.6	1,029	0.7	80.5
	Total U.S.:	9,389,950	8.3	3.6	348,329	6.3	0.8
Agriculture, Forestry, Fishing and Hunting	Coal-producing Counties:	**	**	**	**	**	**
	Statewide– all counties:	1,297	0.0	-19.4	64	0.0	-34.6
	Total U.S.:	156,520	0.1	-14.7	5,854	0.1	-21.7
Educational Services	Coal-producing Counties:	**	**	**	**	**	**
	Statewide– all counties:	3,157	0.1	18.6	94	0.1	2.6
	Total U.S.:	3,386,047	3.0	29.6	122,960	2.2	17.4

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries are counted in the region where they fall.
** Northwest data includes only Alaska.** Data not reported.

Figure 3.14-13 Coal Production and Employment Trends in the Northwest Region, 1998-2012



Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.2.7 Western Interior

The Western Interior coal region has the second lowest per capita income and second lowest median home value among all coal regions (Table 3.14-4). Per capita income within coal-producing counties is $22,050. Median home value in these counties is $104,353, approximately 44 percent less than the national median home value. Per capita income, median household income, and median home value are all less in coal-producing counties than Western Interior states and the broader U.S. The Western Interior has a greater prevalence of poverty than the national population, with 16.8 percent of the population in coal-producing counties living below the poverty line, compared with 14.3 percent nationwide. These counties have an unemployment rate (6.9 percent) comparable to the broader Western Interior states (6.4 percent) but less than the national rate (8.1 percent).

Table 3.14-15 lists the top industries in the Western Interior by employment and annual payroll. Manufacturing, Healthcare and Social Assistance and Retail Trade contribute most to employment and annual payroll in the region. The Mining, Quarrying, and Oil and Gas Extraction industries contribute more to employment and annual payroll in this region than in the states encompassing the region and in the broader U.S., making up 2.4 percent of employment and 4.2 percent of annual payroll in coal-producing counties. As described in Table 3.14-6, coal mining does not contribute measurably to employment or annual payroll in any of the four states within the region. Between 1998 and 2011, employment in the coal mining industry varied, reaching a low point of 186 employees in 2002 and a high point of 682 employees in 2012 (Figure 3.14-14). Corresponding with a fall in regional coal production, coal mining employment fell between 2007 and 2009 but then rose significantly in 2012 in response to an increase in production.

Arkansas and Kansas levy severance taxes on extracted coal. Severance tax rates are listed in Table 3.14-7. Severance tax revenues for 2012 are listed in Table 3.14-8. Severance tax revenue makes up less than 0.1 percent of tax revenue in both Kansas and Arkansas. Missouri and Oklahoma do not collect tax revenue from coal severance.

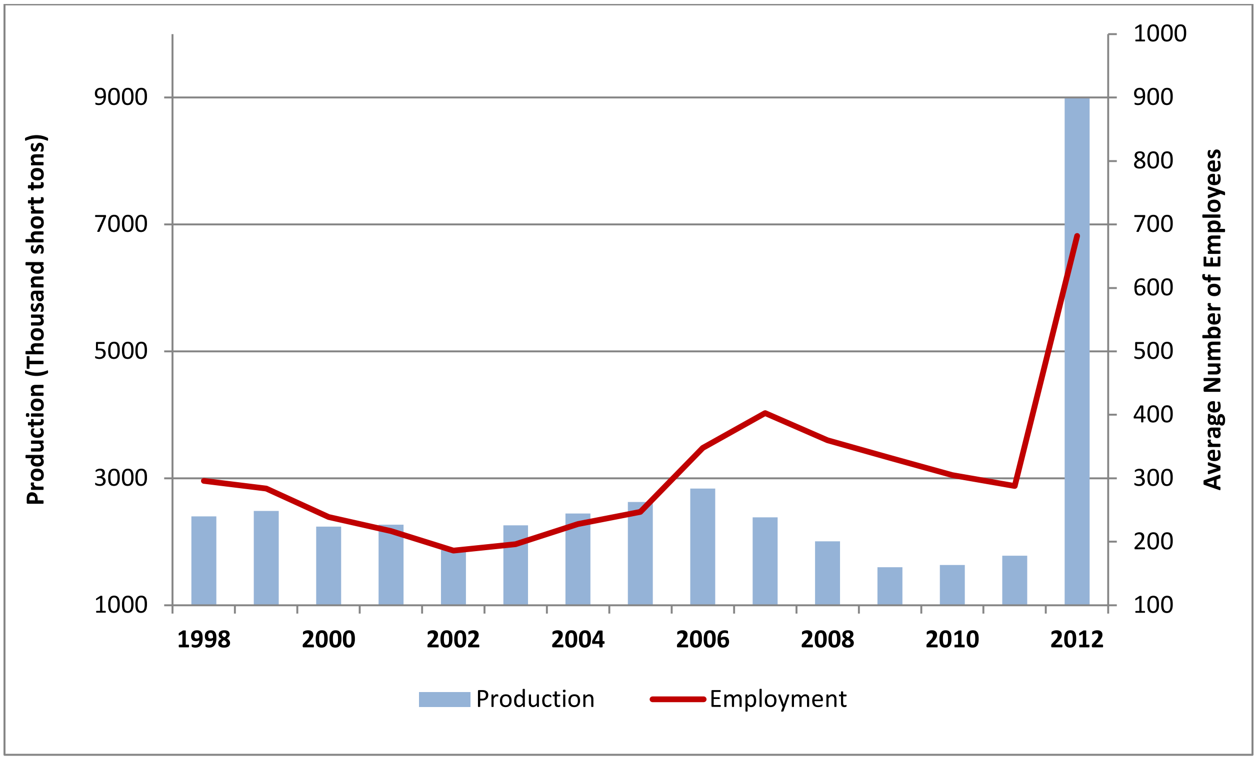
Table 3.14-15
Employment and Annual Payroll by Industry in the Western Interior, 2011

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
Manufacturing	Coal-producing Counties:	24,016	19.6	-31.4	1,112	26.0	-34.1
	Statewide– all counties:	678,401	12.0	-26.1	33,753	14.3	-29.3
	Total U.S.:	10,984,361	9.7	-31.1	613,692	11.1	-36.3
Health Care and Social Assistance	Coal-producing Counties:	23,183	19.0	9.0	842	19.7	-9.4
	Statewide– all counties:	961,104	17.0	20.7	39,096	16.6	10.6
	Total U.S.:	18,059,112	15.9	24.2	832,892	15.1	14.6
Retail Trade	Coal-producing Counties:	17,344	14.2	-1.8	403	9.4	-15.9
	Statewide– all counties:	759,377	13.4	-2.0	19,083	8.1	-16.6
	Total U.S.:	14,698,563	13.0	-1.3	395,818	7.2	-19.4
Construction	Coal-producing Counties:	6,049	4.9	11.2	280	6.6	26.6
	Statewide– all counties:	264,211	4.7	-14.5	13,091	5.5	-22.1
	Total U.S.:	5,190,921	4.6	-20.0	283,149	5.1	-26.6
Management of Companies and Enterprises	Coal-producing Counties:	2,781	2.3	27.5	278	6.5	36.8
	Statewide– all counties:	160,254	2.8	20.8	15,335	6.5	16.3
	Total U.S.:	2,921,669	2.6	1.5	319,028	5.8	-4.1
Wholesale Trade	Coal-producing Counties:	4,576	3.7	2.8	206	4.8	4.1
	Statewide– all counties:	281,849	5.0	-8.0	15,501	6.6	-9.8
	Total U.S.:	5,626,328	5.0	-8.4	381,331	6.9	-11.4
Mining, Quarrying, and Oil and Gas Extraction	Coal-producing Counties:	2,892	2.4	207.0	180	4.2	216.7
	Statewide– all counties:	71,614	1.3	60.8	6,076	2.6	106.9
	Total U.S.:	651,204	0.6	34.1	58,990	1.1	51.1
Finance and Insurance	Coal-producing Counties:	3,910	3.2	-19.1	175	4.1	-23.5

Sector	Geography*	Number of Paid Employees	Contribution to Employment (%)	Employment Growth 2001 - 2011 (%)	Annual Payroll ($ Millions, 2013$)	Contribution to Income (%)	Payroll Growth 2001 - 2011 (%)
	Statewide– all counties:	277,979	4.9	0.3	16,905	7.2	-5.6
	Total U.S.:	5,886,602	5.2	-5.8	526,964	9.6	-9.6
Administrative and Support and Waste Management and Remediation Services	Coal-producing Counties:	5,653	4.6	-30.6	149	3.5	-16.5
	Statewide– all counties:	353,548	6.3	-4.6	11,537	4.9	-2.8
	Total U.S.:	9,389,950	8.3	3.6	348,329	6.3	0.8
Professional, Scientific, and Technical Services	Coal-producing Counties:	3,251	2.7	1.1	139	3.3	-2.9
	Statewide– all counties:	292,742	5.2	12.6	18,135	7.7	4.8
	Total U.S.:	7,929,910	7.0	10.8	606,446	11.0	3.8

Note: Payroll figures are adjusted to 2013$ using U.S. Bureau of Economic Analysis GDP Deflator.
Source: U.S. Census Bureau, County Business Patterns 2001 and 2011 Data Releases.
* Counties within a state that cross regional boundaries are counted in the region where they fall.

Figure 3.14-14 Coal Production and Employment Trends in the Western Interior Region, 1998-2012



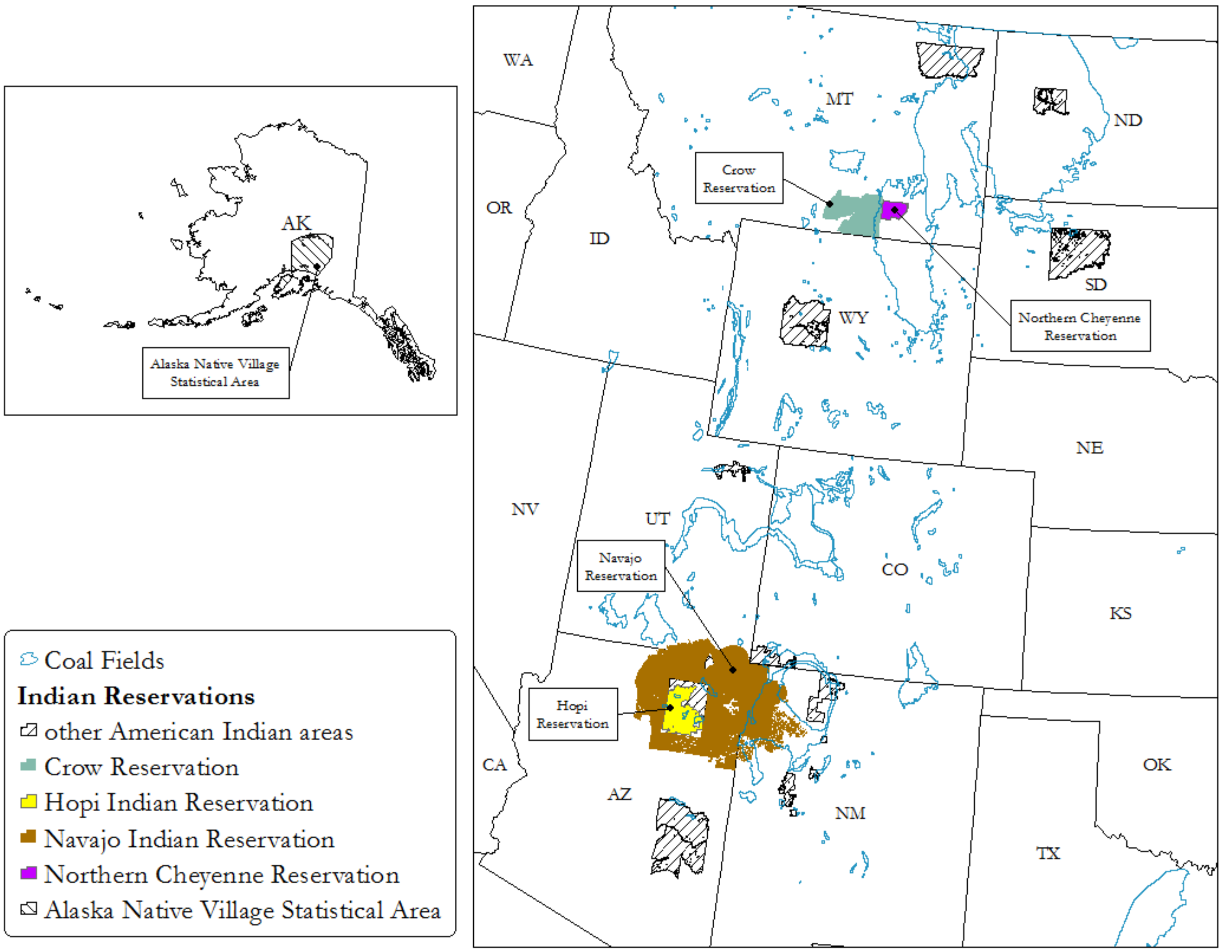
Source: U.S. Energy Information Administration, Annual Coal Reports 1998 – 2012 (EIA-0584).
Note: Employment includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. Employment excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

3.14.3 Tribal Populations

This section characterizes socioeconomic factors similar to the previous two sections, but focuses more specifically on the Native American and Native Alaskan populations potentially affected by the Action Alternatives. Sections 4.3 (describing impacts on socioeconomic conditions) and 4.4 (environmental justice analysis) evaluate potential impacts of the regulatory alternatives on Native American populations.

The U.S. Census identifies 20 “American Indian Areas” and six “Alaska Native Village Statistical Areas” (ANVSA) within the study area for this analysis. These include reservations, off reservation trust lands (ORTLs), and statistical areas that include populations of Native Americans and Alaska Natives. These areas, mapped in Figure 3.15-6, overlap potentially minable coal within coal-producing counties across the U.S. Socioeconomic data for the “American Indian Areas” and ANVSAs are from the 2000 and 2010 U.S. Censuses and the American Community Survey 2007-2011 Five Year Estimates. This characterization focuses on the “American Indian Areas” and ANVSAs; there may be additional tribal subdivisions that overlap the area of analysis but are not separately characterized in this report.

Figure 3.14-15 American Indian Areas Overlapping Coal Regions



Source: U.S. Census Bureau 2010a TIGER/Line® Shapefiles. U.S. Department of Commerce. https://www.census.gov/geo/maps-data/data/tiger-line.html; USGS, 2001a. Coal Fields of the United States: National Atlas of the United States, Reston, VA, Eastern Energy Team; John Tully (comp.), August 2001. http://nationalatlas.gov/mld/coalfdp.html

This discussion gives particular emphasis to the socioeconomic profiles of the Navajo, Hopi, Northern Cheyenne, and Crow Tribes, the four tribes listed in section 710(i) of SMCRA (30 U.S.C. § 1300(i)). The Navajo Nation Reservation occupies northeastern Arizona, southeastern Utah, and northwestern New Mexico. The Hopi Reservation lies entirely within the Arizona portion of the Navajo Reservation. The Northern Cheyenne Reservation and ORTL and Crow Reservation and ORTL lie adjacent to one another in southeastern Montana.

3.14.3.1 Demography

Population trends vary across Native American tribes between 2000 and 2010 (Table 3.14-16). Of all the "American Indian Areas" examined, the Mississippi Choctaw Reservation experienced the greatest population growth (43.3 percent), while the Adais Caddo State Designated Tribal Statistical Area experienced the greatest percent decline in population (93.6 percent). The Navajo Nation has, by far, the largest population of the four tribes listed in section 710(i) of SMCRA; the population living on the Navajo Nation Reservation and ORTL declined by 3.8 percent between 2000 and 2010. The population living on the Crow Reservation and ORTL remained stable, declining by less than one percent over the same time period. The populations of the Hopi Reservation and ORTL and Northern Cheyenne Reservation and ORTL increased by 3.4 percent and 7.1 percent respectively between 2000 and 2010.

The populations of the six ANVSAs experienced varying degrees of growth and decline. Between 2000 and 2010, the Knik ANVSA experienced the greatest population increase (105 percent), whereas the Tyonek ANVSA population declined (16.1 percent).

The populations of the Navajo Nation, the Hopi, the Northern Cheyenne, the Crow, Atqasuk, Chicaloon, Knik, Tyonek, and Wainwright are all typically younger than the general U.S. population, with relatively large segments of their respective populations making up the younger age groups. The age distributions for the 20 examined "American Indian Areas" and six ANVSAs are listed in Table 3.14-17.

Table 3.14-16
Population Trends in American Indian Areas in Coal Regions, 2000-2010

Coal Region	American Indian Area	Population Growth 2000 - 2010 (%)	2010 Population
Appalachian Basin	Echota Cherokee SDTSA[a]	-17.6	53,622
Colorado Plateau	Jicarilla Apache Nation AIR/ORTL[b]	18.1	3,254
	Uintah and Ouray AIR/ORTL[b]	27.0	24,369
	Southern Ute AIR[c]	8.9	12,153
	Ute Mountain AIR/ORTL[b]	3.3	1,742
	Fort Apache AIR[c]	7.9	13,409
	Zuni AIR/ORTL[b]	1.7	7,891
	Navajo Nation AIR/ORTL[b]	-3.8	173,667
	Hopi AIR/ORTL[b]	3.4	7,185
Gulf Coast	Mississippi Choctaw AIR[c]	43.3	7,436
	Kickapoo AIR[c]	-12.9	366
	Adais Caddo SDTSA[a]	-93.6	2,517
Northern Rocky Mountains and Great Plains	Fort Berthold AIR[c]	7.2	6,341
	Crow AIR/ORTL[b]	-0.4	6,863
	Northern Cheyenne AIR/ORTL[b]	7.1	4,789
	Fort Peck AIR/ORTL[b]	-3.0	10,008
	Turtle Mountain AIR/ORTL[b]	4.1	8,669
Northwest	Atqasuk ANVSA[e]	14.8	233
	Chickaloon ANVSA[e]	39.3	23,087
	Knik ANVSA[e]	105.0	65,768
	Ninilchik ANVSA[e]	9.4	14,512
	Tyonek ANVSA[e]	-16.1	177
	Wainwright ANVSA[e]	1.4	566
Western Interior	Choctaw OTSA[d]	3.9	233,126
	Creek OTSA[d]	7.7	758,622
	Cherokee OTSA[d]	9.2	505,021

Source: U.S. Census Bureau, Census 2010, Census 2000. U.S. Department of Commerce.
[a] State Designated Tribal Statistical Area
[b] American Indian Reservation (AIR) and Off-Reservation Trust Lands
[c] American Indian Reservation
[d] Oklahoma Tribal Statistical Area
[e] Alaska Native Village Statistical Area

Table 3.14-17
Age Composition in American Indian Areas in Coal Regions (Percent of Population), 2010

Coal Region	American Indian Area	Under 5	5-14	15-24	25-34	35-44	45-54	55-64	65+
Appalachian Basin	Echota Cherokee SDTSA	6.5	13.7	12.6	11.4	14.3	17.0	12.1	12.4
Colorado Plateau	Jicarilla Apache Nation AIR/ORTL	10.3	17.8	18.2	14.1	12.4	12.1	8.0	7.1
	Uintah and Ouray AIR/ORTL	10.5	18.4	14.2	14.9	10.4	11.9	9.3	10.3
	Southern Ute AIR	6.3	12.9	11.0	10.4	12.2	17.9	16.4	12.9
	Ute Mountain AIR/ORTL	9.5	19.2	19.3	12.9	13.8	13.5	7.0	4.8
	Fort Apache AIR	12.6	19.0	19.6	12.9	11.7	11.4	7.2	5.5
	Zuni AIR/ORTL	9.1	15.1	18.0	12.8	14.2	14.5	9.1	7.2
	Navajo Nation AIR/ORTL	8.7	18.2	18.0	11.7	11.7	13.0	9.0	9.5
	Hopi AIR/ORTL	9.0	17.3	15.5	11.9	10.9	13.6	10.8	11.0
Gulf Coast	Mississippi Choctaw AIR	12.8	22.0	17.8	14.3	11.4	10.1	6.4	5.2
	Kickapoo AIR	13.1	25.1	15.3	15.8	10.4	9.0	4.9	6.3
	Adais Caddo SDTSA	6.4	14.9	11.5	10.8	13.2	13.0	14.3	16.1
Northern Rocky Mountains and Great Plains	Fort Berthold AIR	9.3	16.8	16.5	12.2	10.9	14.2	11.0	9.1
	Crow AIR/ORTL	10.8	18.1	16.0	11.4	10.1	13.5	10.9	9.1
	Northern Cheyenne AIR/ORTL	11.8	22.2	18.5	11.7	11.6	10.3	8.4	5.5
	Fort Peck AIR/ORTL	9.9	17.1	16.8	11.5	10.3	14.1	10.7	9.7

Coal Region	American Indian Area	Under 5	5-14	15-24	25-34	35-44	45-54	55-64	65+
	Turtle Mountain AIR/ORTL	11.2	19.5	16.9	12.7	11.2	13.2	8.6	6.6
Northwest	Atqasuk ANVSA	11.2	21.9	17.6	13.8	14.1	8.6	6.4	6.4
	Chickaloon ANVSA	7.1	15.8	14.3	12.4	13.6	16.4	11.9	8.5
	Knik ANVSA	8.0	16.2	13.2	13.3	13.8	16.1	12.0	7.4
	Ninilchik ANVSA	5.5	12.4	11.0	10.1	11.4	17.7	19.0	12.9
	Tyonek ANVSA	9.0	16.4	9.0	16.4	10.8	19.8	11.3	7.3
	Wainwright ANVSA	9.9	18.7	17.8	15.7	9.9	14.4	8.3	5.3
Western Interior	Choctaw OTSA	6.7	13.2	13.1	11.9	11.8	13.9	12.9	16.5
	Creek OTSA	6.9	13.7	13.4	13.8	12.8	14.2	12.0	13.2
	Cherokee OTSA	6.9	14.5	13.4	11.8	12.4	14.4	12.1	14.6

Source: U.S. Census Bureau. 2013. Census 2010. U.S. Department of Commerce.

3.14.3.2 Economic Baseline

In general, the potentially affected Native American tribes are less affluent than the broader national population. Median household income is less than the national statistic in 18 of the 20 examined "American Indian Areas," with the Southern Ute Reservation and Uinta and Ouray Reservation being the exceptions (Table 3.14-18). Per capita income falls between $10,000 and $12,000 on the Navajo Nation Reservation and ORTL and the Northern Cheyenne Reservation and ORTL, which is less than 57 percent of the national average. The Hopi Reservation and ORTL per capita income is slightly greater than $12,000. Per capita income on the Crow Reservation and ORTL is approximately $14,000, close to half the national figure. The Kickapoo Reservation is subject to the lowest median household income statistic, standing at $22,941, whereas the Fort Apache Reservation has the lowest per capita income at $9,738. The Navajo Nation reports a median household income of $27,022, the lowest of the four tribes listed in section 710(i) of SMCRA. Median home value falls between $60,000 and $80,000 for the Navajo, Crow, and Northern Cheyenne. Median home value for the Hopi is $108,600, still more than $65,000 below the national median home value.

Table 3.14-18
Per Capita Income, Median Household Income, and Median Home Value in American Indian Areas in Coal Regions, 2011

Coal Region	American Indian Area	Per Capita Income*	Median Household Income*	Median Home Value**
Appalachian Basin	Echota Cherokee SDTSA	$24,030	$50,806	$124,400
Colorado Plateau	Jicarilla Apache Nation AIR/ORTL	$15,882	$42,214	$59,600
	Uintah and Ouray AIR/ORTL	$23,080	$56,100	$168,800
	Southern Ute AIR	$27,777	$58,855	$263,100
	Ute Mountain AIR/ORTL	$12,456	$28,355	$91,100
	Fort Apache AIR	$9,738	$26,134	$78,600
	Zuni AIR/ORTL	$10,575	$31,050	$55,500
	Navajo Nation AIR/ORTL	$10,864	$27,022	$64,100
	Hopi AIR/ORTL	$12,363	$34,904	$108,600
Gulf Coast	Mississippi Choctaw AIR	$11,501	$38,058	$57,500
	Kickapoo AIR	$10,782	$22,941	$44,300
	Adais Caddo SDTSA	$16,835	$31,058	$62,400
Northern Rocky Mountains and Great Plains	Fort Berthold AIR	$20,490	$44,637	$59,400
	Crow AIR/ORTL	$13,998	$43,846	$78,100
	Northern Cheyenne AIR/ORTL	$11,843	$36,219	$67,300
	Fort Peck AIR/ORTL	$16,075	$35,794	$58,700
	Turtle Mountain AIR/ORTL	$10,672	$25,469	$45,100
Northwest	Atqasuk ANVSA	$18,747	$56,500	$141,700
	Chickaloon ANVSA	$30,087	$72,844	$227,200
	Knik ANVSA	$28,996	$69,666	$213,100
	Ninilchik ANVSA	$29,039	$53,886	$215,100
	Tyonek ANVSA	$20,976	$28,750	$87,200
	Wainwright ANVSA	$20,651	$67,596	$115,400
Western Interior	Choctaw OTSA	$18,894	$36,070	$77,200
	Creek OTSA	$26,580	$46,781	$124,200
	Cherokee OTSA	$21,048	$41,530	$99,400
Total U.S.	**Nationwide – Coal and Non coal states**	**$27,915**	**$52,762**	**$186,200**

Source: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce.
* Per capita income and median household income are reported in 2011 inflation adjusted dollars.
** Median reported value of owner occupied housing units.

In the potentially affected ANVSAs, general economic characteristics are mixed. The Chicakloon, Knik, and Ninilchik populations are all generally more affluent than the broader national population, whereas the Atqasuk, Tyonek, and Wainwright populations are generally less affluent. The Chickaloon ANVSA per capita income exceeds $30,000 with a median household income of nearly $73,000. The median home value is also 22 percent greater than the broader nation. However, the Atqasuk, Tyonek and Wainwright ANVSAs have per capita incomes of approximately $20,000, almost $8,000 less than the national average. These three ANVSAs also have home values significantly less than the national average, ranging from $87,200 to $141,700.

The statistics listed in Table 3.14-19 also demonstrate relatively high poverty rates among Native Americans. In 16 of the 26 examined areas, more than 20 percent of the population lives below the poverty line. The poverty rate reaches as great as 46.8 percent and 43.4 percent in the Fort Apache and Turtle Mountain Reservations, respectively. The poverty rate falls between 25 percent and 40 percent for the Navajo Nation, the Hopi, and the Northern Cheyenne, and the Crow Reservation and ORTL. The unemployment rate varies widely across the examined American Indian Areas, ranging from 0.0 percent in the Kickapoo Reservation, to 33.8 percent in the Fort Apache Reservation. Unemployment is relatively prevalent among the four tribes listed in section 710(i) of SMCRA. Over 20 percent of the labor force is unemployed in the Crow and Northern Cheyenne Reservations and ORTLs. The unemployment rates for the Navajo Nation Reservation and ORTL and the Hopi Reservation and ORTL are 18.7 percent and 17.7 percent, respectively.

Table 3.14-20 describes employment by industry for the 20 American Indian areas and six ANVSAs. While specific data regarding employment in the coal mining industry is not available for these populations, the Agriculture, Forestry, Fishing, and Hunting, and Mining (including but not limited to coal mining) industries account for 18 percent of total employment in the Uintah and Ouray Reservation and ORTL. In the Navajo Nation and Northern Cheyenne Reservations and ORTLs, Agriculture, Forestry, Fishing, and Hunting, and Mining account for nearly four percent of total employment, respectively. In the Crow and Hopi Reservations and ORTLs, these industries make up 14.4 percent and 4.6 percent of total employment, respectively.

Table 3.14-19
Poverty and Unemployment in American Indian Areas in Coal Regions, 2011

Coal Region	American Indian Area	Percent of Population Below the Poverty Line (%)	Unemployment Rate (%)
Appalachian Basin	Echota Cherokee SDTSA	12.1	8.7
Colorado Plateau	Jicarilla Apache Nation AIR/ORTL	21.1	10.6
	Uintah and Ouray AIR/ORTL	11.2	5.7
	Southern Ute AIR	10.1	7.8
	Ute Mountain AIR/ORTL	29.4	9.1
	Fort Apache AIR	46.8	33.8
	Zuni AIR/ORTL	32.2	8.5
	Navajo Nation AIR/ORTL	38.1	18.7
	Hopi AIR/ORTL	32.5	17.7
Gulf Coast	Mississippi Choctaw AIR	29.1	9.1
	Kickapoo AIR	31.0	0.0
	Adais Caddo SDTSA	25.8	9.4
Northern Rocky Mountains and Great Plains	Fort Berthold AIR	25.6	8.5
	Crow AIR/ORTL	27.6	28.3
	Northern Cheyenne AIR/ORTL	37.2	23.7
	Fort Peck AIR/ORTL	27.6	8.2
	Turtle Mountain AIR/ORTL	43.4	5.5
Northwest	Atqasuk ANVSA	13.8	20.3
	Chickaloon ANVSA	7.4	9.2
	Knik ANVSA	10.4	9.9
	Ninilchik ANVSA	10.9	9.3
	Tyonek ANVSA	28.9	18.5
	Wainwright ANVSA	12.4	31.2
Western Interior	Choctaw OTSA	21.2	8.4
	Creek OTSA	14.6	6.3
	Cherokee OTSA	18.4	8.0

Source: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce.

Table 3.14-20
Employment by Industry in American Indian Areas, 2011

Coal Region	American Indian Area	Total Employment	Industry as Percent (%) of Total Employment												
			Agriculture, Forestry, Fishing, and Hunting, and Mining	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation, Warehousing, and Utilities	Information	FIRE* and Rental/Leasing	Professional, Scientific, and Administrative WMS**	Educational Services and Health Care	Arts, Entertainment, and Recreation, and Accommodation and Food Services	Other Services, Except Public Administration	Public Administration
Appalachian Basin	Echota Cherokee SDTSA	23,894	1.7	9.1	19.6	2.6	10.2	4	1.8	3.6	11.2	17.2	7.1	5.1	6.8
Colorado Plateau	Jicarilla Apache Nation AIR/ORTL	1,338	4.4	6.8	0.9	0.5	5.5	1.5	2	2.2	2	22.3	10.1	1.9	40
	Uintah and Ouray AIR/ORTL	9,120	18.1	7.1	1.5	2.2	10.1	8.1	3	2.7	5.1	20.5	7.8	4.5	9.5
	Southern Ute AIR	6,401	9.5	15.8	3.6	2.2	11.3	5.6	1.2	3.3	8	16.4	12.6	4.5	5.9
	Ute Mountain AIR/ORTL	678	0.4	13.1	2.7	0	14.7	0	0.4	1.8	3.2	18	23.3	3.7	18.6
	Fort Apache AIR	3,446	4.9	6.9	5.3	0.4	7.3	1.7	0.5	3.9	1.2	31.3	19.8	3.3	13.6
	Zuni AIR/ORTL	4,628	4.1	5.7	17.4	1.1	16.7	0.1	0	2.9	0.2	33.7	3.1	4	11.1
	Navajo Nation AIR/ORTL	44,438	3.6	10.1	4.2	0.6	9.7	5.8	0.5	2.3	2.3	37	10.5	3	10.3
	Hopi AIR/ORTL	2,783	4.6	2.4	10.3	2.8	8	3.5	1.9	2.4	3.2	35.5	7.4	1.1	16.7
Gulf Coast	Mississippi Choctaw AIR	2,811	0.2	4.9	3.8	2.5	4.2	5.4	0.4	3.2	1.5	20.5	36.2	3	14.2
	Kickapoo AIR	150	0	0	0	0	0	0	0	0	0	16.7	66.7	0	16.7
	Adais Caddo SDTSA	1,070	15.2	7.9	12.1	3.5	10.4	6.6	0	3.5	5	27.2	3.3	2.6	2.7
Northern Rocky Mountains and Great Plains	Fort Berthold AIR	2,784	13.6	4	5.8	1.4	8.2	2.4	2.8	2.5	2.4	23.4	16.5	1.5	15.6
	Crow AIR/ORTL	2,356	14.4	4.3	0.3	1.9	7.3	4.2	0	2.9	3.6	22.5	7.7	3	28.1
	Northern Cheyenne AIR/ORTL	1,443	4.6	4.1	0	0	5.3	2.8	0.3	2.2	2.7	40.8	3.5	4.6	29

Coal Region	**American Indian Area**	**Total Employment**	**Industry as Percent (%) of Total Employment**												
			Agriculture, Forestry, Fishing, and Hunting, and Mining	**Construction**	**Manufacturing**	**Wholesale Trade**	**Retail Trade**	**Transportation, Warehousing, and Utilities**	**Information**	**FIRE* and Rental/Leasing**	**Professional, Scientific, and Administrative WMS****	**Educational Services and Health Care**	**Arts, Entertainment, and Recreation, and Accommodation and Food Services**	**Other Services, Except Public Administration**	**Public Administration**
	Fort Peck AIR/ORTL	3,429	14.6	5.7	1.5	1.1	11.6	3.1	1.4	2.2	3	30.2	5.1	2.7	17.6
	Turtle Mountain AIR/ORTL	2,268	0	6.7	3.2	0	7.7	4.2	2.3	3.4	4.1	36.9	20.8	1.8	8.8
Northwest	Atqasuk ANVSA	94	0	14.9	0	0	6.4	23.4	0	0	0	39.4	2.1	7.4	6.4
	Chickaloon ANVSA	10,016	5.9	11.6	1.7	1.7	8.7	7.2	3.3	2.7	10.3	25.0	7.1	5.3	9.5
	Knik ANVSA	28,244	5.6	13.9	2.0	1.7	12.5	7.4	2.2	4.1	7.9	21.2	7.8	5.7	7.9
	Ninilchik ANVSA	6,231	10.9	10	3.1	1.0	10.0	8.8	1.3	3.3	6.6	24.4	9.6	5.0	6.0
	Tyonek ANVSA	110	6.4	22.7	0	0	2.7	9.1	0	4.5	8.2	8.2	1.8	17.3	19.1
	Wainwright ANVSA	262	2.3	19.1	0.8	0	7.3	14.5	0.8	9.9	0	24.4	10.3	2.3	8.4
Western Interior	Choctaw OTSA	90,278	8.2	8.2	10.8	2.9	11.2	6.1	1.1	4.1	4.9	23.6	7.4	4.6	6.9
	Creek OTSA	354,618	2.1	6.7	12	3.5	11.4	5.6	3	7.1	9.8	21.3	8.6	5.4	3.4
	Cherokee OTSA	213,475	3.3	8.2	15.3	3	11.1	6.5	1.8	4.5	7	21.4	8.2	5.1	4.6

Source: U.S. Census Bureau, 2011a. American Community Survey Five-Year Estimates, 2007-2011. U.S. Department of Commerce. *Finance, Insurance, and Real Estate
** Waste Management Service

Chapter 4
Environmental Consequences

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Chapter 4
Environmental Consequences

4.0 INTRODUCTION

This chapter evaluates the effects of the Alternatives on the natural, social, and economic resources introduced in Chapter 3. Specifically, the analysis of environmental consequences is organized by resource as follows:

- Mineral Resources and Mining
- Natural Resources
    - Water Resources
    - Biological Resources
    - Topography, Geology, and Soils
    - Air Quality, Greenhouse Gas Emissions, and Climate Change
- Social and Economic Resources
    - Socioeconomic Conditions
    - Land Use, Utilities, Infrastructure, Visual Resources and Noise
    - Recreation
    - Public Health and Safety
    - Archaeology and Cultural Resources
- Environmental Justice

4.0.1 Description

This chapter describes the potential effect of the Alternatives, including the No Action Alternative, on the natural and human environment. The White House Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) regulations (40 CFR 1508) describe three categories of effects[1] to be measured in an Environmental Impact Statement (EIS):

- **Direct Effects** are effects that are caused by the action and which occur at the same time and place;

- **Indirect Effects** are effects that are caused by the action but which occur later in time or farther removed in space, but which are still reasonably foreseeable; and

- **Cumulative Effects** are the impacts on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person

[1] As in NEPA regulations, the terms "effects" and "impacts" are used interchangeably throughout this chapter.

undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The definition of "effects" is broad, and can include ecological, aesthetic, historic, cultural, economic, social, or human health effects.

In accordance with NEPA regulations, Sections 4.1 through 4.7 of this chapter assess both the direct and indirect effects of the Alternatives, as well as the cumulative effects. Specifically, this chapter addresses the following requirements of an Environmental Consequences analysis as described by the CEQ NEPA regulations (40 CFR 1502 and 1508):

- **Environmental impacts of the Alternatives and their significance.** Environmental impacts are the focus of Sections 4.2 through 4.4.
- **Possible conflicts between the Proposed Action and objectives of federal, state, and local plans, policies, and controls.** Each resource-specific analysis considers the potential effects of every Alternative in the context of existing and planned actions and objectives within the study area.
- **Cumulative effects.** Section 4.5 examines the effects of the Alternatives when considered in combination with other past, present, and reasonably foreseeable actions.
- **Any irreversible or irretrievable commitments of resources which would be involved should the proposal be implemented.** A resource commitment is considered "irreversible" when impacts from its use limit future use options. A resource commitment is considered "irretrievable" when the use or consumption of the resource is neither renewable nor recoverable for use by future generations. Section 4.6 identifies those categories of impacts that constitute an irreversible and irretrievable commitment of resources.
- **Identification of any adverse impacts which cannot be avoided should the proposal be implemented.** Section 4.6 also identifies the categories of impacts described in Sections 4.2 through 4.4 for which adverse environmental effects cannot be avoided.
- **The relationship between the short-term use of man's environment and the maintenance and enhancement of long-term productivity.** The resource-specific analyses of the significance of the impacts considers the duration of impact.

All of these analyses are developed in accordance with 43 CFR Part 46, which contain the Department of the Interior's regulations for implementing NEPA.

In addition to addressing the NEPA requirements for the Environmental Consequences portion of an EIS, this chapter was developed in accordance with Executive Order (E.O.) 12866, which directs federal agencies to provide an assessment of both the social costs and benefits of proposed regulatory actions:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available Alternatives, including the Alternative of not regulating. Costs and benefits should be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider.

Because the Stream Protection Rule (SPR) is considered to be an economically significant regulatory action pursuant to E.O. 12866, a detailed Regulatory Impact Analysis (RIA) has been developed for this rule and is provided under separate cover.

4.0.2 Analytic Framework

This section describes the study area for the environmental consequences analysis, summarizes the overarching method for the resource-specific impact analyses, and details the approach to evaluating the relative significance of impacts across the affected resources. The detailed approach to analysis of each resource is detailed in each respective section.

4.0.2.1 Study Area

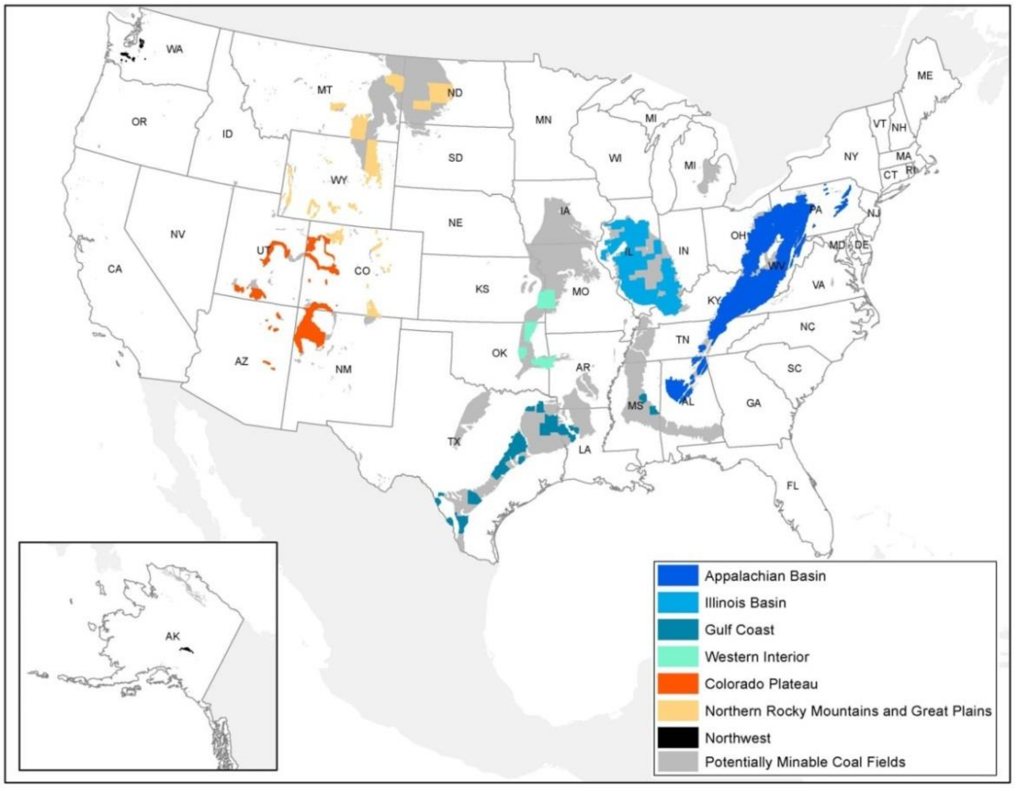
As described in Chapter 3 of this EIS, coal resources in the U.S. are widely distributed throughout the country. However, not all coal resources are accessible with current technologies. Further, some potentially mineable coal resources are unlikely to be mined in the near term because of economic conditions. To establish a reasonable boundary for the geographic areas likely to be affected by this rule, the geographic scope was defined as outlined below. In general, the geographic scope identified is likely to be over-inclusive; it may overestimate the areal extent of mining, unless otherwise noted.

- Spatial data compiled by the U.S. Geological Survey (USGS) Eastern Energy Resources Center on potentially minable coalfields defined the initial extent of the study area. Coalfields were identified as potentially minable if they contained coal of sufficient quality and energy content to justify extraction, based on existing data (USGS, 2001b).
- From the practicably minable coalfields data, areas considered likely to produce coal within the timeframe for this analysis include areas within counties that:
    - Reported coal production between 2007 and 2012 in Energy Information Administration (EIA) Annual Coal Reports;
    - Contain pending but administratively complete Surface Mining Control and Reclamation Act (SMCRA) permits in the Office of Surface Mining Reclamation and Enforcement (OSMRE) Applicant/Violator System (AVS) as of September 2011;
    - The Mine Safety and Health Administration (MSHA) reports as containing active coal mines as of April 2013 (MSHA, 2013b); or

- State-level mining assessments, geographic data, or tabular data report as containing active coal mining activity as of August 2012. State-level information contributed additional counties in Colorado (Colorado Division of Reclamation Mining and Safety, 2010), Illinois (Illinois State Geological Survey, 2011), Kentucky (Kentucky Department of Natural Resources, 2011), Ohio (Ohio Department of Natural Resources, 2011), West Virginia (West Virginia Department of Environmental Protection, 2011), Texas (Railroad Commission of Texas, 2011), and Alaska (Alaska Department of Natural Resources, 2011).[2, 3]

- Urban areas, lakes, and ponds were removed from the study area, as mining is not expected to take place in these areas (U.S. Census Bureau, 2002; USGS, 2011b). However, some mining may take place under or adjacent to lakes and ponds, so the study area may slightly under-represent the areal extent of mining in this respect.

Figure 4.0-1 Study Area for Analysis



Sources: USGS 2001a; USGS 2001b; MSHA 2013b; Colorado Division of Reclamation Mining and Safety, 2010; Illinois State Geological Survey, 2011; West Virginia Department of Environmental Protection, 2011; Railroad Commission of Texas, 2011; Alaska Department of Natural Resources, 2011; U.S. Census Bureau, 2002; and USGS, 2011b

[2] The program description for the Alaska Coal Regulatory Program states that active mining currently only occurs near Healy, AK, in the Denali Borough.

[3] State-specific data for other states were examined where available, but contributed no additional counties beyond those listed by EIA.

4.0.2.2 Method

The specific methods and data relevant to the impact analyses vary significantly by resource category. A detailed description of the methods applied in each impact analysis is provided for each relevant resource in Sections 4.2 through 4.4. Each resource-specific impact analysis in this chapter includes:

- A review of regulations and resource impacts under the No Action Alternative;
- A discussion of the Action Alternatives and key elements that may affect the resource;
- A description of the analytic methods;
- The results of quantitative and qualitative analyses;
- A summary of the effects of each Alternative; and
- A discussion of potential minimization and mitigation measures relevant to the impacts described.

For some resource categories, the analysis describes impacts in quantitative terms (e.g., dollars, number of jobs, stream miles impacted, acres affected). Where data limitations prevent reliable quantification of impacts to a given resource, potential impacts are discussed qualitatively. The quantitative analyses apply a common method to estimate the costs or benefits of changes in mine management methods due to the Alternatives, as follows:

Step 1: Estimate compliance costs and changes in coal production under each of the Alternatives, including the No Action Alternative. This step involves assessing how each Alternative affects change in mine operator behavior at typical mines in each of the coal regions. This analysis includes changes in administrative, and operational costs, as well as changes in the tonnage of coal expected to be produced (where relevant), under each of the 13 different mining scenarios in the "model mine" analysis. The "model mine" analysis is discussed in Section 4.1.[4]

Step 2: Estimate the change in affected natural resources across Alternatives at a typical mine. Parallel to the compliance cost analysis, this step involves estimating the changes in impacts to natural resources caused by the mining operations at typical mines in each coal region. This step includes estimating changes to forest cover, stream miles filled, and other relevant metrics. For the land use and water resources metrics in particular, historical GIS data on land cover and mine locations are combined with information on mining impacts from the model mine analysis for surface and

[4] For Alternative 2, the model mine analysis assumes that sufficient offsite storage is available to allow for continued operations at the two Central Appalachian Region surface model mines. See RIA Appendix B.

underground mines to estimate the change in natural resource impacts by mine type (i.e., surface and underground) for each region.[5]

Step 3: **Express the change in the affected natural resource parameters per ton of coal produced at each typical mine.** Model mine analysis results are used to estimate the expected changes in natural resources per ton of coal produced. For example, to estimate the ratio of stream miles impacted to coal production level, the analysis applies information on the forecasted change in the number of stream miles filled, with the forecasted production level at the relevant model mine site. In some cases, data sources other than the engineering analysis are used to understand impacts of the proposed action on resources (e.g., analysis of employment impacts).

Step 4: **Forecasted regional shifts in coal production associated with compliance costs quantified in Step 1.** This DEIS relies on a complex integrated system of energy models to evaluate the impacts of the proposed action on coal demand, supply, and prices. Employing detailed information on a multitude of factors that affect coal production and consumption, these models simulate how changes in market conditions may cascade through different parts of the coal market, affecting both supply and demand. Detailed assumptions and findings are presented in the RIA. Specifically, these behavior changes may: decrease coal production at a particular site or region; affect the mining method or techniques used (e.g., shift from surface to underground extraction methods); or change the cost-competitive nature of coal mining across coal regions (i.e., shift production between regions). Section 4.1 discusses the mine sector model analysis and results.

Step 5: **Estimate total regional impacts.** Multiply total expected coal production by the per-ton metrics developed in Step 3 to estimate total impacts of each Alternative by region.

Generally, environmental impacts of the rule may be generated via two pathways. First, mines may continue to extract coal, but operational changes may change how the mining affects environmental resources. Second, to the extent that coal production changes in a region, environmental effects are associated with the changed intensity of mining in the region. Comparing the anticipated coal production and model mine operations-related environmental impacts for the No Action Alternative to the anticipated coal production and model mine operational environmental impacts for each Action Alternative captures both of the effects.

4.0.2.3 Categories of Impact

With respect to impacts evaluated as part of an EIS, CEQ defines “significantly” in terms of context (i.e., geographic scope of effect, as well as length of effect in terms of short-term versus

[5] For the historical data analysis, the U.S. Geological Survey’s National Land Cover Database (NLCD) and the National Hydrography Dataset (NHD) are used for the land cover and streams analyses, respectively. The NLCD contains data from 1992 and includes 21 classes of land cover. The NHD’s data on streams by type (i.e., intermittent, perennial, ephemeral) across the nation allow analysis of the breakdown of identified streams in areas of potentially mineable coal.

long-term) and intensity (i.e., severity of effect) (40 CFR 1508.27). This determination refers to all types of effects of the Alternatives, including the direct, indirect, and cumulative effects.

Communicating the relative significance of impacts across the diverse categories of affected resources presents unique challenges. For example, this chapter describes potential effects on water quality in terms of stream miles impacted, effects on employment in terms of number of jobs, and effects on visual resources qualitatively. It may therefore be difficult to discern the relative effects of the Alternatives on these resources. To facilitate this comparison and promote understanding of the key impact categories of interest, all impacts in this analysis are summarized at the end of each section in common terms. These "impact categories" include both adverse and beneficial effects and consider three key factors:

- **Length of impact:** Short-term effects generally occur during active mining within the EIS study period of 2020 to 2040; long-term effects extend beyond the study period.[6]
- **Scope of impact:** This factor considers whether the impacts occur within a small, medium, or large geographic area (i.e., whether impacts are expected within or directly adjacent to mining activity or beyond and to what extent). In addition, this factor considers whether impacts occur within the context of small, medium, or large communities or economies.
- **Potential for offsetting the impact:** This factor considers the extent to which the application of best management practices (BMPs), restoration activities, or mitigation may change the net effect.

Based on these factors, Table 4.0-1 describes the impact categories referenced in each section of the analysis. For each impact described in Sections 4.1 through 4.3, the discussion supports the characterization of the impact as minor, moderate, or major by relating it to these definitions. For the purpose of the analysis, a short-term effect to a small geographic area, community or economy within the context of the affected resource would likely not be measureable, and therefore is categorized as negligible. Mitigation also works to decrease length or scope of impact to analyzed resource.

The analysis examines the impacts of the Action Alternatives and the extent to which they would reduce or increase coal mining-related impacts on resources as compared to the No Action Alternative. The analysis does not examine the entirety of impacts that occur due to mining. For example, an Alternative characterized as having a Major Beneficial impact on biology would reduce mining impacts in a way that would provide major benefits to biological resources as compared to the No Action Alternative. This finding is not equivalent to saying that mining itself would benefit biological resources.

[6] The EIS study period begins in 2020, approximately three years after OSMRE's anticipated publication of the final SPR. Development of average annual impacts requires forecasts of coal production over an extended time horizon. The study period ends in 2040 because energy use forecasts produced by the EIA extend only to 2040; beyond this point, reliable coal forecasts are not feasible.

Table 4.0-1
Impact Category Definitions

Impact Characterization	Definition
Negligible	• Minimal measurable impacts (adverse or beneficial) are expected; or • Short term effects to a small geographic area, community or economy within the context of the affected resource.
Minor Adverse	• Short-term effect to a medium geographic area, community or economy within the context of the affected resource; or • Long-term effect to a small geographic area, community or economy within the context of the affected resource; or • Short-term effect and the resource would recover completely without any offsetting activities (e.g., restoration activities) once the action is completed.
Moderate Adverse	• Short-term effect to a large geographic area, community or economy within the context of the affected resource; or • Long-term effect to a medium geographic area, community, or economy within the context of the affected resource; or • Effect occurs to a large geographic area, community, or economy within the context of the affected resource, but the resource likely recovers substantially through mitigation.
Major Adverse	• Long-term effect to a large geographic area, community, or economy within the context of the affected resource; and • Effects are irreversible, even if BMPs, restoration, or mitigation activities are undertaken.
Minor Beneficial	• Short-term benefit to a medium geographic area, community or economy within the context of the affected resource; or • Long-term benefit to a small geographic area, community or economy within the context of the affected resource.
Moderate Beneficial	• Short term benefit to a large geographic area, community or economy within the context of the affected resource; or • Long-term benefit to a medium geographic area, community, or economy within the context of the affected resource.
Major Beneficial	• Long-term benefit to a large geographic area, community, or economy within the context of the affected resource.

4.0.3 Summary of Results

This section summarizes the results of the resource-specific analyses presented in this chapter. Results are organized in two ways. The first set of tables (Tables 4.0-2 through 4.0-8) presents comparisons of impacts for each coal region under each Alternative and resource. The second set of tables (Tables 4.0-9 through 4.0-16) describes the impacts for each Alternative across all coal regions and resources. The determinations in these exhibits are detailed in the individual resource sections of this document (Section 4.3 and 4.4). Table 4.0-17 summarizes overall impacts of the Alternatives on all resources.

Mining under the No Action Alternative (i.e., continuation of existing regulations) has known effects on physical, biological, and human resources, and these effects vary by region. Impacts of the No Action Alternative (Alternative 1) are detailed in the resource-specific sections of this chapter. When assessing the Action Alternatives, all the impacts characterized throughout this chapter represent incremental effects relative to conditions realized under the No Action Alternative.

Finally, Table 4.0-17 summarizes overall impacts of the Action Alternatives by resource. In order to create summary determinations, analysts considered the variation in impacts across all the regions to designate a final impact classification for the resource. As shown, Alternative 2 has the most adverse impacts, which are anticipated for socioeconomic conditions, as well as the most beneficial impacts, which occur for most other resources, when compared to impacts of the No Action Alternative. Alternative 9 shows Negligible impacts when compared to impacts of the No Action Alternative. Remaining Alternatives exhibit the same pattern of impacts as Alternative 2, but with varying degrees of adverse effects on socioeconomic conditions and benefits to natural resources. The following sections summarize the results of the analysis by resource in more detail.

4.0.3.1 Water Resources

Consistent with the purpose of the proposed action, the Action Alternatives (except Alternative 9) would result in benefits to water resources relative to the No Action Alternative at the national scale. In particular, the analysis finds that Action Alternatives would result in Major Beneficial impacts to water resources under Alternatives 2, 3, 4, and 8 (Preferred) at the national scale. Moderate Beneficial impacts to water resources would be expected under Alternatives 6 and 7, with Minor Beneficial impacts under Alternative 5 at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on water resources.

On a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin under Alternatives 2, 3, 4, and 8 (Preferred). Moderate Beneficial impacts are anticipated in the Appalachian Basin for Alternatives 5, 6, and 7, in the Illinois Basin for Alternatives 6 and 7, and in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions for Alternatives 2, 3, 4, 6, 7, and 8 (Preferred). Other effects on water resources are anticipated to be Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.2 Biological Resources

Action Alternatives are generally anticipated to benefit biological resources at the national scale when compared to the No Action Alternative, with Alternatives 2, 3, 4, 7, and 8 (Preferred) providing Moderate Beneficial impacts, and Alternatives 5 and 6 providing Minor Beneficial impacts at a national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on biological resources.

On a regional scale, and similar to water resources, Major Beneficial impacts are anticipated in the Appalachian Basin and the Illinois Basin under Alternatives 2, 3, 4, and 8 (Preferred). Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 5. Moderate

Beneficial impacts are anticipated in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 7, and 8 (Preferred). Moderate Beneficial impacts are also anticipated in the Appalachian Basin and the Illinois Basin under Alternative 7. Other effects on biological resources are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.3 Air Quality, Greenhouse Gas Emissions, and Climate Change

None of the Action Alternatives explicitly target air quality resources. Regardless, implementation of the elements of the Action Alternative may have both beneficial and adverse effects on air quality. On the beneficial side, the Action Alternatives may increase carbon sequestration potential due to reforestation and riparian corridor requirements of Action Alternatives (except for Alternative 9) and reduce greenhouse gas emissions from coal extraction due to reductions in overall production levels (with the exception of Alternatives 2 and 9). However, the Alternatives may also increase the use of equipment and vehicles to haul materials and therefore increase greenhouse gas emissions from these sources and, under Alternative 2, result in a shift from surface to underground mining, which may increase air emissions. While data are not available to quantify the net effect of the Action Alternatives on emissions or ambient air quality, the net effects to air quality, greenhouse gas emissions, and climate change are likely to be Minor Beneficial at the national scale (except under Alternative 9 where it would be Negligible).

On a regional scale, beneficial impacts on air quality are anticipated in Appalachia across Alternatives 3, 4, 5, 6, 7, and 8 (Preferred). While a predicted shift from surface to underground production under Alternative 2 may increase methane emissions from coal extraction in Appalachia, this adverse effect is anticipated to be minor and would potentially be offset by the major beneficial effects on air quality of reforestation and riparian corridor requirements. Four other regions are also expected to experience Minor Beneficial effects on air quality from reforestation (Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains) under Alternatives 2, 3, 4, 7, and 8 (Preferred). The Illinois Basin and the Northern Rocky Mountains and Great Plains regions are also expected to experience Minor Beneficial effects under Alternative 6. Other effects on air quality, greenhouse gas emissions, and climate change are anticipated to be Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.4 Topography, Geology, and Soils

Action Alternatives are generally anticipated to benefit topography, geology, and soils when compared to the No Action Alternative, with Minor Beneficial impacts anticipated for Alternatives 2, 3, 4, 5, 7, and 8 (Preferred). Alternatives 6 and 9 are anticipated to result in Negligible effects on topography, geology, and soils at a national scale.

On a regional scale, Moderate Beneficial impacts are anticipated in the Appalachian Basin under Alternatives 2, 4, 5, 7, and 8 (Preferred). Other effects on topography, geology, and soils resources are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.5 Land Use, Utilities, Infrastructure, Visual Resources, and Noise

Alternative 2 is anticipated to result in Minor Beneficial results to land use, utilities, infrastructure, visual resources, and noise at the national scale when compared to the No Action Alternative. Other alternatives are anticipated to result in Negligible impacts at the national scale.

At a regional scale, Moderate Beneficial impacts to land use, utilities, infrastructure, visual resources, and noise are anticipated in the Appalachian Basin under Alternative 2, 3, 4, 5, 7, and 8 (Preferred). Other effects on land use, utilities, infrastructure, visual resources, and noise are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.6 Socioeconomic Conditions

At the national scale, Alternative 2 is anticipated to result in Moderate Adverse impacts on socioeconomic conditions including, in particular, employment and severance taxes when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 (Preferred) are anticipated to result in Minor Adverse impacts socioeconomic conditions including employment and severance taxes at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on socioeconomic conditions.

At a regional scale, Major Adverse impacts on socioeconomic conditions including employment are anticipated in the Appalachian Basin under Alternative 2. Moderate Adverse impacts on socioeconomic conditions are anticipated in the Appalachian Basin under Alternatives 3, 4, 5, 7, and 8 (Preferred). Impacts to other regions to socioeconomic conditions are anticipated to be Minor Adverse or Negligible across alternatives at the regional scale when compared to the No Action Alternative.

4.0.3.7 Public Health and Safety

At the national scale, Alternatives 2, 3, 4, and 8 (Preferred) are anticipated to result in Major Beneficial impacts to public health and safety when compared to the No Action Alternative. Alternatives 6 and 7 are anticipated to result in Moderate Beneficial impacts to public health and safety. Alternative 5 is anticipated to result in Minor Beneficial impacts to public health and safety at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on public health and safety.

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin regions under Alternatives 2, 3, 4, and 8 (Preferred). Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 7. Moderate Beneficial impacts are expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 6, 7, and 8 (Preferred). Moderate Beneficial impacts are also anticipated in the Appalachian Basin for Alternatives 5 and 6, and in the Illinois Basin for Alternatives 6 and 7. Other effects on public health and safety are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

4.0.3.8 Archaeology, Paleontology, and Cultural Resources

Nationally, all Alternatives are expected to have Negligible impacts on Archaeology, Paleontology, and Cultural Resources. At a regional level, Negligible impacts are expected in all regions under all Alternatives. To the extent that any particular rule element reduces the extent of ground disturbance associated with mining, it would also reduce the disturbance of cultural resources located within that area. Therefore, cultural resources may benefit from some or all of the rule elements.

4.0.3.9 Recreation

At the national scale, Alternative 2 is anticipated to result in Moderate Beneficial impacts to recreational activities when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 (Preferred) are anticipated to result in Minor Beneficial impacts to recreation. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on recreational activities.

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin under Alternative 2. Moderate Beneficial impacts are anticipated in the Appalachian Basin region under Alternatives 3, 4, 5, 7, and 8 (Preferred) and in the Colorado Plateau region under Alternatives 2, 3, 4, 7, and 8. Other effects on recreational activities are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Table 4.0-2
Summary of Impacts in the Appalachian Basin Region by Alternative, Relative to the No Action Alternative

Resources	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Air Quality, Greenhouse Gas Emissions, and Climate Change	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Biological Resources	Major Beneficial	Major Beneficial	Major Beneficial	Major Beneficial	Minor Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Negligible
Water Resources	Major Beneficial	Major Beneficial	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Negligible
Socioeconomic Conditions	Major Adverse	Moderate Adverse	Moderate Adverse	Moderate Adverse	Minor Adverse	Moderate Adverse	Moderate Adverse	Negligible
Public Health and Safety	Major Beneficial	Major Beneficial	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Major Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-3
Summary of Impacts in the Colorado Plateau Region by Alternative

Resources	**Impacts Relative to the No Action Alternative**							
	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**	**Alternative 8 (Preferred)**	**Alternative 9**
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Biological Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible
Water Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Public Health and Safety	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible	Moderate Beneficial	Moderate Beneficial	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-4
Summary of Impacts in the Gulf Coast Region by Alternative

Resources	Impacts Relative to the No Action Alternative							
	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**	**Alternative 8 (Preferred)**	**Alternative 9**
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Biological Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible
Water Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Public Health and Safety	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-5
Summary of Impacts in the Illinois Basin Region by Alternative

Resources	Impacts Relative to the No Action Alternative							
	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**	**Alternative 8 (Preferred)**	**Alternative 9**
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible
Biological Resources	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible
Water Resources	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Socioeconomic Conditions	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Negligible
Public Health and Safety	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-6
Summary of Impacts in the Northern Rocky Mountains and Great Plains Region by Alternative

Resources	Impacts Relative to the No Action Alternative							
	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible
Biological Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible
Water Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Minor Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Negligible
Public Health and Safety	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-7
Summary of Impacts in the Northwest Region by Alternative

Resources	Impacts Relative to the No Action Alternative							
	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**	**Alternative 8 (Preferred)**	**Alternative 9**
Air Quality, Greenhouse Gas Emissions, and Climate Change	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Biological Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Topography, Geology, and Soils	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Public Health and Safety	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-8
Summary of Impacts in the Western Interior Region by Alternative

Resources	Impacts Relative to the No Action Alternative							
	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**	**Alternative 8 (Preferred)**	**Alternative 9**
Air Quality, Greenhouse Gas Emissions, and Climate Change	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Biological Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Topography, Geology, and Soils	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Public Health and Safety	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Tables 4.0-9 through 4.0-16 compare the impacts of each Action Alternative across coal regions. Under Alternatives 2 through 9, for seven of the eight resource categories considered, every coal region experiences a Beneficial or Negligible impact. Adverse impacts are anticipated only for socioeconomic resources, where production decreases may trigger job losses. This effect is most pronounced in the Appalachian Basin under Alternative 2, where production decreases are predicted to be the greatest.

Table 4.0-9
Summary of Impacts of Alternative 2 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Negligible	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Water Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Socioeconomic Conditions	Major Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Major Beneficial	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-10
Summary of Impacts of Alternative 3 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Water Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-11
Summary of Impacts of Alternative 4 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Water Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-12
Summary of Impacts of Alternative 5 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Biological Resources	Major Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-13
Summary of Impacts of Alternative 6 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Minor Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Minor Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-14
Summary of Impacts of Alternative 7 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-15
Summary of Impacts of Alternative 8 (Preferred) Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Biological Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Topography, Geology, and Soils	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible
Water Resources	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible
Public Health and Safety	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Moderate Beneficial	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-16
Summary of Impacts of Alternative 9 Compared to the No Action Alternative

Resources	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Air Quality, Greenhouse Gas Emissions, and Climate Change	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Biological Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Topography, Geology, and Soils	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Public Health and Safety	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

Table 4.0-17
Summary of the Overall Impacts of the Regulatory Alternatives Compared to the No Action Alternative

Resource	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Air Quality, Greenhouse Gas Emissions, and Climate Change	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible
Biological Resources	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Topography, Geology, and Soils	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Water Resources	Major Beneficial	Major Beneficial	Major Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	Minor Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Socioeconomic Conditions	Moderate Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse	Negligible
Public Health and Safety	Major Beneficial	Major Beneficial	Major Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Archaeology, Paleontology, and Cultural Resources	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Recreation	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible

Note: For a discussion of the impacts of the No Action Alternative (Alternative 1), see resource-specific sections.

4.0.4 Limitations and Uncertainties

Two primary limitations and uncertainties are present in this analysis. First, this DEIS relies on five inter-related models to evaluate the impacts of the Action Alternatives on coal demand, supply, and prices. Employing detailed information on a multitude of factors that affect coal production and consumption, these models simulate how changes in market conditions may cascade through different parts of the coal market, affecting both supply and demand. Detailed assumptions and findings are presented in the RIA for the proposed action. Second, the study uses a model mine approach to determine the regional effects of the Action Alternatives. The fidelity of these model mines to the average regional mine characteristics determines the accuracy of the analysis. These two key uncertainties and limitations and how they are addressed in this analysis are presented in Table 4.0-18. Resource-specific limitations and uncertainties are addressed in the appropriate resource-specific sections.

Table 4.0-18
Summary of Key Uncertainties and Limitations

Limitation and Uncertainty	Explanation
Coal Forecasts	Future coal supply and demand are not known with certainty. This limits the precision of the analysis.
Model Mine Approach	To capture the heterogeneity of the coal industry, the analysis employs 13 model mines across the U.S. This approach strives to capture the overall scope and scale of potential changes under each Alternative, but is not likely to be accurate for any specific mining operation.

4.1 MINERAL RESOURCES AND MINING

Chapter 3 describes general characteristics of mineral resources and mining. This section of Chapter 4 analyzes how mineral resources and mining are affected by the No Action Alternative and by the Action Alternatives under consideration for the SPR.

This section:

- Provides an overview of the current and forecasted coal industry, which forms the baseline for analysis of the No Action Alternative in the study period from 2020 to 2040;
- Presents the model mines approach used to analyze effects of Alternatives 2 through 9 relative to the No Action Alternative; and
- Presents forecasted changes in the distribution of industry compliance costs and overall coal production during the study period.

Subsequent sections present impacts of each Alternative on natural resources and socioeconomic conditions.

4.1.1 Effects of the Current Regulatory Environment (the No Action Alternative)

This section summarizes the conditions of the coal mining industry and market under the No action Alternative, including regional distribution of coal production, the quantity of coal produced by method of coal mining, and the coal industry market structure.

In 2013, the most recent year for which complete data are available, 25 states reported active coal mine production to MSHA (U.S. EIA, 2015a). OSMRE classifies coal-producing areas into regions, seven of which produced coal in 2013. These regions are described below:

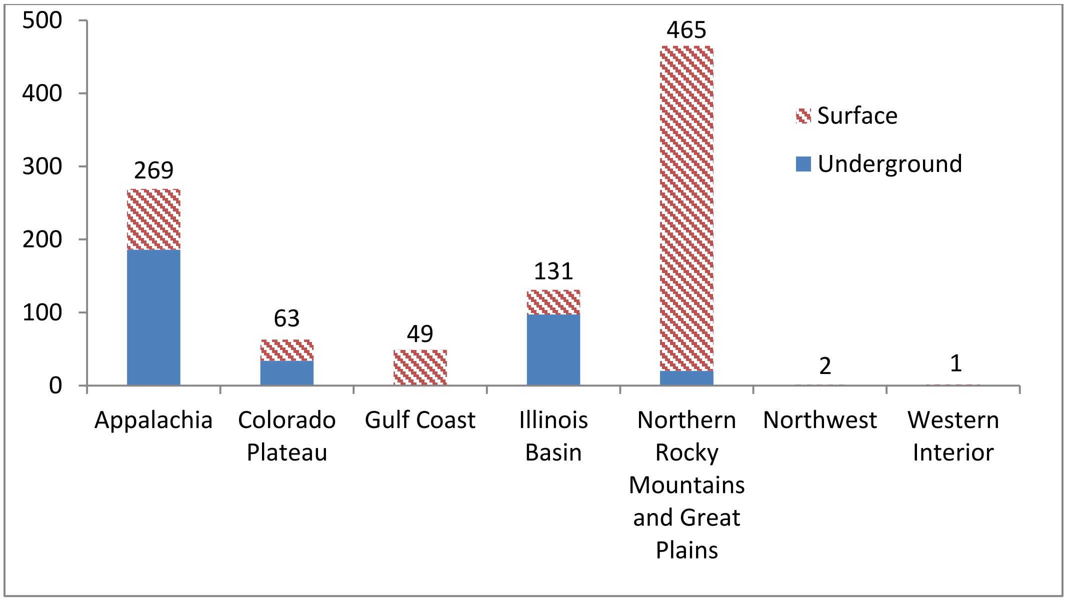
- **Appalachian Basin**: West Virginia, Eastern Kentucky, Pennsylvania, Ohio, Virginia, Alabama, Tennessee, Maryland
- **Colorado Plateau**: Western Colorado, New Mexico, Utah, Arizona
- **Gulf Coast**: Texas, Mississippi, Louisiana
- **Illinois Basin**: Illinois, Indiana, Western Kentucky
- **Northern Rocky Mountains and Great Plains** (including the Powder River Basin): Wyoming, Montana, North Dakota, Northern Colorado, South Dakota[7]
- **Northwest**: Alaska, Washington[8]
- **Western Interior**: Oklahoma, Missouri, Kansas, Arkansas

[7] South Dakota is included in the Northern Rocky Mountains and Great Plains region but did not produce any coal in 2013.

[8] Washington is included in the Northwest region but did not produce any coal in 2013.

Current and projected total coal production and mining type vary by region. All regions have surface mining operations, but not all regions have underground mines. The Gulf Coast and the Northwest have no underground mines. As shown in Figure 4.1-1, total production tonnage and production tonnage by mine type varies across the regions. For instance, the Northern Rocky Mountains and Great Plains region produces coal primarily from surface mines, whereas the Appalachian Basin produces the majority of its coal using underground mining methods.

Figure 4.1-1 Coal Production by Mine Type by Region, Million Tons (2013)



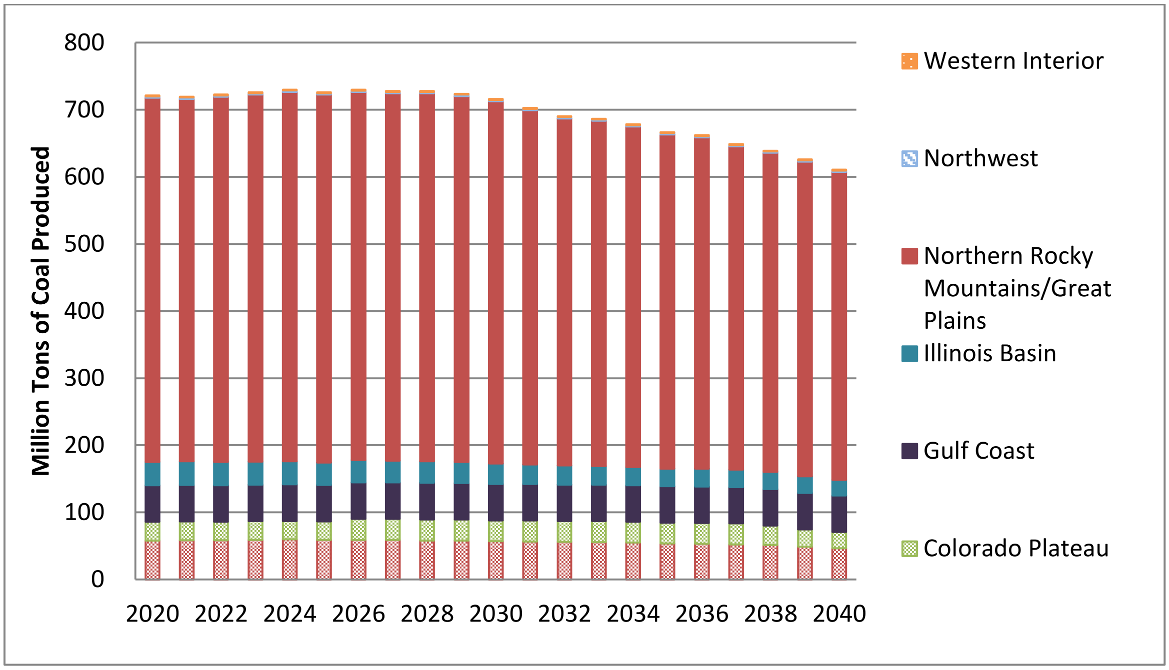
Source: U.S. EIA, 2015a. Annual Coal Report 2013. Table 2. Coal production and Number of Mines by State, County, and Mine Type, 2013. U.S. Department of Energy. http://www.eia.gov/coal/annual/pdf/acr.pdf

Total U.S. coal production has fluctuated somewhat over time, with production from particular regions varying to a greater degree. Total production in 2013 from surface and underground mines was 985 million tons (U.S. EIA, 2015a). The two primary coal production regions in the U.S. are the Northern Rocky Mountains and Great Plains and the Appalachian Basin. In 2013, these two regions together accounted for approximately 75 percent of domestic coal production.

4.1.1.1 Forecasted Coal Production Under the No Action Alternative

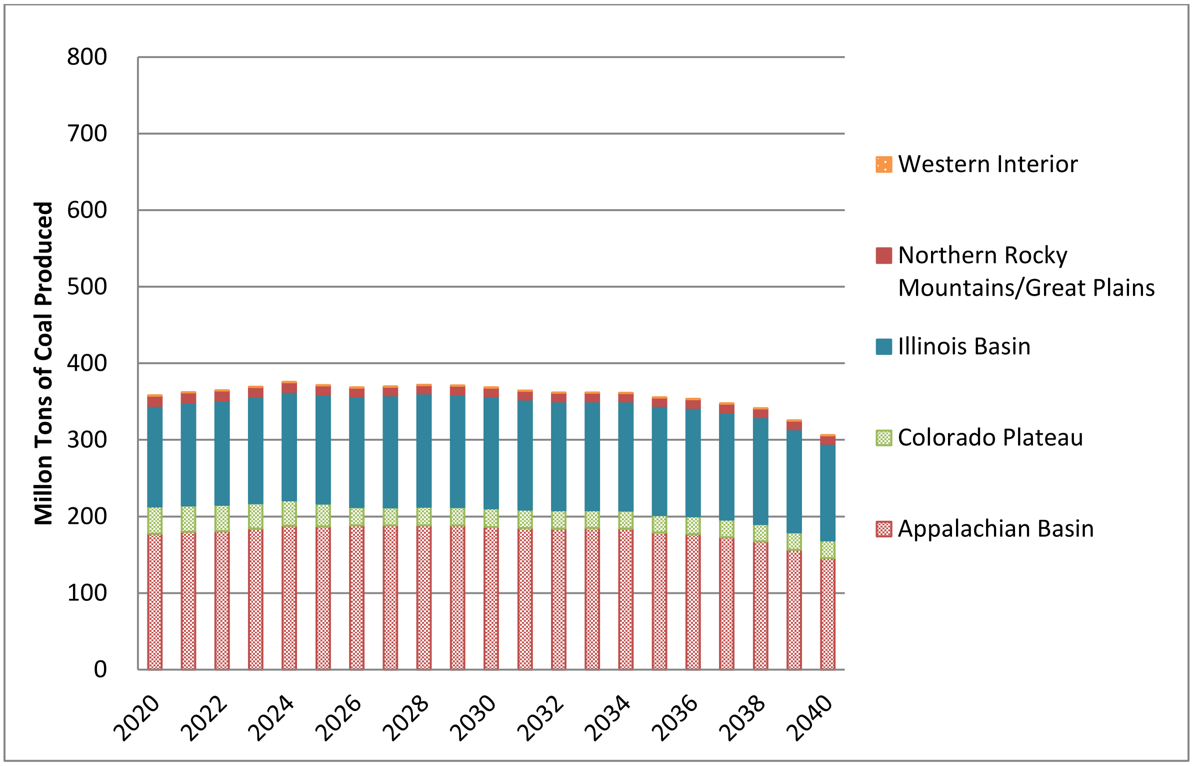
The coal mining industry is expected to continue to change, even under the No Action Alternative (i.e., absent the SPR). These changes will be driven by market conditions and the characteristics of remaining coal reserves. Over the study period of 2020 to 2040, the No Action Alternative as reflected by the baseline analysis conducted as part of the Regulatory Impacts Analysis anticipates a general decline in annual total surface and underground production of approximately 15 percent (162 million tons). Figures 4.1-2 and 4.1-3 summarize the projected changes in production for surface and underground mining by region.

Figure 4.1-2 Forecasted Surface Coal Production by Region, Millions of Tons Produced, 2020 to 2040



Source: Energy Ventures Analysis (EVA) analysis, 2014.

Figure 4.1-3 Forecasted Underground Coal Production by Region, 2020 to 2040



Source: EVA analysis, 2014.

Under the No Action Alternative, declines in surface coal production are anticipated in nearly all coal regions between 2020 and 2040, with annual production falling from 721 million tons to 610 million tons over the time period. Most of the drop in total surface production (76 percent) is anticipated in the Northern Rocky Mountains and Great Plains region where a decline of over 80 million tons in annual production between 2020 and 2040 is expected. The steepest declines in terms of the percent of regional production are expected in the Illinois Basin and Appalachian Basin regions, where declines of 33 percent and 20 percent of regional production, respectively, are anticipated between 2020 and 2040.

As with surface mining, declines in underground production are expected in nearly all coal regions between 2020 and 2040, with annual production falling from 358 million tons to 306 million tons over the study period (a reduction of 52 million tons in annual production). In the near term, however, underground production is expected to grow temporarily because of the addition of several new longwall mines, peaking in 2024. Most of the drop in total underground production (62 percent) is anticipated in the Appalachian Basin region, where a decline of over 30 million tons between 2020 and 2040 is expected. The steepest declines in terms of the percent of regional production are expected in the Colorado Plateau region, where a decline of 36 percent of regional production is anticipated between 2020 and 2040.

4.1.1.2 Energy Use

Given the dominant role electricity generation plays in coal markets, even small changes in the electricity market can influence both short and long-term demand for domestic coal. According to U.S. Energy Information Administration's (EIA) *Annual Energy Outlook (AEO) 2013*, U.S. electricity energy demand is expected to grow at a 0.9 percent annual rate through 2040 (U.S. EIA, 2013d). In 2014, approximately 39 percent of all electric power generated in the U.S. was derived from coal (U.S. EIA, 2015b). The first time in over a half century that coal's market share fell below 40 percent was in 2012, where it has held since. The primary reason for the low level of coal-fired power generation in 2012 and 2013 was the dramatic decline in natural gas prices during this period, giving natural gas-fired combined cycle power plants a cost advantage over coal-fired power plants in many parts of the country. As a result, while electric power generation remained the most important market for domestic coal, the electric power generation sector accounted for about 90 percent of U.S. coal production in 2012 and 2013 (U.S. EIA, 2014d).

4.1.1.3 Industrial Use

Industries, such as steel, iron, and cement manufacture, rely on coal for energy. Thus, fluctuations in these markets can also cause changes in coal demand. Steel and iron production relies on metallurgical coal, which is relatively high-energy, low-sulfur, and low-ash coal and is primarily mined in the Appalachian and Illinois Basins. This coal is used for coking purposes or in direct coal injection into blast furnaces.

International demand for U.S. coal, primarily metallurgical coal, represents 12.5 percent of total U.S. production (EVA, 2013). The U.S. has the potential to significantly increase its coal exports. Across the industry, the export market shows signs of expansion, as detailed in *AEO 2012* and *AEO 2013*. A number of coal terminals have been proposed for the Pacific Northwest including SSA Marine's Gateway Pacific Terminal, the Millennium Bulk Terminals, which is a joint venture between Ambre Energy Ltd. and Arch Coal Inc., and the Morrow Pacific Terminal being developed by Ambre. These terminals are in the process of obtaining the necessary permits, which may or may not be granted. In 2012, total exports of coal exceeded 125 million tons, with projections for further growth to 159 million tons by 2040 (U.S. EIA, 2013d). Whether exports will rise by this amount depends largely on world market conditions, as well as the development of port capacity in the Pacific Northwest.

All of these factors are incorporated into projecting the baseline coal market prices under the No Action Alternative in each of the major coal supply regions as shown in Table 4.1-1 in inflation adjusted 2014 dollars.

Table 4.1-1
EVA Baseline Forecast of Regional, Inflation Adjusted, Coal Prices for Price-Setting Mines ($2014/Ton)

Coal Region	2015	2020	2025	2030	2035	2040
Northern Appalachia	$56.04	$58.26	$59.96	$63.03	$66.36	$69.98
Central Appalachia	$64.00	$67.34	$68.73	$70.43	$72.28	$74.27
Illinois Basin	$42.48	$44.75	$45.44	$46.15	$46.92	$47.72
Powder River Basin	$14.19	$16.02	$16.49	$17.33	$18.35	$19.57
Rockies	$36.24	$38.50	$38.68	$38.95	$39.26	$39.60

Source: EVA, 2014.

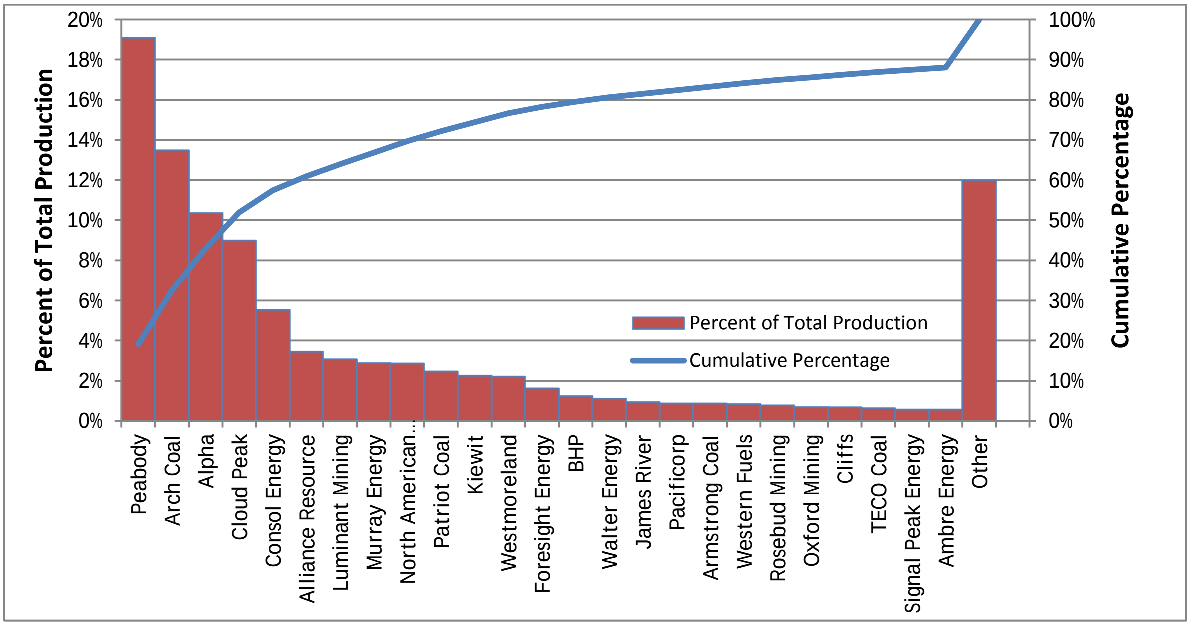
In addition to coal production, the number and size of mines and mining companies are important characteristics of the industry.

Consolidation has been a trend in recent years within the coal industry.[9] Major consolidations include Alpha Coal’s purchase of Massey Energy and Arch Coal’s purchase of International Coal Group, Inc. (ICG). Additional consolidation is possible, particularly in regions with declining production. Overall, the most productive 25 corporations produced more than 93 percent of annual coal production in the U.S. in 2013 (U.S. EIA, 2015a; EVA, 2013).[10] The top ten producers produced over 76 percent of total production in 2013 (U.S. EIA, 2015a; EVA, 2013). In 2013, Peabody Energy Corporation was the largest producer in the U.S. and was responsible for about 19 percent of all coal production in the U.S. (U.S. EIA, 2015a; EVA, 2013). Figure 4.1-4 presents the largest coal firms and the cumulative percentage of total production.

[9] See the Regulatory Impacts Analysis, which discusses market forces driving these trends in greater detail.

[10] All percentages are based upon tons of coal mined.

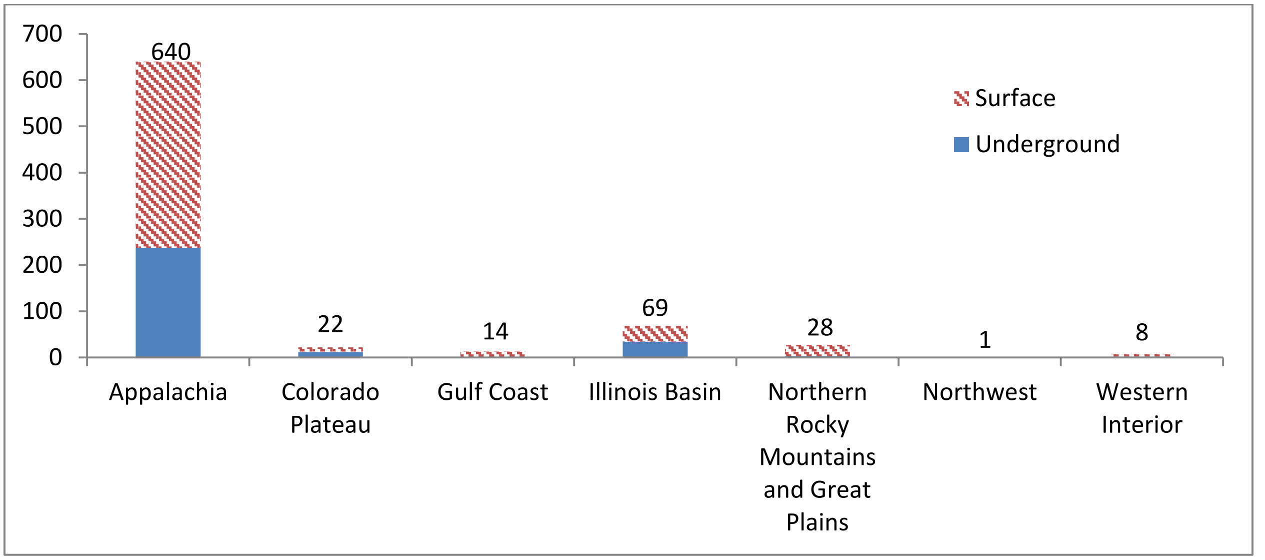
Figure 4.1-4 Cumulative Percentage and Percent of Total Production by Controlling Company, 2012



Source: MSHA, 2013

In June 2014, 785 active mines reported coal production to MSHA for 2013 (MSHA, 2014). Although the mines in Appalachia have relatively small average production levels compared to mines in other regions, the largest number of mines are found in that region (MSHA, 2014). In fact, of the 785 actively-producing surface and underground mines operating in June, 2014, 640 were located in Appalachia. In contrast, the Northwest region had only one producing mine in 2014, as shown in Table 4.1-2. Similarly, the share of small firms, defined as firms with one to 500 employees, is disproportionately large in the Appalachian Basin region, as shown in Table 4.1-2.

Figure 4.1-5 Number of Active Coal Mines by Region, 2014



Source: MSHA, 2014

Table 4.1-2
Mines Operated by Firms with 1 to 500 Employees across Regions

Coal region	Surface Mines (Number of Companies)	Underground mines (Number of Companies)
Appalachian Basin	260	89
Colorado Plateau	3	2
Gulf Coast	0	N/A
Illinois Basin	12	3
Northern Rocky Mountains	3	1
Northwest	1	N/A
Western Interior	6	2

1) MSHA 2014 (Annual production, number of mines and number of employees per mine).
2) For full details on analysis, please see the SPR RIA.

4.1.2 Model Mine Approach to Understanding Coal Industry Impacts

This section provides an overview of the model mines approach used to analyze industry and environmental conditions under the various Alternatives.

The analysis in this DEIS uses a model mine approach to examine the impacts of elements under each Action Alternative. The goal of the analysis is to design mines representative of the operations located in each region and to identify and quantify the effects of each Action

Alternative on mining operations. This analysis is not an evaluation of individual mining operations, which vary in practice due to factors such as topography, geology, and hydrology. Instead, the analysis approximates changes expected to occur in a region as a result of each of the Action Alternatives.

The model mines were created after evaluating the overall distribution of coal production by location, mine type, and controlling company. Each of the seven major coal-producing regions is evaluated to determine the type and size of mining operations that are representative of those providing the majority of production for the region.[11] Using this information, specific model mines that capture the regional characteristics were developed.[12] Future production trends were taken into account, most notably in the Illinois Basin, where increases in longwall mining production are anticipated. Overall, 13 model mines were developed, which together represent over 90 percent of coal mining production nationwide. Table 4.1-3 shows the location, mining type, and typical annual production for each model mine.

After considering the locations, sizes, and mining methods for the 13 model mines, permit data on topography, geology, and stream characteristics are used to establish a realistic physical setting for each model mine. Surface topography from the USGS Seamless Server, GIS analysis, and AutoCAD software are used to develop contours, delineate watersheds and streams, and insert coal seams. Based upon the geology, topography, and mine size, a mineral removal boundary is created for each model mine.

After designing the location and characteristics of each model mine, the effects of each Action Alternative relative to the No Action Alternative were assessed.

[11] Because the Western Interior region shares features with the Illinois Basin, the Illinois Basin surface model mine was applied to the Western Interior region.

[12] Alaska's only operating mine is taken to be representative of coal production in Alaska.

Table 4.1-3
Model Mine Analysis, Type and Estimated Annual Production

Region	Mine Type	Yearly Production (Million Tons)
Central Appalachia	Surface Area Mine	2.3
Central Appalachia	Surface Contour Mine	0.5
Central Appalachia	Underground Room and Pillar	0.2
Northern Appalachia	Surface Contour Mine	0.3
Northern Appalachia	Underground Longwall	4.6
Colorado Plateau	Surface Area Mine	3.3
Colorado Plateau	Underground Longwall	3.0
Gulf Coast	Surface Area Mine	3.3
Illinois Basin	Surface Area Mine*	1.0
Illinois Basin	Underground Room and Pillar	2.1
Illinois Basin	Underground Longwall	6.0
Northern Rocky Mountains and Great Plains	Powder River Basin Surface	27.2
Northwest (Alaska)	Surface Area Mine	2.0

* The Illinois Basin surface model mine was used to represent the Western Interior, owing to similar characteristics.

4.1.3 Total Compliance Costs

The compliance cost analysis estimates the incremental administrative and operational costs anticipated to result from each Action Alternative (i.e., the changes in administrative and operational costs expected as a result of each Action Alternative over and above costs that would be incurred under the No Action Alternative). To estimate the total compliance costs of an Action Alternative, the analysis first estimates the expected increase in operational and administrative costs for each of the thirteen model mines. The analysis then converts them to costs per ton of coal produced. These increases in per-ton costs of operations are then combined with estimates of government and industry administrative costs and modeled to anticipated production impacts in each region.

Forecasted compliance costs for underground mining activities in all regions are anticipated to be driven by increased administrative costs from increased monitoring as well as increased reforestation costs. All of the Action Alternatives had increased compliance costs over the No Action Alternative, except for Alternative 9. The operational requirements of Alternative 9 were determined to be either the same as the No Action Alternative or achievable at comparable costs to baseline practices. The administrative costs were determined to be negligible.

After calculating the revised coal production forecast that takes into consideration the implementation of the Action Alternatives, the total compliance costs are calculated. Table 4.1-4 presents the regional annualized increased compliance costs. Additional details about this analysis are presented in the RIA. Several features of the cost estimates are noteworthy:

- Annualized compliance costs are highest in Alternative 2 at $121 million. Compliance costs under Alternative 2 are greater than costs under the other Alternatives because of the stringency and broad applicability of the requirements. Appalachian Basin mines, especially surface mines, contribute most to the high costs under this Alternative. These costs are driven by requirements (prohibition of mining near streams, spoil management, approximate original contour (AOC) restoration) that increase haulage costs.

- Annualized compliance costs for Alternatives 3 and 4 are anticipated to be $76 million and $77 million. Like Alternative 2, these Alternatives apply nationally with varying requirements. Under Alternatives 3 and 4 the majority of costs are seen in the Appalachian Basin and the Illinois Basin.

- Annualized compliance costs for Alternative 5 are anticipated to be $29 million. Under Alternative 5, costs accrue primarily in the Appalachian Basin because the requirements are limited to areas where mining operations place excess spoil outside of the mined area or where coal mine refuse disposal occurs in in perennial or intermittent streams. These practices are largely restricted to the Appalachian Basin.

- Annualized compliance costs for Alternative 6 are anticipated to be $29 million. Under Alternative 6, the mix of costs among regions is different. Specifically, surface mines in Illinois incur a proportionally larger share of costs (roughly 50 percent). Although the Alternative prohibits mining activities within 100 feet of intermittent or perennial streams, it allows regulatory authorities to approve placement of excess spoil or coal mine waste in an intermittent or perennial stream under certain conditions. These conditions are prevalent in the Appalachian Basin, lowering costs in this region.

- Annualized compliance costs for Alternative 7 are anticipated to be $44 million. Although Alternative 7 applies only where enhanced permitting conditions exist, costs are still moderately high because these conditions exist throughout much of the Appalachian Basin.

- Annualized compliance costs for Alternative 8 (Preferred) are anticipated to be $52 million. Alternative 8 (Preferred) costs are similar, but somewhat lower than those anticipated for Alternative 4 primarily because enhanced permitting conditions and landforming requirements do not apply under Alternative 8 (Preferred).

- As discussed previously, Alternative 9 is not anticipated to result in additional compliance costs over and above the No Action Alternative.

For context, EIA reports 2012 coal production of 1,284 million short tons and an average sales price of $39.95 per short ton for approximate revenues of $51 billion (U.S. EIA, 2013). Annualized compliance costs as share of 2012 industry revenue would have ranged from approximately 0.06 percent (Alternatives 5 and 6) to 0.24 percent (Alternative 2).

Table 4.1-4
Total U.S. Annualized Increased Compliance Costs under the Action Alternatives, 7 Percent Real Discount Rate (Millions of 2014 Dollars)

Alternative	Appalachia	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains	Northwest	Western Interior	Total
Alternative 2	$71	$4.0	$9.0	$27	$8.0	$0.2	$1.1	$121
Alternative 3	$39	$3.7	$8.5	$17	$7.5	$0.1	$0.7	$76
Alternative 4	$38	$4.4	$9.1	$17	$8.2	$0.1	$0.7	$77
Alternative 5	$29	$0	$0	$0	$0	$0	$0	$29
Alternative 6	$12	$0.6	$0.9	$14	$0.9	$0.04	$0.6	$29
Alternative 7	$36	$2.4	$1.5	$2.5	$1.3	$0.01	$0.1	$44
Alternative 8	$24	$2.7	$6.2	$14	$4.8	$0.1	$0.6	$52
Alternative 9	$0	$0	$0	$0	$0	$0	$0	$0

4.1.4 Effects of Action Alternatives on Coal Production

The difference in compliance costs for each Action Alternative yields changes relative to the No Action Alternative's projected coal production presented in Section 4.1.1. Table 4.1-5 presents the forecasted annual changes in coal production across the different Action Alternatives and regions; these are average annual production changes across the 21-year study period, relative to the forecasted baseline included within the No Action Alternative.

All of the Action Alternatives, except Alternative 9, are expected to result in some net decrease in total national production, resulting from the anticipated decrease in surface production primarily from the Appalachian Basin. As discussed, the analysis found negligible incremental compliance costs for Alternative 9. Consequently, Alternative 9 would lead to the same level of coal production as in the No Action Alternative. This finding is consistent with the requirements of Alternative 9, which contains no absolute prohibitions on mining in or within streams. Therefore, Alternative 9 would not change coal production any more than the No Action Alternative.

As Alternative 9 forecasts no change in national production from the No Action Alternative, it will be excluded from the following discussion of Table 4.1-5. The average annual decreases range from a low 1.4 million tons (0.13 percent of baseline production) under Alternative 6, to a high of 3.2 million tons (0.31 percent of baseline production) under Alternative 2. Alternative 2 forecasts a shift in production from surface to underground production in the Appalachian Basin; surface production is estimated to decrease by an annual average of 4.6 million tons and underground production is estimated to increase by an annual average of 2.5 million tons. Net production decreases are also forecast for the Illinois Basin and the Northern Rocky Mountains, with all Action Alternatives expected to experience similar changes. For context, annual coal production in the U.S. in 2012 was 1,284 million short tons and Appalachia production was 292 million short tons (U.S. EIA, 2013).

Table 4.1-5
Regional Forecast Changes in Annual Coal Production under the Action Alternatives Compared to the No Action Alternative (Millions of Tons)

Alternative	Mine Type	Appalachia	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains	Northwest	Western Interior	**Total**
Alternative 2	Surface	(4.6)	0	0	(0.1)	(0.7)	0	0	(5.4)
	Underground	2.5	0	-	(0.4)	0	-	0	2.1
	Net Change	(2.1)	0	0	(0.4)	(0.7)	0	0	(3.2)
Alternative 3	Surface	(0.4)	0	0	(0.1)	(0.7)	0	0	(1.2)
	Underground	(0.8)	0	-	(0.2)	0	-	0	(1.1)
	Net Change	(1.3)	0	0	(0.3)	(0.7)	0	0	(2.3)
Alternative 4	Surface	(0.3)	0	0	(0.1)	(0.7)	0	0	(1.1)
	Underground	(0.7)	0	-	(0.3)	0	-	0	(1.0)
	Net Change	(1.0)	0	0	(0.3)	(0.7)	0	0	(2.1)
Alternative 5	Surface	(0.3)	0	0	0	(0.7)	0	0	(1.0)
	Underground	(0.6)	0	-	(0.2)	0	-	0	(0.8)
	Net Change	(0.9)	0	0	(0.3)	(0.7)	0	0	(1.8)
Alternative 6	Surface	(0.1)	0	0	(0.1)	(0.7)	0	0	(0.9)
	Underground	(0.3)	0	-	(0.2)	0	-	0	(0.5)
	Net Change	(0.5)	0	0	(0.3)	(0.7)	0	0	(1.4)
Alternative 7	Surface	(0.3)	0	0	(0.1)	(0.7)	0	0	(1.1)
	Underground	(0.7)	0	-	(0.3)	0	-	0	(1.1)
	Net Change	(1.1)	0	0	(0.4)	(0.7)	0	0	(2.2)
Alternative 8	Surface	(0.3)	0	0	(0.1)	(0.7)	0	0	(1.0)
	Underground	(0.6)	0	-	(0.3)	0	-	0	(0.8)
	Net Change	(0.9)	0	0	(0.3)	(0.7)	0	0	(1.9)
Alternative 9	Surface	0	0	0	0	0	0	0	0
	Underground	0	0	-	0	0	-	0	0
	Net Change	0	0	0	0	0	0	0	0

4.2 NATURAL RESOURCES

4.2.1 Water Resources

As described in Chapter 1, the primary purpose of the proposed action is to anticipate and prevent adverse impacts to streams and related resources as a result of coal mining activities while balancing the Nation's need for an adequate coal supply. To achieve this objective, meaningful protection of water resources is essential. Therefore, this section of Chapter 4 analyzes how water resources are currently impacted by the No Action Alternative and what is expected to occur if no changes are made as a result of this rulemaking effort. Following a synopsis of the No Action Alternative relative to water resources, the various effects of the Action Alternatives on water resources are analyzed. This analysis considers impacts upon both surface water and groundwater. The remaining subsections are structured as follows:

- Subsection 4.2.1.1 provides an overview of SMCRA and the Clean Water Act (CWA) to describe how implementing regulations under these laws interact to regulate water quality impacts related to coal mining. This subsection then describes mining-related effects on water quality that are occurring under these existing regulations, i.e., under the No Action Alternative;
- Subsection 4.2.1.2 describes how particular elements of the proposed action would likely affect water resources;
- Subsection 4.2.1.3 describes the analytic methods employed to evaluate potential effects to water resources;
- Subsection 4.2.1.4 presents results of the quantitative analysis of surface water impacts; and
- Subsection 4.2.1.5 presents a summary of the results that would be achieved from the Action Alternatives.

4.2.1.1 Effects of the Current Regulatory Environment (the No Action Alternative)

This subsection provides an overview of the existing regulatory environment governing water resources related to coal mining. The subsection begins with a discussion of important sections of the CWA since there is a high degree of interaction between the requirements of SMCRA and the requirements of the CWA. While a SMCRA permit addresses all parts of the mining activity, those activities affecting waters of the U.S. will also require a CWA permit. For example, a proposed surface coal mining operation requires a SMCRA permit to authorize the mining activity itself, and a permit under section 404 of the CWA, and a state water quality certification under section 401 if the mining activity requires the discharge of fill material into the waters of the U.S.

Each relevant CWA section is discussed below, followed by a water quality focused discussion of existing requirements under SMCRA.

Existing Regulatory Environment

Clean Water Act

Congress established the CWA with the goal of "restor[ing] and maintain[ing] the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C. § 1251(a)). To achieve that objective, the CWA prohibits the discharge of pollutants from point sources into waters of the U.S. unless consistent with the requirements of that act (*Id*. § 1311(a)). The CWA allows for the discharge of pollutants into waters of the U.S. under two permitting programs. Section 402 governs the discharge of pollutants other than dredged or fill material; section 404 governs the discharge of dredged or fill material. Congress charged EPA with oversight authority of state-authorized permit programs (*Id.* §§ 1342(b)-(e); 1344(g)(l), (n)) and provided EPA with other authorities in connection with section 404 permits issued by the U.S. Army Corps of Engineers (USACE) (*Id*. § 1344(b)-(c), (q), (n)).

CWA Section 303 Water Quality Standards

Section 303 of the CWA requires states to adopt water quality standards applicable to their intrastate and interstate waters (33 U.S.C. § 1313). Water quality standards assist in maintaining the physical, chemical, and biological integrity of a waterbody by designating uses, setting criteria to protect those uses, and establishing provisions to protect water quality from degradation. Water quality standards established by states[13] are subject to EPA review (40 CFR 131.5; 33 § U.S.C. 1313(c)). EPA may object to state-adopted water quality standards and may require changes to the state-adopted water quality standards and, if the state does not respond to EPA's objections, EPA may promulgate federal standards (33 U.S.C. § 1313(c)(3)-(4); 40 CFR 131.5, 131.21).

Water quality criteria may be expressed numerically and implemented in permits through specific numeric limitations on the concentration of a specific pollutant in the water (e.g., 0.1 milligrams of chromium per liter) or by more general narrative standards applicable to a wide set of pollutants. To assist states in adopting water quality standards that will meet with EPA's approval, Congress authorized EPA to develop and publish recommended criteria for water quality that accurately reflect "the latest scientific knowledge" (33 U.S.C. § 1314(a)). Water quality standards are not self-implementing; they are implemented through permits, such as the section 402 permit or the section 404 permit (33 U.S.C. § 1311(b)(1)(C); 40 CFR 122.44(d), 230.10(b)).

CWA Section 401 Water Quality Certification

State water quality standards are incorporated into all federal CWA permits through section 401, which requires each applicant to submit a certification from the affected state that the discharge will be consistent with state water quality requirements (33 U.S.C. § 1341(a)(1)). Thus, section 401 provides states with a veto over federal CWA permits that may allow exceedances of state water quality standards, and empowers states to impose and enforce water quality standards that are more stringent than those required by federal law (33 U.S.C. § 1370).

[13] EPA may treat an eligible federally-recognized Indian tribe in the same manner as a state for implementing and managing certain environmental programs, including under the Clean Water Act.

CWA Section 402 Permits

Section 402 of the CWA, 33 U.S.C. § 1342, governs discharges of pollutants other than dredged or fill material. Permits issued under the authority of section 402 are known as National Pollutant Discharge Elimination System (NPDES) permits, and typically contain numerical limits called "effluent limitations" that restrict the amounts of specified pollutants that may be discharged. NPDES permits must contain technology-based effluent limits, and any more stringent water quality-based effluent limits necessary to meet applicable state water quality standards (33 U.S.C. §§ 1311(b)(1)(A),(C), 1342(a); 40 CFR 122.44(a)(1), (d)(1)). Water quality-based effluent limitations are required for all pollutants that the permitting authority determines "are or may be discharged at a level [that] will cause, have the reasonable potential to cause, or contribute an excursion above any [applicable] water quality standard, including State narrative criteria for water quality" (40 CFR 122.44(d)(1)(i)). The procedure for determining the need for water quality-based effluent limits is called a reasonable potential analysis, or "RPA."

Section 402 permits are issued by EPA, unless the state has an approved program whereby the state issues the permits, subject to EPA oversight (33 U.S.C. § 1342(b)(e); *Nat'l Ass'n of Home Builders v. Defenders of Wildlife*, 551 U.S. 644, 650-651 (2007)). The state must submit draft permits to EPA for review, and EPA may object to a proposed permit that is not consistent with the CWA and federal regulations (33 U.S.C. § 1342(d); 40 CFR 123.43 and 123.44). If the state does not adequately address EPA's objections, EPA may assume the authority to issue the permit (33 U.S.C. § 1342(d)(4)). EPA's procedures for the review of state-issued permits are set forth in regulations at 40 CFR 123.44 and in memoranda of agreement with the states.

Sediment control ponds and other sediment control structures, connected by various diversion channels and other conveyances, often form an integral part of the wastewater effluent treatment systems on coal mine sites. Section 402 authorizations (NPDES permits) consider the effectiveness of these systems on the mine site in ensuring that discharges leaving coal mining permit areas meet applicable water quality standards.

CWA Section 404 Permits

Section 404(a) of the CWA, 33 U.S.C. § 1344(a), authorizes the Secretary of the Army, acting through the USACE, to "issue permits ... for the discharge of dredged or fill material into the navigable waters at specified disposal sites" (33 U.S.C. § 1344(a)). By this authority, the USACE regulates discharges of dredged and fill material into waters of the United States in connection with surface coal mining activities. The USACE's regulations governing section 404 permit procedures are set forth at 33 CFR Part 325.

Although the USACE is the permitting authority under section 404, EPA has an important role in the permitting process. Section 404(b) of the CWA requires that USACE's permit decisions comply with guidelines developed by EPA in conjunction with the USACE, referred to as the "404(b)(1) Guidelines" (33 U.S.C. § 1344(b)(1)). Among other things, the 404(b)(1) Guidelines prohibit the discharge of fill if it would cause or contribute to a violation of a water quality standard or cause or contribute to significant degradation of the waters of the U.S. (40 CFR 230.10(b), (c)(1)-(3)). The "404(b)(1) Guidelines" require the USACE to analyze more than 15 different factors that could be impacted by the proposed action, including substrate, suspended particulates, turbidity, water quality, water circulation, water level fluctuations, salinity gradients, threatened and endangered species, aquatic organisms in the food web, other wildlife special aquatic sites, water supplies, fisheries, recreation, aesthetics, and parks (40 CFR 230 (c)-(f)). The 404(b)(1) Guidelines provide that the USACE must ensure that the proposed discharges would not cause or contribute to significant adverse effects on human health or welfare, aquatic life, or aquatic ecosystems (40 CFR 230.10(c)(1)-(3)).

Before the USACE may issue a section 404 permit, it must provide notice to the public, EPA, and other resource agencies, which may all provide comments to the USACE for consideration (33 CFR 325.3(d)). In addition, the USACE and EPA have entered into a Memorandum of Agreement (MOA) as directed by section 404(q) of the CWA, 33 U.S.C. § 1344(q), that expressly recognizes that "the EPA has an important role in the Department of the Army Regulatory Program under the Clean Water Act[.]" The MOA provides that "[p]ursuant to its authority under section 404(b)(1) of the Clean Water Act, the EPA may provide comments to the Corps identifying its views regarding compliance with the section 404(b)(1) Guidelines" and USACE "will fully consider EPA's comments when determining [compliance] with the National Environmental Policy Act, and other relevant statutes, regulations, and policies" (*Id*).

In addition, and in recognition of "EPA's expertise and concentrated concern with environmental matters," (*James City County v. EPA*,12 F.3d 1330, 1336 (4th Cir. 1993)), Congress gave EPA the authority in section 404(c) to prohibit, withdraw, deny, or restrict the specification of disposal sites that would otherwise be authorized by a section 404 permit--often referred to as EPA's "veto" authority.

The USACE reviews "individual" permit applications on a case-by-case basis under section 404(a) (33 U.S.C. § 1344(a)). Individual permits may be issued or denied after a review involving, among other things, site specific documentation and analysis, opportunity for public hearing, public interest review, and a formal determination that the permit is lawful and warranted (33 CFR Parts 320, 323, 325).

Not every discharge is of such significance that an individual evaluation of the discharge's environmental effects is necessary. Instead, section 404(e)(1) authorizes the Secretary of the Army to issue general permits for categories of activities involving discharges of dredged or fill material that, as a group, have only minimal impacts on the waters of the U.S. The USACE can issue these general permits (as well as individual permits) on a state, regional, or nationwide basis. The USACE refers to general permits issued on a nationwide basis as "Nationwide permits" (NWP). Current NWPs related to coal mining include NWP 21, which the USACE reissued on February 21, 2012 (77 FR 10184).

NWP 21 provides USACE authorization for the discharge of dredged or fill material into waters of the U.S. associated with surface coal mining activities. The USACE review under NWP 21 is focused on the individual and cumulative adverse effects to the aquatic environment, and on determining appropriate mitigation should mitigation become necessary. The USACE review does not extend to the mining operation as a whole, unlike the SMCRA permit.

To qualify for NWP 21 an activity must meet all of the following criteria:

> (1) The activities are already authorized or are currently being processed by a SMCRA-approved state program or an integrated permit processing procedure by the Department of the Interior;
>
> (2) The discharge will not cause the loss of more than ½ acre of non-tidal waters of the United States, including the loss of no more than 300 linear feet of stream bed, unless for intermittent and ephemeral stream beds the district engineer waives the 300 linear foot limit by making a written determination concluding that the discharge will result in minimal individual and cumulative adverse effects; and
>
> (3) The discharge is not associated with the construction of valley fills which are fill structures associated with surface coal mining activities that are typically constructed within valleys associated with steep, mountainous terrain.

Surface coal mining activities that impact waters of the U. S., and that do not meet the requirements of NWP 21, would require an individual section 404 permit to proceed. Consideration of resources occurs under either an individual permit or an NWP, as required by the 404(b)(1) guidelines. The primary differences between the two processes are the extent of public review opportunities, the degree of administrative burden, and the amount of time involved in processing the permit.

Surface Mining Control and Reclamation Act

Congress enacted SMCRA for the purpose of, among other things, striking a balance between protecting the environment from the adverse effects of surface coal mining operations and meeting the Nation's energy requirements (30 U.S.C. § 1202(a), (d), (f)). SMCRA expressly provides that "[n]othing in this chapter shall be construed as superseding, amending, modifying, or repealing" the CWA or "any rule or regulation promulgated thereunder" (*Id*. § 1292(a)(3)). In addition, SMCRA requires that "[t]o the greatest extent practicable each federal agency shall cooperate with the Secretary and the States in carrying out" its provisions, and it directs the coordination of regulatory activities among departments and agencies responsible for implementation of identified statutes, including the CWA (*Id*. §§ 1292(c), 1303(a)).

As discussed previously in Chapter 1 of this DEIS, a state may assume primary jurisdiction (primacy) over the regulation of surface coal mining and reclamation operations within its borders by submitting a program proposal to the Secretary for approval (*Id*. § 1253). Regardless of whether OSMRE is the regulatory authority or whether the state has an approved program, consideration and protection of surface and groundwater resources are required throughout the permitting, mining, and reclamation phases.

The regulations implementing SMCRA include extensive permitting requirements and performance standards intended to protect the hydrologic balance (see, e.g., 30 CFR Parts 780, 784, 785, 815, 816, and 817). For example, the regulatory authority may authorize mining activities in or adjacent to perennial or intermittent streams only when the permit applicant has successfully demonstrated that the "activities will not cause or contribute to the violation of State or Federal water quality standards, and will not adversely affect the water quantity or other environmental resources of the stream" (30 CFR 816.57(a)(1); 30 CFR 817.57(a)(1)).

Each SMCRA permit application must include an assessment of the probable hydrologic consequences of the proposed mining and reclamation operations (30 U.S.C. § 1257(b)(11) and 30 CFR 780.21(f) and 784.14(e)). The assessment must include a review of groundwater and surface-water quantity and quality, both on and off the mine site. Each permit application must include specific, detailed information concerning the hydrology and geology of the proposed permit and adjacent areas. Subsection 2.4.1 of Chapter 2 describes baseline data collection and analysis requirements under existing regulations.

The regulatory authority uses this assessment of the probable hydrologic consequences and other available information to prepare the cumulative hydrologic impact assessment and to determine if the permittee has designed the proposed operation appropriately to prevent material damage to the hydrologic balance (30 CFR 780.21 and 784.14). The regulatory authority cannot approve the permit application unless the applicant successfully shows that the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area (30 U.S.C. § 1260(b)(3); 30 CFR 773.15(e)).

However, there are shortcomings in the current regulations implementing SMCRA. Insufficient baseline data can make it difficult or impossible for the regulatory authority to determine whether problems detected during and after mining are a result of the mining operation or are instead related to other sources. Although the regulations require baseline characterization they do not establish standard protocols for determining the placement and number of water sampling points. The regulations at 30 CFR 780.21(b) require water quality descriptions for pH, total iron, total manganese, and total dissolved solids or specific conductance, but they do not require monitoring of other constituents, such as selenium, that have also been scientifically linked to some coal mining activities. The existing SMCRA implementing regulations also do not expressly require baseline assessment of biological conditions in streams.

Although the statute and the regulations clearly prohibit material damage to the hydrologic balance outside the permit area, neither SMCRA nor the implementing regulations provide a definition of "material damage to the hydrologic balance outside the permit area." Without a clear definition of this term, it is difficult for applicants to show that they have adequately designed their proposed mining operation to avoid damage, and the regulatory authority may have insufficient information to perform an objective review of the proposed design. The lack of a clear federal definition also contributes to variability among states, and even among permits, in what the regulatory authority might require of the applicant.

The lack of a federal definition for material damage to the hydrologic balance outside the permit area also complicates enforcement of permit conditions. SMCRA regulatory authorities have historically relied upon a qualitative approach when defining material damage to the hydrologic balance outside the permit area and have not specifically assigned numerical values to the point at which material damage to the hydrologic balance outside the permit area would occur. Absent a clearly defined threshold, it is difficult for operators to identify an impending problem and address it before damage occurs. It is also difficult for the regulatory authority to demonstrate that material damage to the hydrologic balance outside the permit area has occurred, or conversely that the operation is in fact in compliance or has been brought into compliance through the application of corrective measures.

Determining whether damage is occurring based on any definition requires monitoring. Whereas baseline data provides a snapshot of conditions before mining, monitoring of conditions throughout the activity provides data on conditions resulting from the activity itself. There are important gaps in our current regulations regarding how the operator is to conduct the monitoring. As with the baseline data requirements, our current regulations do not establish standard protocols for the number of water sampling points and they are not inclusive of all mining-related water quality concerns (see the list of analytes required above in the discussion of baseline data). For example, monitoring of selenium is not currently required (30 CFR 780.21(b)). However, since 2007, OSMRE has received twenty-one Notices of Intent to Sue (NOI) relative to selenium contamination and eleven NOIs related to conductivity impacts.

Vegetated buffer zones can slow overland water flow and allow sediment particles to settle out before they reach surface waters. SMCRA's implementing regulations at 30 CFR 816.57 and 817.57 require a 100-foot buffer along perennial and intermittent streams. However, the regulations allow the regulatory authority to grant an exception to this requirement, which they routinely do. The exception review and decision process is inconsistent among regulatory authorities.

Impacts of the No Action Alternative on Water Resources: Surface Water and Groundwater Effects

Despite existing regulations, both surface and underground mining operations continue to produce adverse effects on the quality and quantity of surface water and groundwater outside the permit area. These effects are occurring for a variety of reasons related to the nature of the mining activity, the sensitivity of the resources, and the efficacy of current regulations.

Surface Water Effects

Both surface and underground mining operations have the potential to adversely affect surface water quality. These effects can be chemical (e.g., changes to the water column chemistry and characteristics) or they can be physical (e.g., changes to the size, location, and flow characteristics). The effects are generally more pronounced in areas with a long history of mining, such as sites disturbed prior to the enactment of SMCRA in 1977, as compared to more current operations, as mining practices have improved over time.

However, as described in the studies presented below, mining under current regulations is continuing to result in physical and chemical effects on surface waters. Certain effects of mining are unavoidably associated with the activity. For example, during the duration of the mining activity, vegetation is removed and surfaces remain exposed, topography is altered and surfaces are compacted, infiltration of rainwater and uptake of water into vegetation is reduced and consequently overland runoff of water is increased. The local geology has a profound influence on the quantity and quality of surface water and groundwater. Mining activities break rock into smaller fragments, exposing previously unexposed minerals and increasing the amount of surface area available for weathering. As weathering commences, chemical constituents contained within the rock are released to the environment. In the mining environment, these constituents would be released into waters on the site, which would then make their way to water-treatment structures before being discharged from the permit area. Constituents also make their way into groundwater and then are discharged as groundwater baseflow into receiving streams.

Chemical Effects on Surface Waters

Under existing regulations, mining continues to affect downstream water chemistry. Studies have shown that mining-impacted waterways often contain elevated levels of iron, aluminum, manganese, and sulfate. These waters typically have lower alkalinity concentrations and lower pH, while specific conductivity and total suspended solids are typically higher, as compared to streams unimpacted by mining (Wangsness et al., 1981; Zuehls et al., 1984; Cravotta, 2008; Paybins, 2003; Howard et al., 2001; Stauffer and Ferreri, 2002; Bryant et al., 2002; Hartman et al., 2005; Pond et al., 2008; Petty et al., 2010).

Acid mine drainage has historically been a primary concern associated with coal mining due to the effects of low pH on the viability of the system for aquatic life, and impacts on human use and enjoyment of the water. Generally, aquatic life forms do best in a pH range of 6.5 to 9.0. Outside this range, certain analytes become more toxic to aquatic life (Lowry et al., 1983). This concern is relevant to mining nationwide, although not as prevalent in the western coalfields, where the geology, soils and hydrology provide high buffering capacity (alkalinity). For example, in coal regions of the Colorado Plateau and Northern Rocky Mountains and Great Plains, if sulfuric acid forms through the oxidation of sulfide materials within mine spoil and waste, it is usually neutralized by the highly alkaline conditions of surface waters in this region (Lowry et al., 1983).

Excess spoil fills constructed during large-scale mining operations in steep-slope areas impact aquatic ecosystems by, among other things, increasing ion concentrations in receiving waters. These impacts occur both during the mining activity and after reclamation. Palmer and Bernhardt (2009) found that streams impacted by valley fills often have 30- to 40-fold increases in sulfate concentrations and that sulfate concentrations in receiving waters continued to increase after mining activities ended. In addition, streams and rivers below valley fills receive elevated concentrations of calcium, magnesium, and bicarbonate ions and often trace metals, which mean that electrical conductivity levels in receiving streams below mining operations can be extremely high and create toxic conditions for aquatic life. Biological impairment of streams is highly correlated to elevated levels of these ions (Palmer and Bernhardt, 2009).

Direct impacts to streams from mining and reclamation activities also occur in association with the practice of mining through ephemeral, intermittent, and perennial streams. The impacts of large-scale mining operations upon the water quality of ephemeral, intermittent, and perennial streams in Central Appalachia are highlighted in Bernhardt and Palmer (2011). Research compiled in Bernhardt and Palmer (2011) demonstrated that multiple surface mines and valley fill activity within large watersheds resulted in increases in concentrations of sulfate, bicarbonate, calcium, and magnesium ions further downstream.

Physical Effects on Surface Waters

Physical effects on surface waters include all those effects that would change the size (width and or depth) and location of the water. These effects occur from mining activities that include mining through waters, placement of fill in waters to cross them with mining roads, and placement of spoil or refuse in waters. Each of these activities has difference consequences as discussed below.

Excess spoil placement into streams is allowable under longstanding interpretations of our current regulations and substantial effects of excess spoil generation on streams continues to occur, particularly in Appalachia. For example, a 2007, *Times West Virginian* article reported that surface mining permits issued between October 2001 and June 2005 affected approximately 535 miles of streams, including 367 miles of streams in the Appalachian coalfields. More specifically, the West Virginia Department of Environmental Protection completed a report titled; *Trends in Mining Fills and Associated Stream Loss in West Virginia 1984-2012*, in 2013 (Shank and Gebrelibanos, 2013. The authors of the report calculated stream loss due to spoil and refuse fill construction between 1984 and 2012. The analysis indicated the following:

- Completed or under construction fills included 1,932 spoil fills and 392 refuse fills;
- Fill acreage totaled 62,471 acres or approximately 97 square miles;
- Direct stream loss (under the fills) totaled 764.3 miles (297.5 miles of intermittent and 466.8.1 miles of perennial streams); and
- Indirect stream impacts above fills, including change in ecologic function, totaled 279.5 miles.

Activities that involve land disturbance, such as mining and reclamation, increase the risk of erosion and, therefore have the potential to affect the quantity of sediment that reaches waterways. Sediments are fragmented materials originating from the weathering and erosion of rocks or unconsolidated deposits, which are transported or deposited by or suspended in water. Sediments are a pollutant of waters because sediment particles can carry attached contaminants with them. They can also affect biological processes directly by burying or smothering aquatic organisms or their habitats, and reducing the amount of light available for photosynthesis or activities requiring visibility. Excessive sediment reduces stream depth, which increases water temperatures and reduces the dissolved oxygen content (Slagle et al., 1986).

An unintended consequence of the storage function provided by sediment ponds is that the impoundment of the waters affects the timing and volume of water received downstream from the pond; peaks and lows in the hydrograph are smoothed out due to the impoundment and controlled release of the water. This, in turn, affects the physical and biological characteristics downstream. In semi-arid, dry-land fluvial systems, captured runoff released from impounding structures such as sediment ponds can be a source of downstream channel instability. The energy potential of the “clear” water that was once used to transport sediment is now available to erode the receiving channel (Leopold and Maddock, 1953). Limiting the frequency of flow and sediment delivered to streams below mined areas may initiate changes in channel form due to deposition of eroded sediment and mass wasting processes, altering the channel’s capacity to convey flow and causing subsequent channel incision or widening.

When streams are filled for any reason, the water that once made its way to that stream will find a new pathway. Flooding or, conversely, water deprivation, scouring, and gullies are all possible consequences of poor water management. Additionally, changes in drainage divides, contributing area, and drainage density may affect how much runoff is contributed to the receiving stream system.

The quantity and rate of water flow are important hydrologic characteristics that help to determine the water that will be available to support aquatic life and other stream benefits. Mining activities have had documented impacts on hydrologic characteristics. Higher infiltration rates on mined areas increased stream base flow, and increased storage capacity in replaced mine spoils reduced peak flow in streams receiving drainage from mine sites (Corbett and Agnew, 1968). Conversely, negative effects on streamflows have also been documented, particularly in the Appalachian Basin region. For example, there are documented cases of subsidence-induced stream dewatering caused by longwall mining operations in Pennsylvania and West Virginia (Wade, 2008; Rauch et al., 1984; Hobba, 1993; Stout, 2004). In some cases, the streamflow rebounded within months while other cases have shown the dewatering to persist for years.

Groundwater Effects

Chemical Effects on Groundwater

Mining can have effects on groundwater chemistry similar to those discussed previously for surface water. A U. S. Geological Survey (USGS) study (Paybins et al., 2000) investigating groundwater water quality downgradient of reclaimed surface coal mines showed lowered pH and increased sulfate concentrations at sampling locations affected by mining. The same study showed higher sulfate concentrations in groundwater in shallow wells within 1,000 feet of reclaimed surface mines. This study also documented higher iron, manganese, and aluminum concentrations (1,800, 640, and 11 µg/L, respectively) within about 2,000 feet of reclaimed surface mines (Paybins et al., 2000). Another USGS study focusing on groundwater resources in the Allegheny and Monongahela River Basins found groundwater in shallow private domestic wells near reclaimed surface coal mines had higher concentrations of sulfate, iron, and manganese compared to unmined areas, even after all mining and reclamation had been completed (Anderson et al., 2000).

Physical Effects on Groundwater

Mining activities can affect both the quantity and direction of groundwater flow. Water infiltration contributes to groundwater, and coal mining and reclamation activities can change overland flow and the amount of water that infiltrates the surface to ultimately recharge the groundwater system. Subsidence due to underground mining impacts the direction of groundwater flow as well because it changes the contour and infiltration capacity of the overlying surface (discussed in greater detail in the next section). According to the USGS Groundwater Atlas of the United States, HA 730-L (Trapp and Horn, 1997):

> Underground mining of coal disturbs the natural groundwater flow system when the mines are active because artificial drains are constructed to dispose of unwanted water and mining activities can create new fractures and thus increase permeability. The regional water table can be lowered when the drains are effective and groundwater flow directions can be changed in some cases until flow moves across former groundwater divides into adjoining basins. Groundwater tends to flow toward mines, which are usually dewatered by

> pumping. Adverse effects of mine drainage on well yields are greatest where the mines are not much deeper than the bottoms of the wells and where vertical fractures connect the aquifers and the mines.

Overburden removal and coal excavation to a depth below the groundwater table is commonly done during mining and results in a new hydraulic gradient (resulting in changes to direction of the groundwater flow). Although intact portions of the aquifer(s) may still exist beyond the extent of the coal removal area, water availability from within these aquifers will generally be reduced as the water flows towards the active pit in response to a lowering of hydraulic head values. As a result, water levels in existing wells installed in these aquifers are lowered, reducing the amount of water available for use (e.g., as drinking water) and the amount of water discharged downstream as baseflow.

Mines and preparation facilities may also need to use groundwater resources for their operations. Some mines must continuously pump water from the mine to facilitate mining operations. The interception of groundwater and continuous mine pumping lowers the surrounding groundwater table. The lowered groundwater table may affect springs, streams, or users of groundwater resources. In doing so, water levels in affected aquifers may be significantly lowered over long periods of time (OSMRE, 2007). These levels may recover over time once mining and reclamation activities are complete and the mine pits fill, saturating the backfilled spoil material.

Wells can also be affected when streams find a new course underground through new fractures in underlying strata. Streams that disappear into underground mine voids form mine pools, which are an underground accumulation of water where the water fills a void left after coal has been removed. Flooded mines can then induce artesian conditions where water from the flooded mine is higher (but still subsurface) than the surrounding materials that wells are drawing water from, creating a pressure situation where the water will be forced vertically upward in the well. This effect was seen at Spruce Laurel Fork, a perennial stream in Boone County, WV, which was adversely affected by both pre- and post-SMCRA underground mining operations, resulting in the formation of a mine pool. Downstream artesian effects on residential wells then occurred when pumping did not control the mine pool level (Galya, 2008).

Subsidence and Effects on Surface Water and Groundwater

Underground mining can have significant impacts upon surface waters and groundwater due to subsidence (downward vertical movement of the overlying land surface from the removal of underlying strata). With respect to surface hydrology, the major concern associated with subsidence is that it changes the shape of the overlying surface with commensurate impacts on surface-water flow and drainage. With respect to groundwater, the most common problem is dewatering aquifers above the mined-out coal seam, which most often affects the hydrologic balance outside the permit boundary by adversely impacting baseflow to intermittent and perennial streams. In addition, subsidence within the permit boundary can impact water-quality of the groundwater providing baseflow to the streams outside the permit boundary.

Several studies have documented subsidence-related impacts to hydrologic systems that continue to occur under our existing regulations. These studies are summarized below.

Subsidence from longwall mining continues to affect base flow in affected streams, despite the requirements contained in the current regulations. Carver and Rauch (1994) reported the following findings from a study looking at West Virginia streams affected by subsidence associated with longwall mining:

> Subsidence from longwall mining typically reduced stream discharge for two to three years. Panels positioned beneath upland catchment areas and not under streams caused no apparent stream dewatering. … Monitored stream reaches within the angle of draw zone of an adjacent panel did not normally become dewatered for panels older than 2.3 years. However, stream reaches in basins less than 200 acres in size often experienced dewatering for up to 3.1 years after undermining. … After two to three years since mine subsidence occurred recovered streams displayed lower high base flow and higher low base flow discharge, or more uniform base-flow discharge, compared to unsubsided streams.

Subsidence impacts to hydrology are continuing to occur in other regions as well. The USGS conducted several studies describing the effects of longwall mining in Carbon and Emery Counties, Utah. The initial study reported that subsidence had impacted the hydrologic system by loss of flow in reaches of perennial streams, and had increased dissolved solids content in streams and dewatering of the aquifer above the mine workings (Slaughter et al., 1995). The initial study also reported that there was not a clear relationship between mining subsidence and spring discharge. The follow-up study reported on hydrologic and water quality conditions thirteen years after longwall mining (Wilkowske et al., 2007). This study concluded that some of the previously reported impacts still remain, while others appear to have lessened. The persistent effects include increases in the dissolved solids and sulfate content in water samples, increased base flow, and a significant increase in spring discharge.

4.2.1.2 Action Alternatives and Potential Effects on Water Resources

As described in Chapter 2, the SPR Action Alternatives address multiple components of coal mining operations. Table 4.2.1-1 summarizes how specific SPR elements affect water resources relative to the No Action Alternative (Alternative 1). The comparison of each Action Alternative to the No Action Alternative determines whether and to what extent the Action Alternative creates beneficial or adverse effects on water resources. In general, the Action Alternatives have the potential to impact water resources in one or more of the following ways:

- Reduce the miles of filled streams;
- Increase the number of mined-through ephemeral streams that are restored;
- Improve stream water quality and stream flow;
- Improve the quality and quantity of groundwater; and
- Improve quality of interconnected surface waters within the watershed (i.e., lakes, ponds, wetlands).

For each SPR element, Table 4.2.1-1 describes: how the requirements for that element vary by Alternative; the anticipated effect on water resources; and the rationale behind the anticipated water resource impacts.

Alternative 9 considers a scenario in which the 2008 Stream Buffer Zone rule is repromulgated and fully implemented across the timeframe of this analysis. Engineering analysis of current coal industry practices finds that, during the period that the 2008 Stream Buffer Zone rule was in place, the permits issued in Appalachia changed in response to USACE, EPA, and state policies that are similar to the No Action Alternative. As a result, Alternative 9 is anticipated to have Negligible effects on water resources.

Table 4.2.1-1
Stream Protection Rule Elements and Projected Effects on Water Resources

SPR Element	Treatment in Action Alternatives[1]	Primary Effects on Water Resources in Comparison to the No Action Alternative	Explanation
Baseline Data Collection and Analysis	• Alternatives 2, 3, 4, 5, and 8 (Preferred) require expanded data collection and analysis. • Alternative 2 requires greater monitoring frequency of stream flow, groundwater levels, and rainfall using continuous recording devices. • Alternatives 6 and 7 are similar to Alternative 2 with respect to baseline data collection. • Alternatives 5, 6, and 7 are limited to specific scenarios. • Alternative 9 is the same as the No Action Alternative.	• Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Additional baseline characterization of surface water and groundwater provide a better understanding of the premining hydrologic regime by 1) improving the probable hydrologic consequences determination and the cumulative hydrologic impact assessment; 2) gaining a better understanding of the premining hydrology which allows the regulatory authority to determine whether the mine plans are designed in accordance with the regulatory program and later assessing whether mining and reclamation operations are being conducted in accordance with the plans approved in the permit.
Monitoring During Mining and Reclamation	• Alternatives 2, 3, 4, 5, and 8 (Preferred) require expanded data collection and analysis. • Alternative 2 requires greater monitoring frequency of stream flow, groundwater levels, and rainfall using continuous recording devices. • Alternatives 6 and 7 are similar to Alternative 2 with respect to monitoring. • Alternatives 5, 6, and 7 are limited to specific scenarios. • Alternative 9 is the same as the No Action Alternative.	• Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Additional monitoring of the surface water and groundwater quantity and quality during mining and reclamation operations allows operators to detect adverse impacts more readily before they cause material damage to the hydrologic balance outside the permit area, and allows the regulatory authority to determine whether mine operators are conducting mining and reclamation operations in accordance with the plans approved in the permit.
Definition of Material Damage to the Hydrologic Balance	• Alternatives 2, 3, 4, and 8 (Preferred) include a definition of material damage to the hydrologic balance outside the permit area. • Alternatives 5, 6, 7, and 9 are the same as the No Action Alternative. • Alternative 7 requires the regulatory authority to determine material damage to the hydrologic balance outside	• Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Establishing a definition for material damage to the hydrologic balance outside the permit area should improve protection of perennial and intermittent streams and groundwater outside the permit area and provide an early warning system to prevent adverse impacts from developing to the point that they cause material damage to the hydrologic balance outside the permit area.

SPR Element	Treatment in Action Alternatives[1]	Primary Effects on Water Resources in Comparison to the No Action Alternative	Explanation
	the permit area under enhanced permitting conditions.		
Corrective Action Thresholds	• Alternatives 2, 3, 4, and 7 require corrective action thresholds. • Alternatives 5, 6, 8 (Preferred), and 9 are same as the No Action Alternative. • Alternative 7 is limited to specific scenarios.	• Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Establishing corrective action thresholds should improve protection of surface water and groundwater outside the permit area, while providing an objective early warning system that could prevent adverse impacts from developing to the point that they cause material damage to the hydrologic balance outside the permit area.
Activities In or Near Streams, Including Excess Spoil and Coal Refuse	• All Action Alternatives require changes to fill placement and design to varying degrees. • Alternative 9 is not expected to lead to changes in mining operations.	• Reduction in miles of filled streams • Improved stream-water and groundwater quality	• Limiting activities in or near intermittent and perennial streams should minimize the number and length of intermittent and perennial stream segments disturbed by mining, clarify that the regulatory authority can prohibit adverse impacts to perennial and intermittent stream segments of high environmental value, and ensure that operations promote enhancement of fish, wildlife, and related environmental values wherever and whenever practicable.
Mining through Streams	• All Action Alternatives (excluding Alternative 9) require restoration of hydrologic form and ecological function for intermittent and perennial streams and hydrologic form for ephemeral streams that are mined-through.[2] • Alternative 9 is not expected to lead to changes in mining operations.	• Additional stream restoration • Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Increase in miles of intermittent and perennial streams with restored hydrologic form and ecological function and increase in miles of ephemeral streams restored to hydrologic form after being mined through.
Approximate Original Contour (AOC) Variances	• Alternative 2 prohibits AOC variances • Alternatives 3, 4, 5, and 8 (Preferred) require that the permittee demonstrate that watershed would be improved by the mining when compared with the condition of the watershed before mining *and* with its condition if the AOC were to be restored. • Alternatives 3, 4, and 5 prohibit approval of an AOC variance if it would result in placement of excess spoil in intermittent and perennial streams. • Alternatives 6, 7, and 9 are unchanged from the No Action Alternative.	• Reduction in streams filled • Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Specific requirements for AOC restoration should result in a surface configuration that resembles and functions like the premining landforms, with convex and concave patterns, and ephemeral channels. When appropriate, it should include the creation of aquitards that would facilitate the re-creation of perennial and intermittent streams. • Reduce the number and length of intermittent and perennial streams reaches filled with excess spoil.
Surface Configuration and Fills	• All Alternatives except Alternatives 6 and 9 require changes to surface configuration and fills to varying degrees. • Alternatives 6 and 9 are	• Reduction in streams filled • Improved stream-water and groundwater	• These specific requirements should more completely implement the statutory requirement that the surface configuration of the reclaimed area closely resemble the general surface configuration of the land prior to mining, so that the reclaimed land functions

SPR Element	Treatment in Action Alternatives[1]	Primary Effects on Water Resources in Comparison to the No Action Alternative	Explanation
	unchanged from the No Action Alternative.	quality	as it did before mining and does not discharge substances that cause material damage to the hydrologic balance outside the permit area. • Changes in fill practices are designed to reduce the miles of filled streams.
Revegetation, Topsoil Management, and Reforestation	• All Action Alternatives except Alternatives 6 and 9 require changes to revegetation, topsoil management, and reforestation. • Alternatives 6 and 9 are unchanged from the No Action Alternative.	• Improved stream-water and groundwater quality • Preserve stream flow and groundwater quantity	• Improved revegetation and increased reforestation requirements improve the ability of the landscape to filter contaminants from runoff as water travels across the landscape to receiving surface waters.
Fish and Wildlife Protection and Enhancement	• All Action Alternatives, except Alternative 9, require varying protections of riparian corridors and fish and wildlife.	• Improved stream water quality	• Improved ability of the landscape to filter contaminants from runoff as water travels across the landscape to receiving streams because of the enhanced riparian corridors. Improved stream water quality and more abundant riparian areas would improve habitat and contribute to survival and abundance of fish and wildlife.

Notes:

[1] Chapter 2 includes a more complete description of the specific differences in rule elements across the No Action and Action Alternatives. Key points include the following: Alternative 5 applies only to operations that dispose of excess spoil or coal mine waste; Alternative 6 applies only to operations within 100 feet of intermittent or perennial streams; Alternative 7 applies only to operations where conditions warrant enhanced permitting requirements.

[2] While the Action Alternatives additionally specify that mined-through intermittent and perennial streams be restored to form and function, this is also required under the No Action Alternative due to Clean Water Act requirements. This analysis accordingly does not assume restoration of intermittent and perennial streams as a benefit of the Action Alternatives.

Only the rule elements shown in Table 4.2.1-1 are anticipated to affect water resources. For additional rule elements (e.g., stream restoration practices for intermittent and perennial streams and requirements for stream enhancement), the engineering analysis described in Section 4.1 did not identify measurable differences in the expected behavior at mining operations under the Action Alternatives as compared to the No Action Alternative. That is, the engineering analysis found that these rule elements were met with mining practices required in the No Action Alternative under the CWA.

Some of the rule elements in Table 4.2.1-1 have indirect implications for surface water and groundwater quality that may not be readily apparent. For example, Action Alternatives that require expanded baseline monitoring will help authorities assess the premining quality of water resources and better isolate the effect of individual mining operations. Expanded monitoring programs will also incorporate new pollutants and water quality indicators not previously tracked. For instance, Alternative 2 requires more frequent monitoring, which may increase the likelihood that water quality problems are detected early, when more effective and less costly corrective measures are possible. Finally, improved monitoring may enhance the ability to manage ground and surface water interactions. For instance, increased groundwater monitoring may signal changes in groundwater levels, allowing appropriate action to decrease the risk of dewatering the aquifer, and avoiding reduced baseflow to surface waters. Although these types of impacts are indirect and site-specific, they have the potential to provide additional impacts to the more readily quantifiable impacts of elements such as riparian buffers.

The remainder of this section accordingly focuses on the expected improvements to water resources described in Table 4.2.1-1.

Reduce Miles of Filled Streams

The Action Alternatives have the potential to reduce the miles of filled streams from surface and underground mining activities. Table 4.2.1-2 identifies the rule elements that relate to stream miles filled relative to the No Action Alternative. In general, the Action Alternatives restrict fill amounts or the type of fills allowed to varying degrees. All the Action Alternatives require the minimization of excess spoil volume and except for Alternative 9, the Action Alternatives prohibit end-dumping techniques in constructing durable rock fills. Alternative 2, 4, 5, 6, 7, and 8 (Preferred) prohibit flat decks on top of excess spoil fills, which are allowed under the No Action Alternative and Alternatives 3 and 9. Alternative 2 prohibits fills within 100 feet of intermittent and perennial streams. The other Action Alternatives impose differing restrictions on fills in these areas.

Table 4.2.1-2
Action Alternatives with Elements that Related to Miles of Filled Streams

Alternative	Contains Proposed Limitation On Activities in or Near Streams	Contains Proposed Requirements for Excess Spoil or Fills
2	●	●
3	●	●
4	●	●
5	●	●
6	●	●
7	●	●
8 (Preferred)	●	●
9	●	●

Improve Stream Water Quality

The Action Alternatives (excluding Alternative 9) are expected to generate improvements to downstream water quality as compared to the No Action Alternative. The primary rule elements expected to generate improvements in downstream water quality for each Action Alternative are identified in Table 4.2.1-3. In general, Alternatives 2, 3, and 4 provide similar protections to downstream water quality by increasing the amount of monitoring required, defining material damage to the hydrologic balance, and establishing corrective action thresholds to determine when preventative actions are required to avoid material damage to the hydrologic balance. Increased monitoring provides better information for early identification of potential water quality impacts. Alternative 2 requires more frequent monitoring than the other Action Alternatives, possibly allowing earlier detection of water quality degradation.[14] Defining material damage to the hydrologic balance and establishing corrective action thresholds to determine when preventative actions are required to avoid material damage to the hydrologic balance sets protective limits on downstream water quality and a mechanism for correcting problems before damage has occurred, improving downstream water quality. Alternative 7 includes no standard material damage to the hydrologic balance definition but defines material damage to the hydrologic balance on a permit-specific basis. Alternative 8 (Preferred) includes similar provisions as 2, 3, and 4, but does not include a corrective action threshold.

Riparian buffers would also benefit stream water quality as riparian vegetation decreases flow velocity, limiting the mobility of sediment to receiving surface water bodies. Recent studies have documented the effectiveness of riparian buffers in reducing water quality impacts from coal mining (Willard et al., 2013). The Alternatives differ with respect to the size of the riparian buffers prescribed and the type of streams where riparian corridors are required. Specifically, Alternatives 2, 5, 6, 7, and 8 (Preferred) specify a 100-foot riparian buffer for all streams, whereas Alternatives 3 and 4 specify a greater riparian corridor (300 feet) for a narrower set of streams (just intermittent and perennial, but not ephemeral). The wider stream corridor under Alternatives 3 and 4 would provide increased protection against sediment and chemical runoff to streams, but ephemeral streams would have no buffer-based protections.

Additionally, for approximate original contour (AOC) exceptions for mountaintop removal operations, Alternatives 3, 4, and 5 (Alternative 5 only applies to operations that dispose of excess spoil or coal mine waste) would generate improvements to surface-water quality by requiring a demonstration of (1) no damage to natural watercourses within the proposed permit and adjacent areas; (2) no increase in parameters of concern in discharges to surface water or ground water; (3) no change in size or frequency of peak flow as compared to what would occur if the operator returned the site to AOC; and (4) no variance in total flow volume during any season of the year. Similarly, for steep-slope operations, these Alternatives require demonstration that AOC variances would improve surface water flow and limit aquatic ecological impacts. Alternative 2 prohibits all variances from the requirements to return the mined area to its AOC. This should ensure that postmine surface configuration always resembles and functions like the premining landforms, with convex and concave patterns, and ephemeral channels, reducing stream fills, improving stream-water and groundwater quality, and preserving streamflow and groundwater-flow quantity.

[14] Peer reviewers noted that increased monitoring may not translate directly into better environmental protection if regulatory authorities are not sufficiently staffed to handle the added data review workload. Reviewers noted that some kinds of pollution (e.g., storm-related runoff events) that could be missed by monitoring are better addressed preventatively, i.e., through carefully prepared and implemented reclamation plans. Communication from Jack Nawrot, "OSMRE Proposed Stream Rules: Comments – Water and Biological Resources."

Alternatives 5, 6, and 7 do not require all of the elements described above and apply to fewer mining operations. Alternative 5 applies to limited areas of steep-slope mining with excess spoils and does not contain either a definition of “material damage to the hydrologic balance outside the permit area” or corrective action thresholds. Alternative 7 applies only when enhanced permitting conditions exist, as described in Chapter 2, and does not contain either a definition of “material damage to the hydrologic balance outside the permit area” or additional surface-water protections for AOC exceptions. Alternative 6 provisions apply only to activities inside stream buffer zones, does not contain a definition of “material damage to the hydrologic balance outside the permit area,” corrective action thresholds or additional surface water protections for AOC exceptions. Consequently, these three Action Alternatives provide a lesser benefit to downstream water quality than Alternatives 2, 3, 4, and 8 (Preferred).

Table 4.2.1-3
Elements Benefiting Downstream Water Quality

Alternative	Additional Monitoring	Definition of Material Damage to the Hydrologic Balance	Corrective Action Thresholds	100-Foot Riparian Buffer for E/I/P Streams	300-Foot Riparian Buffer for I/P Streams	Additional Surface Water Protections in Issuing AOC Variances
2	●	●	●	●		(prohibits AOC variances)
3	●	●	●		●	●
4	●	●	●		●	●
5	●			●		●
6	●			●		
7	●		●	●		
8 (Preferred)	●	●		●		●
9						

Other rule elements may contribute indirectly to improvements in downstream water quality by reducing negative effects of mining activities on water resources on the mine site. These include reduced stream filling on mine sites and improved postmining reforestation and revegetation practices. For example, Alternatives 2 through 8 (Preferred) reduce filling of streams from surface mines. In addition, all Action Alternatives, except Alternative 6 and 9, improve revegetation, topsoil management, and reforestation practices, changes which benefit water quality through reduced sedimentation.

While not attributable to a particular element, the Action Alternatives (excluding Alternative 9) would collectively yield slight changes in the amount of coal produced in particular coal regions, as described in Section 4.1. Decreases in coal production in a given region would reduce the effects of coal mining on downstream water quality.[15] The impacts of reduced mining activity would span all the various processes through which coal mining affects water quality, including transport of sediment and minerals, alteration of topography and stream flow, and other processes described earlier in this section. In addition, some Alternatives can lead to a reduction in the size of the disturbed area in surface mines, further preserving water quality in the relevant regions. The quantitative analysis discussed later in this section estimates the miles of streams where water quality is preserved (i.e., adverse effects avoided) due to the reduction in intensity of coal mining activity under each Alternative.

Improve Groundwater Quality and Quantity

The Action Alternatives (excluding Alternative 9) would generate improvements to groundwater quality and/or quantity as compared to the No Action Alternative, albeit to different degrees. The relevant rule elements of each Action Alternative are identified in Table 4.2.1-4.

In general, Alternatives 2, 3, and 4 would provide similar protections to groundwater quality and quantity by: (1) increasing monitoring requirements in order to detect material damage to the hydrologic balance; (2) requiring a definition of when material damage to the hydrologic balance occurs; and (3) establishing corrective action thresholds to determine when preventative actions are required to avoid material damage to the hydrologic balance. Alternative 8 (Preferred) includes similar provisions as 2, 3, and 4 but does not include a corrective action threshold. Alternative 7 includes no standard material damage to the hydrologic balance definition, but defines material damage to the hydrologic balance on a case-by-case basis whenever enhanced permitting conditions (e.g., the presence of unique hydrologic environments) exist. Alternatives 5 and 6 require additional monitoring but do not require a definition of material damage to the hydrologic balance or establish corrective action thresholds. As a result, Alternatives 5, 6, and 7 present less potential for alerting regulators to emerging groundwater problems and contain less clear standards for restoring groundwater quality.

Additionally, Alternatives 3, 4, 5, and 8 (Preferred) would improve groundwater quality through AOC variance conditions. Specifically, for AOC variances for mountaintop removal operations, Alternatives 3, 4, 5, and 8 (Preferred) would require a demonstration of no increase in parameters of concern in discharges to groundwater. Alternative 2 disallows AOC variances altogether. As a result of more frequent monitoring and the ban on AOC variances, Alternative 2 is anticipated to generate the greatest improvements to groundwater.

Alternatives 5, 6, and 7 would not include blanket provisions for material damage to the hydrologic balance definition and corrective action thresholds, but would pertain to a more specialized segment of mining activity: Alternative 5 applies only to operations that dispose of excess spoil or coal mine waste; Alternative 6 applies only to operations within 100 feet of intermittent or perennial streams; Alternative 7 applies only to operations where conditions warrant enhanced permitting requirements (e.g., steep slope areas, riparian areas). These Action Alternatives, therefore, would provide a lesser benefit to groundwater than Alternatives 2, 3, and 4 because of more limited application and fewer concrete standards against which to judge

[15] Note that reduced mining impacts resulting from decreased coal production are realized only during the study period of this analysis. Ultimately, market forces will lead to the extraction of all minable coal resources, even if new environmental requirements are imposed.

compliance with permit conditions. Alternative 9 has provisions similar to the No Action Alternative, so it would likely provide no incremental benefit to groundwater.

Table 4.2.1-4
Elements Benefitting Groundwater Quality or Quantity

Alternative	Additional Monitoring	Definition of Material Damage to the Hydrologic Balance	Corrective Action Thresholds	Additional Groundwater Quality Protections in AOC Variances
2	●	●	●	(prohibits AOC variances)
3	●	●	●	●
4	●	●	●	●
5	●			●
6	●			
7	●		●	
8 (Preferred)	●	●		●
9				

Other rule elements may also contribute indirectly to improvements in or preservation of groundwater quality or quantity by reducing negative effects of mining activities on water resources on the mine site. These include elements that reduce filling of streams on the mine site and improve postmining reforestation and revegetation practices. These practices may improve surface water quality and hence improve the quality of groundwater recharge supplies.

<u>Improve Quality of Interconnected Surface Waters within the Watershed</u>

Water quality in receiving water bodies, such as lakes, ponds, and wetlands, is expected to vary in a manner consistent with changes in connected water resources. For instance, if a stream experiences improved water quality, the pond into which it feeds may experience improved water quality (all else equal). The magnitude of the improvement is uncertain as it depends on many other factors, such as the size of the pond, the rate of inflow and outflow, and other factors.

4.2.1.3 Analytic Methods for Surface Water Resources

This section describes the methods used to characterize the impact of the Action Alternatives on surface water resources. Overall, the approach involves quantifying the linear extent of streams (measured in stream miles) affected within each region under each Action Alternative. The quantified factors include:

- Reduction in streams filled;
- Increased restoration of ephemeral streams that are mined through;

- Stream miles downstream of mine sites experiencing improved water quality; and
- Stream miles that are preserved from adverse effects of mining.

Table 4.2.1-5 describes the steps involved for each of these quantified factors, and the subsequent text describes the methods in greater detail.

Reduction in Miles of Streams Filled and Increased Restoration of Ephemeral Streams

As described in Table 4.2.1-5, the method to quantify the reduction in stream miles filled and in ephemeral stream miles restored is a direct extrapolation from the model mine analysis described in Section 4.1. That is, the model mine analysis determines how mines in each coal region would implement the Action Alternatives, and how these practices would affect stream fill and stream restoration. To quantify the broader, national benefits of the Action Alternatives, the analysis translates the reduction in streams filled and the increase in stream miles restored into an average change in impacts per ton of coal produced for the modeled "typical" mines in each region. Then the analysis applies this multiplier to the estimated production (tons of coal produced) in each region under each Alternative.

Table 4.2.1-5
Methods for Quantification of Benefits to Water Resources

Step	Reductions in Miles of Streams Filled	Additional Miles of Ephemeral Streams Restored	Stream Miles Downstream of Mine Sites Experiencing Improved Water Quality	Stream Miles Downstream of Mine Sites that are Preserved from Adverse Effects of Mining
1	For each Alternative, including No Action, determine number of stream miles filled by region based on conditions at the "typical mine"	For each Alternative, including No Action, determine number of ephemeral stream miles restored by region based on conditions at the "typical mine"	Based on scientific literature, determine how far downstream of a mine site negative effects of coal mining persist. Limited data require use of a national average rather than mine-specific figures.	Determine how far downstream of a mine site negative effects of coal mining persist, on average
2	For each Alternative, convert to impact per million tons of coal produced by region/mine type, i.e., divide "typical mine" miles of streams filled by total "typical mine" coal production	For each Alternative, convert to impact per million tons of coal produced by region/mine type, i.e., divide "typical mine" miles of ephemeral streams restored by total "typical mine" coal production	Analyze, by region and mine type (i.e., surface versus underground), the number of streams that flow off of a mine site, on average	Analyze, by region and mine type (i.e., surface versus underground), the number of streams that flow off of a mine site, on average
3	For each Alternative, multiply the figure on stream miles filled per million tons (Step 2) by total regional coal production in each year of analysis	For each Alternative, multiply the figure on stream miles restored per million tons (Step 2) by total regional coal production in each year of analysis	Multiply the number of streams crossing the mines (Step 2) by the average extent of downstream water quality effects (Step 1) to estimate the "typical mine" downstream miles affected	Multiply the number of streams crossing the mines (Step 2) by the average extent of downstream water quality effects (Step 1) to estimate the "typical mine" downstream miles affected
4	For each Alternative, sum miles of stream filled across the 21year time frame	For each Alternative, sum miles of ephemeral streams restored across the 21 year time frame	For each Alternative, convert to impact per million tons of coal produced by region/mine type, i.e., divide "typical mine" downstream miles affected by total "typical mine" coal production	For each Alternative, convert to impact per million tons of coal produced by region/mine type, i.e., divide "typical mine" downstream miles affected by total "typical mine" coal production
5	For each Alternative, estimate average annual stream miles filled, i.e., divide total stream miles filled by years in study period	For each Alternative, estimate average annual ephemeral stream miles restored, i.e., divide total ephemeral stream miles restored by years in study period	For each Alternative, multiply the downstream miles affected per million tons by the expected coal production for the relevant mine type/region for each year in the study period	For each Alternative, multiply the downstream miles affected per million tons by the expected coal production for the relevant mine type/region for each year in the study period

Step	Reductions in Miles of Streams Filled	Additional Miles of Ephemeral Streams Restored	Stream Miles Downstream of Mine Sites Experiencing Improved Water Quality	Stream Miles Downstream of Mine Sites that are Preserved from Adverse Effects of Mining
6	Estimate benefit of Action Alternatives by subtracting Action Alternative annual average miles from No Action Alternative annual average miles	Estimate benefit of Action Alternatives by subtracting No Action Alternative annual average from Action Alternative annual average	For each Alternative, sum downstream miles affected across the study period	For each Alternative, sum downstream miles affected across the study period
7			For each Alternative, estimate average annual downstream miles affected by dividing total downstream miles affected (Step 6) by years in study period	For each Alternative, estimate average annual downstream miles affected by dividing total downstream miles affected (Step 6) by years in study period
8			For each Action Alternative, total downstream miles improved is equal to the downstream miles affected (i.e., water quality in these streams is improved as compared to the No Action Alternative)	Estimate benefit of Action Alternatives by subtracting Action Alternative annual average miles from No Action Alternative annual average miles

Stream Miles Downstream of Mine Sites Experiencing Water Quality Improvements

The analysis uses the following method to estimate the number of improved stream miles downstream of mine sites. First, the analysis incorporates findings from the scientific literature to estimate how far downstream of a mine site negative effects of coal mining persist. The scientific literature addressing effects of coal mining on water resources primarily focuses on how coal mining affects stream water quality, as summarized in Table 4.2.1-6.

The history and extent of mining in the Appalachian Basin makes it the subject in the majority of the water quality studies (e.g., Lindberg et al., 2011, Merriam et al., 2011, Petty et al., 2010, Pond et al., 2008, Fulk et al., 2003). In general, these studies describe coal mining's effects on stream quality but do not specify the particular aspect of mine operations that generates the adverse effects. As such, the studies do not support an explicit analysis of the SPR elements' impact on downstream water quality.

Table 4.2.1-6
Selected Scientific Literature Regarding the Effects of Coal Mining on Water Quality

Study Authors and Title	Conference/ Publication	Study Location	Study Subject
Fulk et al., 2003. Ecological assessment of streams in the coal mining region of West Virginia using data collected by the U.S. EPA and environmental consulting firms[1]	Mountaintop Mining/Valley Fills in Appalachia Final Programmatic Environmental Impact Statement	Five watersheds: Mud River, Spruce Fork, Clear Fork, Twentymile Creek, & Island Creek Watersheds	Analysis of water quality and biota metrics in watersheds rated as unmined, mined, filled, and filled/residential
Lindberg et al., 2011. Cumulative impacts of mountaintop mining on an Appalachian watershed	Proceedings of the National Academy of Sciences Early Edition	Upper Mud River, southwest West Virginia	Analysis of areal extent of mining in watersheds and use of physical water quality metrics, including conductivity, and concentrations of sulfate, selenium, and magnesium; assessed these metrics upstream and downstream of mine sites, as well as in reference streams
Merriam et al., 2011. Additive effects of mining and residential development on stream conditions in a Central Appalachian watershed	Journal of North American Benthological Society	Pigeon Creek watershed, southern West Virginia	Analysis of mining intensity in a watershed and correlation with metrics of stream health, including EPT richness
Petty et al., 2010. Landscape indicators and thresholds of stream ecological impairment in an intensively mined Appalachian watershed	Journal of North American Benthological Society	Lower Cheat River basiorthern West Virginia	Analysis of mining intensity in a watershed and correlation with metrics of stream health, including EPT richness
Pond et al., 2008. Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools	Journal of North American Benthological Society	37 small West Virginia streams	Analysis of mining effects judged by specific conductance correlated with four measures of biological health, including Ephemeroptera richness, but not EPT richness

Note: 1. Not published in the peer reviewed literature.

While a review of the available literature identified many analyses of coal mining's impact on water quality, only one study identified the geographic extent of the adverse effects of mining on downstream water quality. Specifically, Petty et al. (2010) estimates that the downstream effects of mining extend approximately 6.2 miles from the mine site. The Petty et al. (2010) research includes stream sampling from both underground and surface mining and includes both pre- and post-SMCRA mining activities in the Appalachian coal region. Although the Petty et al. (2010) study represents the best available information with respect to the geographic scope of adverse water quality impacts of mining, the inclusion of pre-SMCRA mining activity in the stream sampling may lead to an overestimate of the adverse impacts associated with the No Action Alternative. In the absence of additional studies estimating the geographic extent of downstream effects from mining in other coal regions, this analysis applies findings from Appalachia to other regions. Extent of downstream effects may be influenced, however, by a variety of site-specific factors that may vary considerably across regions and even within regions, such as mine density, topography, and precipitation. Consequently, it is difficult to determine if this analysis over- or underestimates affected stream length in other regions or at any given mine site. Lacking site-specific information on the extent of downstream water quality effects of mines, this analysis assumes, on average, that adverse effects of mining on water quality persist 6.2 miles downstream of mines for streams that cross the disturbed area of a mine site.

In the second step, the analysis estimates the average number of streams that flow off of a mine site by region and mine type (i.e., surface versus underground). This step employs geographic information system (GIS) data identifying locations of historical mines in each region by mine type.[16] As the GIS data are only points identifying locations of historical mines, the analysis estimates the size of each mine site relying on the size of the "disturbed area" for typical mines, as described in Section 4.1. After mapping the location and size of historical surface and underground mines in each region, the analysis references the USGS's high resolution National Hydrography Dataset to estimate the average number of streams flowing off of surface and underground mines in each region.[17]

For these historical surface mines, between one and seven streams cross each mine site, and the average varies by region. An average of one stream flows through the surface portion of underground mines (consistent with the structure of coal preparation facilities at underground mines). Table 4.2.1-7 presents the results of the GIS analysis quantifying number of streams crossing mine sites.

[16] GIS data on historic mines collected from National Mine Map Repository provided by OSMRE on June 5, 2013; U.S. Plants and Impoundments Point Shapefile, provided by Morgan Worldwide Consultants, Inc. on July 26, 2013; Arkansas Department of Environmental Quality, Facility and Permit Summary. http://www.adeq.state.ar.us/home/pdssql/pds.aspx; Colorado Division of Reclamation Mining and Safety. Department of Natural Resources, GIS Data. http://mining.state.co.us/Reports/Pages/GISData.aspx; Illinois State Geological Survey, Coal Maps and Data https://www.isgs.illinois.edu/research/coal/maps; Indiana Geological Survey, Coal Mine Information System. http://igs.indiana.edu/CMIS/Downloads.cfm; and Railroad Commission of Texas, Surface Mining and Reclamation Division. Active Coal Mines. http://www.rrc.state.tx.us/about-us/organization-activities/divisions-of-the-rrc/surface-mining-reclamation-division/

[17] To estimate the average number of streams flowing off of the mine site, this analysis counts the number of times perennial and intermittent streams intersect the mine site and divides this by two. This method assumes that each stream crosses the mine site once upstream of the mine and once downstream of the mine. Ephemeral streams are not included in the calculations. The analysis uses USGS classifications to differentiate streams.

Table 4.2.1-7
Results of GIS Analysis of Stream Crossings at Mine Sites

Region/Mine Type	Estimated Number of Streams Crossing Mine Site
Central Appalachia - Surface	3.1[1]
Northern Appalachia - Surface	1.3
Colorado Plateau - Surface	3[2]
Gulf Coast - Surface	4.3
Illinois Basin - Surface	3.4
Northern Rocky Mountains - Surface	7.2
Western Interior - Surface	3.3
Northwest - Surface	5[3]
Underground Mines (All Regions)	1

Notes:

[1] The number of stream crossings in the Central Appalachian surface mine under Alternative 2 is 2.7. This figure is different for Alternative 2 than for the other Alternatives because under Alternative 2, Central Appalachia Surface mines haul excess spoil off-site; fills are not constructed due to the prohibition on spoil placement in perennial and intermittent streams. As such, the model mine disturbed areas for these mines are smaller in Alternative 2 than all other Alternatives; accordingly, the number of stream crossings is lower.

[2] The Colorado Plateau surface mine figure is the average of the number of streams leaving the mine site from the one surface mine site in the GIS database for the Colorado Plateau and the Colorado Plateau surface mine site in the engineering analysis.

[3] The Northwest surface mine figure is the number of streams leaving the Northwest surface mine site in the engineering analysis as there are no sites that meet the criteria for the GIS analysis.

The third step of the analysis multiplies the average number of streams crossing the mines by the average spatial extent of downstream water quality effects (6.2 miles) to estimate the total number of downstream stream miles affected by coal mining for each Alternative and each region/mine type combination.

Note that the estimate of total downstream stream miles affected at a given mine implicitly assumes no downstream convergence. This assumption allows for a comparison across regions that reflects the stream density of different regions. However, it is likely that for some mines, streams crossing the mine sites ultimately converge. In such cases, the total number of stream miles experiencing improved water quality may be overestimated. On the other hand, the extent of the water quality improvement may be greater downstream of the convergence of two improved streams.

In the fourth step, the analysis divides the total downstream miles affected by coal mining activity by the estimated coal production at each "typical mine," as described in Section 4.1. This calculation yields an estimate of average miles of stream water quality affected per million tons of coal produced under each Alternative.

The next steps of the analysis yield an estimate of the total extent of water quality effects over the study period. The analysis multiplies the estimated per-million-ton downstream effects of the regional "typical mines" by the regional forecasted production over the study period (Steps 5 and 6). Dividing the total miles of downstream water quality affected over the study period by the number of years of analysis (21) yields an average annual downstream water quality impact in miles (Step 7).

The analysis calculates these results for each region, mine type, and Alternative. As each of the Action Alternatives (excluding Alternative 9) improves the management of mining operations to mitigate effects on water quality, the stream reaches downstream of the mine sites would experience some amount of improvement in water quality as compared to the No Action Alternative. While data are not available to determine whether the Action Alternatives would reduce the number of downstream miles adversely affected by mining, implementing the Action Alternatives (excluding Alternative 9) would at least reduce the level of adverse effect within the 6.2-mile downstream areas. Improvement in water quality does not mean that a stream affected by mining operations is completely unaffected; rather, improvement is considered an incremental betterment of water quality due to the Action Alternative.

As an example, results for the Appalachian Surface Contour Mine for Alternative 2 are presented in Table 4.2.1-8. Other Alternatives are calculated in the same manner.

Table 4.2.1-8
Calculations for Downstream Improved Stream Miles for the Central Appalachian Surface Contour Mine, Alternative 2

Step	Category	Inputs	Results
1	Average Number of Streams that Flow Off of Model Mine Site	See Table 4.2.1-7	Average of 2.7 streams flowing off of the mine site.
2	Per Million Ton Estimate of Downstream Improved Stream Miles	2.7 streams * 6.2 miles of affected downstream length / 5 million tons of forecasted production over the study period at the representative Central Appalachia Surface Contour Mine	3.35 stream miles per million tons
3	Annual Regional Downstream Improved Stream Miles	3.35 stream miles per million tons * 518 million tons mined in the study period / 21 years in study period	82 downstream improved stream miles per year in study period

<u>Stream Miles Downstream of Mine Sites Preserved from Adverse Effects of Mining</u>

This analysis estimates the downstream miles for which adverse effects are avoided. For each Action Alternative, the difference between the length of downstream affected stream miles in the No Action Alternative minus miles estimated for the Action Alternative represents miles preserved. The No Action Alternative calculation follows the same steps as the Action Alternatives, except the results are for stream miles affected, not stream miles improved. In cases where production increases for a particular region and mine type, the downstream stream miles preserved can be negative, reflecting an increase in downstream stream miles affected by mining. Aggregated across mine types, however, no net increase in downstream miles occurs.

4.2.1.4 Results of Quantitative Analysis of Surface Water Impacts

Streams

The results of the quantitative analysis are presented in Tables 4.2.1-9 through 4.2.1-12. Discussion of the results follows.

- **Reductions in streams filled:** The quantified reduction in the miles of filled streams varies across regions and Action Alternatives (Table 4.2.1-9). The Appalachian Basin is the only region where excess spoil fills are common, making it the only region where a change in stream filling practices is anticipated.[18] Reduced fill benefits of the Action Alternatives (other than Alternative 9, which does not have these benefits) on surface mining are accordingly limited to this region.
- **Increase in ephemeral stream restoration:** Ephemeral stream restoration also varies by region and Action Alternative (Table 4.2.1-10). As more ephemeral streams occur in the Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains regions, the benefits of ephemeral stream restoration requirements are concentrated in these regions. Alternative 5 applies specifically to steep slope mining areas (primarily, the Appalachian region), where there are generally fewer ephemeral streams than in the more westerly regions. Currently, many of these ephemeral streams are already restored due to CWA section 404 requirements. As such, benefits to ephemeral stream restoration are negligible under this Alternative.
- **Downstream miles experiencing improved water quality:** The majority of improved stream miles occur in Appalachia, as small mine size and high stream density leads to high per-ton effects on downstream stream miles (Table 4.2.1-11). The level of improvement varies across the Action Alternatives in a manner consistent with the stringency of the requirements. Rule elements related to monitoring and the definition of material damage to the hydrologic balance may improve water quality at surface mine sites, as would changes in mine site practices related to stream restoration and fills. The engineering analysis found that direct stream impacts from underground mines were temporary; therefore, downstream improved miles from underground mines are not quantified. However, rule elements related to monitoring and the definition of material damage to the hydrologic balance may improve water quality at underground mine sites.
- **Downstream miles preserved:** The length of downstream miles preserved varies across Action Alternatives primarily due to changes in coal production (see Section 4.1) expected as a result of the Action Alternatives (Table 4.2.1-12). The production changes generally influence between one and two percent of total affected downstream miles. Only in Alternative 2 does a production change result in a significant change in preserved miles. The vast majority of preserved stream miles occur in Appalachia, the region

[18] Illinois Basin ephemeral streams are sometimes used in the construction of sediment basins or slurry impoundments.

anticipated to experience the greatest reduction in surface coal mining activity under the Action Alternatives.

Interpretation of the incremental impacts of the rule and Alternatives on stream fill, miles of mined through streams, and downstream stream degradation, would benefit from contextual information that describes impacts on streams from coal mining under the No Action Alternative. For instance, estimates of the total number of stream miles that are mined through, filled, and impaired annually by coal mining under current regulatory conditions would be helpful. While comprehensive contextual information is not generally available, the following studies and analytic observations provide some context:

- **Stream fills.** With respect to stream miles not filled (Table 4.2.1-9), five studies provide some context:
    - Shank (2010) and Shank and Gebrelibanos (2013) use GIS analysis to compile data on refuse fill in West Virginia between 1984 and 2012, and estimate linear stream loss due to fill construction over time. The more recent study estimates that 766 miles of perennial and intermittent streams were filled during the study period (1984 to 2012, which equates to 28 miles per year on average). It also shows a marked decrease in fill construction starting in approximately 2003. In 2012, stream miles filled decreased to approximately 18 miles in West Virginia for that year.
    - The 2005 Mountaintop Mining EIS (U.S. EPA, 2005) included two studies that estimate the effect of mountaintop mining and valley fills in West Virginia, Kentucky, Tennessee, and Virginia. This first study estimated that between 1985 and 2001, 724 stream miles (1.2 percent of streams) were covered by valley fills (equating to 45 miles per year). This study , known as the fill inventory, includes a variety of information regarding valley fills constructed from 1985 to 2001, including the feet of stream under valley fill footprints. This study measured streams based on a synthetic stream network defined on a 30-acre watershed accumulation threshold over the National Elevation Dataset (NED). The NED for each state was processed to enforce hydrologic integrity. A flow accumulation grid was prepared and queried to define a drainage network over the entire region. The synthetic stream network represents all drainage for watersheds greater than 30 acres.
    - The 2005 Mountaintop Mining EIS (U.S. EPA, 2005) also included a study that estimated impacts of mountaintop mining and valley fills between 1992 and 2002 of 1,200 stream miles (equating to approximately 110 per year), out of 58,998 streams in the study area. As with the previous study, this study also used GIS modeling of “synthetic streams” (in that they were not generated from existing maps, but instead were created by assuming that 30-acre areas generate a stream, which was not ground truthed) to estimate potential impacts. The study also estimated 50 miles of direct stream impact per mineral extraction area; 156 miles per valley fill, and 307 miles per permit area. The study states that these may be

overestimates. This estimate of filled or mined through streams represents 2.05 percent of the stream miles in the study area.

- In a 1998 study, U.S. FWS evaluated stream miles permitted or filled with excess spoil and other coal mining wastes in Kentucky, Pennsylvania, Virginia, and West Virginia between 1986 and 1998. This study found that at least 900 stream miles were permitted for filling in this time period (about 75 stream miles per year). The study did not evaluate actual stream miles filled, which are believed to be less than the number of miles permitted to be filled. Other uncertainties relating to the accuracy of this estimate are presented in study. Most notably, the study evaluated fills only for streams marked by USGS topographic maps as blueline streams.

Overall, the available data suggest that the incremental impact of the Action Alternatives (excluding Alternative 9) could be fairly significant relative to baseline levels of stream filling.

- **Mined through streams**. Few studies characterize the extent to which ephemeral streams are mined through. Inputs used in the model mines analysis provide partial context to the estimated incremental impacts. For instance, a typical surface mine in the Illinois Basin is estimated to create about nine miles of mined through ephemeral stream. Likewise, a surface mine in the Northern Rocky Mountains and Great Plains region is estimated to fill nearly 35 miles of ephemeral streams.

- **Streams degraded downstream of mining operations**. It is especially difficult to provide context to estimates of miles where water quality is improved given the general nature of this indicator. Chapter 3 (Section 3.5) presents an overview of water resources in each of the coal-producing regions, including an analysis of the total miles of intermittent and perennial streams in each region. These figures suggest that the incremental downstream miles improved by the Action Alternatives represent a relatively small share of the overall water resources in affected regions. For instance, while several of the Alternatives could contribute to water quality improvements in roughly 174 stream miles in the Appalachian Basin, this can be compared to approximately 126,000 total stream miles in the region. A more focused point of comparison would be to examine the total stream miles degraded by coal mining activities. While state CWA section 303(d) water quality reports routinely identify coal mining as a pollution source, these data are not compiled at the regional level.

Table 4.2.1-9
Regional Annual Stream Miles Not Filled, Relative to the No Action Alternative: 2020 to 2040

Region	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Appalachia	8	0	4	4	0	4	4	0
Colorado Plateau	0	0	0	0	0	0	0	0
Gulf Coast	0	0	0	0	0	0	0	0
Illinois Basin	0	0	0	0	0	0	0	0
Northern Rocky Mountain	0	0	0	0	0	0	0	0
Northwest	0	0	0	0	0	0	0	0
Western Interior	0	0	0	0	0	0	0	0

Table 4.2.1-10
Regional Annual Ephemeral Stream Miles Restored, Relative to the No Action Alternative: 2020 to 2040

Region	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Appalachia	1	1	1	1	1	1	1	0
Colorado Plateau	8	4	4	0	5	5	4	0
Gulf Coast	12	7	7	0	7	2	7	0
Illinois Basin	20	11	11	0	11	2	11	0
Northern Rocky Mountain	15	6	6	0	6	3	6	0
Northwest	0	0	0	0	0	0	0	0
Western Interior	1	0	0	0	0	0	0	0

Table 4.2.1-11
Regional Annual Downstream Stream Miles Improved, Relative to the No Action Alternative: 2020 to 2040

Region	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Appalachia	149	173	174	174	174	158	174	0
Colorado Plateau	6	6	6	0	6	4	6	0
Gulf Coast	36	36	36	0	36	7	36	0
Illinois Basin	51	51	51	0	51	5	51	0
Northern Rocky Mountain	22	22	22	0	22	4	22	0
Northwest	2	2	2	0	2	0	2	0
Western Interior	2	2	2	0	2	0	2	0

Table 4.2.1-12
Regional Annual Downstream Stream Miles Preserved, Relative to the No Action Alternative: 2020 to 2040

Region	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Appalachia	26	1	1	1	0	1	1	0
Colorado Plateau	0	0	0	0	0	0	0	0
Gulf Coast	0	0	0	0	0	0	0	0
Illinois Basin	0	0	0	0	0	0	0	0
Northern Rocky Mountain	0	0	0	0	0	0	0	0
Northwest	0	0	0	0	0	0	0	0
Western Interior	0	0	0	0	0	0	0	0

Note: Estimates may not sum to the totals reported due to rounding error.

Characterization of Impacts on Other Water Resources

Groundwater and Drinking Water

The Action Alternatives (excluding Alternative 9) require, to varying degrees, additional monitoring of groundwater quality and quantity before, during, and after mining activities; in addition, some of these Alternatives require groundwater protections when considering AOC variances. In addition to benefits to groundwater, improvements in water quality may benefit public drinking water suppliers by reducing pollutant levels and therefore costs of water treatment. Overall, Alternatives 2, 3, 4, 7, and 8 (Preferred) are more protective of groundwater. Of these, Alternative 2 is the most protective due to more frequent monitoring, which may allow earlier detection of emerging water quality issues. Alternatives 3, 4, and 8 (Preferred) have similar elements (e.g., groundwater protection in material damage to the hydrologic balance definitions) and therefore may affect groundwater to a roughly equal degree. Ultimately, Alternatives 4 and 8 (Preferred) may be more protective due to increased monitoring of groundwater. Alternatives 5, 6, and 7 are less protective of groundwater because they lack a definition of material damage to the hydrologic balance and because of their limited geographic applicability.[19] Alternative 9 is expected to have a negligible effect on groundwater resources as it is found to be functionally similar to current practices.

To characterize the relative effect of the Alternatives on groundwater by region, this analysis identified regions where groundwater is most often used for private water supplies.[20] Groundwater usage for public and private water supplies by coal region is presented in Table 4.2.1-13. Groundwater supplies are also used for agriculture and commercial/industrial purposes among other uses. Groundwater usage for private supplies is susceptible to changes in water quality and quantity because wells may not be monitored consistently and treated accordingly. The Appalachian Basin has the greatest percentage of withdrawn groundwater used for private supply. Given the limited level of coal mining activity on private land in the Western Interior region, this analysis suggests that the benefits of the Action Alternatives on groundwater are most likely concentrated in the Appalachian Basin.

[19] Alternative 5 applies only to operations that dispose of excess spoil or coal mine waste; Alternative 6 applies only to operations within 100 feet of intermittent or perennial streams; Alternative 7 applies only to operations where conditions warrant enhanced permitting requirements (e.g., steep slope areas, riparian areas).

[20] Private water supplies receive less detailed and frequent monitoring than municipal supplies, and therefore represent a more significant pathway for potential exposure to groundwater pollution. Municipal and other public water suppliers may also benefit from reduced pollution in their water sources.

Table 4.2.1-13
Percent of Regional Groundwater Withdrawals used for Public Supply Utilities and Private Supply for Domestic Use

Coal Region	Public Supply Utilities	Private Supply for Domestic Use
Appalachian Basin	21%	11%
Colorado Plateau	22%	2%
Gulf Coast	13%	2%
Illinois Basin	31%	0.1%
Northern Rocky Mountains and Great Plains	19%	4%
Northwest	None	None
Western Interior	42%	5%

Source: USGS, 2010b

Wetlands, Lakes, and Ponds

While the elements of the Action Alternatives do not specifically target wetlands, lakes, and ponds, these water resources would be influenced by the changes in the quality and quantity of surface and groundwater within watersheds. Improved stream water quality downstream of mine sites may improve inflow to lakes, ponds, wetlands, and the overall hydrologic balance.[21]

4.2.1.5 Summary of Effects

Table 4.2.1-14 summarizes the anticipated effects of the Action Alternatives on water resources compared to the No Action Alternative. In applying the criteria used to define major, moderate, and minor effects (see discussion in Section 4.0) this analysis considers: (1) the length of the impact (i.e., during mining activity or beyond the life of the mine); and (2) the geographic scope of impact (to what extent impacts are expected to be limited to the mine site or extend beyond it). Most notably, in evaluating the effects of the Action Alternatives, beneficial effects associated with reductions in filled streams, downstream and groundwater quality improvements, and ephemeral stream restoration are all considered long-term as they extend indefinitely once they are completed. Where long-term impacts exist, and where the spatial extent of the impact is not negligible, benefits are either moderate or major.

Consistent with the intent of the regulations to reduce adverse impacts of mining activities on perennial and intermittent streams, the Action Alternatives (except Alternative 9) would result in benefits to water resources relative to the No Action Alternative at the national scale. In particular, the analysis finds that Action Alternatives would result in Major Beneficial impacts to water resources under Alternatives 2, 3, 4, and 8 (Preferred) at the national scale. Moderate Beneficial impacts to water resources would be expected under Alternatives 6 and 7, with Minor Beneficial impacts under Alternative 5 at the national scale. Alternative 9 is anticipated to be

[21] Hydrologic Balance is defined at 30 CFR 701.5 as follows: "Hydrologic Balance means the relationship between the quality and quantity of water inflow to, water outflow from, and the water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir. It encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground and surface water storage."

functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on water resources.

On a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin under Alternatives 2, 3, 4, and 8 (Preferred). Moderate Beneficial impacts are anticipated in the Appalachian Basin for Alternatives 5, 6, and 7, in the Illinois Basin for Alternatives 6 and 7, and in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions for Alternatives 2, 3, 4, 6, 7, and 8 (Preferred). Other effects on water resources are anticipated to be Negligible at the regional scale when compared to the No Action Alternative.

For all Action Alternatives, the benefits to water resources in the Western Interior and Northwest coal regions are Negligible due to the limited coal mining activity expected in these regions. For all other regions, specific findings are discussed below.

Alternative 1 (No Action Alternative)

Under the No Action Alternative, no changes in mining practices would occur and current water quality issues would likely persist. Subsection 4.2.1.1 above describes these issues in detail. They include pH impacts from acid mine drainage; elevated concentrations of iron, aluminum, manganese, and sulfate; sedimentation in the water column; flow alteration and stream elimination as a result of mining through streams and spoil management practices; drawdown of groundwater levels; and degradation of groundwater through increased concentrations of sulfate, iron, and other pollutants.

Alternative 2

At the national level, Alternative 2 is classified as Major Beneficial. Alternative 2 provides major benefits to water resources in the large coal regions of the Appalachian and Illinois Basins, suggesting a long-term benefit to an extensive geographic area. Moderate Beneficial impacts are anticipated for other coal regions. Specifically:

- Major Beneficial impacts in the Appalachian Basin include:
    - No streams are filled from surface mining and no perennial streams are filled from underground mining, yielding a total of eight fewer stream miles filled annually;
    - Reduced production and change in mining operations leads to 26 downstream stream miles preserved annually;
    - Improved mining practices lead to improved stream quality in 149 stream miles annually;
    - Appalachia's percentage of groundwater usage for private consumption is the highest of the regions, suggesting a relatively high potential for groundwater benefits; and
    - The geographic scope of these long-term impacts is expected to be broad and extend significantly beyond the mine sites in Appalachia.
- Major Beneficial impacts expected in the Illinois Basin, include:
    - Downstream water quality is improved for an estimated 51 stream miles annually;
    - Ephemeral stream restoration occurs for 20 stream miles annually;

- Alternative 2 provides the most significant benefit to groundwater and downstream water quality within this region; and
- The geographic scope of these long-term benefits is expected to be broad and extend significantly beyond the mine sites in the Illinois Basin.

- For the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains/Great Plains, regional impacts are expected to be Moderate Beneficial:
    - Six, 36, and 22 stream miles, respectively, are improved annually, suggesting a more limited geographic influence beyond the mine site when compared to the Appalachian and Illinois Basins;
    - Eight, 12 and 15 ephemeral stream miles, respectively, are restored annually; and
    - Two to four percent of households rely on private groundwater supplies, suggesting a more limited potential for groundwater benefits.

<u>Alternative 3</u>

At the national level, Alternative 3 is classified as Major Beneficial. Alternative 3 provides major benefits to water resources in the large coal regions of the Appalachian and Illinois Basins, suggesting a long-term benefit to an extensive geographic area. Moderate benefits to other coal regions are also anticipated. Specifically:

- Major Beneficial impacts are anticipated in the Appalachian Basin. In particular:
    - A reduction in production leads to one mile of preserved stream annually;
    - Improved mining practices lead to improved groundwater and stream quality in 173 stream miles annually;
    - The percentage of groundwater usage for private consumption is the highest of the regions, suggesting a relatively high potential for groundwater benefits; and
    - The geographic scope of these long-term impacts is expected to be broad and extend significantly beyond the mine sites in Appalachia.

Table 4.2.1-14
Summary of Effects of the Action Alternatives on Water Resources Compared to the No Action Alternative

Coal Region	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8 (Preferred)	Alternative 9
Appalachian Basin	Major Beneficial	Major Beneficial	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Colorado Plateau	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Gulf Coast	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Illinois Basin	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Northern Rocky Mountains / Great Plains	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Northwest	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Western Interior	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
National	**Major Beneficial**	**Major Beneficial**	**Major Beneficial**	**Minor Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**	**Major Beneficial**	**Negligible**

Note: See Section 4.0 for a definition of negligible, minor, and moderate effect terms used above. These effect categories consider the length of effect, geographic scope of effect, and potential for offsetting the effect. For a discussion of the impacts of the No Action Alternative (Alternative 1), see subsection 4.2.1.1 above.

- Major Beneficial impacts are expected to occur in Illinois Basin. In particular:
    - Downstream water quality is improved for 51 stream miles annually;
    - Ephemeral stream restoration occurs for 11 stream miles annually;
    - As noted previously, Alternative 3 provides significant benefit to groundwater and downstream water quality; and
    - The geographic scope of these long-term benefits is expected to be broad and extend significantly beyond the mine sites in the Illinois Basin.
- For Colorado Plateau, Gulf Coast, and Northern Rocky Mountains/Great Plains, regional impacts are anticipated to be Moderate Beneficial. In particular:
    - Six, 36, 22 stream miles, respectively, are improved annually, which suggests a somewhat more limited geographic reach beyond the mine site;
    - Four, 7 and 6 seven ephemeral stream miles, respectively, are restored annually;
    - Two to four percent of households rely on private groundwater supplies, suggesting a more limited potential for groundwater benefits; and
    - Regional benefits are moderate as they are long-term and cover a limited geographic scope.

Alternative 4

At the national level, Alternative 4 is classified as Major Beneficial. Alternative 4 provides major benefits to water resources in the large coal regions of the Appalachian and Illinois Basins, suggesting a long-term benefit to an extensive geographic area. Moderate Beneficial impacts to other coal regions are also anticipated. Specifically:

- Major Beneficial impacts are anticipated in Appalachia. In particular:
    - Four fewer stream miles are filled annually;
    - A reduction in production yields a mile of preserved downstream water quality annually;
    - Improved mining practices lead to improved groundwater and stream quality in 174 stream miles annually;
    - Percentage of groundwater usage for private consumption is the highest of the regions, suggesting a relatively high potential for groundwater benefits; and
    - The geographic scope of these long-term impacts is expected to be broad and extend significantly beyond the mine sites in Appalachia.
- Major Beneficial impacts are expected to occur in Illinois Basin. In particular:
    - Downstream water quality is improved for 51 stream miles annually;
    - Ephemeral stream restoration occurs for 11 stream miles annually;
    - As noted previously, Alternative 4 provides significant benefit to groundwater and downstream water quality; and
    - The geographic scope of these long-term benefits is expected to be broad and extend significantly beyond the mine sites in the Illinois Basin.
- For Colorado Plateau, Gulf Coast, and Northern Rocky Mountains/Great Plains, regional impacts are anticipated to be Moderate Beneficial. In particular:
    - Six, 36, and 22 stream miles, respectively, are improved annually, which suggests a somewhat more limited geographic reach beyond the mine site;
    - Four, 7 and 6 ephemeral stream miles, respectively, are restored annually;

  - Two to four percent of households rely on private groundwater supplies, suggesting a more limited potential for groundwater benefits; and
  - Regional benefits are moderate as they are long-term and cover a limited geographic scope.

Alternative 5

At the national level, Alternative 5 provides Minor Beneficial impacts to water resources. It provides Moderate Beneficial impacts in the Appalachian Basin and Negligible effects in the rest of the country. Specifically:

- Moderate Beneficial impacts are expected to occur in the Appalachian Basin. In particular:
  - Four fewer stream miles are filled annually;
  - A reduction in production leads to one mile of preserved stream annually;
  - Improved mining practices lead to improved water quality in 174 stream miles.
  - The geographic scope of these long-term impacts is expected to be limited to primarily the mine sites in Appalachia.
- Other regions experience Negligible benefits as the rule elements are effective only in Appalachia.

Alternative 6

At the national level, Alternative 6 provides Moderate Beneficial impacts to water resources. Alternative 6 applies only to activities inside the stream buffer zone; it also does not contain material damage to the hydrologic balance definitions or corrective action thresholds. As a result, impacts are expected to be long-term but primarily limited to improvement of water resources on the mine sites. Specifically:

- Moderate Beneficial impacts are expected to occur in Appalachia. Improved mining practices lead to improved groundwater and stream quality in 174 stream miles.
- The Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains/Great Plains regions experience Moderate Beneficial effects from ephemeral stream restoration, with ranges from 5, 7, and 11 stream miles, respectively, are restored annually. Similarly Moderate Beneficial impacts are estimated for improved groundwater and downstream water quality.

Alternative 7

At the national level, Alternative 7 provides Moderate Beneficial impacts to water resources, primarily because long-term benefits occur, but for a relatively limited geographic region due to its applicability requirements related to enhanced permitting conditions. Specifically:

- Moderate Beneficial impacts are anticipated in Appalachia. In particular:
  - Four fewer stream miles are filled annually. This outcome is partially attributable to enhanced permitting in steep slope areas and riparian areas, limiting the number of streams filled from underground mining;
  - A reduction in production leads to a mile of preserved stream annually;

  - Improved mining practices lead to improved groundwater and stream quality in 158 stream miles annually;
  - Percentage of groundwater usage for private consumption is the highest of the regions, suggesting a relatively high potential for groundwater benefits; and
  - The geographic scope of these long-term impacts is expected to be broad and extend beyond the mine sites in Appalachia.
- Other regions are less affected by Alternative 7 because its rule elements are expected to be applied less frequently. As discussed in the engineering analysis, the percentage of mines affected by Alternative 7 varies by region, as follows:
  - Appalachian Basin – 95 percent;
  - Colorado Plateau – 60 percent;
  - Gulf Coast – 20 percent;
  - Illinois Basin – 10 percent;
  - Northern Rocky Mountains – 20 percent;
  - Northwest – 10 percent; and
  - Western Interior – 10 percent.
- In Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains/Great Plains regional impacts are expected to be Moderate Beneficial. In particular:
  - These regions experience increases in ephemeral stream restoration ranging from three to five miles annually and downstream water quality improvements from four to seven miles annually; and
  - For these reasons, the geographic scope of these long-term impacts is expected to be limited primarily to the mine sites.

<u>Alternative 8 (Preferred)</u>

At the national level, Alternative 8 (Preferred) is classified as Major Beneficial. Alternative 8 (Preferred) provides Major Beneficial impacts to water resources in the large coal regions of the Appalachian and Illinois Basins, suggesting a long-term benefit to an extensive geographic area. Moderate Beneficial impacts to other coal regions are also anticipated. Specifically:

- Major Beneficial effects are anticipated in Appalachia. In particular:
  - Four fewer stream miles are filled annually;
  - A reduction in production yields a mile of preserved downstream water quality annually;
  - Improved mining practices lead to improved groundwater and stream quality in 174 stream miles annually;
  - Percentage of groundwater usage for private consumption is the highest of the regions, suggesting a relatively high potential for groundwater benefits; and
  - The geographic scope of these long-term impacts is expected to be broad and extend significantly beyond the mine sites in Appalachia.
- Major Beneficial impacts are expected to occur in Illinois Basin. In particular:
  - Downstream water quality is improved for 51 stream miles annually;
  - Ephemeral stream restoration occurs for 11 stream miles annually;
  - As noted previously, Alternative 8 (Preferred) provides significant benefit to groundwater and downstream water quality; and

  - The geographic scope of these long-term benefits is expected to be broad and extend significantly beyond the mine sites in the Illinois Basin.
- For Colorado Plateau, Gulf Coast, and Northern Rocky Mountains/Great Plains, regional impacts are anticipated to be Moderate Beneficial. In particular:
  - Six, 36, and 22 stream miles, respectively, are improved annually, which suggests a somewhat more limited geographic reach beyond the mine site;
  - Four, 7 and 6 ephemeral stream miles, respectively, are restored annually;
  - Two to four percent of households rely on private groundwater supplies, suggesting a more limited potential for groundwater benefits; and
  - Regional benefits are moderate as they are long-term and cover a limited geographic scope.

Alternative 9

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zone rule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible effects on water resources.

4.2.1.6 Potential Minimization and Mitigation Measures

The effects of Action Alternatives on water resources are beneficial, themselves comprising minimization and mitigation measures in many cases. Thus, potential minimization and mitigation measures are not relevant to this evaluation.

4.2.2 Biological Resources

This section evaluates the potential effects of the Alternatives on biological resources in each of the coal mining regions. Chapter 3 provides an overview of the terrestrial and aquatic habitats occurring in coal-producing areas, describing vegetative cover for terrestrial systems as well as the features of flowing and ponded aquatic systems. Changes to the quality and quantity of these resources in turn affect the wildlife communities they support.

This chapter assesses the potential impacts of the Action Alternatives on these biological resources by comparing relative levels of protection afforded by the Action Alternatives as compared to the No Action Alternative (Alternative 1) at typical (model) mine sites within each coal region. The section is organized as follows:

- It first describes the existing regulatory environment to assist the reader in understanding the impacts of the No Action Alternative on biological resources.
- Second, the discussion identifies the biological resources most likely to be affected by implementation of the Action Alternatives and the rationale for these findings.
- It then describes the methods for assessing the expected magnitude of impact of the Action Alternatives on these resources.
- Next, the results of the quantitative analysis are presented, along with additional qualitative evaluation of other potential impacts.
- The section concludes with a summary of the expected effects of the Action Alternatives, characterizing the impacts by coal region and Alternative.

4.2.2.1 Effects of the Current Regulatory Environment (the No Action Alternative)

Coal mining alters the surface landscape by changing its configuration and physical properties. The short- and long-term disturbance created by surface and underground coal extraction significantly changes the biological resources of surface lands. Specifically, coal mining affects: (1) the biological composition, or the number and proportion of habitat types (e.g., the amount of forest, length of stream habitat); (2) the biological structure, or the geographical arrangement of the habitat types; and (3) the biological function, or how these arranged habitat types interact with their respective plant and animal species. These effects vary in temporal and spatial scale; in some instances, these effects extend past the coal mining permit boundary and after final bond release.

Several existing laws and regulations address protection of the terrestrial and aquatic biological resources that occur near coal mining areas. The following discussion in this section identifies the laws and regulations protecting fish, terrestrial fauna, and endangered species, with a focus on key aspects of SMCRA and the Endangered Species Act.

<u>SMCRA</u>

Section 515 of SMCRA requires that, "to the extent possible using the best technology currently available," surface coal mining operations "minimize disturbances and adverse impacts . . . on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable" (30 U.S.C. § 1265(b)(24)). This provision applies to any fish, wildlife, or related environmental values identified during the permitting process that could benefit from protective measures to minimize disturbances and adverse impacts or enhancement of such resources.

Fish, wildlife, and related environmental values are addressed directly within the implementing regulations of SMCRA. To achieve the mandate of section 515, OSMRE regulations include specific requirements for these resources from the permit application stage, during mining through the requirement for enhancement measures, and during consideration and implementation of the post mining land use.

The implementing regulations for SMCRA require the permit application to contain information on fish and wildlife resources within the permit and adjacent area (30 CFR 780.16(a)). The regulatory authority (RA) determines the required scope and level of detail for such information in consultation with state and federal agencies responsible for fish and wildlife. Each application must include a description of how, to the extent possible using best technology currently available (BTCA), the operator would minimize disturbances and adverse impacts on fish and wildlife and related environmental values, including compliance with the Endangered Species Act. This is the protection and enhancement plan specifically required by 30 CFR 780.16(b).

The protection and enhancement plan is required to be consistent with applicable performance standards at 30 CFR 816.97 and 817.97 that require the operator to include protective measures for use during active phases of the mining operation, and to include proactive measures to minimize or avoid impacts. For example, 30 CFR 816.97(e) and 817.97(e) require that each operator shall, to the extent possible using BTCA:

- Ensure that electric power lines and other transmission facilities used for, or incidental to, surface mining activities on the permit area are designed and constructed to minimize electrocution hazards to raptors, except where the RA determines that such requirements are unnecessary;
- Locate and operate haul and access roads so as to avoid or minimize impacts on important fish and wildlife species or other species protected by state or federal law;
- Design fences, overland conveyors, and other potential barriers to permit passage for large mammals, except where the RA determines that such requirements are unnecessary; and
- Use fencing, covers, or other appropriate methods to exclude wildlife from ponds that contain hazardous concentrations of toxic-forming materials.

The regulations at 30 CFR 816.97(f) and 817.97(f) provide additional protections for wetlands and habitats of unusually high value for fish and wildlife. The operator must avoid disturbances to, enhance where practicable, restore, or replace, wetlands and riparian vegetation along rivers and streams and bordering ponds and lakes. Surface mining activities must avoid disturbances to, enhance where practicable, or restore, habitats of unusually high value for fish and wildlife.

The regulations also require an applicant who intends to select certain postmining land uses to incorporate specific measures to the benefit of fish and wildlife resources. The regulations at 30 CFR 816.97(g) and 817.97(g) require that, where fish and wildlife habitat would be part of the postmining land use, the reclamation plan must include plant species selected on the basis of the following criteria:

- Their proven nutritional value for fish or wildlife;
- Their use as cover for fish or wildlife; and
- Their ability to support and enhance fish or wildlife habitat after the release of performance bonds. The selected plants must be grouped and distributed to optimize edge effect, cover, and other benefits to fish and wildlife.

The regulations at 30 CFR 816.97(h) and 817.97(h) require that, where cropland would be the postmining land use, and where appropriate for wildlife- and crop-management practices, the operator must intersperse fields with trees, hedges, or fence rows throughout the harvested area to break up large blocks of monoculture and to diversify habitat types for birds and other animals. Likewise, 30 CFR 816.97(i) and 817.97(i) require that, where residential, public service, or industrial uses are to be the postmining land use, and where consistent with the approved postmining land use, the operator must intersperse reclaimed lands with greenbelts using species of grass, shrubs, and trees useful as food and cover for wildlife.

Beyond these specific requirements that pertain to consideration and protection of fish, wildlife and related environmental values there are many aspects of the implementing regulations that affect the mining operation and in turn affect the impacts of this operation on biological resources. For example, current SMCRA implementing regulation requirements for spoil placement, activities in and within streams, and reclamation all have impacts either directly or indirectly on biological resources by allowing activities to occur in certain habitats, and by restricting them in others. Scientific findings on impacts to biological resources under the full suite of existing regulations are discussed more thoroughly below in the section entitled "Documented Impacts under the No Action Alternative."

The Endangered Species Act (ESA) and SMCRA

Purpose of the ESA

Prior to the enactment of SMCRA, Congress, in 1973, enacted the ESA to, among other purposes, "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved [and] to provide a program for the conservation of such endangered species and threatened species…" (16 U.S.C. § 1531(b)). Through the ESA, Congress declared "that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the [ESA]" (16 U.S.C. § 1531(c)).

To carry out these purposes and the policies, ESA section 7(a)(1) requires all federal agencies, in consultation and with the assistance of the U.S. Fish & Wildlife Service (U.S. FWS), to exercise their authorities to carry out programs for the conservation of endangered and threatened species (16 U.S.C. § 1536(a)(1)). Section 7(a)(2) requires each federal agency, in consultation with the U.S. FWS, "to insure that any action authorized, funded, or carried out…is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat" (16 U.S.C. § 1536(a)(2)). Section 7(a)(4) requires federal agencies to confer with the U.S. FWS on any agency action that is likely to jeopardize the continued existence of any species proposed for listing or result in adverse modification of proposed critical habitat (16 U.S.C. § 1536(a)(4)). Each agency is required to use and provide the U.S. FWS with the best scientific and commercial data available when undergoing consultation in order to determine the effects of its action upon listed species or critical habitat (*Id.*; 50 CFR 402.14(d)(2)). The ESA regulations outlining the substantive and procedural requirements for section 7(a)(2) consultation are codified at 50 CFR Part 402. The regulations require the federal agency taking the action to formally consult with the U.S. FWS if its action "may affect" a listed species (50 CFR 402.14(a)).

On September 24, 1996, the U.S. FWS issued a biological opinion (BO) and conference report to OSMRE (OSMRE, 1996) on the continuation and approval and conduct of surface coal mining and reclamation operations under state and federal regulatory programs adopted pursuant SMCRA where such operations may adversely affect species listed as threatened or endangered or designated critical habitat under the ESA. After reviewing SMCRA, its implementing regulations, the effects of the proposed action, and the cumulative effects of future state, tribal, local or private actions that are reasonably certain to occur, the U.S. FWS concluded in the 1996 BO that surface coal mining and reclamation operations conducted in accordance with properly-implemented regulatory programs under SMCRA are not likely to jeopardize the continued existence of ESA-listed or proposed species or future listed species and are not likely to result in the destruction of adverse modification of designated or proposed critical habitat. The Incidental Take Statement (ITS) in the 1996 BO exempted OSMRE or the state RA from the prohibitions of section 9 of the ESA if it complied with the terms and conditions included in the ITS.

The terms and conditions are as follows:

1. The regulatory authority, acting in accordance with the applicable SMCRA regulatory program, must implement and require compliance with any species-specific protective measures developed by the U.S. FWS field office and the regulatory authority (with the involvement, as appropriate, of the permittee and OSMRE).
2. Whenever possible, the regulatory authority must quantify the take resulting from activities carried out under this program. Whenever a dead or impaired individual of a listed species is found, the local U.S. FWS office must be notified within one (1) working day of the discovery.
3. Whenever the regulatory authority decides not to implement one or more of the species-specific measures recommended by the U.S. FWS, it must provide a written explanation to the U.S. FWS. If the U.S. FWS does not concur, the issue must be elevated through the chain of command of the regulatory authority, the U.S. FWS, and (to the extent appropriate) OSMRE for resolution.

The "fish, wildlife, and related environmental values" described in section 515 of SMCRA clearly encompass threatened or endangered species or their critical habitats. Existing OSMRE regulations require that applicants for surface coal mining operations provide sufficient fish and wildlife resources information for the proposed permit area and adjacent area to design a protection and enhancement plan (PEP) that complies with sections 7 and 9 of the ESA and minimizes disturbances and adverse impacts on fish, wildlife, and related environmental values, and enhances those resources where practicable (30 CFR 780.16). Before the RA can approve the permit application, the RA must find that the "operation would not affect the continued existence of endangered or threatened species or result in destruction or adverse modification of their critical habitats, as determined under the Endangered Species Act of 1973" (30 CFR 773.15(j)).

U.S. FWS field staff provide technical assistance and recommendations to OSMRE and the appropriate RA. The RA ensures that any listed species or designated critical habitats are considered as the application is developed. As part of the process of ensuring full compliance with SMCRA and the ESA, OSMRE and state RAs have worked with U.S. FWS to develop comprehensive protection and enhancement plans/guidelines (PEPs) for commonly encountered threatened and endangered species. As of 2013, PEPs were developed for the Indiana Bat

(*Myotis sodalist*) and the blackside dace (*Chrosomus cumberlandensis*) (OSMRE, 1996; U.S. FWS, 2004b).

U.S. FWS and OSMRE or the appropriate RA work together under the 1996 BO. However, neither the regulations nor the 1996 BO contain a clear description of a process for resolving disputes between the U.S. FWS and the permitting RA. Therefore, it is possible that a permit to conduct surface coal mining activities could be issued that does not contain all of the protections that the U.S. FWS believes are necessary.

As provided in 50 CFR 402.16, reinitiation of formal consultation is required when discretionary federal agency involvement or control over the action has been maintained (or is authorized by law) and if (1) new information reveals that the agency action may affect listed species or critical habitats in a manner or to an extent not considered in the original opinion, or (2) the agency action is modified in a manner that causes an adverse effect to listed species or critical habitat that was not considered in the original opinion. OSMRE is in the process of formal consultations with the U.S. FWS on the proposed rule. As a result of early discussions with U.S. FWS, OSMRE has decided to initiate formal consultation on the current program at this time as well. If we determine that adoption of the proposed rule (or a selected alternative) may affect species under the jurisdiction of the National Marine Fisheries Service (NMFS), we will consult with NMFS, which is responsible for administration and enforcement of the Endangered Species Act with respect to anadromous and marine species.

Documented Impacts under the No Action Alternative

Under the existing regulations (the No Action Alternative), scientific studies have found a correlation between the effects of SMCRA permitted mining operations on the hydrologic balance and adverse impacts to biological resources downstream of the mine site. These impacts to biological resources include habitat loss and habitat degradation. Documented downstream effects to the hydrologic balance on biological resources include:

- Effects to the thermal regime (the fluctuation of water temperature throughout the year);
- Effects to the flow regime (the baseline flow, or minimum flow of water throughout the year, and the pulses of water due to significant precipitation events);
- Effects to downstream chemistry (e.g., water pH and conductivity); and
- Changes in downstream sedimentation (e.g., the amount and particle size of sand, silt, and decaying organic matter deposited onto streambeds).

Adverse impacts on ecological communities continue to occur in coal mining regions, as documented in studies discussed below. Many of the available studies were conducted in the Appalachian Basin region (e.g., U.S. EPA et al., 2003; Pond et al., 2008; Palmer et al., 2010; Woody et al., 2010; Bernhardt et al., 2012; Pond, 2012; Pond et al., 2014). However, studies are available from other coal-producing areas, e.g., Big Black River tributaries in Mississippi (Rohasliney and Jackson, 2009), Hocking River drainage basin in southeastern Ohio (Verb and Vis, 2000), and streams in British Columbia (Harding et al., 2005). Two other states, Colorado and Indiana, have studies reporting directly on stream effects of coal mining; however, these studies were performed before 1983 (Canton and Ward, 1981; and Wangsness, 1982) and may not be representative of impacts that are occurring under existing regulations.

The discussion below reviews key studies that have documented adverse mining impacts on biological resources under current regulations. The first subsection reviews literature examining how activities in or near streams have affected aquatic ecosystems; the second subsection focuses on postmining land use and reclamation, and its influence on biological systems.

Documented Impacts Related to Activities in or Near Streams

Under the No Action Alternative, the RA may authorize mining activities within 100 feet of a stream, including placement of spoil, only after finding that the proposed activities would not cause or contribute to a violation of applicable federal or state water quality standards under the Clean Water Act and would not adversely affect the water quantity and quality or other environmental resources of the stream (30 CFR 816.57). However the studies presented in the paragraphs below show that mining continues to have effects on aquatic habitats due to chemical effects to the water column itself, removal of streamside vegetation which then can cause thermal effects to the water, diversion of the waters of the stream, or changes to the texture and composition of the stream substrates. The studies described below also indicate that mining related degradation of aquatic habitats may cause shifts in species composition, changes in demographics and dynamics of aquatic populations, and loss of taxa.

Changes in the aquatic biological community as a result of mining have been demonstrated through surveys of macroinvertebrate communities. Macroinvertebrates are organisms that are large (macro) enough to be seen with the naked eye and lack a backbone (invertebrate). They inhabit all types of running waters, and most live part or most of their life cycle attached to submerged rocks, logs, and vegetation. Examples of aquatic macroinvertebrates include insects in their larval or nymph form, crayfish, clams, snails, and worms.

Water quality assessment relies so heavily on macroinvertebrate surveys because these organisms:

- Are affected by the physical, chemical, and biological conditions of the stream;
- Cannot escape pollution and thus do show the effects of short- and long-term pollution events;
- May show the cumulative impacts of pollution;
- May show the impacts from habitat loss not detected by traditional water quality assessments; and
- Differ by genus and species in their tolerance of pollution.

The abundance and diversity of macroinvertebrate species is, therefore, indicative of the relative health of a stream. For example, a stream that contains robust populations of pollution-sensitive macroinvertebrate species can be seen as healthier (i.e., less impacted by mining) than a stream dominated by pollution-tolerant species.

Mining has impacts on downstream water chemistry conditions even when done in compliance with existing regulations. Under existing federal regulations, measurement of conductivity (total dissolved solids) in water discharged from mine sites is not required. However, high conductivity can be directly toxic to freshwater aquatic organisms by disrupting osmoregulation (Pond et al., 2008). An increase in the specific conductivity (e.g., the product of dissolved sulfate, bicarbonate, calcium, magnesium, and other ions) of surface waters has been correlated with the lower abundance and diversity of macroinvertebrates, diatoms, and fish species (Chambers and Messinger, 2001; Hartman et al., 2005; Carlisle et al., 2008; Smucker and Vis, 2009; Kimmel and Argent, 2010; and Bernhardt et al., 2012).

Pond et al. (2008) characterized macroinvertebrate communities in 37 streams in West Virginia (ten unmined sites and 27 sites near coal mining activity) and found that coal mining affected the condition of streams in the following four respects: shifts in species assemblages; losses of Ephemeroptera (mayfly) taxa; and changes in water chemistry. Additionally, Pond, et al. (2008) showed that benthic macroinvertebrate communities in streams below valley fills in West Virginia were impaired at conductivity levels as low as 500 µS/cm. This study also found a nearly complete absence of mayflies in streams below mined sites. Pond (2010) showed that relative mayfly abundance was negatively correlated with specific conductance. A follow-up study published by Pond (2012) studied headwater stonefly (Plecoptera) and caddisfly (Trichoptera) assemblages in reference, mined, residential, and residential/mined areas. Much like Ephemeropteran declines seen by Pond, et al. (2008), Plecopteran and Trichopteran communities were radically altered in streams near mining and residential areas. In West Virginia, Green, et al. (2000) found that median conductivity was strongly negatively correlated with the condition of streams assessed under the West Virginia Stream Condition Index. Howard, et al. (2001) found a strong negative correlation between conductivity and biological condition in streams in Kentucky. Pond (2004) showed a strong negative correlation between conductivity and biological condition as well as wholesale loss of mayflies (Ephemeroptera) below mined sites in Kentucky.

In addition, Palmer, et al. (2010) reported that several metals known to be stressors of aquatic life (e.g., selenium, aluminum, iron) were associated with sulfate, which is highly correlated with conductivity. Streams with selenium-impacted mine runoff have exhibited decreased abundance of salamander, fish, and bird populations (Patnode et al., 2005; U.S. EPA, 2011b; Hitt and Chambers, 2014). Aluminum is also toxic to invertebrates and fish, and can occur in higher concentrations downstream of mine runoff (Chambers and Messinger, 2001).

Current OSMRE regulations require baseline data and monitoring but are not preventing all impacts to water quality. Only some of these adverse impacts are linked to contaminants (substances at levels high enough to cause damage to biological resources) that must be identified as part of the water quality and quantity measurements required by the regulations implementing SMCRA and the CWA. As discussed above, coal mining is known to change the concentration of total dissolved solids downstream to an extent sufficient to adversely affect downstream biological communities (e.g., Locke et al., 2006; U.S. EPA et al., 2003; Hartman et al., 2005; Pond et al., 2008; Palmer et al., 2010). In addition, high levels of total suspended solids (i.e., sediment) below mining operations have also been shown to be predictive of downstream biological communities. High levels of total suspended solids have been shown to be correlated to lower species diversity of macroinvertebrates (e.g., aquatic insects and mussels), and reduced abundance of salamanders and fish downstream of mining operations (Chambers and Messinger, 2001; Wood and Williams, 2013).

Under current federal regulations, mining through streams requires the complete reconstruction of the streambed. Mining-related effects to biological resources occur both directly (at the mine and fill sites during mining and after final reclamation) and indirectly (impairing downstream water quality and quantity, more thoroughly described in Subsection 4.2.2.1). Generally, when streams are mined through, a majority of the biota is lost (OSMRE, 2008; Pond et al., 2008). In many cases where streams are buried by overburden, the streams are eliminated along with the biota that once inhabited them (U.S. EPA et al., 2003; Pond et al., 2008; Palmer et al., 2010). Reclamation of the stream often focuses only on its return to form (e.g., the length of the stream, how it interacts with surface and groundwater) and does not include restoration of the stream function (e.g., returning the streambed habitat to a state where wildlife present before mining can return) (OSMRE, 2008; Pond et al., 2008; Northington et al., 2011; Petty, et al., 2013). The species composition of aquatic systems in areas surrounding mining activities has been shown to become more homogenized and dominated by generalist species more tolerant of disturbance as a result (Weed and Rutschky, 1971; Chapin et al., 1997; Walters et al., 2003; Carlisle et al., 2008; Pond et al., 2008; Pond, 2012).

Macroinvertebrates are often the most directly damaged by these downstream effects (e.g., U.S. EPA, et al., 2003; Pond, et al., 2008; Fritz, et al. 2010; Palmer, et al., 2010; Woody, et al., 2010; Bernhardt, et al., 2012; Pond, 2012; Pond, et al., 2014). Macroinvertebrates provide an important food source to amphibians, fish, bats, and other wildlife, have an important influence on nutrient cycling within streams, and serve as valuable indicators of stream degradation (U.S. EPA, 2005; U.S. EPA, 2011b). Wildlife that feed on macroinvertebrates (fish, bats, birds, etc.) may be indirectly affected through reduced prey populations or through the bioaccumulation of contaminants from feeding on contaminated prey (Woodward, et al., 1997; Harding, et al., 2005; Kimmel and Argent, 2010; Hopkins, et al., 2013). Loss of diversity and abundance of macroinvertebrates and contamination of these organisms is important therefore not only as an indication that a stream is degraded but also because of the implications for other important functions these organisms perform.

Valley fills are currently permitted under the existing regulations implementing SMCRA as part of certain mining methods (notably area mines and mountaintop removal mines) and in several coal basins these fills permanently bury ephemeral, intermittent, and perennial streams (U.S. EPA, et al., 2003; Pond, et al., 2008). Under the current regulations as historically applied, operators can be allowed to place spoil directly into streams under certain circumstances. Spoil placed directly into streams (a notably common practice at area mines, mountaintop removal mines, and when using durable rock fills) permanently buries sections of streams (U.S. EPA, et al., 2003; Pond, et al., 2008). Organisms that cannot escape may experience immediate mortality or may experience longer-term mortality or stress as they are subjected to unsuitable habitat conditions.

Valley fills also affect aquatic systems through contamination; precipitation and groundwater percolate through the unconsolidated overburden and dissolve minerals until they discharge from the bottom of the fills as surface water (Pond et al., 2008). The dissolved minerals are then transported into the on-site and downstream surface waters and can alter water quality and the corresponding biological resources. Contaminants originating from valley fills can affect aquatic organisms as toxic substances in the water or as toxins in the food chain (Woodward et al., 1997; Kimmel and Argent, 2010; Hopkins et al., 2013). These effects can last for decades (Pond et al., 2014).

Documented Impacts Related to Land Alteration, Vegetation, and Wildlife

During the process of site preparation prior to coal mining the site must be cleared of vegetation to provide access to the materials below. This activity clearly and unavoidably results in the loss of terrestrial species habitat throughout the duration of the mining activity, and continues until reclamation of the site has successfully occurred. Postmining management of the land influences the habitat value of the reclaimed land. Under the No Action Alternative, vegetative cover must be established following mining activity, in accordance with the approved permit and reclamation plan (30 CFR 816.116 and 817.116). While this protection emphasizes revegetation with native species, the existing regulations do allow the use of introduced species (30 CFR 816.111 and 817.111). Permittees often choose to replant trees on mined sites, and this is promoted by OSMRE's Appalachian Regional Reforestation Initiative (ARRI); however, reforestation is not required under the No Action Alternative. Restoration of full habitat value within these replanted forests occurs over a long time frame. Under favorable growth conditions and management, forest canopy closure can occur within 15 to 20 years after mine closure (Groninger et al., 2007). Succession of mined lands to native forest may take hundreds of years (Angel et al., 2005).

The No Action Alternative contains minimal requirements for creating favorable growth conditions to return forest land to its premining condition. For instance, the regulations do not require the operator to salvage and redistribute all soil horizons (30 CFR 816.22 and 817.22). As a result the seed bank contained within the topsoil is not returned to the site to facilitate reestablishment of vegetation; and the loss of soil organic matter reduces the quality of the soil for vegetative regrowth, as does the compaction of the soil during filling and grading. The return to full site productivity may be delayed as a result (Angel, et al., 2005; Zipper, et al., 2011).

The existing implementing regulations at 30 CFR Part 810 establish the permanent program performance standards, including requirements that pertain to stockpiling of materials, site disturbance and revegetation to address and prevent erosion. Erosion remains a commonly encountered concern on mine sites despite these regulations, as it would with any activity that requires intensive land disturbance. When land is cleared for mining, the exposed and disturbed surface can result in erosion of particles from the land surface and increased runoff of these particles to downstream bodies of water. Sediment can have adverse impacts on the quality of receiving streams. For example, the diversity and population size of fish species, mussels, and benthic macroinvertebrates associated with coarse substrates can be greatly reduced if the substrates are covered with sand and silt (Appendix C of Berry et al., 2003). Amphibians are reported to avoid areas in streams with excessive siltation (Humphries and Pauley, 2005).

Other ways in which suspended sediments can interfere with ecosystem processes include: reduction of water clarity, impairment of food capture for sight-feeding fish and invertebrate species; absorption of sunlight and associated reduction in plant photosynthesis; warming of the stream; and filling of interstitial spaces that would otherwise provide shelter and foraging habitat for aquatic invertebrates (Bernhardt and Palmer, 2011). Impacts of sediment release are not always limited to near-field habitats (Chambers and Messinger, 2001). Sediments can be transported downstream, and large influxes of sediment can impair many miles of a stream system. Excess fine sediment runoff from mining activities has been shown to increase in the downstream reaches of streams below valley fills and decrease habitat quality for species that are sensitive to higher levels of turbidity (Wiley and Brogan, 2003; Pond et al., 2008).

As discussed previously the RA must consider fish, wildlife, and related environmental resources during the review of proposed mining operations, and the proposed operation would be required to address associated concerns including proposed destruction of riparian habitat (30 CFR 816.97). Removal of riparian vegetation and alteration of valley contours adversely impact aquatic ecosystems. These activities alter the patterns by which water flows through the affected valleys and change how water is delivered to streams below valley fills (Palmer et al., 2010). Riparian buffers are important for the nesting, movement, and feeding behaviors of some species. Narrowing the width of these buffers can also have adverse effects on the quality of the habitat (e.g., Klapproth and Johnson, 2000). Mining activities in the stream also result in the removal or alteration of components (substrate composition and particle size, riparian vegetation, temperature, and organic matter) of the stream and riparian zone that are important to the quality of the habitat for the organisms that use that habitat (Feminella, 1996).

Under existing regulations of the No Action Alternative surface water degradation through water contamination continues to occur, as described in the preceding section (4.2.1) on impacts of activities in and near streams. Water contamination can affect terrestrial wildlife that relies on aquatic systems for at least some of their life cycle requirements. Wildlife that feed on fish and other aquatic organisms may be indirectly affected through reduced prey or directly affected through food chain bioaccumulation of contaminants with potential to produce adverse impacts (Harding et al., 2005). Selenium is a contaminant of concern in association with coal mining, and has also been shown to accumulate in live animal tissues (Palmer et al., 2010). Selenium is known to be toxic to wildlife and livestock (Merck Sharp & Dohme Corp, 2008).

The existing regulations (No Action Alternative) allow mining through intermittent and perennial streams when the RA makes a finding that diversion of the stream will not adversely affect water quantity, water quality, and related environmental resources of the stream (see 30 CFR 816.43(b) and 817.43(b)). The No Action Alternative requires that a permanent stream-channel diversion or a restored stream channel be designed and constructed so as to approximate the premining characteristics of the original stream channel, including riparian vegetation (30 CFR 816.43(a)(3)), but it does not require restoration of the stream's biological condition or ecological function. Fragmentation of stream channels has resulted from coal mining (U.S. EPA et al., 2003). Direct stream fragmentation occurs on permitted sites when roads, culverts, fills, dams, and other built features impede organisms from moving upstream and downstream and cause an interruption in the natural connections within a stream network (i.e., reduce stream connectivity) (Freeman et al., 2007). This stream fragmentation may cause distinct patch formation within a stream and may produce negative effects to both the abiotic and biotic factors of the stream (Kirkham and Fischer, 2004). Stream fragmentation can strongly influence population dynamics and species survival in spatially structured populations (Smucker and Vis, 2009; Letcher et al., 2007).

The requirements of 30 CFR 816.43 provide for restoration of stream flow and riparian vegetation, but do not require restoration of biological communities. Studies have shown that it can be difficult to restore biological characteristics in an engineered stream channel (e.g., Northington et al., 2011). In another example, Fritz, et al. (2010) compared ephemeral, intermittent, and perennial streams at reclaimed valley fills to naturally occurring forested streams. They detected significant differences in leaf litter breakdown (a critical process that provides nutrients and energy to the stream ecosystem beyond the mine site) and invertebrate assemblage when comparing valley fill reclaimed (constructed) perennial and intermittent streams to naturally occurring forested perennial and intermittent streams. The study also detected significant differences in coarse benthic organic matter and invertebrate assemblage (important parts of the foundation to the stream ecosystem) between reclaimed and natural ephemeral streams.

Finally, current regulations contain requirements for the construction of siltation and discharge structures to prevent additional contributions of suspended solids outside the permit area to the extent possible (30 CFR 816/817.46 and 816/817.47). These engineered features detain water, by design, until sediments have settled out to allow the effluent from the structure to meet state and federal effluent limitations. As a result, these structures alter the timing and amount of water that reaches streams, which in turn adversely impacts downstream habitats (U.S. EPA et al., 2003; Woody et al., 2010). The creation of artificial water bodies alters flow dynamics and flood regimes, promotes the biotic homogenization of in-channel environments, and can alter the influx of allochthonous organic materials that are essential to the energy flow and biological productivity in stream ecosystems (Jackson, 2005; Rohasliney and Jackson, 2009; Fritz et al., 2010; Palmer et al., 2010).

Documented Impacts on Forest and Other Ecosystems

Mining activities can greatly influence forests and other terrestrial habitats due to the necessity to initially clear vegetation from the site to accommodate the mining activity. Land clearing for any activity, including coal mining, results in localized reduction in the extent of natural forest, shrubland, grassland, and arid (e.g., cryptobiotic soil) communities, and may reduce populations of locally important medicinal and culturally sensitive plants. Those reductions become long-term if the use of the land changes after mining is complete, or if the restoration of the impacted environmental component itself occurs only over a long timeframe, as with cryptobiotic soils.

Mining activity under existing regulations frequently leads to a changed land use on the reclaimed site in comparison to the use of the land prior to mining. When mining occurs on federal lands the federal land managing agency determines the postmining land use and OSMRE as the RA is required to consult with the managing agency to determine any special requirements related to achieving the postmining land use (30 CFR 740.4(c)(2)). Otherwise the permanent program performance standards at 30 CFR 816.33 and 817.133 require that all disturbed areas be restored to a condition capable of supporting the uses they were capable of supporting before the mining, or to support a higher or better use. The RA may approve a change to a “higher or better use” if the landowner or land management agency successfully demonstrates the proposed change would be safe, compliant with other state and federal laws and reasonably certain to be achievable. Mining can facilitate conversion of land by making it economically feasible to clear and recontour a site, since these activities would transpire as a matter of course during the mining activity.

Land transformation reduces the availability of habitats for some species, and increases the availability for others. The conversion of a site from forest to grassland for example is positive for grassland bird species, but negative for forest-dwelling bird species. Habitat loss is a leading cause of decline of some organisms (Vitousek et al., 1997) including salamanders in West Virginia (Wood and Williams, 2013), and mining activities cause acute changes to the landscape that often create unsuitable conditions for a variety of species (e.g., Carlisle et al., 2008).

In addition to the reduction in the acreage of premining habitats, this land transformation produces discontinuous patches, or fragments, within the original habitat that remains. Where continuous habitat once existed, patches of premining and postmining (i.e. transformed) habitat now exists, and in general the size of a habitat is the primary determinant of the number of species it can support (Rosenzweig, 1995). This habitat fragmentation often does not provide sufficient continuous cover, forage, or area to support the original wildlife populations that existed before mining and may cause species to become threatened or endangered, and can contribute to species extinction (Rosenzweig, 1995). Bird, mammal, and insect species of forest interiors may refuse to cross even very short distances of open areas (e.g., land transformed by mining), reducing their ability to feed, reproduce, and maintain healthy populations (Laurance and Bierregaard, 1997; Primack, 2002). Crooks, et al. (2001) examined the impact of habitat fragmentation on eight bird species in chaparral and sagebrush communities of the U.S. and found that smaller habitat fragments had higher rates of extinction and lower rates of colonization by the birds.

As species of plants and animals are often adapted to narrow ranges of environmental conditions, changes in those conditions may make the habitat unsuitable once it is fragmented Habitat fragmentation also produces more edge habitat where interior habitat once existed. These edge habitats have reduced quality for some species due to changes in light, temperature, humidity, and wind, as well as increases in the incidence of fire (Stevens and Husband, 1998). Nests located along the edge may be more vulnerable to discovery and predation. Each effect can significantly influence the vitality and composition of species within the fragment (Primack, 2002). Shade-tolerant plant species and humidity-sensitive animals, such as amphibians, are often rapidly eliminated in edge habitats; invasive plants along the habitat edge can disperse seeds into the habitat interior where they may become established (Primack, 2002).

As with any type of land clearing activity, land clearing for mining increases the likelihood that invasive species can take hold within the cleared areas and encroach into surrounding intact habitats (Hobbs and Humphries, 1995). Surface mining techniques (such as area mining) involve more surface disturbance and therefore a higher potential for encouraging encroachment of invasive species Land clearing continues in phases through the active operation of the mine; invasive plant species that colonize one area then become established and spread to other areas as mining progresses (Richardson et al., 2000).

Because many invasive species are aggressive early colonizers of disturbed areas, even temporary spoil/overburden piles can offer invasive plants a foothold for establishment (Richardson et al., 2000). The magnitude of the adverse impacts may differ among coal extraction methods, depending on their methods of disposal. The dragline method of area mining has relatively lower potential for adverse impacts, as the excess spoil is placed in the cut or strip, reducing the area required for disposal, which in turn reduces the area available for invasive species to become established. Other mining methods, such as open-pit mining, and mountaintop removal mining may have Moderate to High Adverse impacts related to the spread of invasive species, as they often require larger areas for spoil disposal compared to other coal extraction methods. This is not universally true, however. In a study of terrestrial plant populations of forested and reclaimed sites, Handel (2003) found few invasive species on mined sites within the study area.

In summary, existing regulations under the No Action Alternative contain many mechanisms for ensuring protection of fish, wildlife, and related environmental resources but coal mining practices occurring under these regulations continues to have adverse effects on aspects of the biological, chemical, and physical environment. These adverse impacts include: fragmentation of habitats; degradation of habitat quality; exposure of biota to changed chemical conditions in aquatic environments; and permanent loss of terrestrial and aquatic habitat. Adverse impacts would continue to occur, as described above, with all mining methods and in all coal regions under the No Action Alternative.

4.2.2.2 Action Alternatives and Potential Effects on Biological Resources

The Action Alternatives include elements intended to reduce the adverse effect of coal mining activities on biological resources. Table 4.2.2-1 describes the specific elements of the Alternatives that may affect biological resources. The discussion below describes how the rule elements vary by Alternative, and how they may affect the biological resources described in Table 4.2.2-1.

Table 4.2.2-1
SPR Elements and Potential Effects on Biological Resources in Coal Mining Regions

SPR Element	Forest Land Cover/ Habitat	Riparian Habitat	Fish and Wildlife, Including T&E Species
Baseline Data Collection and Analysis		■	■
Monitoring During Mining and Reclamation		■	■
Definition of Material Damage to the Hydrologic Balance		■	■
Corrective Action Thresholds		■	■
Mining Through Streams	■	■	■
Activities In or Near Streams Including Placement of Excess Spoil and Coal Refuse	■	■	■
Revegetation, Topsoil Management, and Reforestation	■	■	■
Fish and Wildlife Protection and Enhancement	■	■	■

<u>Protection of the Hydrologic Balance</u>

As described more fully in Chapter 2, the rule elements described under this functional group are related to direct water sampling procedures, collection and review of stream hydrologic parameters, clarifying a federal definition for *material damage to the hydrologic balance*, and establishing the early detection of impending material damage to the hydrologic balance to promote prevention (i.e., corrective action thresholds). These elements focus on reducing the effect of mining activities on water quality at and in the vicinity of mine sites.

Under the No Action Alternative, RAs have approved stream-channel diversions and reconstructed stream channels that focus primarily on creation of a stable channel instead of the restoration of stream form and function. Consequently, reconstructed streams often neither look nor act in the way they did before mining. Frequently, these reconstructed stream channels no longer support the same abundance or diversity of benthic organisms and aquatic communities after mining.

The rule elements related to protection of the hydrologic balance have implications for biological resources that may not be readily apparent. These benefits derive primarily from the water quality described in Section 4.2.1. Protection of the hydrologic balance is achieved through several interrelated elements. For instance, newly collected monitoring data on selenium may show elevated concentrations in water. A clearly defined corrective action threshold may facilitate prompt changes in the mining operation to limit selenium contamination. This action may help avoid bioaccumulation of selenium in fish and in wildlife that consume fish (e.g., raptors). In this way, rule elements that improve water quality are also likely to benefit aquatic and riparian fish and wildlife communities.

Activities in or Near Streams: Mining Through Streams

The No Action Alternative allows for exemptions from general prohibitions against mining in or through streams. While it is feasible to restore the form and function of stream segments that are mined through or permanently diverted as a result of mining, there is no requirement to restore ecologic function. In addition it may be difficult to restore ecologic function of certain high gradient streams and or high quality streams. As a result, biological resources may be negatively impacted.

The Action Alternatives limit the circumstances under which streams may be mined through and increase ephemeral stream restoration, providing benefits to biological resources. Specifically:

- Alternatives 2 and 7 (in areas warranting enhanced permitting requirements) would prohibit all mining activities in or within 100 feet of a perennial stream and require hydrologic form and ecologic function restoration for all perennial and intermittent streams. Ephemeral streams would be restored in form only. These additional requirements would result in increased protection of in-stream and riparian habitat, ensuring that fewer streams are negatively affected by mining activities. Where forest land cover occurs within 100 feet of a perennial stream, this rule element would also reduce deforestation within a coal region. With less disruption of the aquatic resources at the mine site, there may be improved water quality, greater similarities between premining and postmining stream flow, and reduced impacts on aquatic habitat downstream. While this benefit applies to all mine sites under Alternative 2, Alternative 7 would only be applicable to a limited subset of mines, as described in Chapter 2. As a result, Alternative 2 restrictions on mining through streams and additional stream restoration requirements are expected to generate the greatest benefits to biological resources. The benefits would accrue primarily in the Appalachian Basin, with other regions realizing more limited benefits.
- Alternatives 3, 4, 5, 6, and 8 (Preferred) would implement additional protections to all

streams, including requiring that at least some ephemeral streams be restored in form. These additional protections would likely improve water quality and positively impact downstream biological communities as described above for Alternatives 2 and 7, but to a lesser extent. In addition, Alternative 5 pertains specifically to the Appalachian region and therefore generates benefits in a more limited geographic region than Alternatives 3, 4, 6, and 8 (Preferred).

- Alternatives 7 (in areas not warranting enhanced permitting requirements) and 9 are identical to the No Action Alternative with respect to mining through streams and would in these circumstances continue the same degree of impact.

Activities In or Near Streams: Excess Spoil and Coal Refuse

Mining activities in and within 100 feet of streams, and the treatment of excess spoil and coal refuse, may adversely affect onsite riparian and downstream habitat. Excluding Alternative 9, all of the Action Alternatives (Alternatives 2 through 8) increase the stringency of the historic requirements that guide mining activities near streams and the placement of excess spoil and refuse. In particular, under Alternative 2, mining operations would be prohibited from filling perennial streams. In special circumstances (see section 2.4.7), Alternative 7 would also prohibit these activities. All Alternatives would also restrict mining activities within 100 feet of perennial and intermittent streams, providing benefits for both water quality and wildlife.[22]

Postmining Land Use and Enhancement: Revegetation, Topsoil Management, and Reforestation

This rule element dictates the types and levels of postmining revegetation, including reforestation, required under each of the Action Alternatives. As such, this rule element most directly influences the quantity and quality of forest land cover and other vegetative communities within the coal mining regions. The loss of forest and other habitat at mine locations under the No Action Alternative has a direct adverse effect on wildlife by reducing the total quantity of available habitat, as well as an indirect effect through habitat fragmentation. Impaired habitat conditions adversely affect the ability of a coal mining region to support particular species and may in turn negatively affect wildlife-related recreational activities, including hunting and wildlife viewing (as described in Section 4.3.3). Forest and other vegetated lands also provide benefits by increasing the carbon sequestration potential of the landscape (i.e., reducing the amount of carbon in the atmosphere). This benefit is described in the "Potential Climate Stabilization Benefits of Reforestation" text box below, and is detailed in Section 4.2.4.

In addition, reduced forest land cover and riparian vegetation impairs water quality, as described in Section 4.2.1. Specifically, the vegetation provides a filter for contaminants as runoff travels across the landscape to receiving water bodies. This rule element focuses on increasing forest and vegetative habitat following mining, but may also benefit the quality of adjacent riparian and aquatic habitats.

[22] Peer reviewers emphasized the importance of stream buffers and habitat enhancement. In particular, the Galum Creek forested riparian corridor documented by Willard, et al. (2013) exemplifies a successful postmining wildlife habitat restoration effort. Communication from Jack Nawrot, "OSM Proposed Stream Rules: Comments – Water and Biological Resources."

The Action Alternatives propose a mix of regulatory changes with respect to revegetation, topsoil management, and reforestation:

- Alternatives 2, 3, 4, 5, 6, 7 (in areas subject to the enhanced permitting requirements), and 8 (Preferred) require reforestation of previously forested areas and of lands that would revert to forest under conditions of natural succession (with an exception for prime farmland). Reforestation would be implemented in a manner that expeditiously enhances the recovery of the native forest ecosystem.
- Alternatives 2, 3, 4, 5, 7, and 8 additionally specify that the revegetation be completed using only native species unless the postmining land use is actually implemented before the end of the revegetation responsibility period. To promote vegetation growth, these Action Alternatives also require the salvage and redistribution of all topsoil (A and E soil horizons) and of the B and C soil horizons to the extent necessary to achieve optimal rooting depths to restore premining land use capability or comply with revegetation requirements.
- Alternatives 2, 4, and 7 require salvage and redistribution or reuse of all vegetative organic materials above the A soil horizon to promote reestablishment of diverse native vegetation and prohibits burning or burying of vegetation or other organic materials. However, Alternatives 3 and 5 require salvage and redistribution of materials from native vegetation above the A soil horizon and root balls only to the extent determined necessary by a qualified ecologist or similar expert. Under those alternatives, the remaining debris from native vegetation could be buried, but not burned. Alternative 8 is similar to Alternatives 3 and 5, but it also prohibits burying of native vegetation.
- Alternatives 7 (in areas not subject to the enhanced permitting requirements) and 9 are identical to the No Action Alternative with respect to revegetation, topsoil management, and reforestation.

Postmining Land Use and Enhancement: Wildlife Protection and Enhancement

The Action Alternatives contain elements that would improve the quality and/or quantity of habitat within a permit boundary, increasing wildlife species richness and abundance within the permit boundary and on adjacent lands. These benefits to wildlife species may improve wildlife-related recreational experiences in the coal regions, as described in Section 4.3.3.

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POTENTIAL CLIMATE STABILIZATON

BENEFITS OF REFORESTATION

Carbon dioxide and other greenhouse gases released into the atmosphere contribute to climate change. Carbon sequestered by and stored in soils and vegetative biomass reduces the total amount of carbon present in the atmosphere, mitigating adverse effects of climate change (e.g., crop damage, coastal protection costs, land value changes, and human health effects). In other words, the value of carbon sequestered reflects the avoided damage generated by that carbon if it is present in the atmosphere. Where forest land cover is lost or is less productive, the carbon storage potential of the landscape is reduced.

Changes in carbon storage potentials are not quantified in this analysis due to the significant uncertainty surrounding carbon sequestration rates over time for forests according to varying revegetation and forest management practices. As the revegetation practices of the Action Alternatives are focused on expeditiously returning productive forest land cover postmining, however, some level of associated benefit in terms of increased carbon sequestration rates on improved acres is likely.

A number of studies have measured carbon sequestration rates for forests and soils at reclaimed mine sites, particularly in the Midwest and Appalachia (e.g., Amichev et al., 2008; Chaudhuri et al., 201;, Zipper et al., 2011; and Midwest Regional Carbon Sequestration Partnership (MRCSP), 2011). These studies generally found that reforestation, as opposed to revegetation to grass or pastureland, increases carbon sequestration rates at the reclamation sites. Carbon sequestration rates of reforested mine sites were, however, less than non-mined forested stands. For example, non-mined hardwood stands in Appalachia contained 62 percent more carbon than the average mined and reforested stands (Amichev et al., 2008). This indicates that reforestation practices in the region have increased carbon sequestration rates as compared to other revegetated land cover, but did not recover the premining carbon sequestration potential of the forested sites.

More recently, the ARRI has encouraged the creation of more valuable timber stands on reclaimed forest land through voluntary implementation of soil management and planting practices referred to as the Forestry Reclamation Approach (FRA). The soil management and planting practices described by OSMRE’s Action Alternatives are similar to FRA practices. The objective is to promote more productive forest stands postmining, which would increase carbon sequestration potential of the reclaimed stands. While implementation of FRA practices is increasing, the approach is still relatively new. The oldest FRA-reclaimed sites are less than a decade old. As a result, additional time and study are required to determine the extent to which these practices are restoring forest ecosystem services, including carbon sequestration, to mined sites (Zipper et al., 2011).

With respect to wildlife protection and enhancement, the Action Alternatives differ in the following ways:

- Under Alternatives 2, 6, and 8 (Preferred) all stream reaches within or adjacent to coal mining operations require a 100-foot riparian buffer (whereas the No Action Alternative provides qualitative guidance on activities bordering waterways). By implementing specific criteria to be met during and after coal mining operations, the likelihood of disrupting habitats and associated wildlife is decreased. This buffer benefits not only the flora and fauna occupying the riparian habitat, but also the connected terrestrial and aquatic communities beyond the permitted site.
- Alternatives 3 and 4 require establishment of a 300-foot riparian corridor along intermittent and perennial streams. These Alternatives also specifically detail the scenarios in which enhancement measures for fish and wildlife resources would be mandatory, including the long-term loss of native forest or plant communities, or the filling of perennial or intermittent streams. Similar to Alternative 2, Alternatives 3 and 4 decrease the probability that wildlife habitat, both aquatic and terrestrial, would be negatively impacted as a result of mining activity. While the benefit to intermittent and perennial streams is greater due to the 300-foot as opposed to 100-foot riparian corridor, Alternatives 3 and 4 do not include a riparian corridor requirement for ephemeral streams. The relative benefits of Alternative 2, 6, and 8 (Preferred) as compared with 3 and 4 accordingly depend on the types of streams present at a mine site. For example, where ephemeral streams are abundant and intermittent and perennial streams scarce, Alternative 2 likely provides a greater benefit.
- Alternatives 5 and 7 require a 100-foot riparian buffer for all streams, similar to Alternatives 2, 6, and 8 (Preferred). However, because the regulations under Alternatives 5 and 7 would only apply under specific circumstances (as described in Chapter 2), associated benefits to riparian and aquatic biological communities apply to a more limited geographic region.
- Alternative 9 would make no changes and bring no additional benefits to these resources in comparison to the No Action Alternative. Under these alternatives the RA could authorize activities within 100 feet of perennial and intermittent streams, and there would be no additional specific requirement to create a preserved buffer along the length of the stream.

With respect to federally listed threatened and endangered species, all Action Alternatives but Alternatives 6 and 9 also require the fish and wildlife protection and enhancement plan in the SMCRA permit application to include any species-specific protection and enhancement plans developed in accordance with the ESA and any applicable biological opinion. As described in Chapter 2, under the No Action Alternative, such a plan is encouraged under current policy guidance following the U.S. FWS's 1996 BO, but is not required. In addition, the Action Alternatives (except Alternatives 6 and 9) would codify the findings of the dispute resolution provisions of the 1996 BO concerning protection of threatened and endangered species. While these improvements would make the process work more efficiently and improve the outcome of efforts to avoid and minimize take of species, regardless of alternative selected mining operations conducted under SMCRA would continue to be subject to the full requirements of the ESA.

4.2.2.3 Analytic Methods for Assessing Forest Land Cover

The Action Alternatives benefit forest resources to varying degrees. Available data allow characterization of potential impacts for two quantitative indicators:

- The number of improved forest acres; and
- The number of preserved forest acres.

The subsections below present the data and analytic methods used to evaluate the Action Alternatives with respect to these two quantitative indicators.

In addition, the Action Alternatives have the potential to benefit riparian habitat as well as fish and wildlife (including threatened and endangered species). While data are not sufficient to support a quantitative analysis of these impacts, the results discussion evaluates them qualitatively, allowing further comparison of the Alternatives.

Methods for Assessing Improved Forest Acres

The improved forest acres metric quantifies the amount of land that would benefit from improved postmining forest land cover due to the Action Alternative, either because: (a) the land would have been restored to grassland, pastureland, or an alternative postmining land use under the No Action Alternative; or (b) the land would have been reforested under the baseline without practices that promote expeditious growth of healthier forest (e.g., Forestry Reclamation Approach (FRA) with practices similar to those reforestation practices described under Alternative 2 in Chapter 2).

The volume of forest acreage that typically exists before mining at mine sites is a useful starting point for assessing how the Action Alternatives differ with respect to reforestation benefits and for identifying regions where reforestation benefits may be greatest. To estimate this acreage, this analysis uses available historical land cover data (the oldest comprehensive dataset was 1992) at sites that have since been mined. As such, Table 4.2.2-2 summarizes the land cover in 1992 that was present at mine sites that were developed after 1992 in each of the coal regions in order to understand premining land cover conditions in each region. This analysis of land cover at mine sites relies upon the following information for each coal region: (1) GIS-based 1992 land cover data;[23] (2) GIS data describing locations of mines;[24] and (3) the size of the typical disturbed area for surface and underground model mines in each region, as determined by the engineering analysis (i.e., model mine analysis) described in Section 4.1. This acreage was used as a buffer around the mine site locations to understand the typical land cover at study sites.

[23] This analysis applies historical land cover data from the USGS's National Land Cover Dataset (NLCD). The NLCD identifies land cover data from 1992 accordingly to 21 land cover classes.

[24] GIS data on historic mines (mine sites developed after 1992) are from: the National Mine Map Repository; Arkansas Department of Environmental Quality; Colorado Division of Reclamation Mining and Safety; Illinois State Geological Survey; Indiana Geological Survey; and Texas Railroad Commission.

Table 4.2.2-2
Premining Land Cover at Historic Mine Sites

Land Cover Category	Appalachia Central - Surface	Appalachia Northern - Surface	Appalachia Central - Under-ground	Appalachia Northern - Under-ground	Colorado Plateau Surface	Colorado Plateau Under-ground	Gulf Coast Surface	Illinois Basin Surface	Illinois Basin Under-ground	Northern Rocky Mountains Surface	Western Interior Surface
Water	0%	2%	1%	3%	1%	0%	1%	1%	6%	0%	1%
Developed	1%	2%	4%	14%	4%	0%	0%	0%	2%	0%	0%
Barren	4%	6%	14%	14%	0%	0%	13%	2%	10%	6%	2%
Deciduous Forest	84%	54%	71%	45%	3%	28%	18%	17%	15%	2%	84%
Evergreen Forest	1%	3%	1%	5%	51%	27%	3%	2%	2%	3%	1%
Mixed forest	8%	6%	5%	4%	0%	0%	5%	0%	1%	0%	3%
Agricultural	2%	27%	2%	13%	1%	14%	31%	75%	59%	4%	10%
Grass/Shrubs	0%	0%	0%	0%	39%	30%	25%	0%	1%	84%	0%
Woody wetlands	0%	0%	0%	0%	0%	0%	2%	1%	4%	0%	0%
Emergent Herbaceous Wetlands	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%
Total forests	93%	63%	78%	55%	55%	55%	26%	19%	17%	5%	88%
*Number of Reference Points**	*49*	*18*	*117*	*55*	*1*	*4*	*24*	*95*	*44*	*17*	*2*

Notes: Due to limited historic mining activity in the Northwest region, data are not available to describe typical land cover at historic mining locations in the Northwest region.
* The number of reference points describes the number of relevant mines site for which GIS data were available to describe locations and land cover.
Source: USGS, 2011c.

The overlap between minable coal and forested landscapes is most prevalent in the Appalachian Basin, as demonstrated in Table 4.2.2-2.[25] Total premining forested land cover ranges between 55 percent (for underground mines in Northern Appalachia) to 93 percent (for surface mines in Central Appalachia). Premining forest cover is also prevalent at Colorado Plateau mining sites.

This analysis quantifies "improved" forest acres according to the following methods:

Step 1: Estimate the acres of forest cut per million tons of coal produced at surface and underground mines in each region and under each Alternative.

a) *Determine the land area (in acres) disturbed by surface and underground mines at model mines in each region under each Alternative.*
This first step references the estimated "disturbed area" at each of the Model Mines under each of Alternatives 1 through 9, as described in the engineering analysis in Section 4.1. The disturbed areas vary only slightly across Alternatives. Specifically, under Alternative 2 in Appalachia the disturbed area for surface mines is slightly decreased reflecting a change in the design of mines to comply with the Alternative 2 rule elements (e.g., avoiding streams and reducing fills).

b) *Determine proportion of the disturbed area likely to be forest land cover premining for each mine type (surface and underground) in each region.*
To accomplish this, this analysis references the premining "typical" land cover types for surface and underground mines in each region based on historical precedence, as described in Table 4.2.2-2. This information is summarized in Column A of Table 4.2.2-3 (discussed below). The analysis assumes that the percentage of forested land cover at a mine site does not vary across Alternatives.

c) *Calculate the number of forest acres disturbed by typical mines for each mine type and region under each Alternative.*
Multiply the total disturbed area (Step 1a) by the proportion likely to be forest (Step 1b). The result is the number of forest acres cut at typical surface and underground mines in each region.

d) *Calculate disturbed (i.e., cut) forest acres per million tons of coal produced for each mine type and region.*
Divide the total disturbed forest acres at each Model Mine calculated in Step 1c by the level of coal produced at each Model Mine as determined by the engineering Model Mine analysis (described in Section 4.1).

The result of this step is a series of multipliers used to calculate the amount of forest cut per million tons of coal produced by surface and underground mining methods in each region. There is limited variation in these multipliers across Alternatives because the

[25] While this analysis focuses specifically on forested lands, mines may affect multiple types of vegetative cover, as described in Table 4.2.2-2 (including grass, shrub, and cropland). However, the Action Alternatives do not identify explicit differences with regard to revegetation practices for other land cover types beyond native species requirements and soil management practices.

disturbed areas and tons of coal produced at the Model Mines do not vary measurably across Alternatives. The exception is an estimated reduction in the disturbed area for Central Appalachian surface mines under Alternative 2 (resulting in a slightly lower multiplier for forested acres disturbed per volume of coal produced under this Alternative). These multipliers are described in Column B of Table 4.2.2-3 below.

Step 2: Establish reforestation practices under the No Action Alternative.

a) *Determine level of reforestation occurring under the No Action Alternative in each region.*
Although not required, reforestation of mine sites is occurring in some regions. In particular, in Appalachia reforestation has become increasingly practiced in recent years. Based on this recent experience, OSMRE estimates that approximately 70 percent of all mining permits are being reclaimed as forestland in the Appalachian Basin region.[26] According to OSMRE's postmining land use data for 2007 through 2010, reforestation is occurring to a lesser extent in the Gulf Coast (approximately four percent of reclaimed acreage) and the Illinois Basin (approximately 11 percent). All other regions are implementing reforestation at negligible rates.[27] The level of baseline reforestation occurring under the No Action Alternative is provided in Column C of Table 4.2.2-3.

b) *Determine level of reforestation occurring under the No Action Alternative in each region that complies with the "improved" reforestation practices (i.e., revegetation, topsoil management, and reforestation elements) described by the Action Alternatives.*
With the exception of some sites in Appalachia, the improved reforestation practices (i.e., FRA practices) required in Alternatives 2, 3, 4, 5, 7 and 8 are generally not being implemented under the No Action Alternative. The improved reforestation practices were first implemented at limited sites in Appalachia beginning in about 2006 (Zipper, et al., 2011). According to data gathered by the ARRI, approximately 37 percent of the trees planted at reclaimed mine sites in Appalachia in 2012 were planted according to the improved reforestation methods.[28] As described in Column D of Table 4.2.2-3, this analysis assumes that 37 percent of disturbed forest in Appalachia is being reclaimed according to improved reforestation practices.

[26] Information provided by OSMRE forestry staff to IEc on July 26, 2013.

[27] Information on reforestation rates for all coal regions except Appalachia is derived from OSMRE data on postmining land use (PMLU) by state and region for 2007 through 2010; these data are compiled from OSMRE's Annual Oversight Reports. Note that the PMLU figures are not directly equivalent to reforestation rates. Specifically, while the reforestation rate is the percent of premining forest land that is reforested, the PMLU forestry rate is the percent of all mined land on which forests are planted. The PMLU forestry rate will be less than the true reforestation rate to the extent that forest land is returned to another use (e.g., agriculture). The PMLU rates are presented to acknowledge that mine operators in some regions appear to implement modest reforestation efforts as part of postmining land use programs.

[28] ARRI data provided by OSMRE on August 13, 2013, "ARRI FRA Data: 2012 Appalachian Region Tree Planting Numbers." While these data reference the percentage of trees planted according to FRA practices, this analysis relies on this percentage as a proxy for the share of the reforested acres planted according to FRA practices.

Step 3: Determine expected reforestation levels under the Action Alternatives.

Action Alternatives 2, 3, 4, 5, 7, and 8 (i.e., all except Alternative 6 and 9) require that reforestation be implemented according to improved reforestation practices to varying degrees (as described in Subsection 4.2.2.2). In addition to specifying reforestation practices, these Alternatives also require that all previously forested acres and lands that would revert to forest under conditions of natural succession be reforested. All of the Action Alternatives include an exception for prime farmland. Absent specific information on the share of previously forested area that would be eligible for exception, this analysis conservatively assumes that 70 percent of the previously forested acres would be forested in each region under the Action Alternatives (Column E of Table 4.2.2-3). This assumption likely leads to an understatement of potential benefits in terms of improved forest acres, as less than 30 percent of the mine sites may be eligible for exceptions to reforestation requirements.

Step 4: Calculate number of reforested acres according to improved reforestation practices under the No Action Alternative from 2020 to 2040.

a) Calculate the estimated forest cut by surface mine activity in each region.
Multiply surface coal production under the No Action Alternative across the timeframe of the analysis by the forested acres cut per million tons of coal produced by surface mines (Step 1, Column B of Table 4.2.2-3). This calculation yields an estimate of the amount of forest cut in each region due to surface mine activity.

b) Calculate the estimated forest cut in each region by underground mine activity.
Repeat step 4a for underground mine activity.

c) Estimate the total regional forest cut.
Sum the expected forest cut due to surface and underground coal mining activity to estimate total forest cut at the regional level across the timeframe of the analysis.

d) Calculate the acres reforested according to improved practices under the baseline.
Multiply the acres of forest cut by the baseline improved reforestation rate for each region (Column D of Table 4.2.2-3). This represents acres reforested according to improved practices under the baseline.

Step 5: Calculate number of reforested acres according to improved reforestation practices under the Action Alternatives (Alternatives 2, 3, 4, 5, 7, and 8) from 2020 to 2040.

Repeat Step 4 using the coal production, forest acres cut per million tons of coal produced (Step 1, Column B of Table 4.2.2-3), and reforestation rates (Column E of Table 4.2.2-3) for each of the relevant Action Alternatives (Alternatives 6 and 9 are the same as the No Action Alternative).

Step 6: Calculate total forest acres improved.

Subtract the No Action Alternative reforested acres (Step 4) from the Action Alternative reforested acres (Step 5) to determine the number of forest acres that are improved due to implementation of each Action Alternative in each region.

Step 7: Calculate average annual forest acres improved.

To estimate average annual acres improved in each region, divide the total improved acres (2020 to 2040) by the 21-year timeframe of the analysis.

Table 4.2.2-3
Assumptions of Land Cover and Reforestation Practices for the Improved Forest Acres Analysis

Mine Region (Type)		A: Percent Premining Forest Land Cover	B: Forest Acres Cut per Million Tons of Coal Produced	C: No Action: Percent Reforested (Postmining Land Use)	D: No Action and Alternatives 6 and 9: Percent Reforested Applying Improved Methods	E: Alternatives 2, 3,4,5,7, 8: Percent Reforested Applying Improved Methods
SURFACE MINES						
Appalachia	North	63%	73.1 (63.8 for Alt 2)[b]	70%	37%	70%
	Central	93%				
Colorado Plateau		55%	19.8	0%	0%	70%
Gulf Coast		26%	12.7	4%	0%	70%
Illinois Basin		19%	16.4	11%	0%	70%
Northern Rocky Mountains and Great Plains		5%	0.3	0%	0%	70%
Northwest		5%[a]	0.7	0%	0%	70%
Western Interior		88%	75.7	0%	0%	70%
UNDERGROUND MINES						
Appalachia	North	55%	6.9	70%	37%	70%
	Central	78%				
Colorado Plateau		55%	1.2	0%	0%	70%
Illinois Basin		17%	0.7	11%	0%	70%
Northern Rocky Mountains and Great Plains		5%	0.4	0%	0%	70%
Western Interior		88%	0.6	0%	0%	70%

Notes:
[a] Absent specific information on land cover at typical surface mines in the Northwest region, this analysis relies on the Northern Rocky Mountains and Great Plains region as a proxy.
[b] The cut forest acres per ton of coal produced is slightly less under Alternative 2 as mines in this region under this Alternative disturb less total acreage but produce the same total amount of coal.

Methods for Assessing Preserved Forest Acres

Preserved forest areas are forest areas that are left undisturbed because of a decrease in surface coal mining activity.[29] Implementation of the Action Alternatives may benefit forest habitat in the coal regions by reducing overall levels of coal production or by shifting coal production from surface methods (which require cutting more forest) to underground methods.

This analysis quantifies "preserved" forest acres according to the following methods:

Step 1: Estimate the acres of forest cut per million tons of coal produced at surface and underground mines under the No Action Alternative.

Similar to Step 1 of the methods for calculating improved acres, the evaluation of preserved acres first requires calculating region-specific multipliers describing the amount of forest cut per million tons of coal produced by surface and underground mining methods.

a) *Determine the land area (in acres) disturbed by surface and underground mines at the Model Mines in each region under the No Action Alternative.*
This first step references the estimated "disturbed area" at each of the Model Mines under the No Action Alternative (Alternative 1).

b) *Determine proportion of the disturbed area likely to be forest land cover premining for each mine type (surface and underground) in each region.*
This information is summarized in Column A of Table 4.2.2-3 above.

c) *Calculate the number of forest acres disturbed by the Model Mines for each mine type and region under the No Action Alternative.*
Multiply the total disturbed area (Step 1a) by the proportion likely to be forest (Step 1b). The result is the number of forest acres cut at the model surface and underground mines in each region under the No Action Alternative.

d) *Calculate disturbed (i.e., cut) forest acres per million tons of coal produced for each mine type and region.*
Divide the total disturbed forest acres at each Model Mine calculated in Step 1c by the level of coal produced (in terms of millions of tons) at each Model Mine as determined by the engineering Model Mine analysis (described in Section 4.1).

Step 2: Calculate forest acres cut under the No Action Alternative in each region across the timeframe of the analysis.

Multiply surface coal production under the No Action Alternative across the timeframe of the analysis by the relevant region-specific cut forest acres multiplier for surface mining from Step 1. Undertake the same calculation for underground coal production. Sum the total acres of forest cut to accommodate surface and underground coal production from

[29] In this analysis, "preserved" forest acres are those areas not cleared for mining during the study period. The forests are not preserved in perpetuity, i.e., they may be cleared for other purposes at some point in the more distant future.

2020 to 2040 to estimate total acres of forest cut for coal mining under the No Action Alternative.

Step 3: Calculate forest acres cut under the Action Alternatives in each region across the timeframe of the analysis.

Conduct the same calculation as in Step 2, but rather than basing acres cut on baseline production, base acres cut on estimated coal production (by region and surface or underground mine methods) for each of the Action Alternatives.

Step 4: Calculate total and average annual forest acres preserved due to implementation of the Action Alternatives.

Subtract the total forest acres cut under the Action Alternatives (2020 to 2040) from the total forest acres cut under the No Action Alternative (2020 to 2040). The difference reflects forest acres preserved due to implementation of the Alternatives. Divide the total number of preserved acres by the 21-year timeframe of the analysis to estimate average annual forest acres preserved by region.

4.2.2.4 Analytic Results for Assessing Forest Land Cover

<u>**Estimate of Improved Forest Acres**</u>

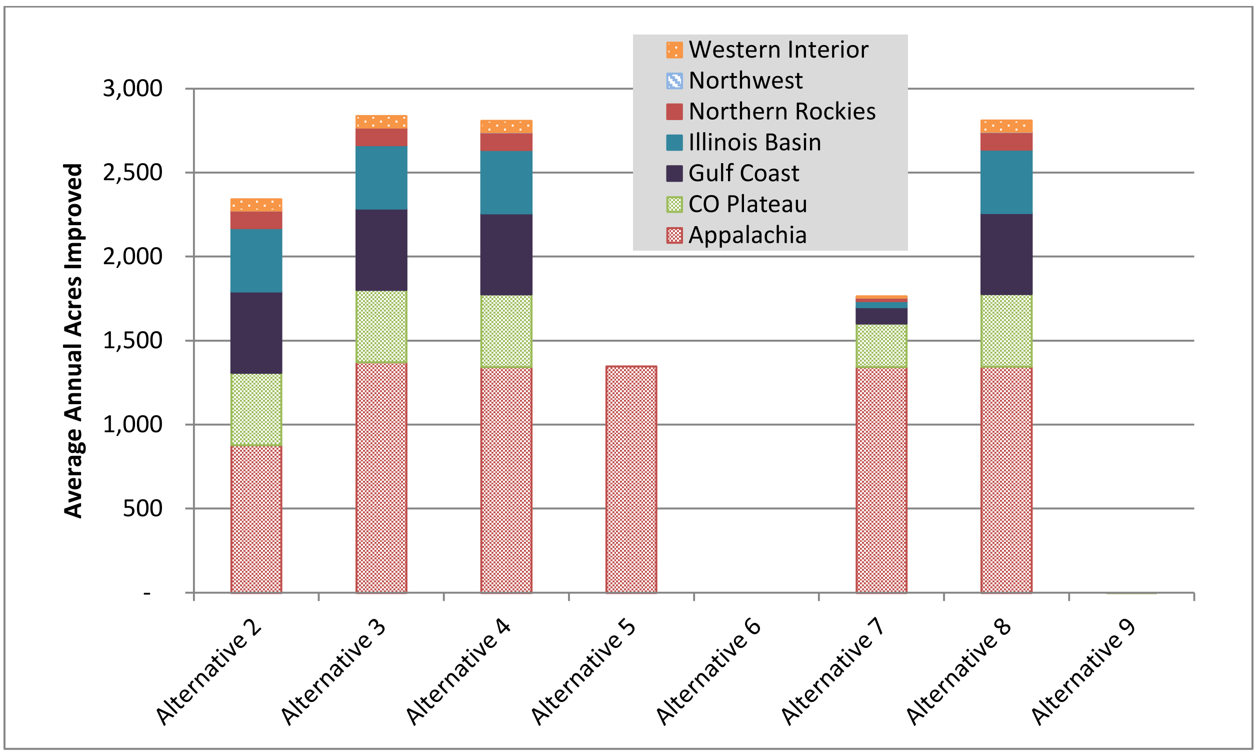
Table 4.2.2-4 and Figure 4.2.2-1 present the results of the analysis of improved forest acres. While Alternative 2 prescribes similar reforestation improvements to several other Action Alternatives (Alternatives 3, 4, and 8), the benefits associated with Alternative 2 in terms of acres of improved forest are less. This result occurs because the estimated amount of coal produced under Alternative 2 is less than under the other Action Alternatives. As a result, fewer forest acres are cut under Alternative 2, which results in more preserved forest acres and fewer improved forest acres. Moreover, as noted above, typical surface mines in Central Appalachia designed according to the requirements of Alternative 2 are associated with a reduced disturbed area compared to the other Alternatives. The amount of forest acres cut per million tons of coal produced under Alternative 2 in Appalachia is therefore slightly less than under the other Action Alternatives.

Alternatives 5 and 7 apply to a more limited geographic area and therefore benefit fewer acres than Alternatives 3, 4, and 8. Alternatives 6 and 9 do not require reforestation of previously forested areas; therefore, they generate no additional forest improvement benefits in comparison to the No Action Alternative.

Table 4.2.2-4
Average Annual Improved Forest Acres Analysis Results (2020 to 2040)

Alternative	Appalachian Basin	CO Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	Total Over the 21 Year Study Period (2020 to 2040)
Alternative 2	878	431	483	377	105	1	67	2342
Alternative 3	1,372	431	483	377	105	1	67	2,836
Alternative 4	1,344	431	483	377	105	1	67	2,808
Alternative 5	1,346	0	0	0	0	0	0	1,346
Alternative 6	0	0	0	0	0	0	0	0
Alternative 7	1,343	259	97	38	21	0	7	1,765
Alternative 8 (Preferred)	1,346	431	483	377	105	1	67	2,810
Alternative 9	0	0	0	0	0	0	0	0

Figure 4.2.2-1 Improved Forest Acres Analysis Results by Coal Region and Alternative



Estimate of Preserved Forest Acres

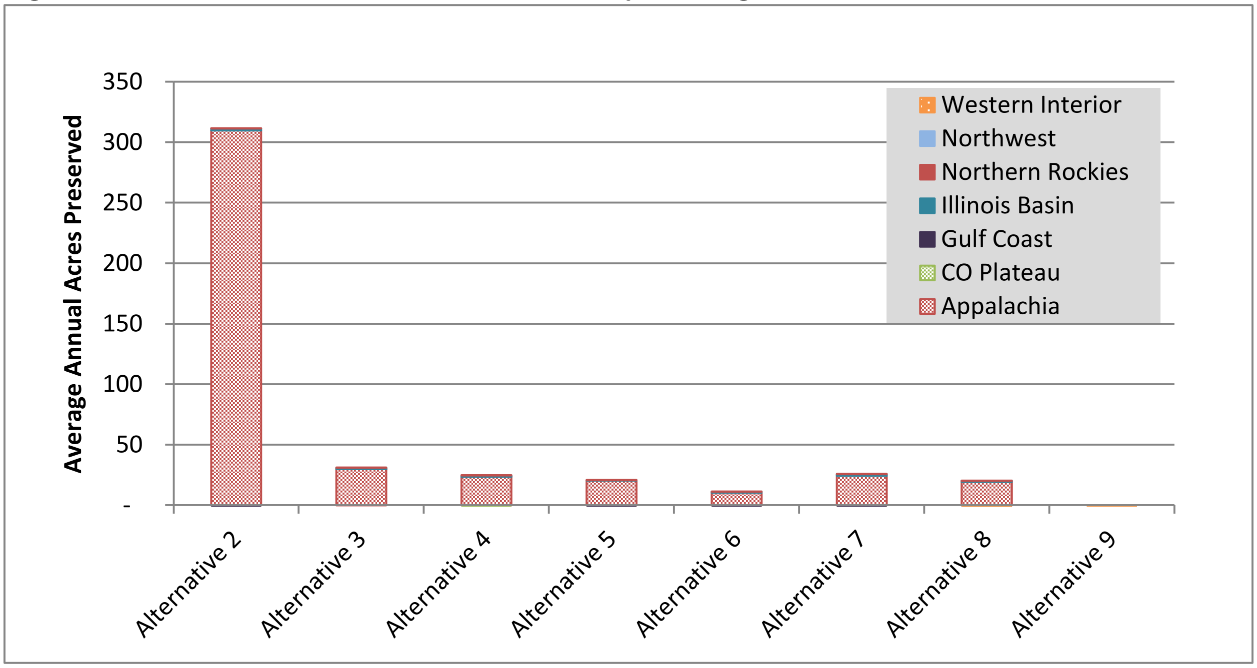
Table 4.2.2-5 and Figure 4.2.2-2 present the results of the preserved forest acres analysis. The benefits are largely limited to the Appalachian coal region for two reasons. First, coal mining (particularly surface production methods) requires cutting more forest in Appalachia than in other regions (see forest acres cut per million tons of coal produced multipliers in Table 4.2.2-3).

Second, implementation of the Action Alternatives affects overall coal production levels in Appalachia to a greater degree than in the other regions. As a result of these factors, implementation of the Action Alternatives in Appalachia reduces the amount of forest cut. The effect is generally zero or Negligible in the other coal mining regions. Alternative 2 generates the greatest benefit in terms of preserving forest land cover as this Alternative is associated with the greatest reduction in surface coal production.

Table 4.2.2-5
Average Annual Estimate of Preserved Forest Acres (2020 to 2040)

Alternative	Appalachian Basin	CO Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	Total Over the 21 Year Study Period (2020 to 2040)
Alternative 2	310	0	0	1	0	0	0	311
Alternative 3	30	0	0	1	0	0	0	31
Alternative 4	24	0	0	1	0	0	0	25
Alternative 5	20	0	0	1	0	0	0	21
Alternative 6	10	0	0	1	0	0	0	11
Alternative 7	24	0	0	1	0	0	0	25
Alternative 8 (Preferred)	19	0	0	1	0	0	0	20
Alternative 9	0	0	0	0	0	0	0	0

Figure 4.2.2-2 Estimate of Preserved Forest Acres, by Coal Region and Alternative



4.2.2.5 Qualitative Analysis of Effects on Riparian Habitat

A key focus of the Action Alternatives is also to improve riparian habitat. As discussed in Subsection 4.2.2.2, multiple elements within each Action Alternative benefit the quantity and quality of riparian habitat in the coal regions, most directly the establishment of riparian corridors. In addition, rule elements that benefit water quality on and downstream of mine sites (e.g., protection of hydrologic balance and limitations on activities in or near streams) may likewise reduce the effects of mining on riparian habitats surrounding streams.

Requirements to implement riparian buffers with native, non-invasive vegetation provide the most direct benefit to riparian habitat. The purpose of the riparian corridors is to support restoration of the ecological function of streams impaired by mining activities. Consequently, in addition to increasing the overall availability of riparian habitat and supporting riparian species, these buffers protect water quality downstream and the aquatic communities contained within them.

Requirements for riparian buffers vary across the Action Alternatives. Alternatives 2, 5, 6, 7, and 8 (Preferred) require that all restored or permanently diverted stream reaches (perennial, intermittent, or ephemeral) implement a minimum 100-foot riparian buffer. On the other hand, Alternatives 3 and 4 specify a minimum 300-foot buffer comprising native, woody species but limit this requirement to restored or permanently diverted intermittent and perennial streams. While the benefit to intermittent and perennial streams is likely greater under Alternatives 3 and 4 due to the 300-foot, as opposed to 100-foot buffer, these two Alternatives do not include a buffer requirement for ephemeral streams. Alternative 9 would require a 100-foot buffer with allowable exceptions, and would be functionally similar to the No Action Alternative.

It is difficult to predict at a given mine site, or at the regional level, whether the larger, but more geographically limited buffers under Alternatives 3 and 4, or the smaller but more broadly implemented buffers under Alternatives 2, 5, 6, 7, and 8 (Preferred) would generate greater riparian and aquatic community benefits. The effects of the riparian corridors would depend on the relative presence of intermittent, perennial, and ephemeral streams. At sites, where limited or no ephemeral stream reaches are affected by mining, Alternatives 3 and 4 provide a greater benefit to the riparian and aquatic habitats within and downstream of the site. Conversely, where the majority of affected streams are ephemeral at a given site, Alternatives such as Alternative 2 provide the greater benefit.

Alternatives 5, 6, and 7 require a 100-foot riparian buffer for all streams, similar to Alternative 2. However, because the requirements under Alternatives 5 and 7 apply only under specific circumstances (as described in Chapter 2), the associated benefits to riparian and aquatic biological communities would be more limited than under Alternative 2, which is applicable to all surface coal mining operations. Likewise, all Alternative 6 elements apply only to activities in the 100-foot riparian corridor of intermittent or perennial streams.

Although not directly quantifiable, each of the Action Alternatives provide some benefit to riparian habitat above and beyond the protections of the No Action Alternative. As discussed below, the expected level of benefit (Negligible, Minor, Moderate, or Major) for each Alternative is based on the number of potential affected streams at the regional level (as quantified in Section 4.2.1) and the particular riparian buffer requirement of the rule elements.

4.2.2.6 Qualitative Analysis of Effects on Fish and Wildlife, and Threatened and Endangered Species

The negative effects of mining on specific features of habitats (soils, topography, water quality, and vegetation) may make it more difficult for wildlife species to reestablish after a mining disturbance and may increase the proliferation of non-native species on reclaimed landscapes. It follows that elements of the Action Alternatives that require the reestablishment of these landscape characteristics are likely to benefit associated fish and wildlife species. To evaluate impacts of the Action Alternatives on fish and wildlife species, this analysis accordingly considers effects on vegetation, topography, water quality, and soils on which the fish and wildlife depend.

Most elements of the Action Alternatives (e.g., water quality and quantity protection, revegetation/reforestation, topography, soils, and riparian buffers) influence habitat quality and quantity at the regional level either directly or indirectly. For example, undisturbed soils contain a seed bank that promotes rapid re-establishment of native species. By returning topsoil to mined areas (as required by Alternatives 2, 3, 4, 5, 7, and 8), some of the original seed bank material may be returned and promote regrowth (though some of the natural seed bank may be destroyed during surface mining). Natural topographical features addressed by rule elements related to approximate original contour variances and surface configuration (as described in Chapter 2) also support multiple species and habitats necessary for diverse ecosystem functioning; restoring these topographical features is therefore expected to benefit species diversity and habitat. Furthermore, physical characteristics that may influence habitat suitability (e.g., erosion, runoff, rainfall infiltration, level of soil compaction) are themselves affected by changes to topography, soils, and the vegetation characteristics. Thus improvements to topography, soils, and vegetation characteristics may improve habitat suitability. Other sections of this chapter provide a more in-depth discussion of the impacts of the Action Alternatives on these features.

The potential for coal mining to adversely affect fish and other wildlife is most directly addressed by the elements of the Action Alternatives designed to protect and enhance the fauna inhabiting the mine site and adjacent areas, including downstream aquatic life. As described in Subsection 4.2.2.1, under the No Action Alternative, disturbances to fish and wildlife resources must be avoided and habitats restored or replaced. The enhancement of these resources is required where practicable under the No Action Alternative. These protections, however, offer only general guidance for treatment of habitats of unusually high value.

Current regulations specify that no surface or underground mining activity “shall be conducted which is likely to jeopardize the continued existence of endangered or threatened species listed by the Secretary or which is likely to result in the destruction or adverse modification of designated critical habitats of such species in violation of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)” (30 CFR 816.97(b) and 817.97(b)). Under the No Action Alternative, a species-specific protection and enhancement plan is recommended under the 1996 BO. As stated above, Action Alternatives 2, 3, 4, 5, 7, and 8 are the same as the No Action Alternative except that they also *require* under SMCRA regulations the development of a species-specific protection and enhancement plan. It is difficult to forecast physical impacts to threatened and endangered species that would result from changing the protection and enhancement plan recommendation to a requirement. While the No Action Alternative provides extensive protection of federally listed species (i.e., federal regulations already protect listed species and their critical habitats, and recommend development of a species plan), the Action Alternatives further benefit these species in terms of improved quality and quantity of stream, riparian, and forest habitats within the coal regions. As the conservation and recovery of threatened and endangered species is inextricably linked to the quality and quantity of their habitats, this analysis finds that the Action Alternatives likely benefit listed species to an extent commensurate with their relative benefits to stream, riparian, and forest habitats.

4.2.2.7 Summary of Effects

Table 4.2.2-6 summarizes the impacts to biological resources under each of the Action Alternatives as compared to the No Action Alternative. For each Action Alternative and region, the expected impacts within each of the coal regions are based on relative impacts to: (1) forest land cover; (2) riparian habitat; and (3) fish and wildlife species. Under the No Action Alternative current trends of mining impacts on these resources are expected to continue. In general, the effects of the Action Alternatives on biological resources are expected to be Negligible or beneficial across all coal regions. The relative level of benefit (Negligible, Minor, Moderate, or Major) considers the length of impact, geographic scope of impact, and magnitude of biological resources affected (e.g., amount of forest or riparian habitat), as described in Section 4.0. As impacts are beneficial, consideration of the potential to offset impacts is not relevant.

As described in Section 4.0, benefits that are long-term and geographically broad are generally classified as being Major Beneficial. Benefits that are long-term but pertain to a more limited geographic area, or are broadly experienced within a region but persist in the short-term (e.g., for the life of the mine), are classified as Moderate Beneficial. Benefits that are both limited geographically and persist only in the short-term are classified as Minor Beneficial. Negligible impacts are those not expected to pose a significant benefit or harm over the study period.

With respect to biological resources, the following broad observations guide the summary and categorization of impacts:

- Impacts to forest land cover are expected to be long-term. While forest land cover may naturally return to reclaimed mine sites absent improved forest practices, available literature suggested this transition can take decades (e.g., Angel, et al., 2005). Accordingly, preserved and improved forests resulting from the Action Alternatives are more productive. Preserved and improved forests result in increased carbon storage potential, improved habitat quality, and improved conditions for recreational and aesthetic benefits (Stephenson, et al., 2014). For four of the regions, the reforestation impacts are relatively limited in geographic scope due to the naturally low level of forest land cover premining. The benefits vary by Alternative, depending on where the reforestation benefits apply. In general, however, for Alternatives that apply the reforestation requirements, benefits to forest land cover are expected to be Moderate Beneficial in the Colorado Plateau, Illinois Basin, Gulf Coast, and Northern Rocky Mountains and Great Plains regions. In the Northwest and Western Interior regions, benefits are Negligible due to the very limited level of mining activity and associated affected forest. Only in Appalachia are benefits likely

Major Beneficial. This region features the most forested land cover and a significant level of mining activity.

- Benefits to riparian habitat are expected to persist long-term. Establishing riparian buffers ensures expanded riparian habitat and enhances the quality of adjacent stream waters by buffering and filtering contaminants. As described in Chapter 3 and Section 4.2.1, negative effects of mining on water quality can persist beyond the life of the mine. It follows then that reduced water quality impairments supported by the riparian buffers generate long-term benefits to fish and wildlife. In ranking the relative level of benefit to riparian benefits across Alternatives and regions, this analysis relies on the findings of benefits to streams described in Section 4.2.1, and the buffer requirement prescribed by the Action Alternatives.
- The characterization of impacts to fish and wildlife are informed by the broader improvements to ecological conditions (i.e., water quality, forest and other vegetative land cover, and topography/soils). For the various regions and Alternatives, the relative level of benefit to fish and wildlife therefore refers to the full suite of findings relevant to these resources, as described in other sections of this analysis.

Under the No Action Alternative, coal mining generally has a negative effect on biological resources and the activities they support (e.g., recreation, ecological and human health) through the disruption of terrestrial and aquatic ecosystems. These negative effects are mitigated by some management practices included in current regulations (e.g., compliance with the ESA and SMCRA regarding avoiding impacts to federally listed species). In addition, postmining requirements include the restoration or replacement of riparian habitats and habitats of high value for fish and wildlife in the No Action Alternative. Such actions would mitigate some of the negative effects of coal mining, improving the area for fish and wildlife.

The following summaries of Action Alternatives 2 through 9 discuss impacts relative to the No Action Alternative. Action Alternatives are generally anticipated to benefit biological resources at the national scale when compared to the No Action Alternative, with Alternatives 2, 3, 4, 7, and 8 providing Moderate Beneficial impacts, and Alternatives 5 and 6 providing Minor Beneficial impacts at a national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on biological resources.

On a regional scale, and similar to water resources, Major Beneficial impacts are anticipated in the Appalachian Basin and the Illinois Basin under Alternatives 2, 3, 4, and 8. Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 5. Moderate Beneficial impacts are anticipated in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 7, and 8. Moderate Beneficial impacts are also anticipated in the Appalachian Basin and the Illinois Basin under Alternative 7. Other effects on biological resources are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

Table 4.2.2-6
Summary of Impacts of the Action Alternatives on Biological Resources Compared to the No Action Alternative

Coal Region	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8 (Preferred)	Alt. 9
Appalachian Basin	Major Beneficial	Major Beneficial	Major Beneficial	Major Beneficial	Minor Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Colorado Plateau	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Gulf Coast	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Illinois Basin	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Northern Rocky Mountains and Great Plains	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Northwest	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Western Interior	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
National	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**	**Negligible**

Note: Please see Section 4.0 for a definition of the Negligible, Minor, and Moderate impact terms used above. For a discussion of the impacts of the No Action Alternative (Alternative 1), see Subsection 4.2.2.1 above.

Alternative 2

Alternative 2 includes many protective elements for biological resources. With respect to forest land cover, benefits are determined to be Major Beneficial in Appalachia; Moderate Beneficial in Colorado Plateau, Illinois Basin, Gulf Coast, and Northern Rocky Mountains and Great Plains regions; and Negligible in the Northwest and Western Interior regions.

The stream (water quality) benefits of this Alternative, as described in Section 4.2.1, reflect similar findings as the forest land cover, with the exception that benefits are Major in Illinois Basin. This conclusion results from the large number of streams and associated riparian habitat present in the region. As such, the fish and wildlife species dependent upon these habitats would experience similar levels of benefit in the Illinois Basin region.

Benefits are Negligible in the Northwest and Western Interior regions, where mining activity generally has fewer impacts on forest, riparian, and stream habitat.

Alternative 3

Overall, based on the level of forest land cover and stream benefits under Alternative 3, estimated impacts to biological resources are on the same order as those for Alternative 2.

Alternative 4

Alternative 4 is very similar to Alternative 3 in terms of the level of protection afforded to forests and streams under its elements. As such, the findings under Alternative 4 are identical to those for Alternative 3, described above.

Alternative 5

As explained in Chapter 2, Alternative 5 has little effect on any coal region other than the Appalachian Basin. As such, the predicted impacts for the other six coal regions are Negligible. For the Appalachian Basin region, however, the predicted level of biological resource protection is Major Beneficial. This designation reflects the abundance of forest, riparian, and stream habitat present in the region.

Alternative 6

Under Alternative 6, the analysis of water quality (Section 4.2.1) indicates that benefits to stream habitat are Moderate in the Appalachian Basin, Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains regions, and Negligible in the Northwest and Western Interior regions. However, Alternative 6 does not incorporate the same reforestation and revegetation requirements as other Action Alternatives. As a result, overall biological resource benefits are generally Minor Beneficial (Appalachian Basin, Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains) or Negligible (Northwest and Western Interior).

Alternative 7

Alternative 7 applies to a more limited number of mine sites (i.e., those sites where enhanced permitting requirements apply). As a result, benefits to forest, stream, and riparian habitats are more geographically limited relative to the Alternatives with a broader geographic range. Specifically, biological resource benefits are Moderate (Appalachian Basin, Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains) or Negligible (Northwest and Western Interior) for Alternative 7.

Alternative 8 (Preferred)

Alternative 8 is very similar to Alternatives 3 and 4 in terms of the level of protection afforded to streams. It is also similar in terms of forest benefits, although the estimate of preserved forest acres is slightly lower given the slightly lower decreases in coal production. Despite these minor differences, the impact classifications for Alternative 8 are the same as those under Alternatives 3 and 4 with respect to biological resources.

Alternative 9

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zone rule would have had its greatest impact if it had remained in effect.

Therefore, if repromulgated, Alternative 9 would now have Negligible effects on biological resources.

4.2.2.8 Potential Minimization and Mitigation Measures

The Action Alternatives of the Stream Protection Rule are not expected to result in adverse environmental consequences in the context of biological resources. Therefore, identifying potential minimization and mitigation measures is not applicable for this analysis.

4.2.3 Topography, Geology, and Soils

Chapter 3 describes general characteristics of topography, geology, and soils at the regional level. This section of Chapter 4 analyzes how the alternatives under consideration for the SPR would affect topography, geology, and soils. The extent to which the Action Alternatives would impact topography, geology, and soils is in part dependent upon the extent to which the Action Alternatives would affect coal production because the process of coal mining necessarily disturbs the topography, geology, and soils of the mine site.

The discussion is organized as follows:

- It first describes the existing regulatory environment to assist the reader in understanding the impacts of the No Action Alternative on topography, geology, and soils.
- Second, the discussion identifies the aspects of topography, geology, and soil resources most likely to be affected by implementation of the Action Alternatives and the rationale for these findings.
- It then describes the method for assessing the expected magnitude of quantified impacts of the Action Alternatives on these resources.
- Next, it presents the results of the quantitative analysis.
- The section concludes with a summary of the expected effects of the Action Alternatives, including additional qualitative evaluation of other beneficial impacts, and characterizes the impacts by coal region and Alternative.

4.2.3.1 Effects of the Current Regulatory Environment (the No Action Alternative)

Topography

Coal mining alters the landscape by removing coal resources and changing the configuration and physical properties of rock and other earthen materials overlying the coal seam. Depending on the original topography, the thickness of the coal seam, the relative thickness of overburden, and mining method, significant changes in topography can result. Under SMCRA, mined land must be backfilled and graded to restore its approximate original contour (AOC), with limited exceptions.

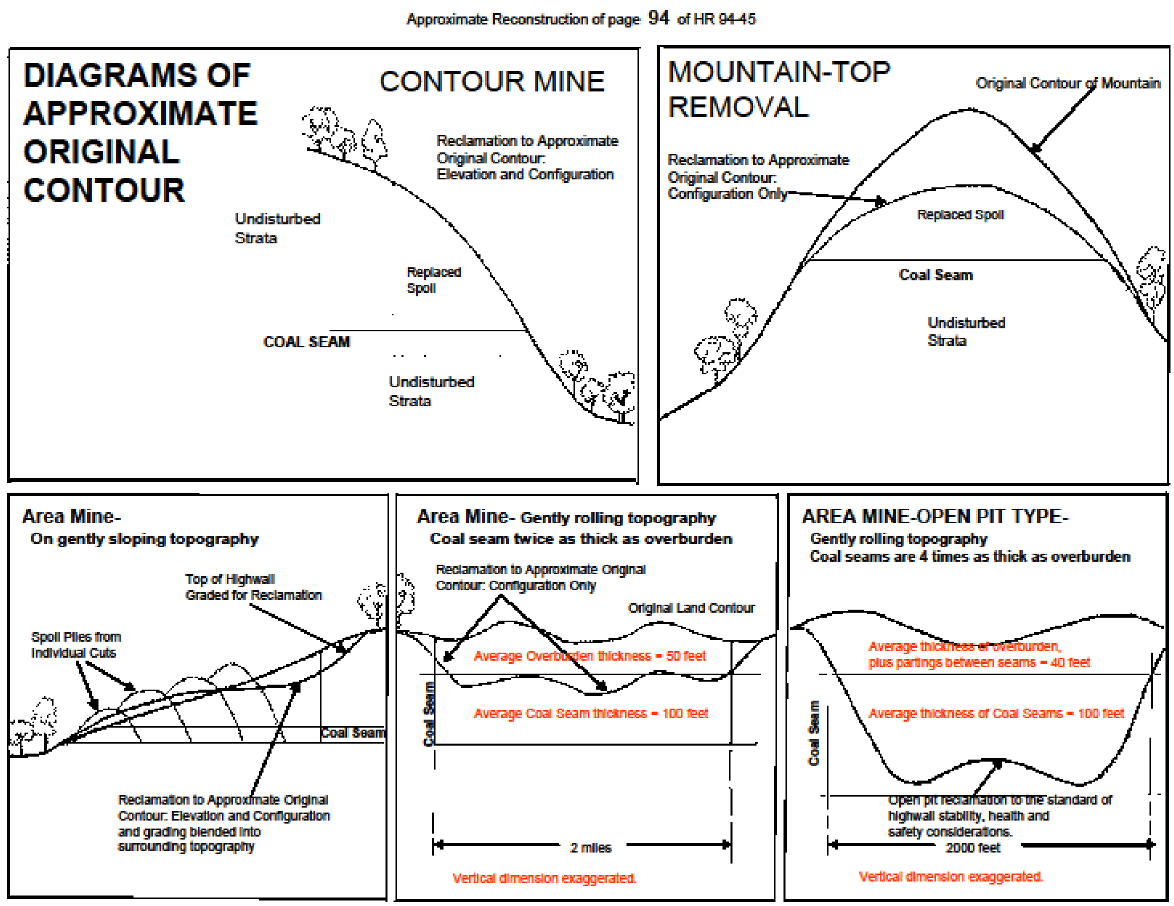
Current AOC Requirements

Section 515(b)(3) of SMCRA (30 U.S.C § 1265(b)(3)) requires that mined lands be backfilled and graded to restore the AOC, with certain exceptions. The implementing regulations at 30 CFR 816.102 and 817.102 require that areas disturbed by mining operations be backfilled and graded to achieve AOC, with the exception of sites with thin or thick overburden, mountaintop removal mining operations, those portions of steep-slope operations for which the regulatory authority has granted a variance from AOC restoration requirements, previously mined areas for which complete highwall elimination is not required, and, for underground mines, settled and revegetated fills. The regulations at 30 CFR 701.5 define AOC as follows:

> *Approximate original contour* means that surface configuration achieved by backfilling and grading of the mined areas so that the reclaimed area, including any terracing or access roads, closely resembles the general surface configuration of the land prior to mining and blends into and complements the drainage pattern of the surrounding terrain, with all highwalls, spoil piles and coal refuse piles eliminated. Permanent water impoundments may be permitted where the regulatory authority has determined that they comply with 30 CFR 816.49[,] 816.56, [and] 816.133 or 817.49, 817.56, and 817.133.

Figure 4.2.3-1 contains a reconstruction of an illustration in the legislative history of SMCRA that demonstrates how the authors of SMCRA envisioned implementation of the backfilling and grading requirements of section 515(b)(3), both for operations required to restore the approximate original contour and for certain operations that are exempt from that requirement (mountaintop removal mining and sites with thin or thick overburden).

Figure 4.2.3-1 Legislative History Schematic of Backfilling and Grading Scenarios



Source: Committee on Interior and Insular Affairs. (1975). House Report No. 94-45 on HR 25, 94th congress 1st session, House of Representatives.

State and Regional AOC Studies

In the Appalachian Basin, OSMRE conducted special oversight studies in the late 1990s in Kentucky, Virginia, and West Virginia (OSMRE, 1999a) to determine how these state regulatory authorities were implementing their approved regulatory programs with respect to AOC restoration, exceptions to AOC restoration, and the postmining land uses needed to justify certain exceptions to AOC restoration. After examining permit files and reclaimed mine sites, OSMRE found that it was difficult to distinguish between the final surface configuration of operations for which AOC restoration was required and the final surface configuration of those operations with an approved exception to AOC restoration. There was no clear difference in the number and size of excess spoil fills on sites that had been reclaimed to AOC and those that had not. Furthermore, operators could have retained more spoil on the mined-out area under applicable AOC restoration requirements instead of placing it in excess spoil fills that were designed to be larger than necessary. The larger size of these fills meant that operations were disturbing more land outside the mined-out area than was necessary.

OSMRE and state regulatory authorities in Kentucky, West Virginia, and Virginia (along with industry and environmental representatives) subsequently developed guidance on restoration of AOC and excess spoil management. Guidance documents produced include: Kentucky Department of Natural Resources (KY DNR) Reclamation Advisory Memorandum # 145 (KY DNR, 2009); Virginia Department of Mines, Minerals and Energy Guidance Memoranda 4-02 (VA DMME, 2002); and West Virginia's Final AOC Document Guidance Policy commonly referred to as AOC-Plus (WV DEP, 1999). Additionally, OSMRE's Knoxville Field Office developed a guidance document titled *Engineering Procedure 2.1: Steep Slope Mining: AOC and Excess Spoil Determination* for the federal program in Tennessee (OSMRE, 2001). These policy documents are not part of those states' approved programs, and they do not have the force of law or regulation.

Each policy guidance document provides a systematic and objective process for achieving AOC in certain steep-slope areas. The documents focus on calculating the volume of spoil that can be returned to the mined-out area and minimizing both the total volume of excess spoil that the operation generates and the footprints of excess spoil fills, while choosing the most efficient excess spoil disposal location. The policies also contain guidelines addressing stability and drainage control. They promote the construction of excess spoil fills with flat top decks rather than placing additional excess spoil on that deck and regrading it to resemble the ridge-and-valley topography that is predominant in the region. Overall, these fill minimization policies are designed to retain more spoil on the mined-out area, produce fewer and smaller fills, and promote contemporaneous reclamation.

In evaluation year 2010, OSMRE conducted a nationwide evaluation of how states were implementing the AOC restoration provisions of their approved programs. The areas studied included AOC interpretation, documentation of AOC-related permitting decisions, the process for on-the-ground verification of the premining surface configuration, and field verification that backfilling and grading are following the approved plan. Detailed permit file reviews of selected sites were performed and the premining and postmining topography of the sites were compared to determine how well the surface configuration of the reclaimed site matched the topographic restoration plan approved in the permit. OSMRE also evaluated other AOC-related factors, including reestablishment of premining drainage patterns. These evaluations found that most states have a satisfactory process for determining the premining surface configuration and ensuring that the postmining surface configuration closely resembles the configuration before mining (OSMRE, 2010a). However, many states do not have written policies outlining how the regulatory authority is to determine whether AOC restoration has been achieved. Furthermore, some states do not verify or document that the final grading of disturbed areas complies with the plan approved in the permit (OSMRE, 2010a).

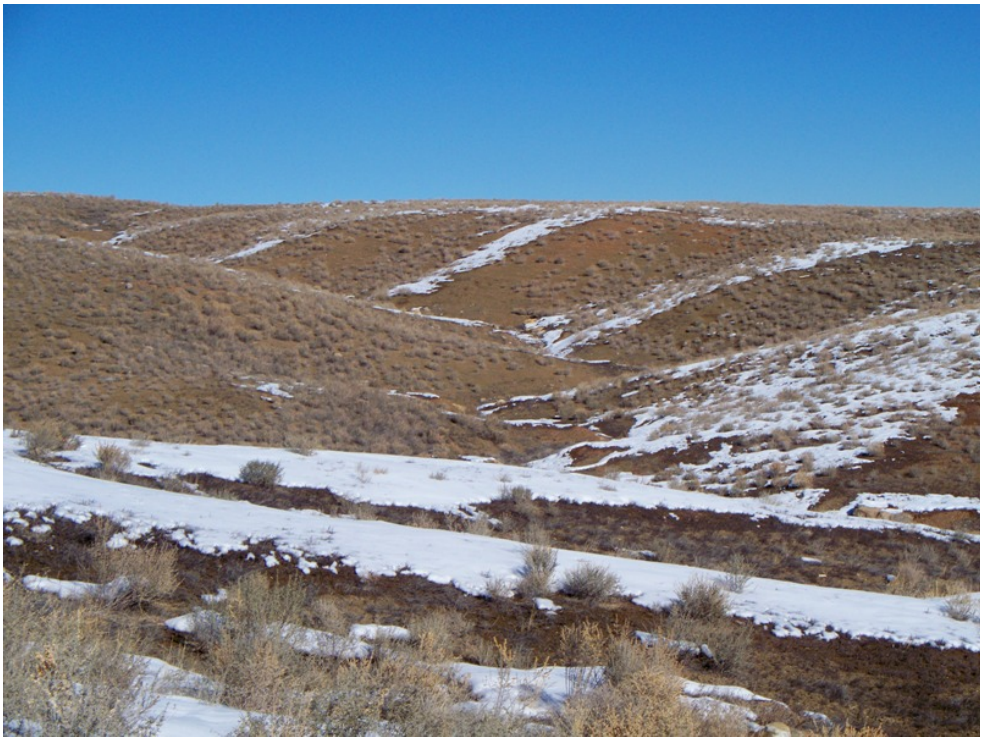
In some states, where no formal method or reproducible process was available for evaluating AOC, implementation of AOC requirements was found to be inconsistent and highly variable. In addition, in several states OSMRE noted that readily available electronic data and technology could be used more efficiently and precisely to ensure the return of mined land to AOC. Applicable technologies include digital terrain modeling or the use of GPS data to more precisely evaluate premining and postmining topography (OSMRE, 2010a).

In Oklahoma, the AOC study determined that three of the five mine permits investigated were not being reclaimed to AOC and/or had serious flaws in the approved reclamation plan or field implementation. At one mine site, an after-the-fact revision to a reclamation plan that originally required restoration of AOC approved the creation of a long narrow spoil ridge with side slopes of approximately 25 percent in an area where premining topography was generally flat with slopes of 3.5 percent or less. On another mine site, a reclamation plan change resulted in the creation of a long remnant spoil ridge immediately adjacent to a minimally backfilled and graded mine pit. The originally approved plan required the backfilling of the mine pit with graded spoil. This change resulted in the creation of a non-AOC postmining configuration with excessive slopes compared to the premining topography and the originally approved plan. At a third site, the reclamation plan approved by the regulatory authority allowed the placement of a large, steeply sloped spoil ridge adjacent to a large final pit, which was approved as a permanent impoundment despite the lack of documentation that it would hold sufficient water for that purpose. OSMRE reviewers could not fully determine whether the pit would fill with water. Ultimately, the pit remained dry. However, even if the pit had held water, the existence of a large final pit impoundment immediately adjacent to a large spoil ridge does not meet AOC restoration requirements. All three cases were in the administrative review process at the time of preparation of this DEIS.

Conversely, some companies elsewhere in the country are applying innovative technology, geomorphic reclamation techniques, and landforming principles in a manner that improves upon conventional AOC restoration techniques. Landforming is a design and grading technique that attempts to replicate the appearance of the natural terrain as well as the water transport and water retention functions of that terrain by constructing slopes, drainage ways, and other surface features that blend with the natural surroundings in an environmentally compatible fashion while meeting any relevant stability requirements (Schor and Gray, 2007).

The use of landforming principles to reclaim mined lands results in greater topographic diversity and stability than conventional backfilling and grading techniques; as such, it is compatible with stream restoration. In the past, conventional techniques have resulted in the creation of long, continuous, uniform, linear slopes that often required terracing and conveyance structures like diversions and downdrains to control surface runoff. However, terraces and diversions are of limited long-term function and stability and ultimately require maintenance. The use of landforming principles also enhances vegetative diversity, fish and wildlife habitat, and aesthetic values (see Figure 4.2.3-2).

Figure 4.2.3-2 Reclaimed Landscape Designed and Constructed Using Landforming Reclamation Principles



Source: OSMRE, [n.d.], *LaPlata Mine*, *New Mexico*, U.S. Department of the Interior.

Exceptions to Approximate Original Contour Restoration Requirements

Both SMCRA and its implementing regulations allow exceptions to AOC restoration requirements. For example, the surface mining regulations at 30 CFR 816.102(a)(1) provide that the disturbed area must be backfilled and graded to achieve AOC, except as provided in paragraph (k), which states that the postmining slope may vary from the AOC when—

(1) The standards for thin overburden in 30 CFR 816.104 are met;

(2) The standards for thick overburden in 30 CFR 816.105 are met; or

(3) Approval is obtained from the regulatory authority for

(i) Mountaintop removal operations in accordance with 30 CFR 785.14;

(ii) A variance from approximate original contour requirements in accordance with 30 CFR 785.16 [variances to AOC requirements for steep-slope mining]; or

(iii) Incomplete elimination of highwalls in previously mined areas in accordance with 30 CFR 816.106.

In addition, the underground mining regulations at 30 CFR 817.102(l) contain an exception for settled and revegetated "fills" containing spoil from the face-up of the underground mine and nontoxic-forming and non-acid-forming underground development waste, provided those fills meet specified conditions.

These variations and exceptions are discussed in detail below.

Thin and Thick Overburden

Thin overburden exists chiefly in the Powder River Basin of the Northern Rocky Mountains and Great Plains region. Thick overburden most commonly occurs in parts of the Appalachian Basin, although it may exist to a very limited extent in other regions.

The federal regulations at 30 CFR 816.104(a) define thin overburden as follows:

> Thin overburden means insufficient spoil and other waste materials available from the entire permit area to restore the disturbed area to its approximate original contour. Insufficient spoil and other waste materials occur where the overburden thickness times the swell factor, plus the thickness of other available waste materials, is less than the combined thickness of the overburden and coal bed prior to removing the coal, so that after backfilling and grading the surface configuration of the reclaimed area would not:
>
> (1) Closely resemble the surface configuration of the land prior to mining; or
>
> (2) Blend into and complement the drainage pattern of the surrounding terrain.

Paragraph (b) of 30 CFR 816.104 provides that, where thin overburden occurs, the permittee must use all spoil and other waste materials available from the entire permit area to attain the lowest practicable grade, but not more than the angle of repose. In addition, the permittee must comply with the backfilling and grading requirements of 30 CFR 816.102 (a)(2) through (j); i.e., all requirements other than AOC restoration.

The federal regulations at 30 CFR 816.105 define thick overburden as follows:

> Thick overburden means more than sufficient spoil and other waste materials available from the entire permit area to restore the disturbed area to its approximate original contour. More than sufficient spoil and other waste materials occur where the overburden thickness times the swell factor exceeds the combined thickness of the overburden and coal bed prior to removing the coal, so that after backfilling and grading the surface configuration of the reclaimed area would not:
>
> (1) Closely resemble the surface configuration of the land prior to mining; or
>
> (2) Blend into and complement the drainage pattern of the surrounding terrain.

Paragraph (b) of 30 CFR 816.105 provides that, where thick overburden occurs, the permittee must restore AOC and then use the remaining spoil and other waste materials to attain the lowest practicable grade, but not more than the angle of repose. In addition, the permittee must comply with the backfilling and grading requirements of 30 CFR 816.102 (a)(2) through (j); i.e., all requirements other than AOC restoration, and must dispose of any excess spoil in accordance with 30 CFR 816.71 through 816.74.

Mountaintop Removal Mining Operations and Steep-Slope Mining AOC Variances

Section 515(c)(1) of SMCRA (30 U.S.C. 1265(c)(1)) provides that each State program may and each federal program must allow mountaintop removal mining operations. Paragraph (c)(2) defines mountaintop removal mining as an operation that "will remove an entire coal seam or seams running through the upper fraction of a mountain, ridge, or hill…by removing all of the overburden and creating a level plateau or a gently rolling contour with no highwalls remaining." The postmining surface configuration must be capable of supporting an industrial, commercial, agricultural, residential or public facility (including recreational facilities) postmining land use. The remainder of paragraph (c) establishes additional permit application requirements and performance standards for mountaintop removal mining operations. Among other things, the application must include specific plans for the proposed postmining land use, the postmining surface configuration must drain inward except at specified points, and the operation must not damage natural watercourses. The federal regulations include corresponding permitting requirements and performance standards in 30 CFR 785.14 and 824.11.

Section 515(e) of SMCRA (30 U.S.C. § 1265(e)) also allows the regulatory authority to approve a variance from AOC restoration requirements for non-mountaintop removal mines in steep-slope terrain if the variance will render the reclaimed land suitable for an industrial, commercial, residential, or public use (including recreational facilities). Unlike for mountaintop removal mining operations, an agricultural postmining land use is not an acceptable basis for a steep-slope AOC variance.

SMCRA and the implementing regulations at 30 CFR 785.16 also impose other requirements and limitations on the AOC variance. For example, the highwall must be completely eliminated in a stable fashion and the variance must improve watershed control of the area relative to the premining condition or the condition that would exist if AOC was restored. Only that amount of spoil necessary to achieve the postmining land use, ensure stability of the spoil retained on the mine bench, and meet other applicable SMCRA requirements may be placed off the mine bench. All spoil not retained on the bench must be placed in accordance with the regulations governing excess spoil disposal (30 CFR 816.71-816.74).

The existing regulations at 30 CFR 816.106 and 817.106 (the No Action Alternative) apply where remining operations occur on previously mined areas that contain a pre-existing highwall. As defined in 30 CFR 701.5, the term "remining" refers to surface coal mining and reclamation operations that affect previously mined areas. Under 30 CFR 816.106 and 817.106, a remining operation must eliminate all highwalls that the operation re-affects unless the volume of all reasonably available spoil is demonstrated to be insufficient to completely backfill the re-affected highwall. In that case, the operator must eliminate the highwall to the maximum extent technically practicable. The operator must use all reasonably available spoil in the immediate vicinity of the remining operation, grading to a slope that provides adequate drainage and long-term stability, and ensuring that any highwall remnant is stable and does not pose a hazard to public health and safety or to the environment.

Excess Spoil

Surface mining methods involve the fracturing of the rock strata overlying the coal to facilitate excavation of the overburden and extraction of the coal. Fracturing formerly solid rock into multiple fragments increases its overall volume because of the numerous void spaces between the rock fragments. This increase in volume is known as "swell" or "bulking."

In areas with steep slopes, the swell factor commonly results in the generation of excess spoil because the volume of overburden removed, after swell, is greater than the volume that can be safely returned to the mined-out area or used to blend the mined-out area with the surrounding terrain. Re-establishment of the premining topography is limited by the physical properties of the spoil material, the associated angle of repose, and regulatory requirements related to angle of repose and stability. Typically, excess spoil is placed in fills constructed in valleys adjacent to the mined-out area. More than 98 percent of excess spoil fills are located in Central Appalachia (eastern Kentucky, southwest Virginia, West Virginia, and northern Tennessee) (OSMRE, 2008).

In non-steep slope areas, mines seldom generate excess spoil. Instead, it is possible to return the spoil to the mined-out area and grade it to closely resemble the premining topography. Because of the increase in volume caused by the swell factor, the backfilled and graded area generally will have a higher elevation than it did before mining, but the edges can be graded to blend with the surrounding terrain, consistent with the definition of AOC.

Types of Excess Spoil Fills

Prior to the passage of SMCRA, excess spoil fills generally were constructed with minimal engineering and placed at locations that were most convenient and least costly to the mining operation. Sometimes spoil was simply pushed over the slope below the mine bench. Section 515(b)(22) of SMCRA (30 U.S.C. 1265(b)(22)) established standards for excess spoil fill construction that focus on engineering and safety, with a goal of ensuring long-term fill stability. Among other things, SMCRA requires that excess spoil be placed within the permit area in a controlled manner to prevent mass movement and to assure mass stability. In addition, the operation must comply with drainage requirements to prevent spoil erosion and movement. The design of the excess spoil fill must be certified by a registered professional engineer in conformance with professional standards.

A study published in 2005 found that excess spoil fills in Appalachia are quite stable, with fewer than 20 reported slope movements out of more than 6,800 fills constructed since 1985 (U.S. EPA et al., 2005). However, the fills studied were constructed prior to the implementation of fill minimization and optimization requirements; they also were generally constructed lower in the watershed and on flatter foundation slopes than fills being constructed today. Fill minimization policies adopted in Kentucky and West Virginia since the completion of the study require fill placement higher in the watershed and on steeper slopes, thus creating the potential for greater instability. Fills placed on steeper foundations would inherently have a lower slope stability factor of safety.

The federal regulations at 30 CFR 816.71 through 816.74 and 817.71 through 817.74 expand upon the statutory requirements. General requirements for constructing excess spoil fills are contained in 30 CFR 816.71 and 817.71. The fill must be designed to achieve a minimum long-term static safety factor of 1.5 and a qualified registered professional engineer with appropriate experience must certify the design. The design must include underdrains constructed of durable rock or perforated pipe if the footprint of the fill contains springs, natural or man-made water courses, or wet weather seeps. Excess spoil must be transported and placed in a controlled manner and concurrently compacted in horizontal lifts that do not exceed 4 feet unless the design engineer certifies that the design will ensure the stability of the fill and meet all other applicable requirements. A qualified registered professional engineer (or other qualified professional specialist under the direction of the engineer) must inspect the fill at least quarterly throughout construction. The engineer must provide a certified report to the regulatory authority after each inspection describing how the fill is being constructed and maintained in accordance with the approved design and regulatory requirements.

The federal regulations at 30 CFR 816.72 and 817.72 contain special requirements applicable to "valley fills" and "head-of-hollow fills," which are two types of fills constructed in steep-slope areas (existing valleys with side slopes greater than 20 degrees) or where the average slope of the profile of the existing valley from the toe of the fill to the top of the fill is greater than 10 degrees. A head-of-hollow fill differs from a valley fill in that the top surface of the fill, when completed, is at approximately the same elevation as the adjacent ridgelines, which means that there is no significant area of natural drainage above the fill. By way of comparison, valley fills are constructed further down the valley and therefore have significant surface drainage from the watershed above the fill that must be diverted around the fill. The regulations allow both valley fills and head-of-hollow fills to use a specially constructed rock-core chimney drain in place of the underdrains and surface diversions that otherwise would be required under 30 CFR 816.71 and 817.71. However, a rock-core chimney drain may only be constructed where the fill is not located in an intermittent or perennial stream. In addition, if the fill is a valley fill, the volume of the fill may not exceed 250,000 cubic yards and upstream drainage must be diverted around the fill.

Durable rock fills are the most commonly constructed excess spoil fill in the Appalachian Basin. The federal regulations at 30 CFR 816.73 and 817.73 require that 80 percent of the spoil volume in a durable rock fill consist of durable, non-acid, and non-toxic-forming rock that does not slake in water and will not degrade to soil material. Durable rock fills are constructed by end-dumping excess spoil into valleys, generally in single lifts, but occasionally in multiple lifts. This construction technique relies upon gravity segregation of the end-dumped material to naturally form an underdrain concurrent with fill placement because the larger rocks roll to the base of the fill. Typically, this process results in a highly permeable zone of large-sized durable rock in the lower one-third of the fill. Existing durable rock fills generally contain single lifts ranging in size from 30 to over 400 feet in thickness. Following completion of spoil placement, the face of the fill typically is graded to a terraced configuration that may not exceed a 2h:1v slope ratio. Durable rock fills must be designed to attain a minimum long-term static safety factor of 1.5 and a seismic safety factor of 1.1.

Both state and federal regulatory programs have recognized that proper drainage control, including the construction of a functioning permeable underdrain, is critical to the long-term stability of durable rock fills. Hence, Kentucky and OSMRE have developed permitting and inspection guidance to address these concerns. See KY DNR's "Reclamation Advisory Memorandum #141, Review of Durable Rock Fill Designs" (2002); and OSMRE's *Final Environmental Impact Statement on Excess Spoil Minimization, Stream Buffer Zones* (2008).

Durable rock fills are susceptible to saturation and severe erosion of fill material, with consequent downslope flooding or mudflows, during significant rainfall events, particularly during the final stages of construction. Lack of contemporaneous reclamation of durable rock fills has been a contributing factor to severe erosion and flooding. One of the most notable significant flooding events associated with durable rock fill construction occurred in Lyburn, West Virginia in 2002. While researching other failures following the event, WVDEP concluded that 49 excess spoil fill washouts had occurred in the 5 years preceding the Lyburn event (Pierce, 2004). To prevent or minimize offsite impacts, West Virginia Department of Environmental Protection (WVDEP) began requiring that durable rock fills be constructed in lifts of no more than 100 feet in thickness. Alternatively, fills may be constructed with an erosion protection zone, which is a free-draining durable rock bench extending downstream from the toe of the fill. It is intended to trap any fill material eroding, sliding, or flowing from an end-dumped fill during construction or final reclamation. Leaving fills with unreclaimed exposed surfaces increases the likelihood for mass soil movement and flooding.

The thick lifts and lack of mechanical compaction of spoil placed in durable rock fills results in greater void spaces and increased infiltration of both surface water and groundwater. These factors result in discharges containing elevated levels of total dissolved solids. Sections 3.5 and 4.2.1 of this DEIS discuss the effects of mining activities on water quality.

The final type of excess spoil fill is the disposal of excess spoil on pre-existing mine benches. Placement of excess spoil on these benches both assists in the reclamation of abandoned mine lands and reduces the number and size of excess spoil fills in areas that have not been previously impacted by mining. The federal requirements at 30 CFR 816.74 and 817.74 regarding placement of excess spoil on pre-existing benches are similar to the requirements for backfilling and grading, more so than the requirements that apply to construction of excess spoil fills on previously undisturbed terrain.

Trends in Excess Spoil Disposal

Since January 2000, at least 2,343 excess spoil fills have been authorized in Kentucky, Virginia, Tennessee, and West Virginia. The majority of these fills were authorized by Kentucky, which approved the construction of 1,488 valley fills through July 30, 2008. West Virginia authorized 511 excess spoil fills through the same time period. Virginia authorized 327 excess spoil fills through August 17, 2009, while Tennessee authorized 17 excess spoil fills through December 31, 2008. Between October 1, 2001 and June 30, 2005, five excess spoil fills were authorized in the Colorado Plateau and four excess spoil fills were authorized in Washington and Alaska.

However, not all excess spoil fills that are authorized are actually constructed. For example, in Virginia, 97 of the 327 excess spoil fills authorized between January 2000 and August 2009 were completed, 103 were under construction, 90 had not begun construction, and 37 were either unnecessary or not constructed as of August 2009 (U.S. GAO, 2009).

From 2002 to 2005, the number of fills that Kentucky approved each year declined from 262 to 92 (65 percent reduction) and the number of fills that West Virginia approved each year declined from 86 to 56 (35 percent reduction). In addition, the average fill footprint in Kentucky declined from 19 to 7 acres (63 percent reduction) (OSMRE, 2008).

Relationship between AOC and Excess Spoil

AOC restoration requirements do not apply to excess spoil fills because section 701(2) of SMCRA (30 U.S.C. § 1291(2)) defines "approximate original contour" as "that surface configuration achieved by backfilling and grading of the mined area." The construction of excess spoil fills does not involve backfilling of the mined area; instead, it involves disposal of spoil that is not needed to restore the approximate original contour of the mined area (OSMRE, 2008).

The federal regulations at 30 CFR 701.5 define "excess spoil" as "spoil material disposed of in a location other than the mined-out area; provided that spoil material used to achieve the approximate original contour or to blend the mined-out area with the surrounding terrain in accordance with §§ 816.102(d) and 817.102(d) of this chapter in non-steep slope areas shall not be considered excess spoil." Thus, spoil used to achieve AOC is not considered excess spoil. Moreover, under the excess spoil minimization policies adopted by Central Appalachian states, spoil that can be returned to the mined-out area without either creating slope instability or a non-AOC surface topography does not qualify as excess spoil. The proviso in the definition means that spoil from box cuts or first cuts in non-steep slope areas would not be excess spoil when that spoil is used to blend the mined-out area into the surrounding terrain.

Coal Mine Waste

The federal regulations at 30 CFR 701.5 define "coal mine waste" as having two components: coal processing waste and underground development waste. Coal produced by either surface mining or underground mining methods may contain non-coal mineral matter (clay, shale, etc.). These impurities may make the coal unsuitable for immediate use by the consumer so the coal is processed to remove impurities or blended with higher quality coal before delivery to the shipping point. The impurities removed during processing are known as "coal processing waste." Underground mining methods also generate underground development waste; i.e., waste rock that must be removed from the underground workings to facilitate the mining process.

Coal mine waste may be disposed of permanently in refuse piles. Coal processing waste also may be stored in impounding structures, which must be dewatered and modified as necessary to meet the standards for refuse piles after they are no longer needed for coal processing purposes. Refuse piles are subject to regulations similar to those for excess spoil fills in terms of design, location, and construction. They are not subject to AOC restoration requirements because they are placed outside the mined area. Coal mine waste disposal regulations may be found at 30 CFR 780.25, 784.16, 784.19, 816.81 through 816.84, and 817.81 through 817.84.

Coal mine waste storage and disposal facilities (slurry impoundments and refuse piles) traditionally have been constructed for individual underground mines and associated coal preparation plants. Many currently active storage and disposal facilities have evolved to accept coal mine waste from other mines and preparation plants. In Central Appalachia, the slurry resulting from the coal preparation process typically is stored in a large impoundment formed by constructing an embankment across an existing hollow or valley. In areas with very flat topography, such as the Illinois Basin, the embankment completely encircles the impoundment. In either situation, the embankment typically is constructed in stages using coarse refuse that is also a waste product of the coal preparation process. In both cases, the fine coal refuse resulting from the coal preparation process is pumped as slurry into the impoundment, from which the water typically is decanted or pumped to be reused. When slurry pumping ceases, the embankment typically is breached so that the basin can no longer impound standing water. The structure then must be reclaimed as a refuse pile.

Few new slurry impoundments have been permitted in the last 15 years. In 2001, there were 713 freshwater and coal mine waste impoundments associated with coal processing facilities in the U.S. (Greb et al., 2006; OSMRE, 2008). Many existing impoundments provide decades of storage capacity and are expanded in stages,[30] which may have minimized the need for new facilities during this time.

Another method of handling fine coal refuse involves partially dewatering the slurry at the preparation plant. The resulting semi-solid material is then disposed of separately or mixed and placed with the coarse refuse material as combined refuse. Transporting and placing the material has been problematic because of the relatively high moisture content of the partially dewatered fine refuse. Recent research suggests that one option may be to transport the fine refuse as a paste (thickened tailings) that can be pumped to a disposal location (MSHA, 2009b).

Most coal mined by underground methods is processed in preparation plants to control ash and, where applicable, to reduce pyritic sulfur.[31] Increased market specifications for higher quality coal initially led to greater percentages of material being considered waste; approximately 20 to 50 percent of the mine production was rejected during processing according to some studies (Lucas, et al., 1979; OSMRE, 2008). More recently, preparation plants have improved, resulting in considerably higher Btu yields; i.e., fewer Btu's lost in the preparation process, and therefore less reject per ton of coal processed.

Underground Mining

Face-up areas of underground mines typically have impacts analogous to those of a similarly situated surface mine of the same size. However, underground mining does have one unique potential impact on topography in that longwall mining will—and other methods of underground mining may, depending on the competence of the overlying rock and the extent of pillars left as support—result in the collapse of overlying strata after the coal is removed, a process known as subsidence. Subsidence may reach the surface, depending upon the depth of the mine and the competence of rock strata between the underground workings and the surface. Subsidence that reaches the surface will alter the surface configuration and topography. Subsidence also can dewater streams in whole or in part. Subsidence mechanisms are more fully discussed in Section 3.1 of this DEIS.

Underground mining also can dewater streams or diminish flows by fracturing strata that support perched aquifers or by draining aquifers to facilitate mining.

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[30] In the Appalachian Basin region, existing slurry impoundments typically are expanded vertically by raising the coarse refuse embankment in stages, thus covering more of the upper reaches of the valley. In the Illinois Basin region, operators may raise the height of the encircling embankment, but, more typically, they expand horizontally with construction of an adjacent cell or cells in series with the existing impoundment.

[31] The Clean Air Act Amendments of 1990 required power plants to lower their emissions of sulfur dioxide, which, in some cases, resulted in modification of the coal preparation process to reduce its sulfur content.

Face-up areas and disturbed areas associated with support facilities are subject to the backfilling and grading requirements of 30 CFR 817.102 through 817.107, including the requirement to restore the land to its AOC. However, 30 CFR 817.102(l) provide an exception for settled and revegetated fills that result from the creation of the face-up of underground mines or from underground development waste. If such fills meet certain environmental, safety, stability, and postmining land use criteria, the regulation does not require that the operator use of the material in the fills to restore the AOC.

Soils

Soils comprise the thin, weathered surface layer that overlies rock or other parent material. They are the medium in which most plant growth occurs, and their thickness, fertility, and structure are significant determinants of plant and ecosystem productivity. Soils are affected by underlying geologic material, climate, topography, biological factors, and time. Under 30 CFR 816.22(a), the operator must remove all topsoil, which 30 CFR 701.5 defines as consisting of the A and E soil horizons, before otherwise disturbing the land. If the topsoil is less than 6 inches in thickness, the operator must remove the top 6 inches of unconsolidated material. The topsoil must be either redistributed on a portion of the mine site upon which backfilling and grading has been completed or stockpiled until redistribution can occur. Under 30 CFR 816.22(d), the topsoil must be redistributed in a manner that achieves an approximately uniform, stable thickness when consistent with the postmining land use, contours, and surface-water drainage systems. Soil thickness may be varied to the extent that such variations would help meet specific revegetation goals identified in the permit.

If the soil is prime farmland historically used for cropland, 30 CFR 823.12(b) requires salvage and redistribution of not only all topsoil, but also enough material from the B and C soil horizons to reconstruct a soil with a depth of at least 48 inches, unless the premining soil contains a subsurface horizon at a lesser depth that inhibits or prevents root penetration. Paragraph (e) of 30 CFR 816.22 also allows the regulatory authority to require salvage and redistribution of the B and C soil horizons for non-prime farmland if those horizons are necessary to meet revegetation requirements.

Soils reconstructed after mining differ biologically, physically, and chemically from their premining counterparts. They are more uniform in texture, organic matter content, and thickness. Historically, soils on reclaimed mine sites are more compacted and contain higher amounts of rock fragments than unmined soils (Bussler, et al., 1984). However, specialized soil handling techniques can minimize compaction and reduce the adverse impacts of compaction on soil productivity and the hydrologic regime.

Prior to the implementation of SMCRA, coal mining activities often destroyed or degraded the topsoil. In addition, erosion of soil and mine spoil has caused serious sedimentation problems with resultant negative impacts to water quality and aquatic organisms. The legacy of these past practices can be seen today on pre-SMCRA abandoned coal mine sites. Mining operations removed or mishandled large amounts of soil at both surface and underground mining operations. Soils were lost or compacted during mining and construction of ancillary facilities such as buildings and roads. Operations were frequently conducted without regard to protection of the soil resource.

Subsequent to the enactment of SMCRA, topsoil handling improved, but the methods used to remove and redistribute topsoil sometimes resulted in excessive compaction, which reduces the pore space for air and water and impedes root growth, making revegetation with desirable species more difficult and the reclaimed site less productive. Long-term storage of soil can adversely alter texture and structure. In addition, mycorrhizae, soil organisms, and organic matter do not persist long in stockpiled topsoil.

The regulations implementing SMCRA are intended to minimize the impacts of mining on topsoil. In particular, 30 CFR 779.21, 780.18, 784.13, 816.22, and 817.22 require that the topsoil be removed as a separate layer from the area to be disturbed, and then segregated. If the topsoil is less than six inches thick, the topsoil and the unconsolidated materials immediately below the topsoil must be removed and the mixture treated as topsoil. In cases where the topsoil is of insufficient quantity or poor quality for sustaining vegetation, the operator may use selected overburden materials as a topsoil substitute or supplement. However, before doing so, the operator must demonstrate to the regulatory authority that the resulting soil medium will be equal to or more suitable for sustaining vegetation than the existing topsoil, and that the resulting soil medium is the best available in the permit area to support revegetation. The operator must recover these substitute or supplemental materials as a separate layer from the area to be disturbed and then segregate them.

The regulations require that the operator segregate and stockpile topsoil and topsoil substitutes and supplements after removal when it is impractical to redistribute those materials promptly on regraded areas. Stockpiled materials must be selectively placed on a stable site within the permit area and protected from contaminants, unnecessary compaction, and wind and water erosion that could interfere with revegetation. A quick-growing vegetative cover or other measures may be used for protection.

The operator must redistribute topsoil and topsoil substitutes and supplements in a manner that achieves an approximately uniform, stable thickness when consistent with the approved postmining land use, contours, and surface-water drainage systems. However, the thickness of the redistributed materials may vary to the extent necessary to meet the specific revegetation goals identified in the permit. In addition, redistribution must be done in a manner that prevents excess compaction of the materials and protects them from wind and water erosion before and after seeding and planting.

The regulations at 30 CFR 785.17 and Part 823 establish special requirements for prime farmland. The operator must salvage and redistribute the A, E, B, and C soil horizons to (1) an aggregate depth of at least 48 inches, (2) a lesser depth equal to the depth to a subsurface horizon in the natural soil that inhibits or prevents root penetration, or (3) a greater depth if determined necessary to restore the original soil productive capacity. The regulations also require use of soil reconstruction specifications developed by the U.S. Natural Resources Conservation Service (NRCS).

Geology

Coal mining permanently alters the geological structure of the mined area because of the removal of coal and, for surface mines, overburden. Factors that determine the level of geological disturbance are the elevation of the lowest coal seam mined, the depth of overburden above this seam, and the area mined. Surface mining completely alters the geologic structure above the lowest coal seam mined in that previously discrete strata of rock and soil, each stratum with its own distinctive characteristics, are converted to a more or less uniform fragmented mixture of rubble. Typically referred to as spoil, this rubble consists of mixtures of the parent rocks, with percentages of rock types varying at different locations across the site.

Underground mining has a lesser impact on geology because the strata overlying the coal seam remain discrete. However, subsidence may affect the elevation, continuity, and capability of individual strata to function as an aquifer.

4.2.3.2 Action Alternatives and Potential Effects on Topography, Soils, and Geology

Table 4.2.3-1 summarizes the effects of various elements of the Action Alternatives on topography, geology, and soil resources. The text below further characterizes potential effects, organizing the discussion according to each SPR element.

Table 4.2.3-1
SPR Elements and Potential Effects on Topography, Geology, and Soils in Coal Mining Regions

SPR Element	Topography	Geology	Soils	Indirect Impact
Baseline Data Collection and Analysis				■
Monitoring During Mining and Reclamation				■
Definition of Material Damage to the Hydrologic Balance Outside the Permit Area				■
Corrective Action Thresholds				■
Stream Definitions				■
Mining Through Streams	■	■	■	
Activities In or Near Streams Including Excess Spoil and Coal Refuse	■		■	■
AOC Exceptions	■			■
Surface Configuration	■		■	■
Revegetation, Soil Management, and Reforestation			■	
Fish and Wildlife Protection and Enhancement				■

Protection of the Hydrologic Balance

None of the alternatives under consideration for the Protection of the Hydrologic Balance functional group would have any direct impacts on topography, geology, or soils. However, they could have an indirect effect on whether and where mining occurs, which in turn would determine whether and where mining-related impacts to topography, geology, and soils would occur. For example, after reviewing baseline data, analyzing monitoring results, or preparing the cumulative hydrologic impact assessment, the regulatory authority may decide either that the proposed operation cannot be approved or that the existing operation needs to modified to prevent material damage to the hydrologic balance outside the permit area.

Activities In or Near Streams

Stream Definitions

All of the Action Alternatives include definitions of perennial, intermittent, and ephemeral streams; these definitions formally delineate the key natural resource addressed by the proposed action. Current regulations classify all watersheds one square mile or larger in size as intermittent streams; some of the Action Alternatives would delete this provision. To the extent that this change would result in some streams (mostly in the arid and semiarid regions of the West) now protected as intermittent streams being reclassified as ephemeral streams, which lack the protections afforded to perennial and intermittent streams, there could be a direct effect on topography and an indirect effect on geology and soils.

Mining Through Streams

The existing regulations (No Action Alternative) allow mining through intermittent and perennial streams when the regulatory authority makes a finding that diversion of the stream will not adversely affect water quantity, water quality, and related environmental resources of the stream (see 30 CFR 816.43(b) and 817.43(b)). The No Action Alternative requires that a permanent stream-channel diversion or a restored stream channel be designed and constructed so as to approximate the premining characteristics of the original stream channel, including riparian vegetation, but it does not require restoration of the stream's biological condition or ecological function.

Under each Action Alternative (excluding Alternative 9), specific standards would guide stream restoration, such as the requirement to restore natural hydrologic form and ecological function for intermittent and perennial streams and restoration of natural hydrologic form for ephemeral streams. Alternatives 2 and 7 would explicitly prohibit mining through or within 100 feet of perennial streams. Alternatives 4, 5, 6, and 8 would require that applicants demonstrate that complete restoration of the hydrologic form and ecological function of intermittent and perennial streams can be accomplished. The requirement to restore form and function should minimize alterations in stream configuration and hydrological characteristics under these alternatives. The requirement to avoid effects on intermittent and perennial streams, or to apply a higher reclamation standard to some or all types of streams, would minimize the effect of mining through streams and any resultant impacts on topography and soils. Perennial and intermittent streams would be less likely to be mined through and, if they are mined through, the stream and its resources must be restored or replaced in most cases.

Activities In or Near Streams, Including Placement of Excess Spoil and Coal Refuse

The existing regulations at 30 CFR 816.57 and 817.57 (the No Action Alternative) prohibit disturbance of the land surface by mining activities within 100 feet of an intermittent or perennial stream unless the regulatory authority specifically authorizes activities closer to or through the stream. That authorization requires a finding that the mining activities will not cause or contribute to the violation of applicable state or federal water quality standards and will not adversely affect the water quantity or quality or other environmental resources of the stream. See 30 CFR 816.57(a)(1) and 817.57(a)(1). Historically, some regulatory authorities have applied this regulation in a manner that allows construction of excess spoil fills and coal mine waste disposal facilities in streams within the permit area, as long as the findings can be made with respect to the remaining portion of the stream below the toe of the fill or facility.

The Action Alternatives would increase the stringency of the requirements governing mining activities near streams as well as the placement of excess spoil and coal refuse at these locations. All Action Alternatives would require minimization of excess spoil creation. Likewise, all would require that the permit applicant identify and analyze a reasonable range of alternatives and select the alternative that results in the least adverse overall impact on fish, wildlife, and related environmental values.

Alternative 2 would prohibit all mining activity in or within 100 feet of a perennial stream; it also would prohibit placement of excess spoil in intermittent streams. Alternative 3 would prohibit placement of excess spoil or coal mine waste in a perennial stream.

Alternatives 4, 5, 6, 7, and 8 (Preferred) would allow construction of excess spoil fills and coal mine waste structures in or near perennial and intermittent streams, but they would place new restrictions on excess spoil fill construction techniques. These restrictions include a ban on fills constructed by end-dumping (durable rock fills); a ban on flat-topped fills (instead, the surface configuration of the top of the fill must be graded to resemble the surrounding topography); a requirement for construction of aquitards within the fill; a requirement for offsets of any long-term adverse impacts on fish and wildlife; and increased monitoring during fill construction. Alternative 9 would allow construction of excess spoil fills and coal mine waste structures in or within 100 feet of perennial and intermittent streams, but it would not place any significant new restrictions on excess spoil construction techniques.

To the extent that the Action Alternatives reduce mining in or near streams and reduce the footprint of excess spoil fills and coal mine waste structures, there would be fewer or less extensive alterations to the topography, geology, and soils of those areas. Likewise, requirements that the top decks of excess spoil fills be graded to resemble surrounding landforms would reduce adverse impacts on topography, at least in terms of visual impact.

Approximate Original Contour

AOC Exceptions

As discussed in Section 4.2.3.1, SMCRA and the existing regulations (the No Action Alternative) provide several exceptions to the requirement to restore mined land to AOC. Those exceptions include operations with thin or thick overburden, certain remining operations, mountaintop removal mining operations, and steep-slope mining operations. The latter two exceptions apply only when the mountaintop removal mining operation or the AOC variance for a steep-slope mining operation will facilitate one or more specified postmining land uses and certain other requirements are met. These two exceptions apply only to operations consisting primarily of steep slopes (slopes in excess of 20 degrees), a situation that occurs almost exclusively in Central Appalachia.

Under the No Action Alternative, the most visible impact of AOC exceptions on topography would be the continued limited creation of flat or gently rolling terrain in areas that previously contained primarily steep slopes. Alternative 2 would prohibit all AOC exceptions and would likely require amendment of SMCRA. Alternatives 3, 4, 5, and 8 (Preferred) likely would result in the approval of fewer operations with AOC exceptions . Therefore, Alternatives 2, 3, 4, 5, and 8 (Preferred) should result in fewer permanent effects on topography than would be expected under the No Action Alternative. Alternatives 6, 7, and 9 are similar to the No Action Alternative in terms of AOC exceptions and, thus, would have similar impacts.

Surface Configuration

As discussed in Section 4.2.3.1, SMCRA requires that the permittee backfill and grade the mined area to its AOC, which means a surface configuration that closely resembles the premining surface configuration and that blends into and complements the drainage pattern of the surrounding terrain. The existing regulations (the No Action Alternative) contain similar provisions. Alternatives 6, 8 (Preferred), and 9 would not alter the existing regulations with respect to surface configuration requirements.

Alternatives 2, 3, and 4 would require that almost all surface mining operations use digital terrain analysis techniques to determine whether AOC restoration requirements have been met. Alternatives 5 and 7 would require use of digital terrain analysis techniques for a smaller subset of operations; e.g., operations that dispose of excess spoil or coal mine waste.

Alternatives 2, 3, and 4 would require use of landforming principles as part of backfilling and grading to prevent the creation of uniform slopes vulnerable to erosion and to promote restoration of topographical features that will re-create microclimates and ecological niches present prior to mining. However, Alternative 3 would not apply those principles to excess spoil fills.

Alternatives 2 and 4 would require that the thickness of backfilled material at any point in the backfilled area not differ from the combined premining thickness of the coal seam and overburden strata at that point by more than ± 20 percent.

Alternatives 2, 3, and 4 would have the greatest impact on topography because they are most likely to ensure that the final surface configuration and landscape features more closely match the premining configuration and landscape features. The greatest impact would occur in regions highly variable premining topography, such as mountainous terrain. Alternatives 5 and 7 would have a lesser impact on topography than Alternatives 2, 3, and 4, but a greater impact than the No Action Alternative. Alternatives 6, 8, and 9 would not differ in impact from the No Action Alternative.

Postmining Land Use and Enhancement

Revegetation, Soil Management, and Reforestation

The existing regulations (the No Action Alternative) at 30 CFR 816.111 through 816.116 and 817.111 through 817.116 require use of native species in revegetation, although introduced species are permitted under certain conditions. As described in Section 4.2.3.1 of this DEIS, salvage, storage, and redistribution of topsoil (the A and E soil horizons) is required for all operations, with the proviso that operations on prime farmland historically used for cropland typically must salvage, store, and redistribute the B and C soil horizons to the extent needed to provide a minimum of 48 inches of soil on the reclaimed area. Selected overburden materials may be used in place of the topsoil and subsoil if they meet specified criteria and are approved by the regulatory authority.

Under conditions of natural succession, establishment of a forest on bare soil would take 15 to 20 years (Groninger et al., 2007), or longer. The initial loss of forest habitat because of mining activities would be expected to have a negative impact on soils in these forested areas (Belnap and Eldridge, 2001).

Alternatives 2, 3, 4, 5, 7, and 8 (Preferred) require—

- Revegetation of reclaimed lands using only native species unless those species are incompatible with an approved postmining land use that is implemented during the revegetation responsibility period.
- Salvage and redistribution of topsoil, subsoil, and other suitable materials (not just topsoil as in the No Action Alternative) necessary to create the root zone needed to support revegetation (especially trees) and restore premining capability.
- Overburden materials used as a topsoil substitute or supplement must result in a growing medium that is more suitable for vegetation than the original topsoil or the topsoil alone.
- Salvage of organic matter (tree tops, root balls, duff, and other native vegetative debris). These materials must be mixed with the topsoil, redistributed over the re-soiled area, or used for fish and wildlife enhancement purposes.
- Reforestation of previously forested areas or areas that would revert to forest under natural succession unless reforestation is inconsistent with an approved postmining land use that is implemented before the end of the revegetation responsibility period.
- Revegetation success standards must be developed to demonstrate that the permittee has restored the land's capability to support all uses it was capable of supporting before any mining, not just the approved postmining land use as under the No Action Alternative.

These alternatives would enhance fish, wildlife, and related environmental values and ensure that the reclaimed site can support the uses it was capable of supporting before any mining, including the vegetation that it would support in the absence of human influence. These alternatives would restore previously forested areas to a native forest ecosystem as quickly as possible, except where doing so would conflict with the approved postmining land use and that use is implemented before the end of the revegetation responsibility period. Alternatives 2, 3, 4, 5, 7, and 8 (Preferred) would beneficially impact soil quality and productive capability both directly in the form of improved soil reconstruction requirements and indirectly in the form of improved revegetation requirements. Alternatives 6 and 9 would have the same impacts as the No Action Alternative.

Fish and Wildlife Protection and Enhancement

Section 515(b)(24) and 516(b)(11) of SMCRA (30 U.S.C. §§ 1265(b)(24) and 1266(b)(11)) require that surface coal mining and reclamation operations minimize disturbances and adverse impacts of the operation on fish, wildlife, and related environmental values to the extent possible using the best technology currently available; they also require enhancement of those resources where practicable. The existing regulations (the No Action Alternative) at 30 CFR 773.15(j), 816.97(b), and 817.97(b) prohibit the approval of a permit or the conduct of mining activity likely to jeopardize endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. The existing regulations at 30 CFR 780.16 and 784.21 require that each permit application include fish and wildlife resource information and a fish and wildlife protection plan. The existing regulations at 30 CFR 816.97(a) and (e) and 817.97(a) and (e) contain corresponding performance standards requiring enhancement of fish, wildlife, and related environmental values where practicable; they also require implementation of protective measures during mining in all cases. The remainder of existing 30 CFR 816.97 and 817.97 require additional protective measures for fish and wildlife, including avoidance of disturbances to, restoration, or replacement of wetlands, riparian vegetation, and other habitats of unusually high value for fish and wildlife.

The Action Alternatives would improve implementation of sections 515(b)(24) and 516(b)(11) of SMCRA by further protecting fish, wildlife, and related environmental resources through measures such as mandatory enhancement measures to offset any long-term environmental impacts as well as a requirement for establishment or restoration of a minimum 100-foot (Alternatives 2, 5, 6, 7, and 8) or 300-foot (Alternatives 3 and 4) riparian corridor comprised of native species along intermittent, perennial, and (sometimes) ephemeral streams. None of the alternatives, including the No Action Alternative, would have a direct impact on topography, geology, or soils, although all alternatives may have an indirect impact to the extent that they might encourage operators to avoid mining areas of high habitat value.

4.2.3.3 Assessment of Quantified Impacts to Topography, Geology, and Soils

The analysis considers three indicators for characterizing the quantified impacts of the alternatives on topography, geology, and soils:

- First, impacts are directly dependent on the amount of coal mined. Hence, changes in coal production forecasted for the alternatives provide a rough indicator of potential changes in adverse impacts to topography, geology, and soils.
- Second, some of the requirements under the alternatives affect the intensity of land disturbance, i.e., the number of acres disturbed per ton of coal mined.
- Third, an analysis of likely premining and postmining slope ranges provides a measure of how the alternatives may affect topographical changes associated with mining.

Each of these indicators is discussed below.

Coal Production Impacts

Mining itself constitutes a disturbance to topography, geology, and soils. Thus, the Action Alternatives will impact topography, geology, and soils to the extent they influence the quantity of coal produced in a particular region. Table 4.2.3-2 reviews the annual net change in coal production projected for each Action Alternative relative to the No Action Alternative, averaged over the period from 2020 to 2040. Key observations include the following:

- To varying extents, all Action Alternatives (except Alternative 9) would decrease coal production.
- Under all Action Alternatives, coal production would decrease the most in the Appalachian Basin, Illinois Basin, and Northern Rocky Mountains and Great Plains regions.
- In other regions, the Action Alternatives would have negligible effects on future coal production.
- Alternative 2 would result in the largest reduction in coal production. Hence, it likely would have the least adverse impact on topography, geology, and soils of all the alternatives.
- Alternative 2 would result in a minor shift from surface mining to underground mining in the Appalachian Basin. Underground mining typically causes less disturbance to topography, geology, and soils than surface mining.

Table 4.2.3-2
Forecasted Change in Annual Coal Production Compared to the No Action Alternative, 2020 to 2040 (Million Tons)

Alter-native	Mine type	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	N. Rocky Mountains & Great Plains	Northwest	Western Interior	Total
2	Surface	(96)	0	0	(2)	(14)	0	0	(112)
	UG	52	0	-	(7)	0	-	0	45
	Total	**(44)**	**0**	**0**	**(9)**	**(14)**	**0**	**0**	**(68)**
3	Surface	(9)	0	0	(1)	(15)	0	0	(25)
	UG	(18)	0	-	(5)	-	-	0	(23)
	Total	**(26)**	**0**	**0**	**(6)**	**(15)**	**0**	**0**	**(47)**
4	Surface	(7)	0	0	(1)	(15)	0	0	(23)
	UG	15	0	-	(5)	-	-	0	(20)
	Total	**(22)**	**0**	**0**	**(6)**	**(15)**	**0**	**0**	**(43)**
5	Surface	(6)	0	0	(1)	(15)	0	0	(21)
	UG	(13)	0	-	(3)	-	-	0	(16)
	Total	**(19)**	**0**	**0**	**(3)**	**(15)**	**0**	**0**	**(37)**
6	Surface	(3)	0	0	(1)	(14)	0	0	(18)
	UG	(7)	0	-	(4)	-	-	0	(11)
	Total	**(10)**	**0**	**0**	**(5)**	**(14)**	**0**	**0**	**(29)**
7	Surface	(7)	0	0	(2)	(14)	0	0	(23)
	UG	(16)	0	-	(7)	-	-	0	(23)
	Total	**(23)**	**0**	**0**	**(9)**	**(14)**	**0**	**0**	**(46)**
8	Surface	(6)	0	0	(1)	(15)	0	0	(21)
	UG	(12)	0	-	(5)	-	-	0	(17)
	Total	**(18)**	**0**	**0**	**(6)**	**(15)**	**0**	**0**	**(39)**
	Surface	0	0	0	0	0	0	0	0

Alter-native	Mine type	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	N. Rocky Mountains & Great Plains	Northwest	Western Interior	Total
9	UG	0	0	-	0	0	-	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: Parentheses indicate a negative change in forecasted coal production. Please refer to Section 4.1 for a more detailed discussion of these forecasted changes

Section 4.1 of this EIS provides a more detailed discussion of the forecasted change in coal production under each alternative.

Disturbed Area

Another key component of this analysis concerns changes in the size of the area disturbed by coal mining. The analysis quantifies these changes based on estimated rates of acreage disturbed per million tons of coal mined, as determined in the model mines analysis (see Section 4.1). Disturbed areas include all areas from which mining-related activities remove vegetation, topsoil, or overburden, and all areas upon which the operation places spoil, coal mine waste, or other mining-related materials.

The analysis indicates that impacts would be concentrated in Central Appalachia and would primarily affect surface mines. The Action Alternatives would not result in changes in disturbed area in any other region. Therefore, this section discusses only the impacts on Central Appalachia.

Table 4.2.3-3 shows changes in the acreage disturbed per million tons of coal mined for the Central Appalachian region surface mines. The table presents both the absolute acreage as well as the change in disturbed acreage relative to the No Action Alternative. The general finding is that under certain Action Alternatives, less land is disturbed per million tons of coal mined by surface methods in Central Appalachia. The decrease in the disturbance rate likely would reduce adverse impacts on topography, geology, and soils. Specific observations include the following:

- For Central Appalachian surface mines (excluding contour mines), Alternatives 3 through 9 disturb the same amount of land per million tons of coal mined as under the No Action Alternative. Alternative 2, however, has a slightly lower disturbance rate.
- For Central Appalachian surface contour mines, Alternatives 3 and 9 disturb land at the same rate as the No Action Alternative. Alternative 2 significantly reduces land disturbance rates for surface contour mines. The other Action Alternatives (4 through 8) disturb slightly less land per million tons of coal mined as under the No Action Alternative.

Table 4.2.3-3
Disturbed Area, Minable Coal, and Disturbed Area per Million Tons of Coal Mined for Central Appalachian Surface Model Mines: Potential Total Acreage Compared to the No Action Alternative

	Disturbed area per mine (acres)	Volume of mineable coal per mine (million tons)	Disturbed area per million tons mined (acres/million tons)
Central Appalachian Surface Area Mine			
No Action, Alternatives 3 through 9	1,260	37	34
Alternative 2	1,116	37	31
Central Appalachian Surface Contour Mine			
No Action, Alternatives 3 and 9	458	5	92
Alternative 2	371	5	74
Alternatives 4 through 8	448	5	90
Note: Totals may not sum due to rounding.			

Finally, the shift to underground mining under Alternative 2 in the Appalachian Basin would further decrease the negative effects on topography, soils, and, to a lesser extent, geology, given that underground mines disturb significantly less area per million tons of coal produced than surface mines.

Slope Changes and Topographical Impacts

A comparison of premining and postmining slopes using the model mines analysis indicates that all alternatives would result in no more than a one percent change in slope, with the exception of the Central Appalachian and Northern Appalachian regions. The change in slope is used as an indicator of the severity of the change in topography.[32] The objective is to determine whether the Action Alternatives reduce the topographical moderation (i.e., the change from steeper slopes before mining to more moderate slopes after mining) often associated with mining.

Surface mines in the Northern Appalachian region exhibited no clear trends with respect to topographical moderation. However, Tables 4.2.3-4 and 4.2.3-5 and Figures 4.2.3-3 and 4.2.3-4 indicate that Alternatives 2, 4, and 8 would result in measurable differences between premining and postmining slopes for surface mines in the Central Appalachian region compared to the differences between premining and postmining slopes that would exist under the No Action Alternative. Specifically, Alternatives 2, 4, and 8 would result in a lower proportion of flatter postmining slopes and a higher proportion of steeper postmining slopes relative to the other alternatives.

[32] This is an oversimplification because topography represents the three-dimensional arrangement of physical attributes (shape, elevation, and volume), and typically includes an analysis of aspect (direction of slope) of a land's surface and elevation. While important, aspect and elevation are more difficult to characterize across a large area and many model mines. Therefore, they were not included in this analysis.

Table 4.2.3-4
Analysis of Slope Change for Central Appalachian Surface Area Mines[4]

Alternative	Slope Range	Acreage[2]	Percentage[3]	Difference from No Action Alt. (acres)
	<5%	202	14.3%	0
	5%-10%	16	1.2%	0
	10%-15%	26	1.8%	0
No Action Alternative[1]	15%-35%	136	9.6%	0
	35%-45%	156	11.1%	0
	45%-55%	754	53.5%	0
	>55%	119	8.4%	0
	<5%	154	10.9%	-48
	5%-10%	20	1.4%	3
	10%-15%	24	1.7%	-2
Alternative 2	15%-35%	148	10.5%	13
	35%-45%	119	8.4%	-37
	45%-55%	737	52.3%	-17
	>55%	207	14.7%	88
	<5%	129	9.2%	-73
	5%-10%	19	1.4%	3
	10%-15%	29	2.1%	3
Alternatives 4 and 8	15%-35%	268	19.0%	132
	35%-45%	137	9.7%	-19
	45%-55%	708	50.3%	-46
	>55%	118	8.3%	-1

Notes:
[1] Alternatives 3, 5, 6, 7, and 9 would have slope changes comparable to those that would occur under the No Action Alternative.
[2] Mine area acres within designated slope range category.
[3] Percent of total mine area within designated slope range category.
[4] Based on model mine analysis.

Figure 4.2.3-3 Analysis of Slope Change for Central Appalachian Surface Area Mines

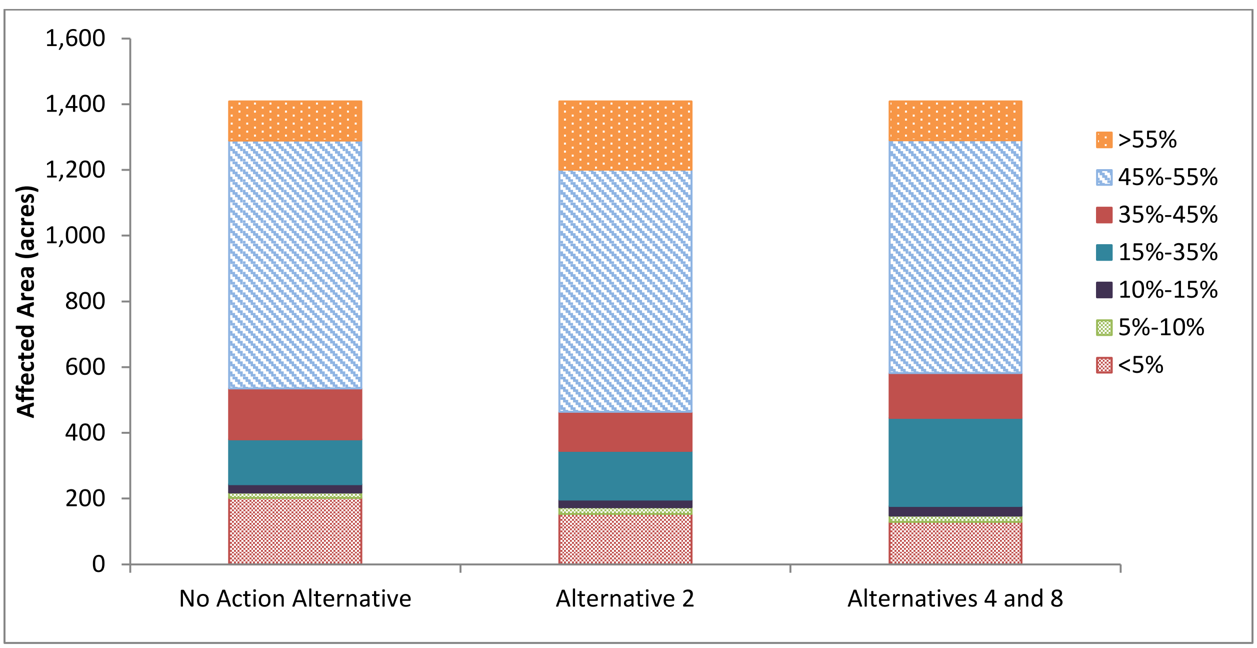
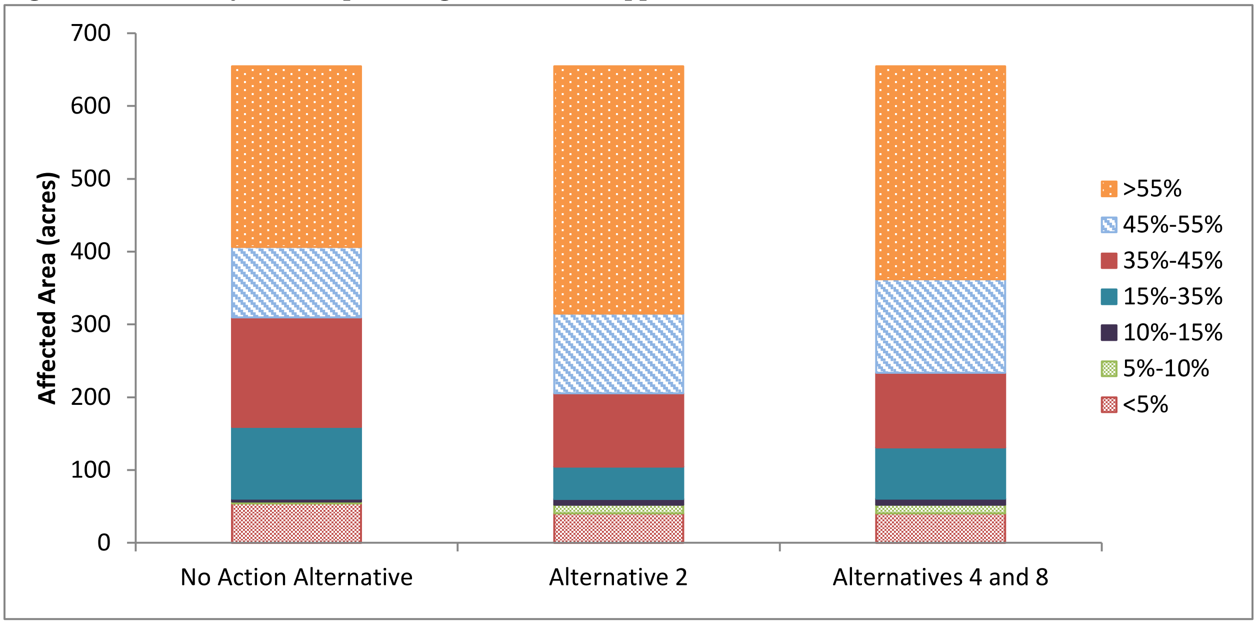


Table 4.2.3-5
Analysis of Slope Change for Central Appalachian Surface Contour Mines[4]

Alternative	Slope Range	Acreage[2]	Percent[3]	Difference from No Action (acres)
No Action Alternative[1]	<5%	54	8.3%	0
	5%-10%	3	0.4%	0
	10%-15%	4	0.6%	0
	15%-35%	99	15.1%	0
	35%-45%	151	23.0%	0
	45%-55%	97	14.8%	0
	>55%	248	37.9%	0
Alternative 2	8.3%	41	6.2%	-13
	0.4%	12	1.8%	9
	0.6%	8	1.2%	4
	15.1%	45	6.8%	-54
	23.0%	101	15.4%	-50
	14.8%	109	16.7%	13
	37.9%	340	51.9%	92
Alternatives 4 and 8	<5%	41	6.2%	-13
	5%-10%	12	1.8%	9
	10%-15%	8	1.3%	5
	15%-35%	70	10.7%	-29
	35%-45%	103	15.7%	-48
	45%-55%	129	19.7%	32
	>55%	292	44.7%	44

Notes:
[1] Alternatives 3, 5, 6, 7, and 9 would have slope changes comparable to those that would occur under the No Action Alternative.
[2] Mine area acres within designated slope range category.
[3] Percent of total mine area within designated slope range category.
[4] Based on model mine analysis.

Figure 4.2.3-4 Analysis of Slope Change for Central Appalachian Surface Contour Mines



4.2.3.4 Summary of Effects

Table 4.2.3-6 summarizes the impacts to topography, geology, and soils under each of the Action Alternatives as compared to the No Action Alternative. In general, the effects of the Action Alternatives on these resources are expected to be negligible or beneficial across all coal regions. The relative level of benefit (Negligible, Minor, or Moderate) considers the duration of impact and geographic scope of impact, as described in Section 4.0. Coal mining is both geographically widespread and of major economic importance in the Appalachian Basin region, so each alternative that would apply to all mining operations is rated as having an impact of at least medium geographic scope for that region.

Alternative 1 (No Action Alternative)

As described more fully above and summarized throughout the following comparisons, the No Action Alternative does not revise the current regulations. Therefore, it would result in continuation of current coal mining impacts on topography, geology, and soils.

Alternative 2

Topography: Alternative 2 would eliminate the AOC exception for mountaintop removal mining operations. It also would eliminate all steep-slope AOC variances, prohibit placement of excess spoil or coal mine waste in perennial streams, and prohibit placement of excess spoil in intermittent streams.

Alternative 2 would require use of digital terrain models to document premining and postmining surface configurations of the mined area, with the exception of remining operations and non-contiguous permits no more than 40 acres in size. The final thickness of backfilled and graded spoil placed in the mined-out area could not vary from the combined premining thickness of overburden and the coal seam by more than ±20 percent at any point on the backfilled area. Landforming principles would apply to both backfilled and graded areas and to excess spoil fills. These requirements should reduce mining-related topographic changes. Alternative 2 also would establish more stringent approval criteria for mining through intermittent streams and would require restoration of the ecological function of intermittent streams that are mined through.

Geology: Alternative 2 would prohibit mining within 100 feet of a perennial stream, which should prevent impacts to the geology of those areas.

Soils: Alternative 2 would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. Alternative 2 also would require salvage of all native vegetation and other organic materials, including root balls, which must be incorporated into the topsoil, redistributed on the surface of topsoiled areas, or used for stream restoration or fish and wildlife enhancement purposes.

Table 4.2.3-6
Summary of Impacts of the Action Alternatives on Topography, Geology and Soil Resources As Compared to the No Action Alternative

Alternative	Metric	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	National
Alternative 2	Classification	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	LT, SS	LT, SS	LT, SS	LT, SS	MMI	MMI	
Alternative 3	Classification	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	LT, SS	LT, SS	LT, SS	LT, SS	MMI	MMI	
Alternative 4	Classification	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	LT, SS	LT, SS	LT, SS	LT, SS	MMI	MMI	
Alternative 5	Classification	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	MMI	MMI	MMI	MMI	MMI	MMI	
Alternative 6	Classification	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**
	Rationale	MMI	MMI	MMI	MMI	MMI	MMI	MMI	
Alternative 7	Classification	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	MMI	MMI	MMI	MMI	MMI	MMI	
Alternative 8 (Preferred)	Classification	Moderate Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	LT, SS	LT, SS	LT, SS	LT, SS	MMI	MMI	
Alternative 9	Classification	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**
	Rationale	MMI	MMI	MMI	MMI	MMI	MMI	MMI	

Notes:
LT = Long-term impact; LS = Large scope impact; MS = Medium scope impact; SS = Small scope impact; MMI = Minimal measurable impact.
Please see Section 4.0 for a definition of negligible, minor, and moderate impact terms used above.
For a discussion of the impacts of the No Action Alternative (Alternative 1), see Section 4.2.3.1 above.

Alternative 2 would allow use of selected overburden materials as substitutes for (or supplements to) topsoil or subsoil, but only if the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed. The operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation, and that the selected overburden materials are the best available within the permit area for that purpose. The operator would be required to redistribute soils in a manner that limits compaction and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and the lack of a suitable root zone and growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 2 would cause a decrease in total coal production for this region, coupled with a small shift toward underground mining, which should decrease the total area disturbed by mining each year. In addition, the area disturbed per million tons of coal mined would decrease. With respect to topography, this alternative is the only alternative that would prohibit mountaintop removal mining operations and steep-slope AOC variances. It also would require use of landforming principles to design and construct the postmining surface configuration and the final thickness of backfilled and graded spoil placed in the mined-out area could not vary from the combined premining thickness of overburden and the coal seam by more than ±20 percent at any point on the backfilled area. The slope analysis indicates a decrease in topographic moderation, which results in a reclaimed surface topography that more closely resembles the premining surface configuration. This alternative would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Therefore, Alternative 2 would have long-term positive impacts of a medium geographic scope that would have a Moderate Beneficial effect on the topography, geology, and soils of this region.

Colorado Plateau and Gulf Coast Regions

Alternative 2 would have qualitative benefits to topography, geology, and soils in the Colorado Plateau and Gulf Coast regions, but substantially fewer topographical benefits than in the Appalachian Basin region because the former regions have a much flatter premining topography than the Appalachian Basin region. This alternative would have long-term benefits, primarily in terms of soil reconstruction and stream restoration, of a relatively small geographic scope. Therefore, Alternative 2 would have a Minor Beneficial effect on the topography, geology, and soils of these regions.

Illinois Basin Region

Alternative 2 would result in a slight decrease in total coal production in this region, thereby decreasing the total acreage disturbed by mining each year. This decrease in acreage, combined with qualitative benefits in terms of landforming and soil restoration requirements, would have long-term positive impacts of a relatively small geographic scope. Therefore, Alternative 2 would have a Minor Beneficial effect on the topography, geology, and soils of this region.

Northern Rocky Mountains and Great Plains Region

Alternative 2 would result in a slight decrease in total coal production in this region, thereby decreasing the total acreage disturbed by mining each year. This decrease in acreage, combined with qualitative benefits in terms of soil salvage and reconstruction and riparian corridors, would have long-term positive impacts of a relatively small geographic scope. Therefore, Alternative 2 would have a Minor Beneficial effect on the topography, geology, and soils of this region.

Northwest and Western Interior Regions

Alternative 2 would have long-term qualitative benefits in terms of soil salvage and reconstruction and protection and establishment of riparian corridors, mostly in the Western Interior region. There is very little active mining in the Northwest region and mining is very limited in geographic scope in the Western Interior region. Therefore, Alternative 2 would have a Negligible effect on the topography, geology, and soils of the Western Interior and Northwest regions.

Alternative 3

Topography: Alternative 3 would allow mountaintop removal mining operations and steep-slope AOC variances, provided that they do not damage natural watercourses on or off the permit area. It would prohibit approval of a steep-slope AOC variance if the variance would result in placement of excess spoil in an intermittent or perennial stream. It also would require that mountaintop removal mining sites and sites with a steep-slope AOC variance be restored to AOC if the approved postmining land use is not implemented during the revegetation responsibility period.

Alternative 3 would require that landforming principles be applied to the surface configuration created by backfilling and grading, but they need not be applied to excess spoil fills. It would require use of digital terrain models to document premining and postmining surface configurations of the mined area, with the exception of remining operations and non-contiguous permits no more than 40 acres in size. Alternative 3 also would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through.

These requirements should reduce some of the adverse topographic disturbances that result from mining.

Geology: Alternative 3 would not differ significantly from the No Action Alternative in terms of geologic impacts.

Soils: Alternative 3 would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. It also would require salvage of all native vegetation and other organic materials, including root balls, which must be redistributed in accordance with an approved plan developed by a qualified ecologist or similar expert. The expert would determine the amounts needed to promote reestablishment of native vegetation and soil flora and fauna.

Alternative 3 would allow use of selected overburden materials as substitutes for (or supplements to) topsoil or subsoil, but only if the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed. The operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soil materials in a manner that limits compaction and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 3 would cause a decrease in total coal production for this region, which should decrease the total area disturbed by mining each year. In terms of qualitative impacts, this Alternative would require use of landforming principles to design and construct the postmining surface configuration. It also would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Therefore, Alternative 3 would have long-term positive impacts of a medium geographic scope with a Minor Beneficial effect on the topography, geology, and soils of this region.

Colorado Plateau, Gulf Coast, Illinois Basin, Northern Rocky Mountains and Great Plains, and Western Interior Regions

Alternative 3 would result in in a slight decrease in total coal production in the Illinois Basin region, thereby decreasing the total acreage disturbed by mining each year. The other regions listed above would experience no measurable change in coal production under this Alternative. Qualitative benefits from landforming, soil salvage and restoration, and riparian corridor requirements would have long-term positive impacts of a small geographic scope with a Minor Beneficial effect on the topography, geology, and soils of these regions.

Northwest Region

There is very little active mining in the Northwest region. Therefore, Alternative 3 would have a Negligible effect on the topography, geology, and soils of this region.

Alternative 4

Topography: Alternative 4 would allow mountaintop removal mining operations and steep-slope AOC variances, provided that they do not damage natural watercourses on or off the permit area. It would prohibit approval of a steep-slope AOC variance if the variance would result in placement of excess spoil in an intermittent or perennial stream. It also would require that mountaintop removal mining sites and sites with a steep-slope AOC variance be restored to AOC if the approved postmining land use is not implemented during the revegetation responsibility period.

Alternative 4 would require that landforming principles be applied to the surface configuration created by backfilling and grading. It would require use of digital terrain models to document premining and postmining surface configurations of the mined area, with the exception of remining operations and non-contiguous permits no more than 40 acres in size. The final thickness of backfilled and graded spoil placed in the mined-out area could not vary from the combined premining thickness of overburden and the coal seam by more than ±20 percent at any point on the backfilled area. Alternative 4 also would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through.

These requirements should reduce some of the adverse topographic disturbances that result from mining.

Geology: Alternative 4 would not differ significantly from the No Action Alternative in terms of geologic impacts.

Soils: Alternative 4 would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. Alternative 4 also would require salvage of all native vegetation and other organic materials, including root balls, which must be incorporated into the topsoil, redistributed on the surface of topsoiled areas, or used for stream restoration or fish and wildlife enhancement purposes.

Alternative 4 would allow use of selected overburden materials as substitutes for (or supplements to) either topsoil or subsoil, provided that the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed.

The operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation, and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soil materials in a manner that limits compaction, and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 4 would cause a decrease in total coal production for this region, which should decrease the total area disturbed by mining each year. In terms of qualitative impacts, this alternative would require use of landforming principles to design and construct the postmining surface configuration and would place restrictions on how much the postmining elevation may differ from the premining elevation at any point in the backfilled and graded area. It also would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Therefore, Alternative 4 would have long-term positive impacts of a medium geographic scope with a Moderate Beneficial effect on the topography, geology, and soils of this region.

Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains Regions

Alternative 4 would result in in a slight decrease in total coal production in the Illinois Basin region, thereby decreasing the total acreage disturbed by mining each year. The other regions listed above would experience no measurable change in coal production under this alternative. Qualitative benefits from landforming, soil salvage and restoration, and riparian corridor requirements would have long-term positive impacts of a small geographic scope with a Minor Beneficial effect on the topography, geology, and soils of these regions.

Northwest and Western Interior Regions

There is very little active mining in the Northwest and Western Interior regions. Therefore, Alternative 4 would have a Negligible effect on the topography, geology, and soils of these regions.

Alternative 5

Alternative 5 would apply only to surface and underground mining activities that result in placement of excess spoil outside the mined area or disposal of coal mine waste material in perennial or intermittent streams. These conditions predominantly exist in the Appalachian Basin region.

Topography: Alternative 5 would allow mountaintop removal mining operations and steep-slope AOC variances, provided that they do not damage natural watercourses on or off the permit area. It would prohibit approval of a steep-slope AOC variance if the variance would result in placement of excess spoil in an intermittent or perennial stream. It also would require that mountaintop removal mining sites and sites with a steep-slope AOC variance be restored to AOC

if the approved postmining land use is not implemented during the revegetation responsibility period. It would require use of digital terrain models to document premining and postmining surface configurations of the mined area, with the exception of remining operations and non-contiguous permits no more than 40 acres in size. For those operations to which it applies, Alternative 5 also would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through.
These requirements should reduce some of the adverse topographic disturbances that result from mining.

Geology: Alternative 5 would not differ significantly from the No Action Alternative in terms of geologic impacts.

Soils: Alternative 5 would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. It also would require salvage of all native vegetation and other organic materials, including root balls, which must be redistributed in accordance with an approved plan developed by a qualified ecologist or similar expert. The expert would determine the amounts needed to promote reestablishment of native vegetation and soil flora and fauna.

Alternative 5 would allow use of selected overburden materials as substitutes for (or supplements to) either topsoil and/or subsoil, provided that the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed.

The mine operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soils in a manner that limits compaction and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 5 would cause a slight decrease in total coal production for this region, which should decrease the total area disturbed by mining each year. In addition, the area disturbed per million tons of coal mined would decrease. The slope analysis indicates no change in topographic moderation compared to the results of the No Action Alternative. For those operations to which it applies, Alternative 5 would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Alternative 5 would have some long-term qualitative positive impacts, primarily in the area of soil salvage and reconstruction and riparian corridors, but the geographic scope of those impacts would be limited because the alternative would not apply to all operations. Therefore, it would have a Moderate Beneficial effect on the topography, geology, and soils of this region.

Other Regions

Alternative 5 would have a Negligible effect on the topography, geology, and soils of regions other than the Appalachian Basin region because very few operations in those regions dispose of excess spoil or coal mine waste outside the mined area, which means that very few operations in those regions would be subject to the requirements of this alternative.

Alternative 6

Alternative 6 would apply only to mining-related activities within 100 feet of an intermittent or perennial stream. It would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through. The model mines analysis indicates that this alternative would have little impact on coal production, disturbance per million tons of coal removed, or postmining slope conditions relative to the No Action Alternative. In addition, Alternative 6 would not differ from the No Action Alternative with respect to requirements for soils and AOC restoration. Therefore, this alternative would have a Negligible effect on the topography, geology, and soils of all regions.

Alternative 7

Alternative 7 would apply only when certain conditions exist that warrant enhanced permitting conditions. For purposes of this DEIS, the model mines analysis assumes that this alternative would apply only to operations in steep-slope areas and to operations that place excess spoil or coal mine waste in perennial or intermittent streams.

Topography: Alternative 7 is identical to the No Action Alternative with respect to exceptions to AOC restoration requirements. For those operations to which Alternative 7 would apply, this alternative would require application of landforming principles to design and create the final surface configuration of the reclaimed mined area. It would require use of digital terrain models to document the premining and postmining surface configurations of the mined area, with the exception of remining operations and non-contiguous permits no more than 40 acres in size. The final thickness of backfilled and graded spoil placed in the mined-out area could not vary from the combined premining thickness of overburden and the coal seam by more than ±20 percent at any point on the backfilled area. Alternative 7 also would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through.

These requirements should reduce some of the adverse topographic disturbances that results from mining.

Geology: Alternative 7 would not differ significantly from the No Action Alternative in terms of geologic impacts.

Soils: Alternative 7 would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. To the extent that this alternative would apply to an operation; i.e., to the extent that enhanced permitting conditions are required, Alternative 7 would require salvage of all native vegetation and other organic materials, including root balls, which must be incorporated into the topsoil, redistributed on the surface of topsoiled areas, or used for stream restoration or fish and wildlife enhancement purposes.

Alternative 7 would allow use of selected overburden materials as substitutes for (or supplements to) either topsoil and/or subsoil, provided that the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed.

The mine operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soils in a manner that limits compaction and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 7 would cause a slight decrease in total coal production for this region, which should decrease the total area disturbed by mining each year. In addition, the area disturbed per million tons of coal mined would decrease. The model mines slope analysis indicates no change in topographic moderation compared to the results of the No Action Alternative. For those operations to which it applies, Alternative 7 would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Alternative 7 would have some long-term qualitative positive impacts, primarily in the area of soil salvage and reconstruction and riparian corridors, but the geographic scope of those impacts would be limited because the alternative would not apply to all operations. Therefore, it would have a Moderate Beneficial effect on the topography, geology, and soils of this region.

Other Regions

Alternative 7 would have a Negligible effect on the topography, geology, and soils of regions other than the Appalachian Basin region because very few operations in those regions dispose of excess spoil or coal mine waste outside the mined area, which means that very few operations in those regions would be subject to the requirements of this alternative.

Alternative 8 (Preferred)

Topography: Alternative 8 (Preferred) would allow mountaintop removal mining operations, provided that they do not damage natural watercourses on or off the permit area. It would define damage in terms of parameters of concern, peak flows, and total flow volumes. This alternative would allow steep-slope AOC variances needed to achieve specified postmining land uses, but prohibit approval of a steep-slope AOC variance if the variance would result in placement of excess spoil in an intermittent or perennial stream. It also would require that mountaintop removal mining sites and sites with a steep-slope AOC variance be restored to AOC if the approved postmining land use is not implemented during the revegetation responsibility period.

Alternative 8 (Preferred) would require that landforming principles be applied to the surface configuration of the top deck of excess spoil fills. While use of landforming principles would not be required for reclamation of the mined area itself, this alternative would require that the postmining drainage pattern of perennial, intermittent, and ephemeral streams restored after mining be similar to the premining drainage pattern, with exceptions for stability, fish and wildlife enhancement, and prevention of downcutting of stream channels. Alternative 8 (Preferred) also would establish more stringent approval criteria for mining through streams and would require restoration of the ecological function of perennial and intermittent streams that are mined through.
These requirements should reduce some of the adverse topographic disturbances that result from mining.

Geology: Alternative 8 (Preferred) would not differ significantly from the No Action Alternative in terms of geologic impacts.

Soils: Alternative 8 (Preferred) would require salvage and redistribution of all topsoil (the A and E horizons) and sufficient quantities of subsoil (B and C horizons) or other suitable materials to provide optimal rooting depths to restore premining land use capability or to comply with revegetation requirements. It also would require salvage of all native vegetation and other organic materials, including root balls, which must be incorporated into the topsoil, redistributed on the surface of topsoiled areas, or used for stream restoration or fish and wildlife enhancement purposes.

Alternative 8 (Preferred) would allow use of selected overburden materials as substitutes for (or supplements to) either topsoil and/or subsoil, provided that the operator demonstrates that: (1) the quality of the existing topsoil and subsoil is inferior to that of other overburden materials; or (2) the quantity of the existing topsoil and subsoil is insufficient to provide the optimal rooting depth or meet other plant growth requirements. In the latter case, all existing topsoil and favorable subsoil must be salvaged and redistributed.

The mine operator also must demonstrate that the resulting soil medium would be more suitable than the existing topsoil and subsoil to sustain vegetation and that the selected overburden materials are the best available within the permit area for that purpose. The operator would have to redistribute soils in a manner that limits compaction and provides optimal rooting depth to support the approved plan for revegetation and reforestation.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

These requirements should reduce some of the adverse soil effects, particularly those related to compaction and lack of an adequate root zone and suitable growing medium for reforestation, that can result from mining under the No Action Alternative.

Impacts on topography, geology, and soils would vary by region. Each region is discussed separately below.

Appalachian Basin Region

Alternative 8 (Preferred) would cause a slight decrease in total coal production for this region, which should result in a slight decrease in the total area disturbed by mining each year. In addition, the analysis indicates that the area disturbed per million tons of coal mined would decrease. With respect to topography, the model mines slope analysis indicates that this alternative would result in less topographic moderation than the No Action Alternative, which means that the postmining surface configuration would more closely resemble the premining configuration. This Alternative also would require that postmining soils be reconstructed with a root zone adequate to restore premining land use capability and fully support reforestation. Therefore, Alternative 8 (Preferred) would have long-term positive impacts of a medium geographic scope with a Moderate Beneficial effect on the topography, geology, and soils of this region.

Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains Regions

The regions listed above would experience no measurable change in coal production under Alternative 8 (Preferred). Qualitative benefits from landforming, soil salvage and restoration, and riparian corridor requirements would have long-term positive impacts of a small geographic scope with a Minor Beneficial effect on the topography, geology, and soils of these regions.

Illinois Basin Region

Alternative 8 (Preferred) would result in in a slight decrease in total coal production in this region, thereby decreasing the total acreage disturbed by mining each year. Qualitative benefits from landforming, soil salvage and restoration, and riparian corridor requirements would have long-term positive impacts of a small geographic scope with a Minor Beneficial effect on the topography, geology, and soils of this region.

Northwest and Western Interior Regions

There is very little active mining in the Northwest and Western Interior Regions. Therefore, Alternative 8 (Preferred) would have a Negligible effect on the topography, geology, and soils of these regions.

Alternative 9

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zonerule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible effects on topography, geology, and soils.

4.2.3.5 Potential Minimization and Mitigation Measures

The Action Alternatives are not expected to result in any negative environmental consequences for topography, geology, and soils. Therefore, identifying potential minimization and mitigation measures is not applicable for this analysis.

4.2.4 Air Quality, Greenhouse Gas Emissions, and Climate Change

This section characterizes the impacts of the Alternatives on air quality. The discussion is organized as follows:

- Section 4.2.4.1 describes the existing regulatory environment and its implications for the No Action Alternative;
- Section 4.2.4.2 describes key elements of Action Alternatives and their role is addressing air emissions;
- Section 4.2.4.3 describes the methods employed to evaluate potential effects to air resources;
- Section 4.2.4.4 presents the results of this evaluation;
- Section 4.2.4.5 summarizes results across Action Alternatives and regions;
- Section 4.2.4.6 describes potential minimization and mitigation measures; and
- Section 4.2.4.7 discusses additional considerations with respect to air quality effects of coal combustion.

This section does not detail public health and safety associated with coal mining-related air pollution; health effects are discussed in Section 4.3.4 of this document.

OSMRE is limited in its ability to regulate air quality. Air emissions permits for coal mines fall under the authority of the Clean Air Act (CAA) and are not issued under SMCRA. The decision discussed in *In re Permanent Surface Min. Regulation Litig. I, Round II*, 1980 U.S. Dist. LEXIS 17660 at *43-44 (D.D.C., May 16, 1980), 19 Env't Rep. Cas. (BNA) 1477, clarifies that OSMRE does not have jurisdiction over industrial emissions, and that its jurisdiction is limited to air pollution attendant to wind and water erosion (e.g., exposing soil to wind causing particulates to become airborne). The decision clarifies that all other mining-related emissions are generally regulated under the CAA and not SMCRA.

The following discussion examines air quality as a resource within the human environment, focusing on the specific components that coal mining operations can influence, and does not limit the discussion to what OSMRE is specifically authorized to regulate (i.e., erosion-related air pollution). This provides the required basis (40 CFR 1502.16) for a scientific and analytic comparison between the Alternatives.

This section focuses primarily on the potential air quality impacts of coal mining operations according to the Alternatives being considered (including the No Action Alternative). The Alternatives may influence air quality in the following ways:

- Changes in the extent equipment and vehicles are used affects combustion engine emissions from coal mining;
- Changes in dust or particulates from burning or wind erosion of materials used and/or soil being exposed on site during coal mining;
- Additional requirements for reforestation and revegetation may increase the carbon sequestration potential of the postmining landscape; and
- Changes in overall emissions levels that may result from shifts in coal production methods (e.g., from surface to underground mining) or levels (e.g., overall reductions in coal production). This includes changes in methane released when coal is extracted (i.e., "fugitive emissions"), as well as changes in emissions associated with activities undertaken through the course of operations (i.e., emissions from vehicle use and release of toxics from explosives detonation).

While the Alternatives do not direct operations at coal burning facilities, this section also includes a qualitative discussion of effects of coal burning on air quality to provide additional context and information for this analysis.

4.2.4.1 Effects of the Current Regulatory Environment (the No Action Alternative)

As discussed in Chapter 3, air emissions emanate from vehicle engines associated with the mining activity, from emissions released during explosives detonation, from the erosion and wind transport of dust and particulate matter, and from the release of greenhouse gases as coal is exposed. Under the No Action Alternative, the effects of coal mining on air quality, with the exception of erosion-related pollution, are regulated primarily under the CAA. Implementation of performance standards for blasting, however, also falls under the purview of SMCRA. Compliance with these standards reduces human exposure to toxic air pollutants that may otherwise result from blasting.

Pollutants released from combustion engines include five of the six EPA defined criteria pollutants: carbon monoxide, sulfur dioxide, nitrogen oxides, volatile organic compounds (VOCs), and particulate matter (PM_{10} and $PM_{2.5}$). EPA regulates toxic emissions from motor vehicles through standards on motor vehicle fuels and engine efficiency; however, mobile sources do not require permitting under the CAA and methane emissions from mobile sources are not subject to performance standards.

The detonation of explosives under ideal field conditions releases nitrogen gas, carbon dioxide, and water vapor. In the case that field conditions are not ideal, or the explosives product formulation is incorrect, the blast may yield nitric oxide, nitrogen dioxide, or carbon monoxide in addition to the gases listed above. Section 515 of SMCRA (30 U.S.C. § 1265(b)(15)) includes a general performance standard that requires limitation of the type and size of explosives and detonating equipment, and timing of the detonation, to prevent injury to persons and damage to property (e.g. livestock) outside the permit area.

The regulations implementing this section of SMCRA are included in the performance standards at 30 CFR 816/817.67. Specifically, 30 CFR 816/817.67(a) provides general regulatory requirements for control of adverse effects from conducting blasting operations, including the requirement to prevent injury to persons and damage to property. Subsequent subsections address specific adverse effects of blasting which include airblast, flyrock, and ground vibrations; however, fumes are not addressed. In addition, 30 CFR 780.13 requires that blast plans describe how blasting will be conducted to meet the performance standards. In the case that concern exists regarding potential danger from fumes to people or property, the Regulatory Authority (RA) may require that blasting be conducted to minimize fume generation or blast area security be expanded to ensure exposure is avoided.

While ground vibrations, airblast, and flyrock are commonly identified in the blast plan, blasting fumes are only addressed under certain circumstances, by a handful of state regulatory authorities. If not addressed in the blast plan, any visible fumes observed during an inspection or reported by a citizen that approach people or living property are considered “imminent harm” (30 CFR 843.11). Industry practice is to never enter a reddish-orange cloud as it is considered toxic and thus poses an imminent danger. Historically, though infrequent, RAs have issued Notices of Violation and imminent harm Cessation Orders through the state counterpart regulations to 30 CFR Part 843.

On April 18, 2014, OSMRE received a petition for rulemaking from WildEarth Guardians requesting that OSMRE “promulgate a rule prohibiting the production of visible nitrogen oxide emissions during blasting at surface coal mining operations in order to protect public and mine worker health, welfare, and safety, and prevent injury to persons, as required by the Surface Mining Control and Reclamation Act of 1977 (SMCRA).” On July 25, 2014, OSMRE published the petition in the Federal Register (79 FR 43326). On February 20, 2015, the Director’s decision to grant the petition in principle was published (80 FR 9256). OSMRE staff are currently developing a proposed rule that would require the regulatory authority to consider protections for persons and private property with regard to fume generation from blasting operations.

Coal mining may also affect particulate matter concentrations in air, specifically fugitive dust. Dust may be released or spread through operations due to wind during mining activities such as blasting; operation of drag lines; hauling overburden and mined coal; and road grading as well as in general from earthmoving activities (Lashof et al., 2007). As noted previously, if related to erosion and wind transport, fugitive dust is regulated under SMCRA, otherwise it is regulated under the CAA. This type of dust is generally coarse (PM_{10} classification). Surface mining produces more PM_{10} emissions in comparison to underground mining as a result of the increased percentage of disturbance occurring aboveground (Lashof et al., 2007).

Section 515 of SMCRA (30 U.S.C. § 1265(b)) contains provisions related to prevention of windborne erosion from stockpiled and transported materials, as well as provisions related to handling vegetative debris. Moreover, SMCRA's implementing regulations at 30 CFR 816.95(a) and 817.95(a) require that all exposed surface areas be protected and stabilized to control erosion. Likewise, §§ 816.150(b)(1) and 817.150(b)(1) require the control or prevention of erosion (including road dust) through measures such as vegetating, watering, using chemical or other dust suppressants, or otherwise stabilizing all exposed surfaces.

However, neither SMCRA nor the implementing regulations specifically require reincorporation of plant debris accumulated from site clearing (for example non-merchantable trees, tree limbs, stumps and branches). As a result these materials are often burned on-site, which may impact local air quality from the addition of particulate matter into the air. SMCRA and the implementing regulations require reforestation of previously forested mine sites unless the permittee has sought and received authorization to implement an alternative post mining land use. Coal regions are currently experiencing a net loss of forested area due to coal mining. This reduction in forested acreage impacts the environment in many ways; specific to air quality it results in the loss of oxygen production potential from the vegetation, and the net loss of sequestered carbon stocks. That is, forest-based carbon is reintroduced to the atmosphere as greenhouse gases from burning of the wood, rather than reincorporated into other stable uses (such as building materials), returned to the soil, or disposed of in ways that prevent carbon decay (e.g., landfilling).

In addition to the air quality impacts from operations at coal mines (from vehicles, blasting, and dust), the greenhouse gas methane may be released as the overburden is removed and coal and rock layers are broken as part of the mining process. Underground coal mining releases more fugitive methane than surface mining because of the higher gas content of deeper seams (Irving and Tailakov, 1999). Methane released from underground mines may be captured and used as an energy source. The objective of the U.S. EPA Coalbed Methane Outreach Program is to promote the recovery and use of coal mine methane by working with industry. Future voluntary involvement in this activity on the part of coal operations is uncertain. However, to the extent that participation grows over time, methane emissions associated with coal mining may decrease in the future under the No Action Alternative.

Finally, coal mining activity under the No Action Alternative reduces the carbon sequestration potential of the landscape by reducing vegetative biomass, at least in the short term. The No Action Alternative requires the establishment of vegetative cover, but not reforestation. As a result, mined areas experience a net loss of forestland. In comparison to other vegetation, forested areas contain more biomass both above and below ground. This increased biomass represents additional carbon storage, additional carbon dioxide consumption during photosynthesis, and increased production of oxygen. The reduction in forested landscapes under the No Action Alternative reduces the level of carbon that is removed from the atmosphere, thus contributing to climate change.

Under the No Action Alternative, air emissions and air quality impacts from coal mining would continue to be regulated under the CAA, and to a lesser extent SMCRA, and would continue to fluctuate with coal mining methods and activity levels. For a more complete discussion of the CAA, please refer to section 3.6.

4.2.4.2 Action Alternatives and Potential Effects on Air Quality, Greenhouse Gas Emissions, and Climate Change

This section identifies the aspects of the Action Alternatives expected to affect air emissions as a result of coal mining and related activities. While the elements of the Action Alternatives as described in Chapter 2 do not directly address air emissions from coal mining activities, implementation of the Action Alternatives may indirectly affect air quality. The requirements of Alternative 9 are not functionally different than the No Action Alternative; most current mining practices are consistent with the now-vacated 2008 SBZ rule and, accordingly, effects of Alternative 9 on air quality are anticipated to be Negligible. All other Action Alternatives have the potential to affect air quality in the following ways:

- **Changes in the amount of earth moving (haulage) required may affect the extent of wind transport of dust ($PM_{2.5}$ and PM_{10}), as well as emissions from mobile sources (combustion engines):** For instance, some Alternatives may require additional movement of surface material around a site, which would be expected to increase vehicle use on some sites. Vehicles are sources of nitrous oxide, carbon dioxide, and particulate matter emissions. Thus, rule elements found in some Action Alternatives may result in increases in air emissions on a per-mine basis. On the other hand, some Action Alternatives reduce overall levels of coal production, which may reduce the generation of dust and emissions from mobile sources.

- **Revegetation and reforestation requirements, as well as requirements to reduce burning of vegetation and other organic materials may reduce the wind transport of dust and increase the carbon sequestration potential of the landscape:** More stringent requirements for reforestation and revegetation of the postmining landscape reduce the extent to which materials are exposed to wind transport and increase the availability of biomass to sequester carbon from the atmosphere. Increased carbon sequestration may have a mitigating effect on the level of greenhouse gases in the atmosphere contributing to climate change. In addition, prohibitions on burning of vegetation and organic matter under the Action Alternatives reduce airborne particulates.

- **Changes in overall levels of surface and/or underground coal production affects: 1) the extent to which overburden is removed, resulting in fugitive methane emissions; 2) the level of activities, such as blasting, that contribute to dust and explosives emissions:** Costs associated with implementing some of the Action Alternatives are expected to affect the overall quantity of coal produced, which would affect the overall impact of coal mining on air quality. Under some Alternatives, the mix of production type, i.e., surface or underground, may also change. As discussed in Chapter 3, surface and underground mining activities have different emissions profiles; therefore a shift in mine types affects the overall amount of fugitive methane emissions from coal mining. Other coal mining activities, such as vehicle use, wind erosion of soils, and blasting, may also be reduced with a reduction in overall production levels. Accordingly, the negative effects of these activities on air quality would likewise be reduced.

Table 4.2.4-1 summarizes the effects that various rule elements incorporated into the Action Alternatives may affect air quality. The remainder of this section describes the potential direction and magnitude of the expected impacts in each of the coal regions.

Table 4.2.4-1
SPR Elements and Potential Effects on Air Quality, Greenhouse Gases, and Climate Change

SPR Element	Criteria Pollutants and Greenhouse Gases
Baseline Data Collection and Analysis	
Monitoring During Mining and Reclamation	
Definition of Material Damage to the Hydrologic Balance	
Corrective Action Thresholds	
Stream Definitions	
Mining Through Streams	■
Activities In or Near Streams Including Excess Spoil and Coal Refuse	■
AOC Variances	■
Surface Configuration	■
Revegetation, Topsoil Management, and Reforestation	■
Fish and Wildlife Protection and Enhancement	■

The “Criteria Pollutants and Carbon Dioxide” column identifies Action Alternative elements that may: 1) result in additional earthmoving activities, thereby increasing the production of particulate matter and emissions of criteria pollutants from operation of vehicles and other equipment; and/or 2) result in additional vegetated land cover (e.g., reforestation) thereby reducing wind erosion of materials and increasing the carbon sequestration potential of the landscape. In addition to the direct effects of the SPR elements on criteria pollutants and carbon dioxide, indirect impacts on methane and other emissions are also expected. While not associated with any particular rule element, the collective cost burden of implementing the Alternatives may change overall levels of coal production, thus affecting the levels of methane and other air pollutants emitted through the course of coal mining activities. That is, removing overburden to extract coal results in fugitive methane emissions. Consequently, increasing or reducing the level of mining activity likewise increases or reduces emissions. The EPA inventory of underground mine greenhouse gas emissions indicates that methane accounts for nearly all greenhouse gas emissions from underground mines; specifically fugitive methane emissions are significantly greater than carbon dioxide and nitrous oxide emissions from vehicles and equipment (U.S. EPA, 2013e). Reductions in coal production levels may also reduce toxic pollutant emissions from blasting activities.

Protection of the Hydrologic Balance

The elements of the Action Alternatives that are focused on the protection of the hydrologic balance are not expected to directly affect air quality for the reasons described below. As noted previously, however, the collective burden of implementing all of the elements of the Action Alternatives (other than Alternative 9), including those related to protection of the hydrologic balance, is expected to change the overall level of coal mining activity (i.e., increased costs of coal production decreases overall production levels). In addition, in the case of Alternative 2, the cost of surface mining methods results in a slight shift toward additional underground mining methods, which emit more methane than surface methods. As a result, the Action Alternatives (excluding Alternative 9) may all affect greenhouse gas emissions, primarily methane, and other emissions (e.g., from vehicles and blasting) released through the course of coal mining.

Baseline Data Collection and Analysis

Baseline data collection and analysis are focused on water sampling procedures and are not expected to affect air resources under the Action Alternatives.

Monitoring During Mining and Reclamation

Additional monitoring requirements are focused on water quality effects and are not expected to influence air resources under the Action Alternatives.

Definition of Material Damage to the Hydrologic Balance

The lack of definition of *material damage to the hydrologic balance* under the No Action Alternative, and the implementation of the proposed definition under Action Alternatives 2, 3, 4, and 8 (Preferred) is not expected to affect air quality effects of mining activities.

Corrective Action Threshold

Corrective action thresholds are monitoring standards set lower than those for material damage to the hydrologic balance and are designed to act as a type of early warning system to prevent material damage from being reached. These corrective action thresholds would not impact air quality directly as they do not establish thresholds related to air emissions.

Activities In or Near Streams

The elements of the Action Alternatives focused on activities in or near streams may affect air pollutant emissions from coal mining both directly through their implementation and indirectly as their implementation contributes to overall shifts in coal production levels. The indirect effect here again refers to the Action Alternatives (excluding Alternative 9) increasing the cost of coal production such that overall production levels, and associated air pollutant emissions, change. The following text describes how the elements regulating activities in or near streams more directly affect air quality.

Stream Definitions

Alternatives 2, 4, 7, and 8 (Preferred) specify a change in how streams are defined as intermittent, ephemeral, or perennial, and therefore, what mining activities may occur in or near a given stream. This rule element is not expected to itself affect air quality impacts of coal mining.

Mining through Streams

The No Action Alternative allows diversion of intermittent and perennial streams where the Regulatory Authority finds that the diversion will not adversely affect the water quality and quantity and related environmental resources of the stream. The No Action Alternative also requires restoration of perennial and intermittent streams to restore or approximate the premining characteristics of the original stream channel, including natural riparian vegetation. The Action Alternatives further specify how mining through streams and associated stream restoration should be implemented. Related to air quality, this element dictates establishment of 100-foot forested or appropriately-vegetated stream corridors (Alternatives 2, 7, and 8 (Preferred)). Additional vegetated land cover has the potential to increase the carbon sequestration potential of the landscape, thereby mitigating potential effects of climate change. In addition, additional vegetated land cover reduces the amount of material vulnerable to wind transport.

Activities In or Near Streams, Including Excess Spoil and Coal Refuse

The Action Alternatives address mining activities, such as placement of excess spoil and coal mine waste, in or within 100 feet of streams. In limiting placement of excess spoil fills and refuse piles, the Action Alternatives (excluding Alternative 9) may increase the hauling distance for, and therefore air pollutant emissions associated with, the vehicles transporting excess spoil. The degree to which emissions are affected is difficult to quantify as it depends upon site-specific and permit-specific factors. In general, however, longer distances and additional operating time may increase emissions of nitrous oxide, carbon dioxide, and particulate matter emissions from mining-related haulage vehicles, relative to the No Action Alternative. This effect, however, may be mitigated by overall reductions in coal production levels under the Action Alternatives, which may produce a countervailing effect of reducing the use of equipment and vehicles.

Approximate Original Contour (AOC)

The elements of the Action Alternatives related to AOC variance and surface configuration may affect air quality by increasing emissions from equipment and vehicles. As with the other rule elements, they also contribute to increasing the costs of coal mining activities and the consequent shifts in coal production levels and methods. As previously described emissions associated with coal mining may change proportionally to the overall levels of surface and underground production.

AOC Variances

SMCRA generally requires the return of the landscape to AOC and the original configuration. Variances to AOC are allowed for mountaintop removal and steep slope mining, common practices in the Appalachian Basin region. Under the No Action Alternative, for both mountaintop removal and steep-slope mining, beneficial postmining land use (PMLU) must be achieved, with equal or better use demonstrated. For steep-slope mining, requests to deviate from AOC do not currently require demonstration that deviations from AOC are necessary for the identified PMLU.

As compared with the No Action Alternative, the most discernible consequence of the AOC variance guidance would be the alteration of postmining land formation. Typically, the variance would be requested to allow for flat areas and gentler slopes better suited to the desired PMLU. These conditions require less handling of the materials than would otherwise be required to recreate the original contours, which would have more variation and require more initial and final manipulation to achieve.

Fewer allowed variances from AOC could occur under the Action Alternatives (excluding Alternatives 6, 7, and 9), which would result in increased need for material handling and movement on the mine site. This would increase heavy equipment and vehicle use, and therefore the associated vehicle-related air emissions. Additional handling of the materials could also result in increased wind-born particulates during landforming.

Surface Configuration

Premining surface configuration guides topography reclamation requirements, both during mining and during postmining reclamation. This entails the use of landform measurements and terrain modeling to confirm premining topography adherence. Some Action Alternatives require that the backfilled areas of a mine not vary from their premining elevation/slope by ±20 percent (the difference between premining surface elevation and the bottom elevation of the lowest coal seam mined). Conditions would be documented by digital terrain models, both before mining and during backfilling. The relevant Action Alternatives may allow the placement of excess spoil in streams only with stringent provisions.

Similar to the AOC variances element, the proposed landforming requirements may result in increased use of equipment and vehicles on mine sites to create the required postmining topography. While the magnitude of this effect would be site-specific, emissions would increase with increased vehicle use. However, reductions in overall levels of coal production under the Action Alternatives may serve to offset this potential effect by reducing the level of equipment and vehicle use.

Revegetation, Topsoil, and Fish and Wildlife Protection and Enhancement

Requirements for reforestation, vegetation, and topsoil management, and fish and wildlife protection and enhancement may benefit air quality by increasing the carbon sequestration potential of the landscape and by reducing the amount of time materials are exposed to wind erosion, thereby reducing particulate matter. In addition, these elements contribute to the increased cost of coal mining activities, affecting mining-related emissions by shifting coal production levels or methods.

Revegetation, Topsoil Management, and Reforestation

Postmining land cover is directed by the revegetation, topsoil management, and reforestation elements of the Alternatives. As described under the No Action Alternative, while establishing vegetative cover is required after mining, reforestation is not currently universally required.

Under the Action Alternatives except for Alternatives 6 and 9, the revegetation of reclaimed lands must be completed using only native species; the use of overburden materials as a replacement for, or as a supplement to, topsoil requires greater justification; available organic materials must be incorporated into the revegetation process; and reforestation of previously forested areas is required. These changes serve primarily to return the postmining land to a native forest ecosystem as quickly as possible. This has two effects on air quality by: 1) potentially limiting particulate matter by reducing the time materials are exposed to wind erosion, and 2) increasing the carbon sequestration capacity of the landscape. In addition, Alternatives 2, 3, 4, 5, and 7 all include some level of prohibition on burning of vegetation and other organic materials, reducing the amount of airborne particulate matter from mining operations.

Fish and Wildlife Protection and Enhancement

Fish and Wildlife Protection and Enhancement elements related to air quality include the provisions for establishing riparian corridors. Specifically the Action Alternatives (excluding Alternative 9) include a specified width requirement for riparian corridors. Alternatives 2, 5, 6, 7 and 8 (Preferred) require creation of a 100-foot riparian corridor comprising native, non-invasive species along ephemeral, intermittent, or perennial streams restored or permanently diverted. Alternatives 3 and 4 generally require establishment of a 300-foot riparian corridor of native species along restored or permanently diverted intermittent and perennial (but not ephemeral) streams. Similar to the reforestation and revegetation requirements, the additional biomass along streams prescribed by the riparian corridors increases the carbon sequestration potential of the mine landscape.

4.2.4.3 Analytic Methods for Estimating Impacts to Air Quality, Greenhouse Gas Emissions, and Climate Change

To evaluate the potential effects of the Action Alternatives on air quality, greenhouse gas emissions, and climate change, this analysis weighs the multiple relevant effects of implementing the Action Alternative elements. Specifically, it is important to consider the potential direction and magnitude of the following potential effects described above:

1) Changes in emissions from equipment and vehicles due to changes in haulage activities and in overall coal production levels;
2) Effects of reforestation and revegetation requirements on wind transport of materials;
3) Effects of reforestation and revegetation on carbon sequestration; and
4) Effects of reduced coal production on toxic emissions from blasting and fugitive methane emissions.

For the most part, information limitations prevent quantifying changes in air quality associated with the Action Alternatives. The assessment of impacts in Section 4.2.2.4 accordingly includes a qualitative assessment of potential effects on vehicle and equipment emissions, wind transport of materials, carbon sequestration, and emissions from blasting. This analysis is based on careful consideration of qualitative information on the potential direction and magnitude of these effects.

With respect to the potential effects of the Action Alternatives on fugitive methane emissions from surface and underground coal extraction, however, data provided by EPA's greenhouse gas inventory supports a quantitative analysis of potential impacts. The method employed to quantify the impact of the Action Alternatives on methane emissions is provided below. Importantly, this quantitative information is one factor in determining the net effect of the Action Alternatives on air quality; the summary of impacts presented in Table 4.2.4-8 includes consideration of both qualitative and quantitative factors.

Data are not available to evaluate effects of the Action Alternatives on other greenhouse gas emissions (e.g., from vehicles and equipment). However, additional discussion of nitrogen oxide and carbon dioxide emitted by vehicles and equipment is provided in this section. Importantly, however, methane emissions account for the significant majority of greenhouse gas emissions associated with coal mining. In 2013, the EPA's Greenhouse Gas Reporting Program (GHGRP) estimated that reporting mines produced 41.3 million tons of carbon dioxide equivalents (MMtCO$_2$e) of methane, compared to 0.2 MMtCO$_2$e of carbon dioxide and less than 0.05 MMtCO$_2$e of nitrous oxide (U.S. EPA, 2014h).

Method for Estimating Changes in Methane Emissions

Each year, EPA's Greenhouse Gas Inventory reports coal mining-related methane emissions data at the national level (U.S. EPA, 2013a). The 2013 report provided methane emissions data and coal production data through 2011. These data are summarized for underground mining and surface mining in Table 4.2.4-2.

Table 4.2.4-2
Methane Emissions from Coal Mining Activities, 2007-2011

	2007	2007	2008	2008	2009	2009	2010	2010	2011	2011
Coal Production and Emissions	**UM**	**SM**	**UM**	**SM**	**UM**	**SM**	**UM**	**SM**	**UM**	**SM**
Coal Production (MM Short Tons)	352	794	357	813	332	740	337	745	346	755
Net CH_4 Emissions (Teragram CO_2 Eq.)	35.7	13.8	44.4	14.3	49.8	12.9	51.8	12.9	42.4	13.0
Net CH_4 Emissions (MM Cubic Feet)	89,604	34,730	111,373	35,868	124,761	32,374	129,821	32,379	106,208	32,658

Source: U.S. EPA, 2013a. Greenhouse Gas Inventory reported methane emissions data in terms of gigagrams (Gg) and coal production in terms of metric tons. This analysis converted the methane emissions data from mass units to volume units (million cubic feet (MMCF) by using a density conversion factor for methane provided in a 2006 IPCC report on guidelines for national inventories of greenhouse gases. This conversion factor estimated that at 20°C and one atmosphere pressure, the density of CH4 is equal to 0.67*10-6 Gg m^3. Cubic meters were then converted to cubic feet using a conversion factor of 0.028316847 m^3 ft^3. Metric tons of coal production were converted to short tons of coal production by using the conversion factor of 0.90718474 short-ton metric-ton-1. Production is reported in terms of million short tons (MM Short Tons).

For underground coal mining, the Mine Safety and Health Administration (MSHA) monitors methane emissions from ventilation systems and transfers these data to EPA. Since 2011, EPA has also reported methane emissions from underground mines that liberate more than 36.5 million cubic feet (MMCF) of methane (U.S. EPA, 2013e). Because EPA's reports on methane emissions data for underground mines are available only for two years and for limited underground mines, this analysis relies on the more comprehensive national-level data provided by the EPA report and described in Table 4.2.4-2.

Surface coal mining does not have concentrated emissions sources such as ventilation systems; therefore, EPA estimates the level of methane emissions from these mines. EPA estimates that methane emissions from surface coal mining are twice that of the *in situ* methane content of the mined coal. The EPA's most recent annual greenhouse gas inventory report provides estimates of this surface *in situ* methane content for six of the seven regions considered in this analysis. For these six regions, Table 4.2.4-3 displays surface average *in situ* methane content. For the seventh basin, the Gulf Coast basin, this analysis relies upon national-level data for surface mining emissions provided in the EPA report (U.S. EPA, 2013a).

Table 4.2.4-3
Surface Average *In Situ* Methane Content by Coal Basin

Basin	Surface Average *In Situ* CH_4 Content (MMCF/Short Ton)
Appalachian Basin	33.5
Colorado Plateau	24.5
Gulf Coast	*
Illinois Basin	34.3
Northern Rocky Mountains and Great Plains	12.8
Northwest	16.0
Western Interior	39.9

Source: U.S. EPA, 2013a.
* For the Gulf Coast Basin, no in situ methane content figure is applied. Instead, the analysis uses national mining emissions reported by EPA (U.S. EPA, 2013a).

Based on the underground and surface mine data provided in the EPA's 2013 Greenhouse Gas Inventory report, this analysis estimates methane emissions factors to calculate the volume of methane emitted per unit of coal production. For underground mining, the analysis calculates a national-level methane emissions factor based on the national data provided above in Table 4.2.4-2. This emission factor is then applied to all seven regions.[33] For surface mining, the analysis uses regional data, described in Table 4.2.4-3, to calculate region-specific methane emissions factors for the six regions with data available. For the seventh region, the Gulf Coast basin, the analysis relies on the national production and methane emissions data for surface mining to estimate a methane emissions factor.[34] Table 4.2.4-4 summarizes the methane emissions factors used for underground and surface mining in each region.

[33] Specifically, total production from underground coal mining (million short tons), and total methane emissions due to underground coal mining, were calculated for the period for 2007-2011. Total underground mining methane emissions (561,767 MMCF) were divided by total underground mining production (1,723 million short tons) to arrive at a national methane emissions factor for underground mining equal to 325.9 MMCF/million short ton.

[34] Similar to the preceding footnote, the analysis calculated total production from surface coal mining (3,847 million short tons) and total methane emissions due to surface coal mining (168,008 MMCF), for the period 2007-2011. Based on these calculations, the national methane emissions factor for surface mining is estimated to be 43.7 MMCF/short ton.

Table 4.2.4-4
Methane Emissions Factors for Underground and Surface Mining

Basin	Underground Mining (MMCF/Short Ton)	Surface Mining (MMCF/Short Ton)
Appalachian Basin	325.9	66.0
Colorado Plateau	325.9	49.0
Gulf Coast	325.9	43.7
Illinois Basin	325.9	68.6
Northern Rocky Mountains and Great Plains	325.9	25.6
Northwest	325.9	32.0
Western Interior	325.9	79.9

Sources: U.S. EPA, 2013a.

Characterization of Nitrous Oxide and Carbon Dioxide

Data describing carbon dioxide and nitrous oxide emissions are more limited than for methane; thus, this analysis is not able to quantify how emissions of these greenhouses gases would change in response to the Action Alternatives. While the GHGRP requires underground mines that emit more than 36.5 MMCF of natural gas annually to report carbon dioxide and nitrous oxide emissions, such a small percentage of mines are required to report that these data do not support generalized estimates of emissions factors. However, the available information from the GHGRP indicates that methane accounts for the vast majority of greenhouse gas emissions from coal mining. Specifically, in 2013, as noted above, reporting mines produced 41.3 $MMtCO_2e$ of methane, compared to 0.2 $MMtCO_2e$ of carbon dioxide and less than 0.05 $MMtCO_2e$ of nitrous oxide. Given the relatively low emissions levels of these other pollutants, and assuming that emission trends are similar for surface mines and smaller underground mines (smaller than those reporting emissions), any changes in carbon dioxide and nitrous oxide emissions resulting from the Action Alternatives are likely to be Negligible.

The existing data on these emissions do, however, provide context for understanding the overall scale of emissions from equipment use on mine sites nationwide (all mining, not just coal mining). For nitrous oxide emissions, EPA reports mobile combustion from overall “Construction/Mining Equipment,” which includes equipment “such as cranes, dumpers, and excavators, as well as fuel consumption from trucks that are used off-road in construction” (U.S. EPA, 2013a). These data are summarized in Table 4.2.4-5a, in teragrams of carbon dioxide equivalence produced nationwide on an annual basis, as reported in the EPA study. In previous years, EPA also provided data on carbon dioxide emissions from construction and mining equipment. These emissions are summarized in Table 4.2.4-5b.

Table 4.2.4-5a
Nitrous Oxide Emissions Related to Mobile Combustion from Mining/Construction Equipment, Teragrams of Carbon Dioxide Equivalence

Source	2007	2008	2009	2010	2011
Mobile Combustion from Mining & Construction Equipment	0.5	0.5	0.5	0.6	0.6
U.S. Total Emissions	376.1	349.7	338.7	343.9	356.9
Mobile Mining Combustion as Percentage of U.S. Total	**0.13%**	**0.13%**	**0.13%**	**0.13%**	**0.13%**

Source: U.S. EPA, 2013a

Table 4.2.4-5b
Carbon Dioxide Emissions Related To Mobile Combustion from Mining/Construction Equipment, Teragrams of Carbon Dioxide Equivalence

Source	2005	2006	2007	2008	2009
Mobile Combustion from Mining & Construction Equipment	65.9	67.3	67.8	69.3	70.6
U.S. Total Emissions	6,113.8	6,021.1	6,120.0	5,921.4	5,505.2
Mobile Mining Combustion as Percentage of U.S. Total	**1.08%**	**1.12%**	**1.11%**	**1.17%**	**1.28%**

Source: U.S. EPA, 2011f

In addition to these data, EPA has released data on carbon dioxide, methane, and nitrous oxide emissions for active or planned underground mines that liberate more than 36.5 MMCF of methane annually. In 2012, this included 151 facilities, or more than 50 percent of the active underground mines (U.S. EPA, 2013e). Approximately 80 percent of emissions from these mines were from the states of Pennsylvania, West Virginia, Illinois, Virginia, and Colorado (U.S. EPA, 2013e). While these data are only for underground mines, underground mines are thought to represent the majority of methane emissions from coal mining (U.S. EPA, 2013a).

4.2.4.4 Assessment of Impacts to Air Quality, Greenhouse Gas Emissions, and Climate Change

The assessment of overall impacts to air quality, greenhouse gas emissions, and climate change considers the magnitude of the factors described in Table 4.2.4-6, as well as their combined effect under each Action Alternative.

Table 4.2.4-6
Adverse and Beneficial Effects of the Action Alternatives on Air Quality, Greenhouse Gas Emissions, and Climate Change

Factor	Potential Adverse Impacts of the Action Alternatives	Potential Beneficial Impacts of the Action Alternatives
Vehicle and Equipment Emissions	• Increased emissions due to increased haulage	• Decreased emissions due to overall reductions in coal production levels.
Wind Transport of Dust	• Increased due to increased haulage	• Decreased due to revegetation and reforestation requirements. • Decreased due to overall reductions in coal production levels.
Release of Toxic Pollutants from Blasting		• Decreased due to overall reductions in coal production levels.
Greenhouse Gas Emissions	• Increased emissions (CO_2, N_2O) due to increased haulage	• Decreased fugitive methane due to overall reductions in coal production levels. • Decreased levels of carbon dioxide in the atmosphere due to increased carbon sequestration potential of landscape given reforestation requirements.

Notes: This table references the national level adverse and beneficial effects of these factors. There are limited differences from these findings at the regional scale under some Action Alternatives. In particular, Alternative 2 is associated with increased underground coal production activity in Appalachia, which may increase fugitive methane emissions in that region.

The Action Alternatives may influence the emissions levels of criteria pollutants and greenhouse gases from vehicles and equipment (e.g., criteria pollutants include carbon monoxide, sulfur dioxide, nitrogen oxides, VOCs, and particulate matter (PM_{10} and $PM_{2.5}$, greenhouse gases include carbon dioxide and nitrous oxide) both positively and negatively. As reduced coal mining activity levels are expected under the Action Alternatives (excluding Alternative 9), it is possible that vehicle and equipment use and associated air pollution would likewise be reduced. On the other hand, some elements of the Action Alternatives may increase the use of equipment and vehicles for hauling materials, which would increase related emissions. Overall, the combined effect on equipment and vehicle emissions is most likely a negligible difference from the No Action Alternative. The changes in levels of coal production are relatively minor across the Action Alternatives (each Action Alternative results in an average annual decrease of less than 0.5 percent of coal production, relative to projected baseline production).

Potential Impacts on Particulate Matter and Wind Transport of Dust

Reforestation and vegetation requirements of the Action Alternatives may reduce the extent to which materials are exposed to wind erosion, reducing particulate matter concentrations in air. This benefit is likely a shorter term benefit, as under the No Action Alternative most postmining landscapes would eventually return to vegetated states. Reduced wind transport of dust is expected to be a relatively minor benefit in most regions, and a potentially greater benefit in Appalachia, which has a greater premining forest land cover profile, as described in Section 4.2.2. In addition, Alternatives 2, 4, and 7 prohibit burning of all vegetation or other organic materials, whereas Alternatives 3, 5, and 8 prohibit burning of aboveground debris from native vegetation. Reductions in the extent of burning that occurs on the mine site reduces the amount of airborne particulate matter, thus benefitting air quality at a local level.

Potential Impacts on Release of Toxic Pollutants from Blasting

None of the rule elements directly reduces or changes blasting practices. The overall reductions in coal production associated with the implementation of the Action Alternatives may, however, reduce overall levels of blasting activity. This benefit is likely negligible, however, as the reductions in coal production levels are modest and it is unclear whether these reductions would be associated with a reduced need for blasting.

Potential Impacts on Greenhouse Gas Emissions/Levels

In 2014, the Council on Environmental Quality (CEQ) released draft guidance on addressing climate change in NEPA documents. This brief subsection addresses key topics and concepts recommended in the CEQ guidance, as they relate to the SPR and its effect on greenhouse gas emissions and climate change. The findings draw on the conclusions discussed throughout this section. As with other aspects of air impacts, data are insufficient for a detailed quantitative analysis of climate change effects; however, qualitative consideration of climate change impacts is possible.

The net impact of the Action Alternatives on emissions of greenhouse gases is difficult to predict. As noted above, hauling vehicles, other heavy equipment, and blasting emit greenhouse gases such as carbon dioxide, nitrous oxides, and methane. While the Action Alternatives are expected to have a Negligible effect on vehicle emissions and blasting, as described above, they may more measurably affect greenhouse gas emissions in other ways. First, a primary greenhouse gas issue with coal mining activity is the release of fugitive methane. The analysis below quantifies the effect of the Action Alternatives on fugitive methane emissions. Second, reforestation and riparian corridor requirements of the Action Alternatives increase the carbon sequestration potential of the landscape, reducing the level of greenhouse gases in the atmosphere. In these ways, the Action Alternatives (except Alternative 9) may result in modest climate change resiliency benefits.

Estimated Changes in Methane Emissions

Tables 4.2.4-7 and 4.2.4-8 summarize how each Action Alternative is projected to affect annual methane emissions from 2020 through 2040. Under Alternative 2, despite an overall decrease in coal production over the timeframe of the analysis, the analysis estimates a slight increase in methane emissions as a result of anticipated shifts from surface to underground mining in the Appalachian Basin. Under all other Action Alternatives (except Alternative 9), decreases in coal production would produce corresponding decreases in methane emissions across the regions. Consistent with patterns in production decreases, the greatest methane emissions decreases are anticipated under Alternatives 3, 4, and 7. The greatest contribution to emissions reduction comes from the Appalachian Basin, with somewhat lesser reductions occurring in the Illinois Basin and Northern Rocky Mountains and Great Plains. Production changes and emissions reductions for other regions are anticipated to be minimal.

The estimated changes in methane emissions are negligible relative to national, aggregate methane emissions from coal mining. The national baseline methane emissions from coal mining are approximately 146,000 MMCF annually. The national changes in methane emissions from the Action Alternatives vary from an increase of 363 MMCF to a decrease of 400 MMCF, thereby constituting less than one-half of one percent of coal mining methane emissions.

Table 4.2.4-7
Annual Methane Emissions (MMCF), 2020 to 2040

Alternative		Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	Total
Alternative 1 (No Action Alternative)	SM	3,752	1,451	2,375	2,061	13,348	64	101	22,099
	UM	58,616	8,554	0	45,855	3,779	0	46	111,537
	Total	62,368	10,005	2,.375	47,916	17,127	64	146	133,636
Alternative 2	SM	3,444	1,451	2,375	2,055	13,331	64	101	21,784
	UM	59,427	8,554	0	45,739	3,778	0	46	112,200
	Total	62,871	10,005	2,.375	47,794	17,109	64	146	133,983
Alternative 3	SM	3,724	1,451	2,375	2,058	13,330	64	101	22,052
	UM	58,342	8,553	0	45,779	3,779	0	46	111,203
	Total	62,066	10,004	2,.375	47,837	17,109	64	146	133,255
Alternative 4	SM	3,730	1,451	2,374	2,057	13,330	64	101	22,057
	UM	58,388	8,555	0	45,775	3,777	0	46	111,243
	Total	62,118	10,006	2,.374	47,832	17,107	64	146	133,300
Alternative 5	SM	3,733	1,451	2,375	2,059	13,330	64	101	22,062
	UM	58,411	8,554	0	45,815	3,778	0	46	111,304
	Total	62,144	10,005	2,.375	47,875	17,108	64	146	133,366
Alternative 6	SM	3,742	1,451	2,375	2,058	13,331	64	101	22,071
	UM	58,510	8,554	0	45,787	3,778	0	46	111,371
	Total	62,252	10,005	2,.375	47,845	17,109	64	146	133,442
Alternative 7	SM	3,729	1,451	2,375	2,056	13,331	64	101	22,056
	UM	58,374	8,555	0	45,746	3,777	0	46	111,203
	Total	62,104	10,006	2,.375	47,802	17,107	64	146	133,258
Alternative 8 (Preferred)	SM	3,734	1,451	2,375	2,057	13,330	64	101	22,061
	UM	58,425	8,555	0	45,774	3,777	0	46	111,278
	Total	62,159	10,006	2,.375	47,832	17,108	64	146	133,340

Alternative		Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	Total
Alternative 9	**SM**	3,752	1,451	2,375	2,061	13,348	64	101	22,099
	UM	58,616	8,554	0	45,855	3,779	0	46	111,537
	Total	62,368	10,005	2,.375	47,916	17,127	64	146	133,636

Note: Totals may not sum due to rounding.

Table 4.2.4-8
Estimated Annual Changes in Methane Emissions (MMCF), Compared to the No Action Alternative, 2020 to 2040

Alternative		Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	Total
Alternative 2	**SM**	-308	0	0	-6	-17	0	0	-330
	UM	811	0	0	-116	-1	0	0	694
	Net Change	**503**	**0**	**0**	**-122**	**-18**	**0**	**0**	**363**
Alternative 3	**SM**	-28	0	0	-4	-18	0	0	-50
	UM	-274	-1	0	-75	0	0	0	-350
	Net Change	**-302**	**-1**	**0**	**-79**	**-18**	**0**	**0**	**-400**
Alternative 4	**SM**	-22	0	-1	-4	-18	0	0	-44
	UM	-228	1	0	-80	-1	0	0	-309
	Net Change	**-250**	**1**	**-1**	**-84**	**-19**	**0**	**0**	**-353**
Alternative 5	**SM**	-19	0	0	-2	-18	0	0	-38
	UM	-205	0	0	-39	-1	0	0	-245
	Net Change	**-224**	**1**	**0**	**-41**	**-19**	**0**	**0**	**-283**
Alternative 6	**SM**	-10	0	0	-3	-17	0	0	-30
	UM	-106	0	0	-67	-1	0	0	-174
	Net Change	**-116**	**0**	**0**	**-71**	**-18**	**0**	**0**	**-204**
Alternative 7	**SM**	-22	0	0	-5	-18	0	0	-45
	UM	-242	1	0	-108	-2	0	0	-351
	Net Change	**-264**	**1**	**0**	**-114**	**-19**	**0**	**0**	**-396**
Alternative 8 (Preferred)	**SM**	-18	0	0	-4	-18	0	0	-39
	UM	-191	1	0	-80	-1	0	0	-271
	Net Change	**-208**	**1**	**0**	**-84**	**-19**	**0**	**0**	**-311**
Alternative 9	**SM**	0	0	0	0	0	0	0	0
	UM	0	0	0	0	0	0	0	0
	Net Change	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Note: Totals may not sum due to rounding. Negative numbers indicate a decrease of emissions and positive numbers indicate an increase of emissions.

Potential Effects on Carbon Sequestration

Each of the Action Alternatives (excluding Alternative 9) specifies additional reforestation/ revegetation and riparian corridor requirements. These changes expedite the return of postmining land to a native forest ecosystem and maintain riparian vegetative. While a primary objective of these requirements is reduction of erosion and sedimentation, trees and other vegetation remove carbon dioxide from the atmosphere and transform the carbon into biomass. This type of carbon sequestration is enhanced by improved and expedited reforestation. Section 4.2.2 evaluates the benefits of the Action Alternative in terms of preserved (forest that is preserved from cutting for mining) and improved (better forest management practices) forest land. The evaluation of the carbon sequestration benefits in this section accordingly reference the reforestation analysis described in Section 4.2.2, as increased forest results in increased carbon sequestration potential.

Social Costs of Carbon

Section 4.2.2 describes the potential climate stabilization benefits of reforestation. Reduced methane emissions likewise contribute to climate stabilization. To the extent that the Action Alternatives influence carbon emissions, they may also influence a variety of socioeconomic outcomes related to climate change, including agricultural productivity, human health, flooding damages, and various ecosystem services. The value of reducing levels of carbon in the atmosphere reflects the avoided damage generated by that carbon if it is present. The Interagency Working Group on the Social Cost of Carbon issued guidelines in 2010, and an update in 2013, to help agencies assess the climate change-related benefits of reducing carbon emissions and integrate these estimates into their assessments of regulatory impacts in cost-benefit analyses (Interagency Working Group on Social Cost of Carbon, 2010 and 2013). The Interagency guidance provides a social cost of carbon (SCC) dollar value based on the average of three specific models. The SCC related to a specific proposed action is calculated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years.

This analysis does not monetize the methane emissions and increased carbon sequestration effects of the Action Alternatives for multiple reasons. Most fundamentally, data limitations prevent a quantitative analysis of the net effect of each Alternative on carbon emissions from coal mining. As noted earlier, available evidence suggests that the Alternatives would have varying offsetting effects on greenhouse gas emissions. For instance, some Alternatives would result in changes that would increase emissions, such as an increase in the amount of time hauling vehicles are operated. Conversely, some of the same Alternatives would increase the number of acres of forest reestablished or undisturbed annually, which would increase the carbon storage potential when compared to the No Action Alternative.

In addition, the Action Alternatives could influence coal use at power plants and thereby affect the emission of greenhouse gases and associated social costs. Modeling suggests that these Alternatives could decrease national coal production; however, predicting the direction and magnitude of impacts on overall U.S. greenhouse gas emissions is highly complex. The impact depends on factors such as the change in coal prices, the technological flexibility that power producers have to switch to substitute fuels, the price trends for those substitutes, the emissions profile for those substitutes, changes in coal export markets, and a variety of other considerations.

While this analysis anticipates that the net effect on climate resiliency is positive at the national level under each Action Alternative (excluding Alternative 9), i.e., less carbon in the atmosphere due to increased carbon sequestration and reduced methane emission, data gaps prevent quantifying, and therefore monetizing, the magnitude of this benefit.

4.2.4.5 Summary of Effects

The qualitative and quantitative findings discussed above are synthesized to summarize impacts of the Action Alternatives on air quality, greenhouse gas emissions, and climate change in each coal region. Table 4.2.4-9 provides this summary, using the criteria established in Section 4.0 (Table 4.0.2-1). Importantly, none of the Action Alternatives explicitly target air quality resources. Regardless, implementation of the elements of the Action Alternatives may have both beneficial and adverse effects on air quality, greenhouse gas emissions, and climate change. On the beneficial side, the Alternatives may increase carbon sequestration potential due to reforestation and riparian corridor requirements of Alternatives (except for Alternative 9) and reduce fugitive methane emissions from coal extraction due to reductions in overall production levels (with the exception of Alternatives 2 and 9). However, the Alternatives may also increase the use of equipment and vehicles to haul materials and therefore increase emissions from these sources. While data are not available to quantify the net effect of the Action Alternatives on emissions or ambient air quality, the net effects to air quality, greenhouse gas emissions, and climate change are likely to be Minor Beneficial at the national scale (except under Alternative 9).

An analysis of the effect of changes in coal production on methane emissions shows that the changes in methane emissions by region and nationally are small relative to baseline emissions, constituting less than one-half of one percent of coal mining methane emissions. This effect is beneficial across Alternatives 3, 4, 5, 6, 7, and 8 (Preferred). Alternative 9 results in a negligible difference from No Action with respect to methane emissions. Alternative 2 results in a slight increase in methane emissions at the national level, although this adverse effect is minor in the context of total methane emissions in the region. Furthermore, available data suggest that emissions of other criteria pollutants and carbon dioxide are minor as compared to the methane emissions and therefore marginal changes in these emissions are likely to result in Negligible effects on air quality regionally and nationally. Finally, the increased carbon sequestration potential due to increased forest postmining and riparian corridor requirements is a benefit across all of the Action Alternatives with the exception of Alternative 9.

At a regional scale, beneficial impacts are focused in Appalachia across Alternatives 3, 4, 5, 6, 7, and 8 (Preferred). While a predicted shift from surface to underground production under Alternative 2 may increase methane emissions from coal extraction in Appalachia, this effect is minor and may be offset to some extent by the beneficial effects on air quality of reforestation and riparian corridor requirements (as described in Section 4.2.2). Four other regions are also expected to experience Minor Beneficial effects on air quality from increased reforestation and reduced fugitive methane emissions (Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains) under Alternatives 2, 3, 4, 7, and 8 (Preferred). The Illinois

Basin and the Northern Rocky Mountains and Great Plains regions are also expected to experience Minor Beneficial effects under Alternative 6. Other effects on air quality, greenhouse gas emissions, and climate change are anticipated to be Negligible at the regional scale when compared to the No Action Alternative.

Table 4.2.4-9
Summary of Impacts of the Action Alternatives Compared to the No Action Alternative on Air Resources

Coal Region	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8 (Preferred)	Alt. 9
Appalachian Basin	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Colorado Plateau	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Gulf Coast	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Illinois Basin	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible
Northern Rocky Mts. and Great Plains	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible
Northwest	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Western Interior	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
National	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Negligible**

Note: See Table 4.0.2-1 for a definition of Negligible, Minor, Moderate, and Major impact terms used above. These impact categories consider the length of impact, geographic scope of impact, and potential for offsetting the impact. For a discussion of the impacts of the No Action Alternative (Alternative 1), see Section 4.2.4.1.

Alternative 2

The two key considerations for all Action Alternatives are effects of the Alternative on fugitive methane emissions and carbon sequestration. All other air quality related factors are Negligible for the reasons discussed above. Alternative 2 affects both methane emissions and carbon sequestration to the greatest extent in Appalachia. The effect on methane emissions (due to the shift from surface to underground production) is adverse and minor relative to total methane emissions in the region. The reforestation benefits are, however, major, in this region, as discussed in Section 4.2.2 and the associated carbon sequestration benefits are therefore measurable. It is difficult to discern with any certainty the overall effect on greenhouse gases in Appalachia.

In the other regions, methane emissions changes are minor (Illinois Basin and Northern Rocky Mountains) or Negligible (all other regions), as described in Section 4.2.4. Carbon sequestration benefits are minor or moderate in all regions except in the Western Interior and Northwest, as described in Section 4.2.2.

Alternative 3

In Appalachia, Alternative 3 is associated with minor (relative to the total) methane emissions reductions, as well as moderate carbon sequestration benefits due to the reforestation requirements. All other regions are similar to Alternative 2 in terms of air quality effects.

Alternative 4

Alternative 4 is similar to Alternative 3 in terms of air quality effects across all regions.

Alternative 5

As explained in Chapter 2, Alternative 5 has little effect on any coal region other than the Appalachian Basin. As such, the predicted impacts for the other six coal regions are Negligible. For the Appalachian Basin region, however, Alternative 5 may reduce methane emissions and increase carbon sequestration.

Alternative 6

Alternative 6 does not incorporate the same reforestation and revegetation requirements as other Action Alternatives and therefore is unlikely to generate measurable carbon sequestration benefits. However, Appalachia, the Illinois Basin, and the Northern Rocky Mountains may experience minor reductions in fugitive methane emissions.

Alternative 7

Alternative 7 applies to a more limited number of mine sites (i.e., those sites where enhanced permitting requirements apply). As a result, benefits to forest, stream, and riparian habitats are more geographically limited relative to the Alternatives with a broader geographic range. Carbon sequestration benefits are expected in the Appalachian Basin, Colorado Plateau, Gulf Coast, Illinois Basin, and Northern Rocky Mountains and Great Plains, and minor reductions in methane emissions are expected in the Appalachian Basin, Illinois Basin, and Northern Rocky Mountains regions.

Alternative 8 (Preferred)

Alternative 8 (Preferred) is similar to Alternatives 3 and 4 in terms of the potential carbon sequestration benefits, although the estimate of preserved forest acres is slightly lower under Alternative 8 (Preferred) given the slightly lesser decrease in coal production. In addition, minor methane emissions reductions are predicted in the Appalachian Basin, Illinois Basin, and Northern Rocky Mountains regions, although, again, to a lesser extent than under Alternatives 3 and 4 due to the lesser decrease in coal production.

Alternative 9

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zonerule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible effects on air quality, greenhouse gas emission, and climate change.

4.2.4.6 Potential Minimization and Mitigation Measures

The rule elements of given Action Alternatives may, however, have some adverse effects at the regional scale. Most notable, shifts in coal production methods from surface to underground in Appalachia under Alternative 2 may increase fugitive methane emissions in the region. This effect is limited, however, and may be offset due to potential increases in methane capture and reuse activities. Overall, however, effects of the Action Alternatives are expected to be Minor Beneficial across all regions.

4.2.4.7 Indirect Impacts Associated with Coal Combustion

In addition to the direct air quality impacts addressed above, coal extracted during mining may affect air quality when the coal is burned. In 2013, electrical power generation accounted for approximately 93 percent of U.S. coal consumption, with the remainder used in a variety of industrial applications (U.S. EIA, 2014b).[35] Electrical power generation includes public utilities that feed electricity to the general power grid, as well as dedicated power plants that generate electricity for specific industrial operations and other commercial facilities. A total of about 1,300 coal-fired electricity generators exist in the U.S. At each generating facility, coal is burned to produce steam (coal combustion), which is used to rotate turbines and generate power. In 2013, coal was the source of approximately 39 percent of all electricity produced in the U.S. (U.S. EIA, 2014a). This percentage has recently fallen from approximately 50 percent, largely due to the declining price of natural gas, a competing fuel source.

In general, coal combustion generates several principal pollutants that have been linked to adverse air quality impacts:

- **Carbon Dioxide**: Coal combustion produces carbon dioxide, the primary greenhouse gas emission from the burning of fossil fuels (coal, oil, and natural gas). The U.S. Energy Information Administration (U.S. EIA) reports that coal combustion accounted for 32 percent of the energy-related carbon dioxide emissions in the U.S. in 2013 (U.S. EIA, 2014b). EPA estimates that carbon dioxide represents roughly 82 percent of the total inventory of greenhouse gases emitted in the U.S. (U.S. EPA, 2014a).

[35] Nearly all coal burned in the U.S. is produced domestically. The EIA reports that in 2012, only one percent of all coal consumed in the U.S. was imported. U.S. coal exports, however, have grown significantly in recent years. The EIA reports that from 2000 to 2010, coal producers exported about five percent of their product; in 2012, exports had grown to 12 percent.

- **Sulfur Dioxide**: EPA estimates that about 73 percent of sulfur dioxide (SO_2) emissions derive from combustion of fossil fuels at power plants. In addition to being one of the primary causes of acid rain, SO_2 can have negative health impacts from acute or chronic over exposure. Some health impacts include adverse respiratory effects, including bronchoconstriction and increased asthma symptoms. SO_2 inhalation has been shown to result in irritation of mucous membranes of the eyes and nose and may also affect the mouth, trachea, and lungs (VCAPCD, 2003).

- **Nitrogen Oxides**: Power generation is the second largest anthropogenic source (behind mobile sources) of nitrogen dioxide (NOx) and other related nitrogen oxides. NOx is a key constituent in the formation of ground-level ozone, the main component of smog and has adverse effects on respiratory systems, causing or aggravating respiratory illnesses such as bronchitis and asthma but also increasing breathing difficulty even in healthy persons (VCAPCD, 2003).

- **Mercury**: EPA estimates that coal-fired power plants accounted for over half of all mercury emissions in the U.S. in 2005. From the air, mercury can be deposited to land and eventually water, where it enters the food chain. Birds and mammals that eat fish are more exposed to mercury than other animals, and mercury can bio-accumulate at higher levels of the food chain. At high levels of exposure, methyl mercury causes harmful effects on animals include death, reduced reproduction, slower growth and development, and abnormal behavior. In humans, mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system. Research shows that moderate fish consumption is not a health concern. However, high levels of methyl mercury in the bloodstream of unborn babies and young children may harm the developing nervous system, impairing cognitive functions (U.S. EPA, 2014d).

Recent regulatory efforts have focused on the need to control emissions from coal-fired power plants. The Mercury and Air Toxics Standards (MATS) rule establishes emission limits for mercury and other air toxics. The Cross-state Air Pollution Rule requires power plants in 27 states to reduce emissions that contribute to ambient ozone and/or fine particle pollution; EPA finalized the rule in 2011, and implementation began in 2012. Recent Supreme Court decisions verified EPA's authority to regulate greenhouse gas emissions, clearing the way for implementation of the Greenhouse Gas New Source Performance Standards Rule (due to be published in 2015).

To the extent that the Action Alternatives influence the quantity of coal mined, the amount of coal that is burned in power plants could also change, affecting emissions of associated air pollutants. While addressing air pollution is not an objective of the SPR, NEPA requires an analysis of the direct, indirect and cumulative effects of the proposed action, including the effects on air quality when such an analysis could assist the decisionmaker.

Several technological and economic factors make it difficult to analyze the effect of the SPR on emissions:

- First, if less coal is mined, the price of coal could increase and coal-fired plants could respond by substituting other fuels for coal, with a potential decrease in combustion-related emissions. However, combustion of substitute fuels produces a different mix of pollutants compared to coal combustion. For example, while natural gas combustion generally releases lower amounts of carbon dioxide and nitrogen oxides relative to coal, it releases greater amounts of methane, also a greenhouse gas (U.S. EPA, 2014e). Therefore, estimating net impacts on greenhouse gas emissions is difficult to analyze in the context of a national rulemaking like the SPR.

- Second, while some power plants have the flexibility to switch to other fuels (e.g., natural gas) readily, other plants would require significant capital investment. The cost effectiveness of such investments is complex and plant-specific, and therefore difficult to analyze in the context of a national rulemaking like the SPR.

- Third, the choice of fuel is a function of the relative prices of coal and substitute fuels; hence, trends in markets and production costs for coal substitutes must be considered.

- The analysis is further complicated at a regional level. The distribution of mined coal to power plants is not straight forward, and may cross mining regions. Thus, predicting where emissions reductions would occur and estimating the ultimate effect on ambient air quality is analytically challenging.

- Furthermore, uncertainty exists with respect to the baseline regulation of emissions at the individual power plant level;

- Finally, the strength of the coal export market will play a role in determining the overall change in the demand for U.S. coal, and hence global emissions. For instance, while carbon dioxide emissions could decrease domestically for a mix of regulatory and economic reasons, the decrease could be offset through increased exports and use of the coal abroad.

For these reasons, the effects of the Action Alternatives on the combustion of coal and substitute fuels, and the subsequent effects on air quality, greenhouse gas emissions, and climate change are difficult to predict with confidence.

4.3 SOCIAL AND ECONOMIC RESOURCES

4.3.1 Socioeconomic Conditions

This section evaluates the potential impacts of the Action Alternatives on socioeconomic characteristics of the seven coal regions. Section 4.1 describes impacts specifically to the coal mining industry, while this section focuses on the effects of the Alternatives on the broader regional socioeconomic environment.

This section:

- Describes the existing environment with respect to socioeconomic resources. For more details on the socioeconomic characteristics of the seven coal regions please refer to Section 3.14;
- Describes the potential effects of the Action Alternatives on employment, regional income, property value, tax revenues, and quality of life;
- Details the analysis conducted to determine the potential impacts to these resources under each Action Alternative and results of these analyses;
- Describes the uncertainty and limitations inherent in the analyses; and
- Describes potential minimization and mitigation measures that could be taken to offset potential adverse impacts.

4.3.1.1 Effects of the Current Environment (the No Action Alternative)

Section 3.14 characterizes the socioeconomic resources in each coal region, including demographics, employment, income, property values, tax revenues, and the quality of life. This section briefly discusses this information in the context of the No Action Alternative.

Employment and Income

As noted in Chapter 3, coal mining accounts for 0.1 percent of national employment and 0.1 percent of national income. Coal mining-related employment is significantly higher in the Appalachian Basin than in the other coal regions. The general trends in coal market employment and income are anticipated to follow the expected trends in coal production between 2020 and 2040. As described in section 4.1, total coal production is anticipated to decline over the study period, with annual production falling from 1.1 billion tons (1,106 million) in 2020 to 917 million tons in 2040 (a reduction of 162 million tons of coal). The decline in the Colorado Plateau is expected to be about 26 percent of its annual coal production in 2020. In the Appalachian Basin, the change in coal production represents 18 percent of 2020 coal production. In the Northern Rocky Mountains and Great Plains region, the expected decline amounts to about 15 percent of 2020 coal production. Declines in the Illinois Basin and the Western Interior are 10 and 7 percent of 2020 production, respectively. Last, the declines expected in the Gulf Coast and the Northwest both represent less than one percent of 2020 production in their respective regions.

Tax Revenues

As noted in Chapter 3, policies on taxing the coal mining industry vary from state to state. Many states levy a direct severance tax on extracted minerals. Severance taxes in some states are levied in the form of a percent of the value of the resources removed or sold and in other states as a per-ton fee. Severance taxes collected would be expected to follow a trend that is generally consistent with the future volume of coal produced under the No Action Alternative, as described above.

Property Value

Mining activities may suppress the value of surrounding properties through noise, aesthetic disturbance, and impacts to air and water quality under the No Action Alternative. For example, the presence of coal dust attributed to nearby coal mining activity has been shown to adversely affect property value in parts of Appalachia (Stockman, 2003). As coal production declines over time under the No Action Alternative, the associated water quality, air quality, and landscape aesthetic improvements may benefit nearby property values. In contrast, to the extent that employment opportunities are reduced due to reductions in coal mining activities under the No Action Alternative, demand for living in coal mining-dependent communities may decrease, which may reduce the value of residential properties in those communities under the No Action Alternative.

Quality of Life

Coal mining plays an important role in the culture and history of certain regions within the U.S.. The industry has played a crucial role in the development and support of communities across the U.S. and often provides the nexus for social networks within these communities. As coal mining declines over time, the social fabric of particular communities may therefore be negatively affected. The quality of life in coal mining communities is also dependent on a reliable employment source. Where coal mining is a key employment opportunity, quality of life may be negatively affected by reductions in mining activity levels, depending on the level of alternative emerging industries and re-employment opportunities.

Demographics

None of the Action Alternatives are expected to produce economic or social impacts on a scale large enough to trigger demographic shifts on a regional basis, such as increasing the relative percentage of any age group.

4.3.1.2 Action Alternatives and Potential Effects on Socioeconomic Conditions

This section focuses on the effects of the Alternatives on regional employment, regional income, property values, tax revenues, and the quality of life in coal-producing regions.

Employment

This section considers the potential for the Action Alternatives to affect employment in the coal mining industry (i.e., direct employment impacts), as well as employment in the broader regional economy (i.e., indirect employment impacts to related economic sectors). The Action Alternatives (excluding Alternative 9) are expected to have both beneficial and adverse effects on employment, varying by industry and region. Employment in the coal mining industry is expected to change as a result of several factors. The applicability of these factors varies by region, and some offset each other. For example, a change in the costs of coal production across regions would shift the regional distribution of coal production or may decrease coal production overall. In these cases, regional reductions in mining employment or an overall decrease in mining-related job opportunities will occur. Individual coal regions may experience either an increase or decrease in mining-related employment, depending on how production levels shift between coal regions. To the extent that the Action Alternatives lead to an overall shift from surface mining to underground mining, the number of mining jobs is expected to increase as underground mining is generally more labor-intensive than surface mining.

Certain elements of the Action Alternatives may increase employment demand within or, in some cases, outside of the mining sector through the introduction of compliance measures. First, some rule elements included under the Action Alternatives may increase employment demand for conducting additional environmental analysis, data collection, or sampling (Baseline Data Collection and Analysis; Monitoring During Mining and Reclamation; Mining Through Streams). Other rule elements may also require labor-intensive field practices (Activities In or Near Streams; Surface Configuration; Revegetation, Topsoil Management, and Reforestation; Wildlife Protection and Enhancement). The extent to which these elements would affect employment demand varies by Action Alternative, both because of differences in the scope of the elements and in the applicability of the elements under each Action Alternative. For example, under Alternatives 2, 3, 4, and 8 (Preferred), the rule elements defined for each Alternative apply to all mining activities, whereas under Alternatives 5, 6, and 7, the applicability of rule elements is more limited.[36] Alternative 9 is not expected to affect employment.

In addition to the direct employment effects within the mining industry, a change in the regional distribution of coal production may also affect employment in industries that provide goods and services to the coal industry or that otherwise rely on coal mining. To the extent that coal production decreases in a particular region, employment in these secondary industries may also be reduced. In contrast, employment in other energy sector industries could increase due to a shift toward substitute fuels (e.g., natural gas) to generate electricity, which would potentially offset the decrease in coal mining employment. While increased natural gas demand could result in increased regional economic activity, these offsetting impacts, both magnitude and location, are uncertain. Subsection 4.3.1.2 quantifies direct employment impacts to the mining industry.

[36] As described in previous sections, under Alternative 5, the application of element components is limited to mining activities that result in placement of excess spoil outside the mined area or coal refuse disposal in perennial or intermittent streams. For Alternative 6, the application of components is limited to stream buffer zones. Under Alternative 7, the rule elements apply when certain conditions exist that warrant enhanced permitting requirements.

The relationship between environmental regulation and employment is a subject debated within the academic literature. As developed in this chapter and as supported by economic theory, environmental regulation can increase production costs, which according to economic theory should raise prices, reduce demand, and ultimately put downward pressure on employment within a given industry. However, compliance with environmental regulation also typically introduces additional labor requirements, which may mitigate that effect. Several studies on this topic have found that environmental regulation has a slightly positive overall impact, if any, on employment (Berman and Bui, 2001; Morgenstern, et al. 2002; Bezdek, et al. 2008, Belova, et al. 2013). This literature suggests that the findings in this chapter are consistent with current research on the impact of environmental regulation in general. It should be noted, however, that the literature does not specifically address the relationship between environmental regulation and labor demand in extractive industries such as coal mining.

Income

The income effects of the Action Alternatives are associated with employment effects, as described above, and may be either beneficial or adverse, depending on the Action Alternative and potential for shifts in coal production between regions or mining methods. Regions that experience a decrease in coal production may experience lower employment and associated income in both the mining industry and in industries providing goods and services to mining operations or that otherwise rely on coal mining. Compliance-related requirements imposed on mine operations by the Action Alternatives may result in some increased demand for employment. Some additional jobs created by the Action Alternatives may differ in skill requirements from the production-oriented jobs that would be reduced due to decreased coal production. See the above discussion of employment effects for the specific elements of the Action Alternatives that introduce new compliance-related work requirements to mine operations. Subsection 4.3.1.3 quantifies direct labor income impacts to the mining industry.

Property Values

As noted above, mining activities may suppress the value of surrounding land through increased noise, aesthetic disturbance, and impacts to air and water quality. To the degree that the Action Alternatives result in benefits to local water quality, forested acreage, and available recreational resources in and around the mine site, property values may be positively impacted.

Water quality improvements in particular may contribute to improved aesthetic conditions, increased recreational opportunities, and real or perceived human health and ecological risk reductions. These benefits may be realized as increases in property values. The economics literature demonstrates that water quality improvements can positively affect nearby property values. For example, properties may benefit from: improved views if the water quality improvements repair visual disamenities in the water (such as abundant algae); greater quality of water-related recreational opportunities; and/or healthier aquatic ecosystem habitats. The majority of the economics literature valuing water quality improvements considers how improvements in water clarity or turbidity affect property values near water bodies (see e.g., Walsh, et al., 2011; Ara, et al., 2006; Kashian, et al., 2006; Krysel, et al., 2003; Gibbs, et al., 2002). However, some studies demonstrate that other water quality characteristics also affect property values, including algal blooms, level of dissolved inorganic nitrogen, and total suspended solids (TSS) (Leggett and Bockstael, 2000; Poor, et al., 2007). Thus, to the extent that Action Alternatives benefit water quality, property values could also benefit.

In addition, to the extent that coal regions experience a reduction in coal mining activity or a shift from surface to underground mining, localized impacts on property value may occur. Some rule elements also may also improve property amenities, such as requiring mining operations to incorporate improvements in the aesthetics of mined land or to improve the quality of the reclaimed land.

In contrast to the potentially beneficial effects, adverse impacts to property values could also occur if the Action Alternative results in decreased coal employment in communities that are particularly dependent on it. The extent to which Action Alternatives would result in changes to property values when compared to the No Action Alternative varies across regions and Action Alternatives. Subsection 4.3.1.4 evaluates the potential effects of the Action Alternatives on property values in coal-producing regions.

Tax Revenue

Where implementation of an Action Alternative generates changes in the location of the mining activity, severance tax revenues gathered by state or tribal governments would be affected.[37] That is, a decrease in coal production as a result of an Action Alternative would result in collection of less revenue from coal severance taxes in states where such a change on production occurs.[38] It is unclear if reductions in coal mining that lead to reduced tax revenues would also lead to commensurate decrease in public services funded by tax revenue. The demand for some services, such as road maintenance, might decrease as mining activity decreased; the demand for other services, such as certain social services, might increase as mining activity decreased.

Reductions in tax revenue associated with reduced coal production have the potential to be offset by new tax revenue collected on substitute fuels, such as natural gas. Subsection 4.3.1.5 evaluates the potential effects of the Action Alternatives on coal tax revenue in coal-producing states.

Quality of Life

As noted above, coal mining plays an important role in the culture and history of certain regions within the U.S. The industry has played a crucial role in the development and support of communities across the U.S. and often provides the nexus for social networks within these communities. To people living in areas where coal mining is deeply-entrenched within the culture, a reduction in mining activity may represent not only reductions in income but also a loss of identity and culture.

In addition, in areas that rely heavily on coal mining employment, reduced mining activity may affect the livelihood of the community. Individuals and families may rely on the availability of mining jobs to provide income and benefits important to their well-being, such as health

[37] Severance taxes are taxes levied on non-renewable resources upon extraction.

[38] Some states base their coal severance taxes on the gross value of coal. Therefore, to the extent that production decreases lead to higher coal prices, tax impacts may be mitigated.

insurance. Consequently, these communities may suffer a reduced quality of life to the extent that the Action Alternatives result in reduced mining activity. In addition, coal companies may have a philanthropic presence in communities; reduced mining could adversely affect these philanthropic activities.

Many elements of the Action Alternatives may also offer quality of life benefits. For example, to the extent that implementation of certain elements of the Alternatives result in improved water and air quality, aesthetic benefits, and increased wildlife populations. Regional populations also may benefit from improved conditions and/or opportunities for recreational activities and health benefits (as described in other sections of this Chapter). Subsection 4.3.1.6 discusses the potential effects of the Action Alternatives on quality of life in coal-producing regions.

4.3.1.3 Employment Impact Analysis

Approach to Employment Analysis

The analysis of employment impacts estimates the effect of the Action Alternatives on employment in each of the coal regions for the 21-year period of study, from 2020 to 2040. For each Action Alternative, two primary factors drive the overall changes in employment: changes in coal production and additional work required to achieve compliance with the new requirements.

Direct effects are those brought about by production changes or additional work required by the Alternative. Indirect effects arise from the "ripple" effect of changes in coal production on local industries that provide goods and services to the coal industry. Induced effects arise from changes in household consumption due to changes in employment and associated income in a region. This analysis focuses on measurement of direct effects, though we recognize that indirect and induced impacts may also occur. In this analysis, direct effects are measured in two categories:

- **Production-related employment effects**: These effects include changes in employment demand associated with changes in coal production that are associated with implementation of the Action Alternatives. Except for Alternative 9, in aggregate, coal production-related effects associated with the Action Alternatives are negative, as overall coal production is expected to decline.

- **Compliance cost-related employment effects**: These effects are changes in employment demand that would occur due to proposed new requirements (e.g., additional labor requirements to conduct landforming activities on-site). The new requirements would generate additional need for labor and equipment to conduct hauling of materials; landforming; stream restoration and enhancement; reforestation; information gathering for enhanced permitting; and various administrative activities. These requirements vary across the Action Alternatives. In general, these employment effects are positive, as the Action Alternatives, while experienced as a cost to the industry, generate demand for local goods and services.

This analysis presents results for each region that show the range of each Action Alternative's potential incremental impacts (over and above what would be expected under the No Action Alternative), given current economic conditions, on these factors in a given year over the timeframe for the analysis.

The Action Alternatives (excluding Alternative 9) may generate indirect and induced effects. However, these are not reported here because of the uncertainty associated with these calculations.

Labor Intensity

Employment in the coal mining industry would adjust according to shifts in coal production across regions and mine types. The size of the employment impact depends on both the change in coal production and the labor effort required to achieve that production. Table 4.3.1-1 lists coal production by coal region and mine type in 2012. Regions where coal mining is more labor-intensive would experience a greater employment impact than areas where coal is more easily extracted, given the same shift in coal production. Labor requirements vary widely across regions and mine type. Table 4.3.1-2 describes average employment in 2012 for both surface and underground mining in the seven coal regions. Table 4.3.1-3 highlights the variation across regions and mine types in terms of mine operator full-time equivalents (FTE) per million tons of coal produced. These employee numbers are collected by MSHA from "reports by operators of mines for personnel directly engaged in production, cleaning, milling, shipping, development, and maintenance and repair work, including direct supervisory and technical personnel and contract mining services" (MSHA, 2013c). This statistic is reported as the standard measure of coal mine labor productivity, average production per employee per hour, in Table 4.3.1-4.

Extraction of coal from surface mines in the Appalachian Basin is relatively labor-intensive (i.e., requiring a high level of labor per ton of coal produced). As such, a small change in coal production would lead to a relatively large change in employment in this region. Surface mines in the Colorado Plateau and Northern Rocky Mountains and Great Plains regions require less labor per ton of coal produced; thus, a change in coal production would generate a relatively lower change in mining-related employment. Underground mining generally is more labor-intensive than surface mining. In particular, the Western Interior and Appalachian Basin regions are the most labor-intensive regions for underground coal mining.

Table 4.3.1-1
Coal Production by Region, 2012 (Thousand short tons)

Coal Region	Surface	Underground	Total
Appalachian Basin	97,884	194,045	291,929
Colorado Plateau	30,475	45,052	75,527
Gulf Coast	51,102	NA	51,102
Illinois Basin	34,771	92,500	127,271
Northern Rocky Mountains and Great Plains	455,320	10,345	465,665
Northwest	2,052	NA	2,052
Western Interior	1,144	445	1,589
Total	672,748	342,387	1,015,135

Source: U.S. Energy Information Administration, 2012 Annual Coal Report.
Note: Estimates may not sum to the totals reported due to rounding.

Table 4.3.1-2
Average Employment by Coal Region and Mine Type, 2011 (Number of Employees)

Coal Region	Surface	Underground	Total
Appalachian Basin	20,486	44,136	64,622
Colorado Plateau	1,743	4,170	5,913
Gulf Coast	3,419	NA	3,419
Illinois Basin	8,765	17,514	26,279
Northern Rocky Mountains and Great Plains	9,407	2,457	11,864
Northwest	136	NA	136
Western Interior	172	116	288
Total	37,087	54,395	91,482

Source: U.S. Energy Information Administration, 2011 Annual Coal Report (EIA-0584).
Note: This table includes all employees engaged in production, preparation, processing, development, maintenance, repair shop, or yard work at mining operations, including office workers. This table excludes preparation plants with fewer than 5,000 employee hours per year, which are not required to provide data.

Table 4.3.1-3
Average Operator Full Time Equivalents per Million Tons of Coal Production, 2013

Coal Region	Surface	Underground
Appalachian Basin	246.2	299.1
Colorado Plateau	77.9	109.5
Gulf Coast	99.8	NA
Illinois Basin	108.3	169.8
Northern Rocky Mountains and Great Plains	31.3	67.2
Northwest	88.7	NA
Western Interior	261.9	305.5

Source: Derived from MSHA, 2014.
Note: Mines within each region were ranked in order of productivity. The total regional production was divided into percentiles. The output of the least productive mines was summed until enough mines were included to account for 25 percent of the total regional production. The employment data from these mines was then used in the calculations above.

Table 4.3.1-4
Mine Productivity (Average Production per Operator Employee Hour) (short tons), 2013

Coal Region	Surface	Underground
Appalachian Basin	2.0	1.6
Colorado Plateau	6.2	4.4
Gulf Coast	4.8	NA
Illinois Basin	4.4	2.8
Northern Rocky Mountains and Great Plains	15.4	7.16
Northwest	5.4	NA
Western Interior	1.8	1.6

Source: Derived from MSHA, 2014.
Note: Derived from 2013 average workers per million tons of coal production. Assumes a single employee works 2080 hours per year.

Results of Employment Impacts Analysis

Estimated employment impacts vary from year to year and across regions and Alternatives. Tables 4.3.1-5 through 4.3.1-12 present the average annual impacts and the maximum and minimum annual impacts for each Alternative and region. Alternative 9 is not expected to results in production changes or employment effects and is therefore excluded from this discussion.

Definitions of the metrics presented in the tables are as follows:

- “Average over 21 years” is the average effect of the Alternative over the study period for the analysis on employment.

- "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
- "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated the Alternatives.
- The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
- The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
- The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
- **"**Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region.

As shown, year to year variation reflects changes in coal production over the study period. In general, as U.S. coal production declines over the time period for the analysis, costs of compliance and associated reductions in production-related employment also decline. In general, regional employment impacts from changes in production are greatest in the Appalachian Basin, Illinois Basin, and Northern Rocky Mountains and Great Plains regions. Compliance-related employment impacts occur more evenly across the regions, but are typically largest in the Appalachian and Illinois Basin regions. Forecasted changes in employment demand are both positive and negative. Decreases in expected employment demand appear in parentheses. The range in production-related employment values reported is driven by annual variability in proportions of mining by type (surface versus underground) and in the overall volume of coal produced.

Production-related employment effects

The volume of coal production nationally is expected to decrease under all the Action Alternatives (except Alternative 9), which would reduce employment in the coal industry as well as industries that process mined coal or provide goods and services to mining operations throughout the production process. Affected entities could include coal processing facilities, power plants, mining and construction equipment manufacturers, the coal transportation industry, and a variety of other local businesses located near mining operations in coal-producing regions. Decreased coal production would lower demand for these goods and services provided, which, in turn, decreases income and employment in these supporting industries. As stated above, to the extent that coal production is replaced by extraction of another domestic fuel supply, employment impacts could be offset at the regional or national level by increasing employment in industries that extract substitute fuels, such as natural gas.

As shown in Tables 4.3.1-5 through 4.3.1-12, production-related employment impacts for mine operations are greatest in Alternative 2, with a reduction of nearly 600 full time equivalents (FTEs) per year on average. Alternatives 3 and 7 are expected to reduce FTEs by approximately 350 per year on average. Alternatives 4, 5, and 8 (Preferred) would cause smaller reductions in FTEs by approximately 310, 260, and 260 FTEs per year on average, respectively. Except for Alternative 9, Alternative 6 is expected to have the smallest reduction in FTEs with approximately 160 FTEs lost per year on average.

Compliance cost-related employment effects

Some increases in employment demand due to work requirements imposed on mining operations by the Action Alternatives could occur. These additional work requirements include performing inspections, conducting biological surveys, constructing digital elevation models, and other tasks that require specific expertise in these fields. Individual workers that are currently involved in coal production would likely require additional training to perform and benefit from these new work requirements. Other increased work requirements associated with elements contained in the Action Alternatives are expected to require similar skills as currently used by the industry (e.g., bulldozer operations).

Compliance-related employment effects would occur primarily in regions with the largest increases in compliance costs, particularly in the Appalachian and Illinois Basin regions. As shown in Tables 4.3.1-5 through 4.3.1-12, total compliance-related employment is greatest under Alternative 2 with employment increasing by approximately 580 FTEs per year on average.[39] Alternatives 3 and 4 each have impacts on compliance-related employment of 370 FTEs per year on average. Alternatives 5 and 6, which have more limited compliance areas, lead to 140 FTEs in compliance-related employment per year on average. Under Alternative 5, effects occur in the Appalachian Basin while under Alternative 6 effects are clustered in the Appalachian and Illinois Basin regions. Alternative 7, which also has targeted compliance efforts, leads to 210 FTEs in compliance-related employment per year on average. As its compliance costs are lower, Alternative 8 (Preferred) leads to slightly lower increases in compliance-related employment with an increase in 250 FTEs per year on average.

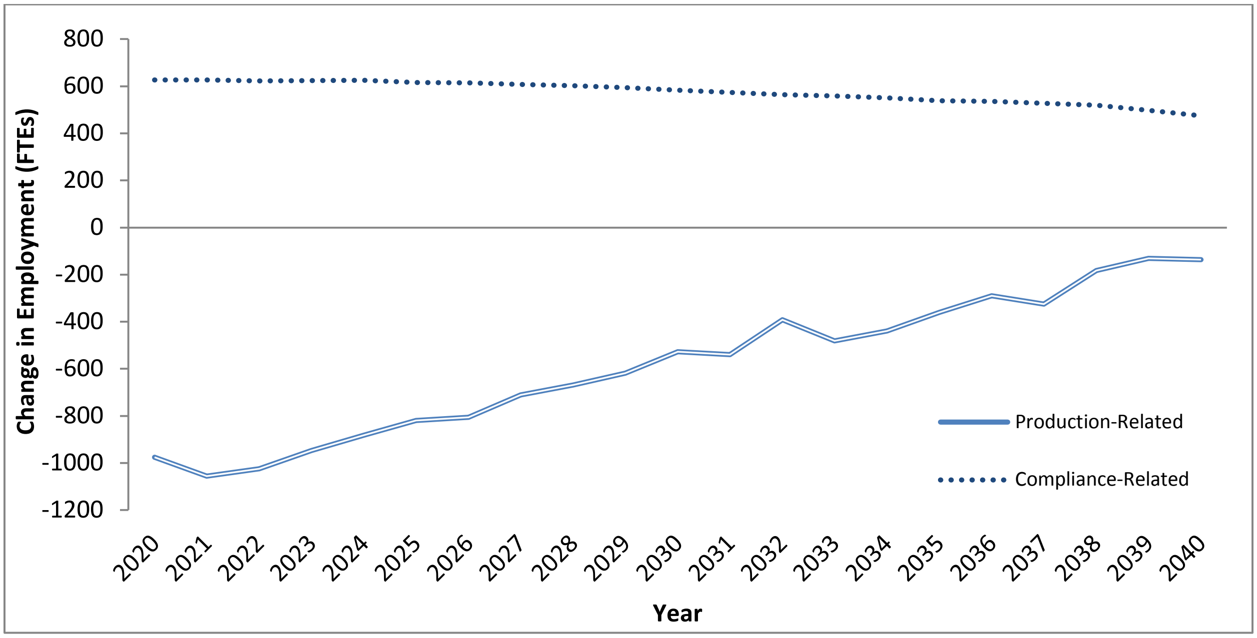
[39] The IMPLAN measure of employment for the coal mining sector is nearly equivalent to an FTE. The terms are used interchangeably in this discussion.

Table 4.3.1-5
Estimated Changes in Annual Employment (FTEs) under Alternative 2 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects Underground[5]	Production-Related Employment Effects Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(1,100)	610	(520)	340
	Range in any year: [2]	(1,400) - (400)	(390) – 1,200	(890) - (130)	280 – 370
Colorado Plateau	**Average over 21 years:**	0	0	0	20
	Range in any year:	0 - 0	0 - 0	0 - 0	17 - 22
Gulf Coast	**Average over 21 years:**	1	0	1	44
	Range in any year:	0 - 3	0 - 0	0 - 3	44 - 45
Illinois Basin	**Average over 21 years:**	(9)	(39)	(48)	130
	Range in any year:	(29) - 0	(110) - (1)	(140) - (1)	100 - 150
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(21)	0	(21)	35
	Range in any year:	(61) - 0	0 - 0	(61) - 0	31 - 37
Northwest	**Average over 21 years:**	0	0	0	1
	Range in any year:	0 – 0	0 - 0	0 - 0	1 - 1
Western Interior	**Average over 21 years:**	0	0	0	5
	Range in any year:	0 – 0	0 - 0	0 - 0	5 - 5
U.S. Total	**Average over 21 years:**	(1,200)	570	(590)	580
	Range in any year:	(1,500) - (480)	(500) – 1,200	(1,100) - (130)	470 – 630

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-1 Estimated Changes in Annual Employment (FTEs) under Alternative 2 Compared to the No Action Alternative



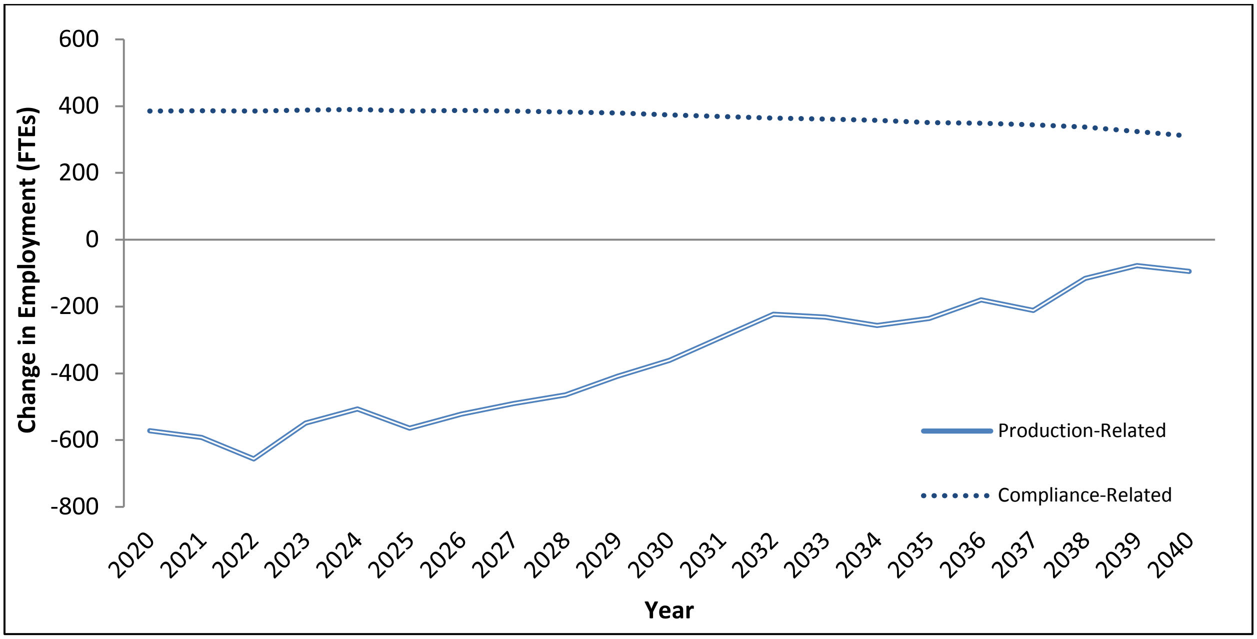
Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 2. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 2. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 2 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not equal.

Table 4.3.1-6
Estimated Changes in Annual Employment (FTEs) under Alternative 3 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(100)	(210)	(310)	190
	Range in any year: [2]	(190) - (28)	(360) - (48)	(540) - (76)	160 - 200
Colorado Plateau	**Average over 21 years:**	0	0	0	19
	Range in any year:	0 - 0	(1) - 0	(1) - 0	16 - 20
Gulf Coast	**Average over 21 years:**	(1)	0	(1)	42
	Range in any year:	(4) - 0	0 - 0	(4) - 0	42 - 42
Illinois Basin	**Average over 21 years:**	(6)	(25)	(31)	79
	Range in any year:	(22) - 0	(81) - (2)	(100) - (2)	62 - 91
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(22)	0	(22)	33
	Range in any year:	(66) - 0	0 – 0	(66) - 0	29 - 35
Northwest	**Average over 21 years:**	0	0	0	1
	Range in any year:	0 - 0	0 – 0	0 - 0	1 - 1
Western Interior	**Average over 21 years:**	0	0	0	3
	Range in any year:	0 - 0	0 - 0	0 - 0	3 - 3
U.S. Total	**Average over 21 years:**	(130)	(230)	(360)	370
	Range in any year:	(260) - (28)	(400) - (50)	(660) - (78)	310 – 390

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-2 Estimated Changes in Total Annual Employment (FTEs) under Alternative 3 Compared to the No Action Alternative



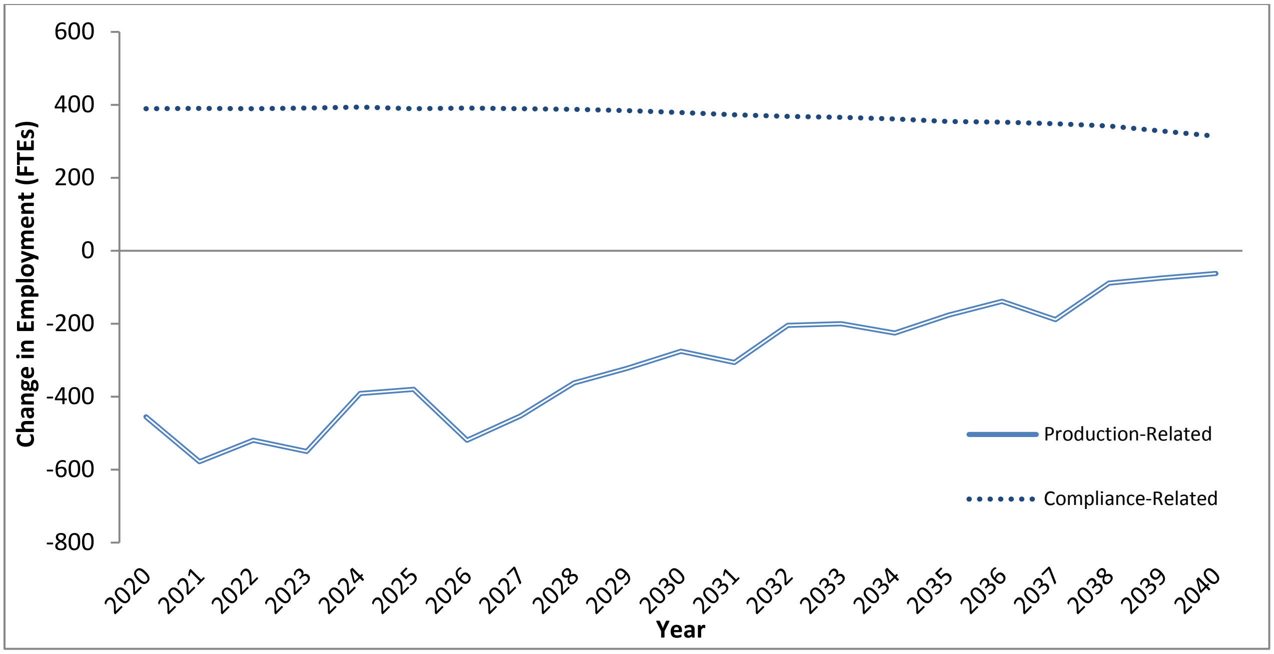
Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 3. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 3. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 3 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-7
Estimated Changes in Annual Employment (FTEs) under Alternative 4 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(80)	(170)	(250)	180
	Range in any year: [2]	(140) - (23)	(310) – (38)	(450) - (62)	150 - 190
Colorado Plateau	**Average over 21 years:**	0	0	0	23
	Range in any year:	0 - 0	0 - 1	0 - 1	19 - 24
Gulf Coast	**Average over 21 years:**	(1)	0	(1)	45
	Range in any year:	(6) - 0	0 - 0	(6) - 0	44 - 45
Illinois Basin	**Average over 21 years:**	(6)	(27)	(33)	81
	Range in any year:	(22) - 0	(84) - 0	(110) - (1)	63 - 94
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(22)	0	(22)	36
	Range in any year:	(51) – 0	0 – 0	(51) – (1)	32 - 38
Northwest	**Average over 21 years:**	0	0	0	1
	Range in any year:	0 - 0	0 - 0	0 - 0	1 - 1
Western Interior	**Average over 21 years:**	0	0	0	3
	Range in any year:	0 - 0	0 - 0	0 - 0	3 - 3
U.S. Total	**Average over 21 years:**	(110)	(200)	(310)	370
	Range in any year:	(210) - (24)	(370) – (39)	(580) - (62)	310 – 390

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-3 Estimated Changes in Total Annual Employment (FTEs) under Alternative 4 Compared to the No Action Alternative



Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 4. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 4. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 4 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-8
Estimated Changes in Annual Employment (FTEs) under Alternative 5 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(69)	(160)	(220)	140
	Range in any year: [2]	(140) - (11)	(330) – (29)	(470) - (41)	120 - 150
Colorado Plateau	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 1	0 - 0
Gulf Coast	**Average over 21 years:**	0	0	0	0
	Range in any year:	(1) – 2	0 - 0	(1) - 2	0 - 0
Illinois Basin	**Average over 21 years:**	(3)	(13)	(16)	0
	Range in any year:	(13) - 0	(48) - (1)	(60) - (1)	0 - 0
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(22)	0	(22)	0
	Range in any year:	(70) – 0	0 – 0	(70) – 0	0 - 0
Northwest	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
	Average over 21 years:	0	0	0	0
Western Interior	**Range in any year:**	0 - 0	0 - 0	0 - 0	0 - 0
U.S. Total	**Average over 21 years:**	(93)	(170)	(260)	140
	Range in any year:	(210) - (14)	(350) – (34)	(530) - (48)	120 - 150

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.

[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.

[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.

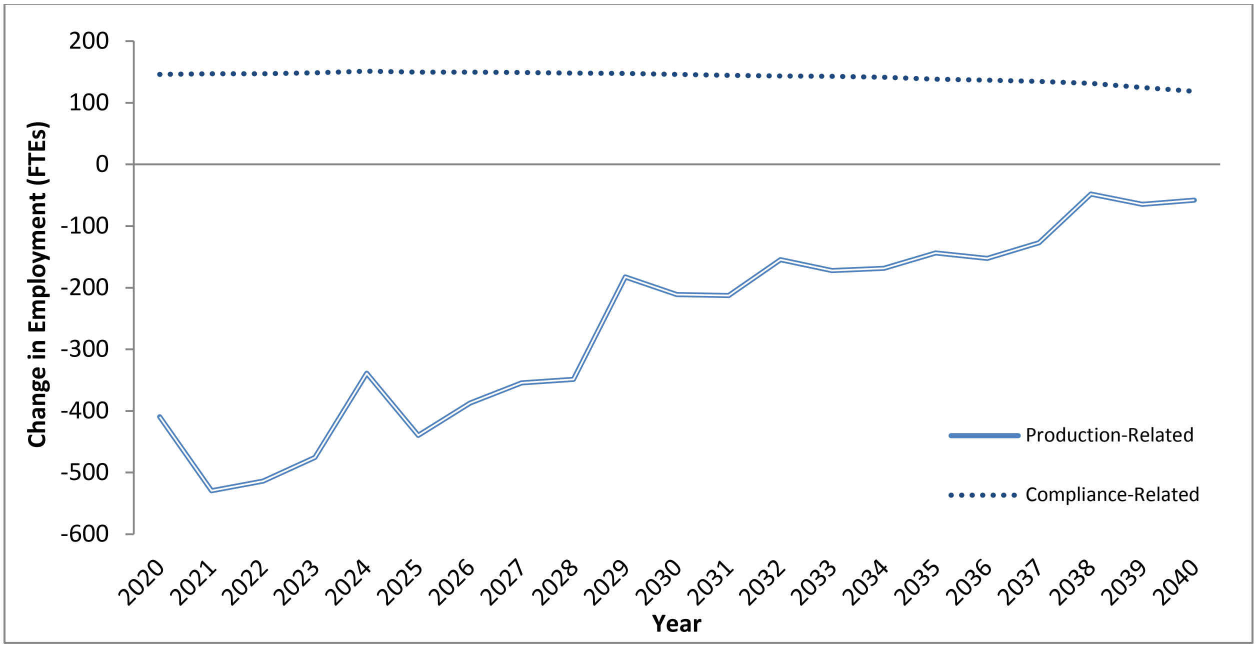
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.

[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.

[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.

[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-4 Estimated Changes in Total Annual Employment (FTEs) under Alternative 5 Compared to the No Action Alternative



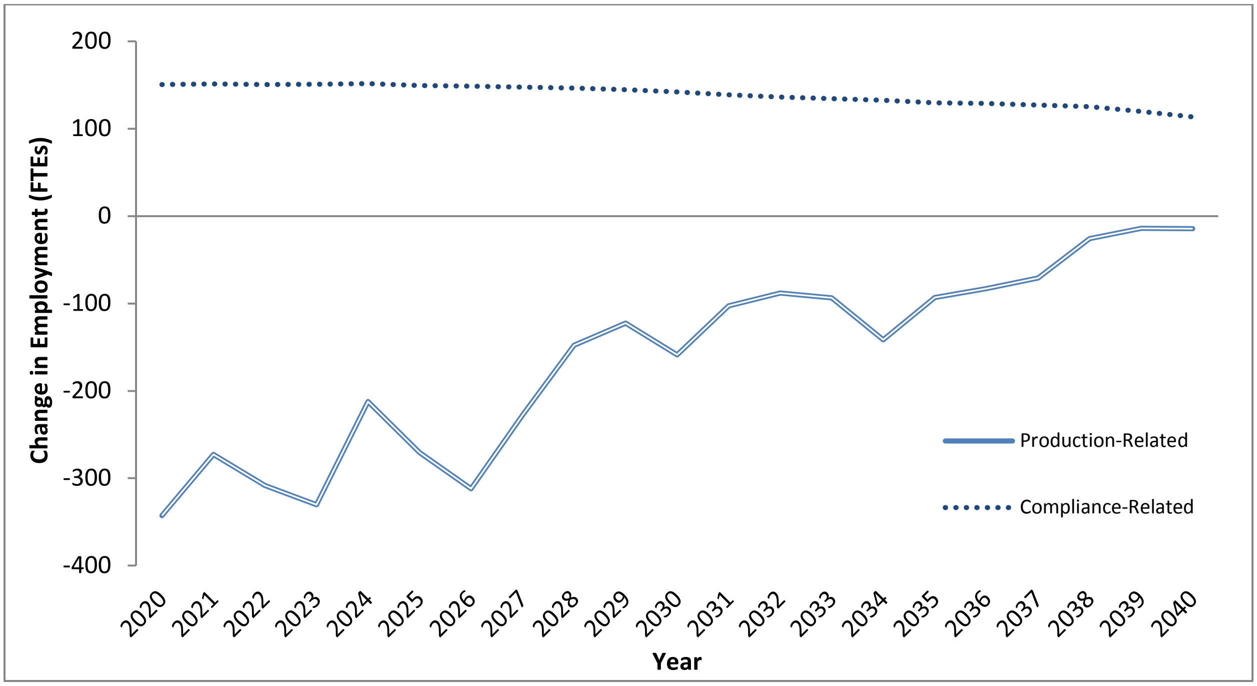
Notes: "Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 5. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 5. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 5 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-9
Estimated Changes in Annual Employment (FTEs) under Alternative 6 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(35)	(80)	(120)	59
	Range in any year: [2]	(67) – (6)	(160) - (6)	(230) - (13)	49 - 63
Colorado Plateau	**Average over 21 years:**	0	0	0	3
	Range in any year:	0 - 0	0 - 0	(1) - 0	2 - 3
Gulf Coast	**Average over 21 years:**	1	0	1	4
	Range in any year:	0 - 4	0 - 0	0 - 4	4 - 4
Illinois Basin	**Average over 21 years:**	(5)	(22)	(28)	66
	Range in any year:	(27) - 0	(100) - 1	(130) - 1	52 - 76
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(21)	0	(21)	4
	Range in any year:	(60) – 0	0 – 0	(60) – 0	3 - 4
Northwest	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Western Interior	**Average over 21 years:**	0	0	0	3
	Range in any year:	0 - 0	0 - 0	0 - 0	3 – 3
U.S. Total	**Average over 21 years:**	(61)	(100)	(160)	140
	Range in any year:	(130) - (6)	(210) - (7)	(340) - (14)	110 - 150

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-5 Estimated Changes in Total Annual Employment (FTEs) under Alternative 6 Compared to the No Action Alternative



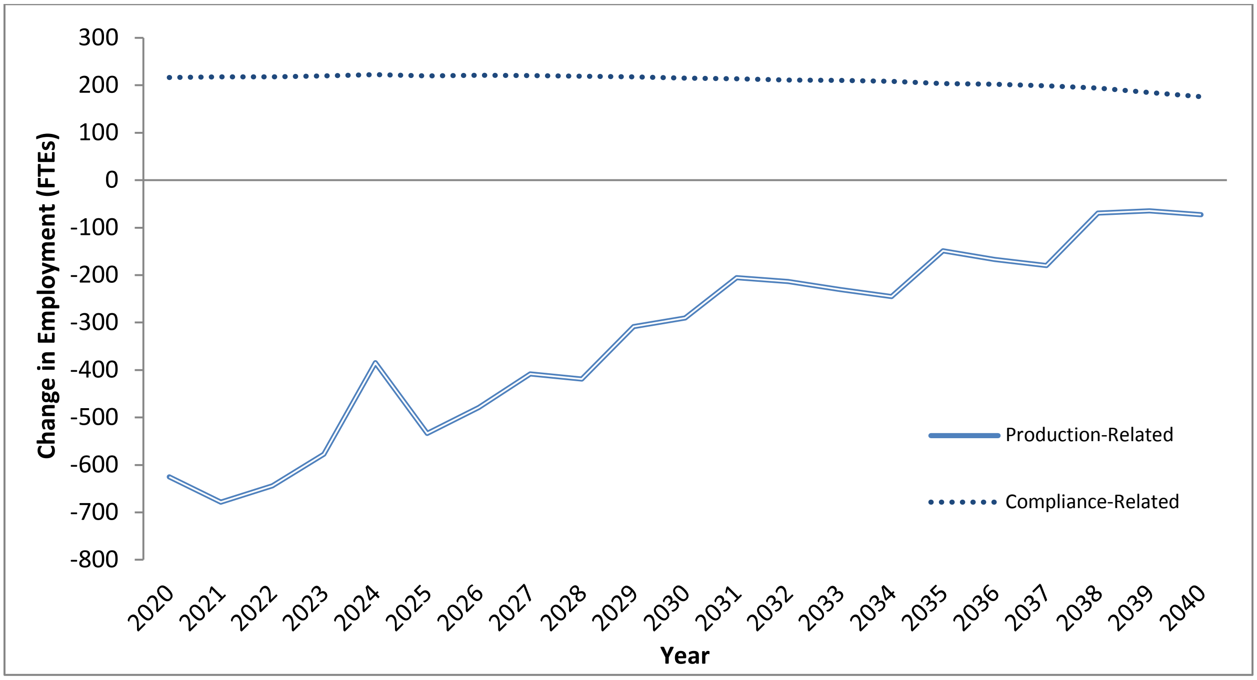
Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 6. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 6. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 6 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-10
Estimated Changes in Annual Employment (FTEs) under Alternative 7 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(82)	(180)	(270)	170
	Range in any year: [2]	(160) – (20)	(360) - (40)	(510) - (62)	140 - 180
Colorado Plateau	**Average over 21 years:**	0	0	0	12
	Range in any year:	0 - 0	0 - 1	0 - 1	10 - 13
Gulf Coast	**Average over 21 years:**	0	0	0	7
	Range in any year:	(1) - 1	0 - 0	(1) - 1	7 - 7
Illinois Basin	**Average over 21 years:**	(9)	(36)	(45)	12
	Range in any year:	(36) - 0	(140) - (1)	(170) - (2)	9 - 14
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(21)	0	(22)	6
	Range in any year:	(54) - 0	0 – 0	(54) - 0	5 - 6
Northwest	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Western Interior	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 1
U.S. Total	**Average over 21 years:**	(110)	(220)	(330)	210
	Range in any year:	(230) - (20)	(450) - (42)	(680) - (65)	180 - 220

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-6 Estimated Changes in Total Annual Employment (FTEs) under Alternative 7 Compared to the No Action Alternative



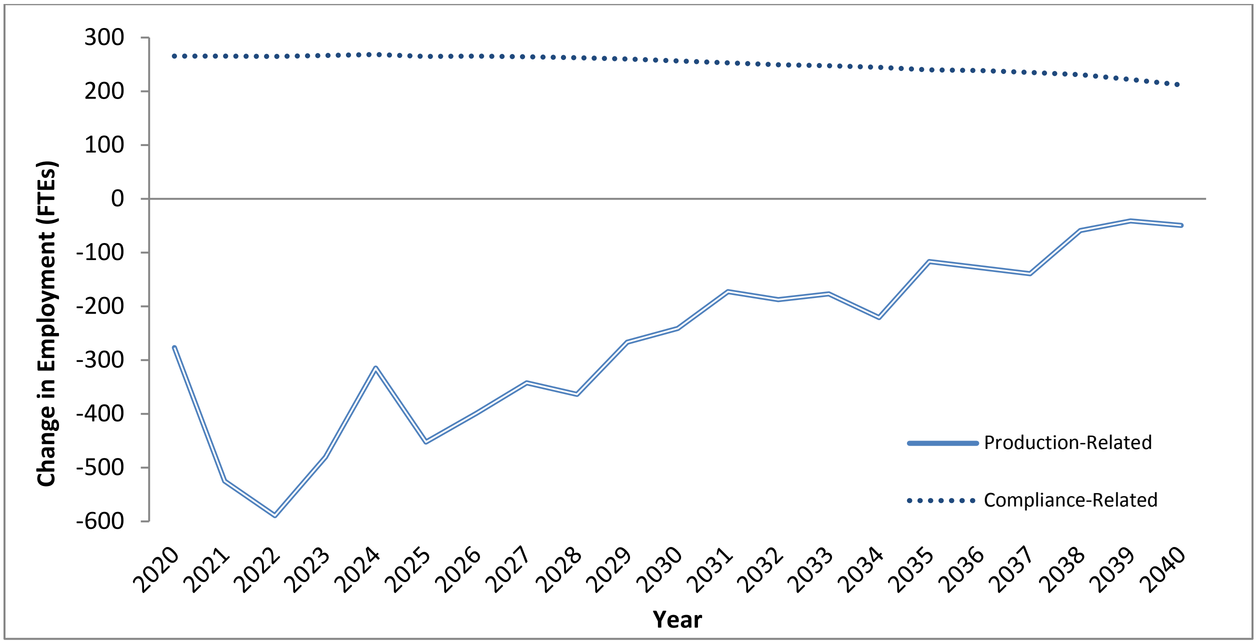
Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 7. These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 7. This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 7 follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-11
Estimated Changes in Annual Employment (FTEs) under Alternative 8 (Preferred) Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	(65)	(140)	(210)	120
	Range in any year: [2]	(140) – (15)	(310) - (24)	(450) - (41)	97 – 120
Colorado Plateau	**Average over 21 years:**	0	0	0	14
	Range in any year:	0 - 0	0 - 1	0 - 1	12 – 15
Gulf Coast	**Average over 21 years:**	0	0	0	30
	Range in any year:	(3) - 2	0 - 0	(3) – 2	30 – 31
Illinois Basin	**Average over 21 years:**	(6)	(27)	(33)	66
	Range in any year:	(19) - 0	(73) - 0	(91) - 0	52 – 76
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	(22)	0	(22)	21
	Range in any year:	(66) – 0	0 –0	(66) – 0	19 – 22
Northwest	**Average over 21 years:**	0	0	0	1
	Range in any year:	0 - 0	0 – 0	0 – 0	1 – 1
Western Interior	**Average over 21 years:**	0	0	0	3
	Range in any year:	0 - 0	0 – 0	0 – 0	3 – 3
U.S. Total	**Average over 21 years:**	(93)	(170)	(260)	250
	Range in any year:	(220) - (17)	(370) - (24)	(590) - (41)	210 -270

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

Figure 4.3.1-7 Estimated Changes in Total Annual Employment (FTEs) under Alternative 8 (Preferred) Compared to the No Action Alternative



Notes: **"**Production-related" are effects on employment associated with changes to coal production that are expected as a result of Alternative 8 (Preferred). These are calculated using assumptions related to employment per ton of coal produced. The production-related job losses are associated only with the coal that is not produced because of changes associated with Alternative 8 (Preferred). This volume also becomes smaller over time given that the industry is getting smaller over time. "Compliance-related" are effects on employment calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance. The compliance-related job effects are a function of all coal that is produced in any year in each region. Thus, the level of compliance-related job effects of Alternative 8 (Preferred) follow the pattern of overall forecast coal production. As shown, both the compliance-related and the production-related impacts of the Alternative are reduced over time. However, the slopes of these curves are not the same.

Table 4.3.1-12
Estimated Changes in Annual Employment (FTEs) under Alternative 9 Compared to the No Action Alternative

Region	Metric	Production-Related Employment Effects[3] Surface[4]	Production-Related Employment Effects[3] Underground[5]	Production-Related Employment Effects[3] Surface and Underground Combined[6]	Compliance-Related Employment Effects[7]
Appalachian Basin	**Average over 21 years:** [1]	0	0	0	0
	Range in any year: [2]	0 - 0	0 - 0	0 - 0	0 - 0
Colorado Plateau	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Gulf Coast	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Illinois Basin	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Northwest	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
Western Interior	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0
U.S. Total	**Average over 21 years:**	0	0	0	0
	Range in any year:	0 - 0	0 - 0	0 - 0	0 - 0

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on employment.
[2] "Range in any year" is the minimum and maximum effect on employment in any year in the study period.
[3] "Production-related employment effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced.
[4] The range of effects to Surface Employment represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to Underground Employment represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to Surface and Underground Combined employment represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-related employment effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance.

4.3.1.4 Regional Income Impacts Analysis

The employment impacts from the Action Alternatives may affect regional income in some areas. These effects would be felt most in areas where coal mining contributes heavily to overall employment. Table 4.3.1-11 reports 2011 coal mining employment and annual payroll by state. Because coal mining contributes most to employment in West Virginia and Wyoming, regional income is most closely tied to shifts in coal production in these states. Income effects may also be felt most heavily in areas experiencing a relatively large shift in production as a result of an Action Alternative. In some parts of the Appalachian Basin region, the coal mining industry provides some of the highest-paying jobs in poor, rural communities. A decrease in mining-related employment may cut off an important source of income in areas that are primarily dependent on coal mining. This analysis estimates effects of each Action Alternative on labor income in coal regions based on the expected regional shifts in production and employment when compared to the No Action Alternative. Labor income is a measure of the employment income received in coal regions as part of the demand for employment, and includes wages, benefits, and proprietor income.

The analysis undertakes the following steps to estimate effects on labor income:

> **1. Derive annual salaries:** The first step involves using the IMPLAN model to estimate typical annual salaries for workers for each region across all Alternatives.
>
> **2. Apply salary coefficients to employment impacts:** The second step involves applying the estimated annual salaries to estimates of employment impacts by region. This generates estimates of the effects on labor income associated with employment effects of the Action Alternative. Impacts to labor income under the Action Alternatives represent the difference from labor income projections under the No Action Alternative, and may be adverse or beneficial. The analysis examines labor income effects from both production-related impacts and compliance-related impacts to employment.

Some increases in employment demand due to work requirements imposed on mining operations by the Action Alternatives could occur. These additional work requirements include performing inspections, conducting biological assessments, and other tasks that require employment of highly trained professionals (e.g., engineers and biologists) as part of compliance with some elements of the Action Alternatives. Other increased work requirements associated with elements contained in the Action Alternatives are expected to require similar skills as currently used by the industry (e.g., bulldozer operations). In general, while some of the increased employment demand may use existing mining labor skills (e.g., requirements that require additional earth moving), other employment demand from Action Alternatives may require other types of labor (e.g., biological monitoring, lab testing, paperwork). As noted above, some additional jobs created by the Action Alternatives may differ in skill requirements from the production-oriented jobs that would be reduced due to decreased coal production.

Estimated effects on labor income are directly associated with estimated effects on employment. Impacts to labor income may be beneficial in some years due to additional labor required for mine operations to achieve compliance with the Action Alternatives. Table 4.3.1-14 through Table 4.3.1-21 report the ranges of estimated impacts to annual labor income expected to result from the Action Alternatives. In sum:

- Under Alternative 2, production-related impacts to annual labor income are expected to range from an adverse impact of $88 million to an adverse impact of $11 million nationally. Compliance-related impacts are expected to range from an increase of $42 million to $52 million nationally;

- Alternative 3 is expected to result in production-related impacts to annual labor income ranging from negative $55 million to negative $6.5 million. Compliance-related impacts are expected to range from an increase of $27 million to $33 million nationally;

- Alternative 4 is expected to lead to production-related impacts to annual labor income nationwide, ranging from an adverse impact of $49 million to an adverse impact of $6.2 million. Compliance-related impacts are expected to range from an increase of $28 million to $33 million nationally;

- The production-related impacts to annual labor income under Alternative 5 range from negative $45 million to negative $4 million. Compliance-related impacts are expected to range from an increase of $10 million to $13 million nationally;

- Under Alternative 6, the production-related impacts are expected to range from a negative $29 million to a negative $1.2 million. Compliance-related impacts are expected to range from an increase of $10 million to $13 million nationally;

- Under Alternative 7, production-related impacts to annual labor income were determined to range from an adverse impact of $57 million to an adverse impact of $5.4 million. Compliance-related impacts are expected to range from an increase of $15 million to $18 million nationally;

- Under Alternative 8 (Preferred), production-related impacts to annual labor income were determined to range from an adverse impact of $50 million to a beneficial impact of $3.4 million. Compliance-related impacts are expected to range from an increase of $19 million to $22 million nationally;

- Finally, under Alternative 9, impacts to annual labor income are equivalent to the No Action Alternative. For comparison, Table 4.3.1-13 presents 2011 coal mining industry payroll at over $7 billion.

Table 4.3.1-13
Coal Mining Employment and Annual Payroll by State, 2011

Geography	Number of Coal Industry Employees	Contribution of Coal Industry Employees to Total Employment (%)	Coal Industry Employment Growth 2001 - 2011 (%)	Coal Industry Annual Payroll 2011 (Millions, 2013$)	Coal Industry Contribution to Total State Annual Payroll (%)	Coal Industry Payroll Growth 2001 - 2011 (%)
Appalachian Basin						
West Virginia	23,307	4.1%	41.9%	$1,867	8.5%	49.3%
Eastern Kentucky	14,281	1.0%	-3.1%	$1,221	2.1%	21.2%
Pennsylvania	8,665	0.2%	6.1%	$746	0.3%	21.9%
Virginia	5,261	0.2%	-1.3%	$454	0.3%	-3.8%
Alabama	4,756	0.3%	43.0%	$330	0.5%	35.1%
Ohio	3,006	0.1%	5.1%	$264	0.1%	-25.5%
Tennessee	505	0.0%	-9.8%	*	*	*
Maryland	488	0.0%	6.1%	$21	0.0%	a
Regional Total:	60,269	NA	NA	$4,904*	NA	NA
Colorado Plateau						
Colorado	2,405	0.1%	23.7%	$182	0.2%	7.7%
Utah	1,797	0.2%	20.8%	$145	0.3%	4.2%
New Mexico	1,292	0.2%	-25.2%	$147	0.6%	-16.2%
Arizona	419	0.0%	-40.0%	*	*	*
Regional Total:	5,913	NA	NA	$475*	NA	NA
Gulf Coast						
Texas	2,936	0.0%	424.3%	$199	0.0%	12.0%
Louisiana	259	0.0%	39.2%	*	*	*
Mississippi	224	0.0%	75.0%	*	*	*
Regional Total:	3,419	NA	NA	$199*	NA	NA
Illinois Basin						
Western Kentucky	4,353	0.3%	81.2%	$1,221	2.1%	21.2%
Illinois	4,105	0.1%	19.1%	$240	0.1%	-18.1%
Indiana	3,540	0.1%	40.0%	$288	0.3%	64.8%
Regional Total:	11,998	NA	NA	$1,749	NA	NA
Northern Rocky Mountains and Great Plains						
Wyoming	7,039	3.4%	61.3%	$632	6.5%	51.5%
Montana	1,251	0.4%	48.4%	*	*	*
North Dakota	1,169	0.4%	28.2%	*	*	*
Regional Total:	9,459	NA	NA	$632*	NA	NA
Northwest						

Geography	Number of Coal Industry Employees	Contribution of Coal Industry Employees to Total Employment (%)	Coal Industry Employment Growth 2001 - 2011 (%)	Coal Industry Annual Payroll 2011 (Millions, 2013$)	Coal Industry Contribution to Total State Annual Payroll (%)	Coal Industry Payroll Growth 2001 - 2011 (%)
Alaska	136	0.1%	14.3%	*	*	*
Washington	0	0.0%	-100.0%	NA	NA	NA
Regional Total:	136	NA	NA	*	NA	NA
Western Interior						
Oklahoma	184	0.0%	21.9%	$16	0.0%	[a]
Arkansas	70	0.0%	-41.2%	*	*	*
Missouri	26	0.0%	-31.6%	*	*	*
Kansas	8	0.0%	-11.1%	*	*	*
Regional Total:	288	NA	NA	$16*	NA	NA
Total U.S.	91,482	0.1%	20.6%	$7,091*	0.1%	20.0%

Sources: U.S. Energy Information Administration, 2000 and 2011 Annual Coal Reports (EIA-0584); U.S. Census Bureau, County Business Patterns 2000 and 2011 Data Releases. 2011 data on employment for all industries were unavailable at the time of study.

[a] Growth not listed because annual payroll data were not released in 2000 for these states.
*****Annual payroll data were suppressed for states with low coal production in order to avoid disclosure of information about individual employers. Regional and national totals do not account for these states.

Table 4.3.1-14
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 2 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:**[1]	($94)	$51	($43)	$28
	Range in any year:[2]	($120) - ($33)	($32) – $98	($74) - ($11)	$24 - $31
Colorado Plateau	**Average over 21 years:**	$0	$0	$0	$1.6
	Range in any year:	($0.01) - $0	($0.03) - $0.03	($0.03) - $0.03	$1.4 - $1.7
Gulf Coast	**Average over 21 years:**	$0	$0	$0.04	$3.7
	Range in any year:	($0.02) - $0.2	$0 - $0	($0.02) - $0.2	$3.6– $3.7
Illinois Basin	**Average over 21 years:**	($0.8)	($3.2)	($3.9)	$11
	Range in any year:	($2.4) - ($0.02)	($9.1) - ($0.08)	($11) - ($0.1)	$8.9 – $12
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	($2.0)	($0.01)	($2.0)	$3.3
	Range in any year:	($5.8) - ($0.07)	($0.01) - $0	($5.8) - ($0.1)	$3.0 – $3.5
Northwest	**Average over 21 years:**	$0	$0	$0	$0.1
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.1 - $0.1
Western Interior	**Average over 21 years:**	$0	$0	$0	$0.5
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.4 - $0.5
U.S. Total	**Average over 21 years:**	**($97)**	**$48**	**($49)**	**$48**
	Range in any year:	**($121) - ($40)**	**($41) - $98**	**($88) - ($11)**	**$42 - $52**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-15
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 3 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	Average over 21 years:[1]	($8.5)	($17)	($26)	$16
	Range in any year:[2]	($15) - ($2.3)	($30) - ($4.0)	($45) - ($6.3)	$14 - $17
Colorado Plateau	Average over 21 years:	$0	($0.01)	($0.02)	$1.5
	Range in any year:	($0.1) - $0	($0.1) - $0.01	($0.1) - $0.01	$1.3 - $1.6
Gulf Coast	Average over 21 years:	($0.1)	$0	($0.1)	$3.5
	Range in any year:	($0.4) - $0.03	$0 - $0	($0.4) - $0.03	$3.4 - $3.5
Illinois Basin	Average over 21 years:	($0.5)	($2.1)	($2.5)	$6.5
	Range in any year:	($1.8) - ($0.02)	($6.7) - ($0.1)	($8.5) - ($0.2)	$5.4 - $7.6
Northern Rocky Mountains and Great Plains	Average over 21 years:	($2.1)	$0	($2.1)	$3.1
	Range in any year:	($6.3) - $0	$0 - $0	($6.3) - $0	$2.8 - $3.3
Northwest	Average over 21 years:	$0	$0	$0	$0.1
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.1 - $0.1
Western Interior	Average over 21 years:	$0	$0	$0	$0.3
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.3 - $0.3
U.S. Total	**Average over 21 years:**	**($11)**	**($19)**	**($30)**	**$31**
	Range in any year:	**($23) - ($2.3)**	**($33) - ($4.2)**	**($55.3) - ($6.5)**	**$27 - $33**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-16
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 4 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:**[1]	($6.7)	($14)	($21)	$15
	Range in any year:[2]	($12) - ($1.9)	($26) – ($3.8)	($37.6) - ($5.8)	$13 - $16
Colorado Plateau	**Average over 21 years:**	$0	$0.02	$0.02	$1.8
	Range in any year:	$0 - $0	($0.02) - $0.1	($0.02) - $0.1	$1.6 - $1.9
Gulf Coast	**Average over 21 years:**	($0.1)	$0	($0.1)	$3.7
	Range in any year:	($0.5) - $0.01	$0 - $0	($0.5) - $0.02	$3.7- $3.7
Illinois Basin	**Average over 21 years:**	($0.5)	($2.2)	($2.7)	$6.7
	Range in any year:	($1.9) - ($0.06)	($7.0) - ($0.3)	($8.8) - ($0.4)	$5.6 - $7.7
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	($2.1)	($0.01)	($2.1)	$3.4
	Range in any year:	($4.8) – ($0.04)	($0.02) – ($0.01)	($4.8) - ($0.1)	$3.1 - $3.6
Northwest	**Average over 21 years:**	$0	$0	$0	$0.1
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.1 - $0.1
Western Interior	**Average over 21 years:**	$0	$0	$0	$0.3
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.3 - $0.3
U.S. Total	**Average over 21 years:**	**($9.4)**	**($17)**	**($26)**	**$31**
	Range in any year:	**($18) - ($2.1)**	**($31.1) – ($4.7)**	**($49) - ($6.2)**	**$28- $33**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-17
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 5 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:[1]**	($5.7)	($13)	($19)	$12
	Range in any year:[2]	($12) - ($1.0)	($28) – ($2.4)	($39) - ($3.4)	$10 - $13
Colorado Plateau	**Average over 21 years:**	$0	$0.01	$0.01	$0
	Range in any year:	$0 - $0	($0.02) - $0.03	($0.02) - $0.04	$0 - $0
Gulf Coast	**Average over 21 years:**	$0.02	$0	$0.02	$0
	Range in any year:	($0.04) - $0.1	$0 - $0	($0.04) - $0.1	$0 - $0
Illinois Basin	**Average over 21 years:**	($0.3)	($1.1)	($1.3)	$0
	Range in any year:	($1.1) - ($0.01)	($3.9) - ($0.1)	($5.0) - ($0.1)	$0 - $0
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	($2.1)	($0.01)	($2.1)	$0
	Range in any year:	($6.7) – ($0.04)	($0.01) - $0	($6.7) – ($0.1)	$0 - $0
Northwest	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Western Interior	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
U.S. Total	**Average over 21 years:**	**($8.0)**	**($14)**	**($22)**	**$12**
	Range in any year:	**($18) - ($1.1)**	**($29) - $2.9**	**($45) - ($4.0)**	**$10 - $13**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-18
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 6 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:[1]**	($2.9)	($6.7)	($9.6)	$4.9
	Range in any year:[2]	($5.5) - ($1.0)	($14) - ($0.7)	($19) - ($1.2)	$4.3 - $5.2
Colorado Plateau	**Average over 21 years:**	$0	$0	$0	$0.2
	Range in any year:	$0 - $0	($0.04) - $0.02	($0.04) - $0.02	$0.2 - $0.2
Gulf Coast	**Average over 21 years:**	$0.1	$0	$0.1	$0.4
	Range in any year:	($0.01) - $.03	$0 - $0	($0.01) - $0.3	$0.4 - $0.4
Illinois Basin	**Average over 21 years:**	($0.4)	($1.9)	($2.3)	$5.5
	Range in any year:	($2.2) - $0.02	($8.3) - $0.1	($11) - $0.1	$4.6 - $6.3
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	($2.0)	($0.01)	($2.0)	$0.4
	Range in any year:	($5.6) - ($0.03)	($0.02) - $0	($5.7) - $0.04	$0.3 - $0.4
Northwest	**Average over 21 years:**	$0	$0	$0	$0.02
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.02 - $0.02
Western Interior	**Average over 21 years:**	$0	$0	$0	$0.2
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.2 - $0.2
U.S. Total	**Average over 21 years:**	**($5.3)**	**($8.5)**	**($14)**	**$12**
	Range in any year:	**($11.7) - ($1.0)**	**($18) - ($0.7)**	**($29) - ($1.2)**	**$10 - $13**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-19
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 7 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:[1]**	($6.9)	($15)	($22)	$14
	Range in any year:[2]	($13) - ($1.6)	($30) - $3.4	($42) – ($5.2)	$13 - $15
Colorado Plateau	**Average over 21 years:**	$0	$0.03	$0.03	$1.0
	Range in any year:	$0 - $0	($0.02) – $0.1	($0.02) – ($0.1)	$1.0 - $1.0
Gulf Coast	**Average over 21 years:**	$0.01	$0	$0.01	$0.6
	Range in any year:	($0.1) - $0.1	$0 - $0	($0.1) - $0.1	$0.6 - $0.6
Illinois Basin	**Average over 21 years:**	($0.7)	($3.0)	($3.7)	$1.0
	Range in any year:	($3.0) - ($0.02)	($11) - ($0.1)	($14) - ($0.1)	$1.0- $1.2
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	($2.0)	($0.02)	($2.1)	$0.5
	Range in any year:	($5.1) - $0.03	($0.02) – ($0.01)	($5.1) - $0.02	$0.5 - $1.0
Northwest	**Average over 21 years:**	$0	$0	$0	$0.01
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.01 - $0.01
Western Interior	**Average over 21 years:**	$0	$0	$0	$0.04
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.04 - $0.04
U.S. Total	**Average over 21 years:**	**($9.6)**	**(18)**	**($28)**	**$18**
	Range in any year:	**($20) - ($1.7)**	**($37) - $3.5**	**($57) – ($5.4)**	**$15 - $18**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-20
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 8 (Preferred)Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	Average over 21 years:[1]	($5.4)	($12)	($17)	$9.7
	Range in any year:[2]	($12) - ($1.3)	($26) – ($2.0)	($37) – ($3.4)	$8.5 - $10
Colorado Plateau	Average over 21 years:	$0	$0.02	$0.02	$1.1
	Range in any year:	$0 – $0.01	($0.027) – $0.1	($0.02) – $0.06	$1.0 - $1.2
Gulf Coast	Average over 21 years:	$0	$0	$0	$2.5
	Range in any year:	($0.3) - $0.1	$0 - $0	($0.3) - $0.1	$2.5 - $2.5
Illinois Basin	Average over 21 years:	($0.5)	($2.2)	($2.7)	$5.5
	Range in any year:	($1.6) - $0.01	($6.0) - $0.03	($7.5) - $0.04	$4.6 - $6.3
Northern Rocky Mountains and Great Plains	Average over 21 years:	($2.1)	($0.01)	($2.1)	$2.0
	Range in any year:	($6.3) - ($0.03)	($0.02) – ($0.01)	($6.3) – ($0.04)	$1.8 - $2.1
Northwest	Average over 21 years:	$0	$0	$0	$0.04
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.04 - $0.04
Western Interior	Average over 21 years:	$0	$0	$0	$0.2
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0.2 - $0.2
U.S. Total	**Average over 21 years:**	**($8.0)**	**($14)**	**($22)**	**$21**
	Range in any year:	**($19) - ($1.5)**	**($31) – ($2.0)**	**($50) - $3.4**	**$19 - $22**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

Table 4.3.1-21
Estimated Changes in Annual Labor Income (Millions of dollars) Under Alternative 9 Compared to the No Action Alternative

Region	Metric	Production-Related Labor Income Effects[3] Surface[4]	Production-Related Labor Income Effects[3] Underground[5]	Production-Related Labor Income Effects[3] Surface and Underground Combined[6]	Compliance-Related Labor Income Effects[7]
Appalachian Basin	**Average over 21 years:[1]**	$0	$0	$0	$0
	Range in any year:[2]	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Colorado Plateau	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Gulf Coast	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Illinois Basin	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Northern Rocky Mountains and Great Plains	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Northwest	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
Western Interior	**Average over 21 years:**	$0	$0	$0	$0
	Range in any year:	$0 - $0	$0 - $0	$0 - $0	$0 - $0
U.S. Total	**Average over 21 years:**	**$0**	**$0**	**$0**	**$0**
	Range in any year:	**$0 - $0**	**$0 - $0**	**$0 - $0**	**$0 - $0**

[1] "Average over 21 years" is the average annual effect of the Alternative over the study period for the analysis on labor income.
[2] "Range in any year" is the minimum and maximum effect on labor income in any year in the study period.
[3] "Production-Related Labor Income Effects" are calculated as effects associated with changes to coal production that are expected as a result of the Alternative. These are calculated using assumptions related to employment per ton of coal produced and labor income per FTE.
[4] The range of effects to labor income related to "Surface" represents the minimum and maximum effect in any year in the study period.
[5] The range of effects to labor income related to "Underground" represents the minimum and maximum effect in any year in the study period.
[6] The range of effects to labor income related to "Surface and Underground Combined" represents the minimum and maximum impact in any year in the study period when the surface and underground mining effects are considered together. Because the minimum and maximum effects of the Alternative on surface and underground mining do not always occur in the same year, the Combined impact is not always equal to the sum of the Surface and Underground ranges.
[7] "Compliance-Related Labor Income Effects" are calculated as effects associated with changes to expenditures on compliance-related activities and are calculated using assumptions related to employment demand per dollar spent on compliance and labor income per FTE.

4.3.1.5 Property Value Impacts Analysis

Table 4.3.1-22 reports median home value in the coal regions in recent years. With the exception of the Northwest region, the median home value is lower within coal regions than in states as a whole.[40] Section 4.1 describes shifts in coal production expected under each of the Action Alternatives. A number of factors could contribute to property value effects associated with Action Alternatives at localized scale. These could include the following:

- More stringent requirements regarding topography and revegetation of reclaimed lands in the Action Alternatives may result in landscapes that resemble pre-mining conditions more than would have been expected under the No Action Alternative. To the extent that buyers prefer a more natural landscape, property value benefits could occur in localized areas.[41]
- Improved water quality near particular properties may also benefit property values (Poor, et al., 2007). These improvements may also benefit property values by increasing the quality or quantity of recreational opportunities that are available.
- If the rule results in reduced coal employment in a region, communities that are dependent on coal production (e.g., in the Appalachian Basin), could see demand for housing decline, with associated property value reductions on a local scale.
- When approximate original contour (AOC) variances are obtained, land is sometimes flattened in preparation for farming or development. If requirements of some Action Alternatives lead to fewer AOC variances, then they may reduce these opportunities, decreasing the resale value of the land.

Given the site-specific and contrasting potential effects of the Action Alternatives on property values, it is not possible to predict the direction of any impacts on property values at a regional or national scale.

[40] Statewide home values include urban and rural areas. Because coal mining largely occurs in rural areas, statewide home values may be an imperfect point of comparison, i.e., part of the differential attributed to coal mining may reflect a more general urban/rural disparity.

[41] These changes are similar to impacts achieved by low-impact development techniques, which have been demonstrated to improve property values (Ward, et al., 2008).

Table 4.3.1-22
Median Home Value in Coal Regions, 2011

Coal Region[1]	Geography	Median Home Value[2]
Appalachian Basin	Within Region	$112,413
	Statewide	$174,551
Colorado Plateau	Within Region	$193,367
	Statewide	$209,077
Gulf Coast	Within Region	$96,084
	Statewide	$125,170
Illinois Basin	Within Region	$130,478
	Statewide	$163,414
Northern Rocky Mountains and Great Plains	Within Region	$199,665
	Statewide	$213,776
Northwest	Within Region	$394,197
	Statewide	$278,629
Western Interior	Within Region	$104,353
	Statewide	$122,718
U.S. Total	Within All Regions	$151,493
	Nationwide	$186,200

Source: U.S. Census Bureau, 2011a. American Community Survey 2007-2011 Five-Year Estimates.
[1] Statistics presented in the non-shaded rows account only for coal-producing counties within the coal region. Statewide statistics account for all states intersecting the coal region.
[2] Median reported value of owner-occupied housing units.

4.3.1.6 Tax Revenue Impacts Analysis

Severance tax revenue for a state is directly related to coal mining activity. Thus, Action Alternatives that reduce production in a given region would result in reduced tax revenue. Conversely, increased coal production would generate increased revenue. The relationship between coal production and tax revenue is complex in some states. For example, some states only tax certain types of coal extracted or offer credits for particular extraction methods. This analysis undertakes the following method to estimate impacts of the Action Alternatives on state tax revenues:

> **1. Derive effective tax rates:** The first step involves examining state tax codes for coal severance taxation rates. For some states, the severance tax rate is a simple dollar-per-ton rate, but many states vary the tax rate for different types of coal mining or provide tax credits and exemptions for certain types of mining. Some states calculate severance tax based on the gross value of severed coal.
>
> **2. Apply effective tax rates to production forecasted:** The second step involves multiplying the effective tax rates by estimates of future production for each state. The difference between estimated severance tax revenues under the Action Alternatives and revenue forecasts under the No Action Alternative represents the projected impact of the Action Alternative on state severance tax revenues.

3. Derive annualized impacts: The final step involves calculating the present value of tax revenue impacts in 2014 dollars, and annualizing the present value over the entire period of study. The analysis uses a discount rate of seven percent.

The states with the most coal production generally collect the most revenue through coal severance taxes. Table 4.3.1-23 reports 2012 coal severance tax revenues by state. The majority of tax revenue levied on coal severance in this year was collected by the top three coal-producing states -- Wyoming, West Virginia, and Kentucky.

Table 4.3.1-24 lists the tax rates on coal severance by state and descriptions of the tax rates used by this analysis to estimate future revenues collected through coal severance. For each state, an attempt was made to use reported tax rates to estimate 2012 coal severance tax revenue based on 2012 production levels. These estimates were then compared with actual 2012 coal severance tax revenues collected by each state. For states where estimates were accurate within plus or minus 10 percent, the analysis uses reported tax rates to estimate future severance tax revenues based on production projections. States where estimated 2012 severance tax revenues differed by more than 10 percent from actual revenues generally have complicated tax provisions that make it difficult or impossible to forecast future revenues based on reported tax rates. For these states, the analysis uses an alternate tax-revenue-to-production coefficient calculated by dividing 2012 coal severance tax revenues by 2012 production levels.

Estimated state coal severance tax impacts depend both on the severance tax rate and the magnitude of estimated production impacts. Table 4.3.1-25 through Table 4.3.1-27 report estimated coal severance tax impacts by state and region. Impacts are reported as a total present value (in 2014 dollars) of all impacts over the study period, as well as annualized over 2020 to 2040 with a seven percent discount rate. Nationally, Alternative 2 is expected to result in an annualized decrease in state coal severance tax revenues of $5.6 million. Under Alternative 3, the decrease in coal severance tax revenues is expected to be $3.4 million annually. Alternative 4 is expected to result in an annualized decrease in coal severance tax revenues of $2.8 million. Annualized decreases in state coal severance tax under Alternatives 5, 6, and 7 were calculated to be $2.5 million, $1.6 million, and $3.0 million, respectively. Under Alternative 8 (Preferred), the decrease in coal severance tax revenues is expected to be $2.5 million. Severance tax revenues are not expected to change from the base case under Alternative 9.

A change in regional energy mixes resulting from increased coal prices could partially offset a decrease in severance tax revenue with increased taxes collected on substitute fuels. This offset would only be experienced in coal-producing states where substitute fuels (e.g., natural gas) are also extracted. Furthermore, any increases in coal prices would mitigate the tax effects in states where taxes are assessed on the gross value of coal, rather than the gross tonnage, in particular West Virginia and Kentucky.

Table 4.3.1-23
Coal Severance Tax Revenues by State, 2012 (Thousands of dollars)

State	2012
Appalachian Basin	
Alabama[1]	$3,453
Kentucky[2]	$277,821
Maryland	$0
Ohio[2]	$5,627
Pennsylvania	$0
Tennessee[2]	$955
Virginia	$0
West Virginia[2]	$460,077
Colorado Plateau	
Arizona	$0
Colorado[2]	$9,747
New Mexico	$10,879
Utah[2]	$0
Gulf Coast	
Louisiana	$484
Mississippi[2]	$0
Texas	$0
Illinois Basin	
Illinois	$0
Indiana	$0
Kentucky[2]	$277,821
Northern Rocky Mountains and Great Plains	
Colorado[2]	$9,747
Montana[2]	$52,743
North Dakota	$10,898
Wyoming	$287,532
Northwest	
Alaska[2]	$40,696
Western Interior	
Arkansas	$13
Kansas[2]	$8,745
Missouri	$0
Oklahoma	$0
Total U.S.	$1,169,670

Sources: U.S. Census Bureau, 2012 Annual Survey of State Government Tax Collections; Individual state revenue reports.
[1] Coal severance tax revenues are reported for the fiscal year ending September 30, 2012. Total state tax revenues are reported for the calendar year ending December 31, 2012. The contribution of coal severance taxes to total taxes is calculated using data from varying timeframes.
[2] Coal severance tax revenues are reported for the fiscal year ending June 30, 2012. Total state tax revenues are reported for the calendar year ending December 31, 2012. The contribution of coal severance taxes to total taxes is calculated using data from varying timeframes.
Notes: Coal severance tax revenues listed for New Mexico are net of the Intergovernmental Tax Credits (ITC) afforded to taxed coal entities. Severance tax revenues listed for Alaska consist of revenue from Alaska's mining license tax. The value of severance tax revenues between the two regions in Kentucky (Illinois Basin and Appalachia) and Colorado (Northern Rocky Mountains and Great Plains and Colorado Plateau) are not separated; the total value is presented for the entire state. In Virginia no state tax is levied, but local areas may impose taxes on coal extracted within limits set by state law. Coal severance taxes for West Virginia are calculated as General Revenue Fund, Infrastructure Fund, and Local Dedication from Coal Severance tax figures provided for FY 2012 by the West Virginia Department of Revenue.

Table 4.3.1-24a
Coal Severance Tax Rates by State, 2012 – Appalachian Basin

State	Severance Tax Type	Rate
Alabama (a)	State Coal Severance Tax	$0.335 per ton for the state.
	Local Coal Severance Tax	$0.20 per ton in Jackson and Marshall County.
Kentucky (b)	Coal Severance and Processing Tax	4.5% of gross value with a minimum tax of $0.50 per ton. A credit is given to thin seam coal extraction on a scale from 2.25% to 3.75% of the coal value.
Maryland (c)	No Coal Severance Tax	-
Ohio (d)	Coal Severance Tax	Base rate of $0.10 per ton, plus an additional $0.012 per ton on surface mined coal. An additional $0.12 to $0.16 per ton is levied on operations without a full cost bond and changes based on the amount remaining in the state Reclamation Forfeiture Fund at the end of each state budget biennium.
Pennsylvania	No Coal Severance Tax	-
Tennessee (e)	Coal Severance Tax	$0.75 per ton on entire production of coal products in the state, regardless of place of sale or outside-of-state delivery.
Virginia (f)	Local Coal Reclamation Tax	Any county or city may impose a severance tax on all coal within its jurisdiction. The rate of tax shall not exceed 1% of the gross receipts from such coal or gases.
West Virginia (g)	Natural Resources Severance Tax	5% of gross value, with the following reduced rates for thin seam underground mining: 2% of gross value for seams with thickness between 37 and 45 inches and 1% of gross value for seams with thickness less than 37 inches.

Table 4.3.1-24b
Coal Severance Tax Rates by State, 2012 – Colorado Plateau

State	Severance Tax Type	Rate
Arizona	No Coal Severance Tax	-
Colorado (h)	Coal Severance Tax	$0.842 per ton.
New Mexico (i)	Coal Severance Tax	$0.57 per ton on surface coal and $0.55 per ton on underground coal. The state also imposes a surtax on coal, which is increased on July 1 each year. The surtax in effect in Fiscal Year (FY) 2009 was $0.83 per ton. Post-2011 renegotiated contracts are not subject to the surtax.
Utah	No Coal Severance Tax	-

Table 4.3.1-24c
Coal Severance Tax Rates by State, 2012 – Gulf Coast

State	Severance Tax Type	Rate
Louisiana (j)	Natural Resources Severance Tax	$0.12 per ton of lignite.
Mississippi	No Coal Severance Tax	-
Texas	No Coal Severance Tax	-

Table 4.3.1-24d
Coal Severance Tax Rates by State, 2012 – Illinois Basin

State	Severance Tax Type	Rate
Illinois	No Coal Severance Tax	-
Indiana	No Coal Severance Tax	-
Kentucky (b)	Coal Severance and Processing Tax	4.5% of gross value with a minimum tax of $0.50 per ton. A credit is given to thin seam coal extraction on a scale from 2.25% to 3.75% of the coal value.

Table 4.3.1-24e
Coal Severance Tax Rates by State, 2012 – Northern Rocky Mountains and Great Plains

State	Severance Tax Type	Rate			
Colorado (h)	Coal Severance Tax	$0.842 per ton			
Montana (k)	Coal Severance Tax	Heat Content	Surface	Auger	Underground
		<7,000 BTU	10% of value	3.75% of value	3% of value
		7,000+ BTU	15% of value	5% of value	4% of value
North Dakota (l)	Coal Severance Tax	$0.375 per ton plus $0.02 per ton for the Lignite Research Fund. Reduced rates apply to coal used in cogeneration facilities. No tax on coal used for the following: (1) to heat state buildings; (2) used by the state or political subdivision of the state; or (3) agricultural processing. Counties may also grant a partial or complete exemption from the counties' 70% portion of the $0.375 tax for coal shipped out of state.			
Wyoming (m)	Coal Severance Tax	7% of taxable valuation of surface coal and 3.75% of taxable valuation of underground coal, with a maximum tax of $0.60 per ton of surface coal and $0.30 per ton of underground coal.			

Table 4.3.1-24f
Coal Severance Tax Rates by State, 2012 – Northwest

State	Severance Tax Type	Rate
Alaska (n)	Mining License Tax on Net Income	No tax if net income is $40,000 or less; $1,200 plus 3% of net income over $40,000; $1,500 plus 5% of net income over $50,000; and $4,000 plus 7% of net income over $100,000.
	Production Royalty on State Lands	3% on same net profits as license tax is based on.

Table 4.3.1-24g
Coal Severance Tax Rates by State, 2012 – Western Interior

State	Severance Tax Type	Rate
Arkansas (o)	Natural Resources Severance Tax	$0.02 per ton of coal, lignite and iron ore plus an additional $0.08 per ton on coal.
Kansas (p)	Minerals Severance Tax	$1.00 per ton coal produced. Severance or production of the first 350,000 tons of coal at any mine is exempt from taxation.
Missouri	No Coal Severance Tax	-
Oklahoma	No Coal Severance Tax	-

Sources for Tables 3.14-7a-g:
(a) Alabama - §§40-13-50, 40-13-61, Code of Alabama, 1975
(b) Kentucky – Kentucky Revised Statutes (KRS) §143.020; KRS §143.010(13); KRS §143.010(14); KRS §143.021(3)
(c) Maryland - Annotated Code of Maryland §15-509 (Environment Article). Annotated Code of Maryland §15-615 (Environment Article)
(d) Ohio - Ohio Revised Code (ORC) §5749.02(A)(1); ORC §5749.02(A)(8); ORC §5749.02(A)(9)
(e) Tennessee – Tennessee Code 67-7-104
(f) Virginia - Virginia Code §58.1-3286
(g) West Virginia - West Virginia Code §11-13A; West Virginia Code §11-13V-4
(h) Colorado – Quarterly Final Tax Rate for most recent reported quarter, December 2012. Severance tax rate is adjusted quarterly and is based on the chance in producer price index as published by Bureau of Land Statistics. Colorado Revised Statutes 39-29-106
(i) New Mexico – 2012 The State of New Mexico Continuing Disclosure: Annual Financial Information Filing for Fiscal Year 2012, p. 12.; 2010 New Mexico Statutes Annotated 1978 7-26-6; “Taxation of Coal and Other Energy Resources.” January 2009. New Mexico Taxation and Revenue Department.
(j) Louisiana – Revised Statutes 47:633
(k) Montana – Montana Code Annotated 15-35-103
(l) North Dakota - North Dakota Century Code §57-61-01.1
(m) Wyoming - Wyoming State Statutes §39-14-104
(n) Alaska - Mining License Tax Law: Alaska Statute 43.65; Alaska Statute 38.05.212
(o) Arkansas - Arkansas Code Annotated §26-58-101 et. seq.
(p) Kansas – Kansas Statutes Annotated 79-42
These collections do not include revenues collected by Tribal governments.

Table 4.3.1-25
Estimated Changes in Coal Severance Tax Revenue under Action Alternatives 2-4 Compared to the No Action Alternative ($2014), 2020 to 2040, Seven Percent Discount Rate

Region	Alternative 2 Net Present Value	Alternative 2 Annualized (2020-2040)	Alternative 3 Net Present Value	Alternative 3 Annualized (2020-2040)	Alternative 4 Net Present Value	Alternative 4 Annualized (2020-2040)
Appalachian Basin						
Alabama	($489,000)	($45,100)	($197,000)	($18,200)	($129,000)	($11,900)
Kentucky[1]	($8,500,000)	($785,000)	($4,450,000)	($411,000)	($3,790,000)	($349,000)
Ohio	($186,000)	($17,200)	($153,000)	($14,100)	($152,000)	($14,000)
Tennessee	($66,700)	($6,150)	($37,000)	($3,410)	($28,400)	($2,620)
West Virginia	($37,500,000)	($3,460,000)	($22,200,000)	($2,050,000)	($18,000,000)	($1,660,000)
Regional Total:	($46,800,000)	($4,320,000)	($27,000,000)	($2,500,000)	($22,100,000)	($2,040,000)
Colorado Plateau						
Colorado	$2,230	$206	($6,240)	($576)	$7,980	$736
New Mexico	($1,060)	($98)	$13	$1	$95	$9
Regional Total:	$1,170	$108	($6,220)	($574)	$8,070	$745
Gulf Coast						
Louisiana	$719	$66	($825)	($76)	($1,750)	($161)
Regional Total:	$719	$66	($825)	($76)	($1,750)	($161)
Illinois Basin						
Kentucky[1]	($8,500,000)	($785,000)	($4,450,000)	($411,000)	($3,790,000)	($349,000)
Regional Total:	($8,500,000)	($785,000)	($4,450,000)	($411,000)	($3,790,000)	($349,000)
Northern Rocky Mountains and Great Plains						
Montana	($889,000)	($82,000)	($914,000)	($84,400)	($898,000)	($82,900)
North Dakota	$0	$0	$0	$0	$0	$0
Wyoming	($3,930,000)	($362,000)	($4,120,000)	($380,000)	($3,880,000)	($358,000)
Regional Total:	($4,820,000)	($444,000)	($5,030,000)	($464,000)	($4,780,000)	($441,000)
Northwest						
Alaska	$0	$0	$0	$0	$0	$0
Regional Total:	$0	$0	$0	$0	$0	$0
Western Interior						
Arkansas	$0	$0	($5)	$0	$0	$0
Kansas	$0	$0	$0	$0	$0	$0
Regional Total:	$0	$0	($5)	$0	$0	$0
TOTAL	($60,100,000)	($5,550,000)	($36,500,000)	($3,370,000)	($30,700,000)	($2,830,000)

[1]Production in Kentucky is evenly divided between the Appalachian Basin and Illinois Basin regions.
Note: All numbers rounded to three significant figures.

Table 4.3.1-26
Estimated Changes in Coal Severance Tax Revenue under Action Alternatives 5-7 Compared to the No Action Alternative ($2014), 2020 to 2040, Seven Percent Discount Rate

Region	Alternative 5 Net Present Value	Alternative 5 Annualized (2020-2040)	Alternative 6 Net Present Value	Alternative 6 Annualized (2020-2040)	Alternative 7 Net Present Value	Alternative 7 Annualized (2020-2040)
Appalachian Basin						
Alabama	($83,300)	($7,690)	$7,760	$716	($164,000)	($15,100)
Kentucky[1]	($2,810,000)	($259,000)	($2,220,000)	($205,000)	($4,350,000)	($402,000)
Ohio	($162,000)	($14,900)	($91,200)	($8,420)	($176,000)	($16,200)
Tennessee	($24,400)	($2,260)	($12,500)	($1,150)	($29,100)	($2,690)
West Virginia	($16,300,000)	($1,510,000)	($8,580,000)	($792,000)	($19,000,000)	($1,750,000)
Regional Total:	($19,400,000)	($1, 790,000)	($10,900,000)	($1,010,000)	($23,700,000)	($2,190,000)
Colorado Plateau						
Colorado	$4,810	$444	$2,230	$205	$12,300	$1,140
New Mexico	$95	$9	($404)	($37)	($50)	($5)
Regional Total:	$4,900	$453	$1,820	$168	$12,300	$1,130
Gulf Coast						
Louisiana	$334	$31	$976	$90	$113	$10
Regional Total:	$334	$31	$976	$90	$113	$10
Illinois Basin						
Kentucky[1]	($2,810,000)	($259,000)	($2,220,000)	($205,000)	($4,350,000)	($402,000)
Regional Total:	($2,810,000)	($259,000)	($2,220,000)	($205,000)	($4,350,000)	($402,000)
Northern Rocky Mountains and Great Plains						
Montana	($913,000)	($84,300)	($870,000)	($80,300)	($915,000)	($84,400)
North Dakota	$0	$0	$0	$0	$0	$0
Wyoming	($4,020,000)	($371,000)	($3,850,000)	($355,000)	($3,940,000)	($364,000)
Regional Total:	($4,930,000)	($455,000)	($4,720,000)	($435,000)	($4,860,000)	($448,000)
Northwest						
Alaska	$0	$0	$0	$0	$0	$0
Regional Total:	$0	$0	$0	$0	$0	$0
Western Interior						
Arkansas	$0	$0	$0	$0	$0	$0
Kansas	$0	$0	$0	$0	$0	$0
Regional Total:	$0	$0	$0	$0	$0	$0
TOTAL	($27,100,000)	($2,510,000)	($17,800,000)	($1,640,000)	($32,900,000)	($3,040,000)

[1]Production in Kentucky is evenly divided between the Appalachian Basin and Illinois Basin regions.
Note: All numbers rounded to three significant figures.

Table 4.3.1-27
Estimated Changes in Coal Severance Tax Revenue under Action Alternatives 8-9, Compared to the No Action Alternative ($2014), 2020 to 2040, Seven Percent Discount Rate

Region	Alternative 8 (Preferred) Net Present Value	Alternative 8 (Preferred) Annualized (2020-2040)	Alternative 9 Net Present Value	Alternative 9 Annualized (2020-2040)
Appalachian Basin				
Alabama	($77,000)	($7,100)	$0	$0
Kentucky[1]	($3,320,000)	($307,000)	$0	$0
Ohio	($138,000)	($12,800)	$0	$0
Tennessee	($23,300)	($2,150)	$0	$0
West Virginia	($15,100,000)	($1,400,000)	$0	$0
Regional Total:	($18,700,000)	($1,720,000)	$0	$0
Colorado Plateau				
Colorado	$8,720	$804	$0	$0
New Mexico	$95	$9	$0	$0
Regional Total:	$8,810	$813	$0	$0
Gulf Coast				
Louisiana	($3)	$0	$0	$0
Regional Total:	($3)	$0	$0	$0
Illinois Basin				
Kentucky[1]	($3,320,000)	($307,000)	$0	$0
Regional Total:	($3,320,000)	($307,000)	$0	$0
Northern Rocky Mountains and Great Plains				
Montana	($904,000)	($83,400)	$0	$0
North Dakota	$0	$0	$0	$0
Wyoming	($3,900,000)	($360,000)	$0	$0
Regional Total:	($4,810,000)	($444,000)	$0	$0
Northwest				
Alaska	$0	$0	$0	$0
Regional Total:	$0	$0	$0	$0
Western Interior				
Arkansas	$0	$0	$0	$0
Kansas	$0	$0	$0	$0
Regional Total:	$0	$0	$0	$0
TOTAL	($26,800,000)	($2,470,000)	$0	$0

[1]Production in Kentucky is evenly divided between the Appalachian Basin and Illinois Basin regions.
Note: All numbers rounded to three significant figures

Outside of state taxes, two excise taxes are imposed by the federal government: The Abandoned Mine Lands Reclamation Tax (also known as the reclamation fee or AML fee) and the Black Lung Excise Tax. Whether these taxes will continue to be imposed prior to and during the study period is uncertain.[42] If either or both taxes are collected during the study period, revenue from them would be less than under the No Action Alternative because of reductions in coal production. The reclamation fee imposes a tax of $0.28 per ton of coal produced by surface mining, $0.12 per ton of coal produced by underground mining, $0.08 per ton for lignite (30 U.S.C. § 1232).[43] The Black Lung Excise Tax imposes a tax at the rate of $1.10 on coal from underground mines, and $0.55 on coal from surface mines 26 U.S.C. § 4121). The expected revenue from these taxes would vary because of differences in tax rates for surface and underground and from the differences in declines in coal tonnages for surface and underground mining. Consequently, reclamation fee collections ($375,000) are less than collections for Black Lung Excise Tax collections ($1.4 million). Less revenue would not necessarily result in short-falls for miner's compensation fund because the incidence of Black Lung would likely be reduced with reduced exposure to underground mining.

4.3.1.7 Quality of Life Impacts Analysis

The coal mining industry has historically brought high-paying jobs to rural areas, particularly in parts of Central Appalachia. The Action Alternatives may impact the quality of life in coal-producing regions either through regional shifts in coal production or overall reduction of coal produced when compared to the No Action Alternative. A decrease in overall coal production caused by the Action Alternatives would contribute to the recent downward trend in coal industry production, putting further stress on communities already experiencing economic distress. A decrease in coal mining activity may threaten not only the primary source of income and health insurance in some areas, but also the sense of community and identity associated with the mining culture. After generations of working in coal mines, many Appalachian Basin communities still maintain social and cultural connections with the coal industry, even as the number of mining jobs has decreased. A reduction in coal production may weaken social networks in rural areas that have traditionally depended on coal mining.

Some Action Alternatives also introduce new restrictions on postmining land use (see Section 4.3.2). With more reclaimed land returned to its AOC and vegetation, developers in coal-producing regions may have reduced access to sources of flat, developable land, which can be a scarce resource in mountainous coal-producing areas. This decrease in developable land has the potential to restrict future economic growth in parts of the country already undergoing economic hardship.

A decrease in coal mining may also improve the quality of life in some areas by reducing some of the adverse impacts associated with coal mining. Decreased prevalence of mining and construction operations would decrease the amount of traffic and noise affecting residents of

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[42] Collection of the reclamation fee is scheduled to end September 30, 2021 (30 U.S.C. § 1232(a)).

[43] The reclamation fee may be based on a percentage of the value of the coal if that specified percentage is less than the per ton rate (30 U.S.C. 1232(a)).

coal-producing areas. More land in coal-producing regions would be left in its original state, improving landscape ecology and visual aesthetics. Finally, reduced coal mining activity may lessen anxiety over possible adverse health impacts attributed to living near coal mining.

4.3.1.8 Summary of Effects

Table 4.3.1-28 presents the impacts of the Action Alternatives relative to the No Action Alternative. Impact determinations consider the length of impact, geographic scope of impact, and potential for offsetting the impact. Specifically, in order to be conservative, i.e., more likely to overstate impacts than understate them, the analysis determines impacts to employment using anticipated changes in production-related employment in each region.[44] The "Overall Impact to Socioeconomics" is the expected overall effect on socioeconomic resources, combining the expected impacts to employment and expected impacts to severance taxes.

At the national scale, Alternative 2 is anticipated to result in Major Adverse impacts on socioeconomic conditions including, in particular, employment and severance taxes when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 (Preferred) are anticipated to result in Minor Adverse impacts socioeconomic conditions including employment and severance taxes at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on socioeconomic conditions.

At a regional scale, Major Adverse impacts on socioeconomic conditions including employment are anticipated in the Appalachian Basin under Alternative 2. Moderate Adverse impacts on socioeconomic conditions are anticipated in the Appalachian Basin under Alternatives 3, 4, 5, 7, and 8 (Preferred). Impacts to other regions to socioeconomic conditions are anticipated to be Minor Adverse or Negligible across alternatives at the regional scale when compared to the No Action Alternative.

[44] Potential increases in employment demand related to compliance activities may mitigate the adverse impacts associated with production-related employment changes.

Table 4.3.1-28a
Impacts of Alternative 2 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Major Adverse	• Long-term, • Large scope	Major Adverse	• Long-term, • Medium scope	Major Adverse	• Long-term, • Large scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28b
Impacts of Alternative 3 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28c
Impacts of Alternative 4 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28d
Impacts of Alternative 5 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Minimal measurable impact	Negligible	• Minimal measurable impact	Minor Adverse	• Minimal measurable impact
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28e
Impacts of Alternative 6 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Minor Adverse	• Long-term, • Medium scope	Minor Adverse	• Long-term, • Medium scope	Minor Adverse	• Long-term, • Small scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28f
Impacts of Alternative 7 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28g
Impacts of Alternative 8 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope	Moderate Adverse	• Long-term, • Medium scope
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope	Minor Adverse	• Long-term, • Small scope
Northern Rocky Mountains and Great Plains Region	Minor Adverse	• Long-term, • Small scope	Negligible	• Minimal measurable impact	Minor Adverse	• Long-term, • Small scope
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Table 4.3.1-28h
Impacts of Alternative 9 on Socioeconomic Conditions Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Employment[1]	Rationale	Impact to Severance Tax	Rationale	Overall Impact to Socioeconomics[2]	Rationale
Appalachian Basin Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Colorado Plateau Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Gulf Coast Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Illinois Basin Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Northern Rocky Mountains and Great Plains Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Northwest Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact
Western Interior Region	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact	Negligible	• Minimal measurable impact

Notes for tables a through h:

Please see Table 4.0.2-1 for a definition of Negligible, Minor, and Moderate impact terms used above. These impact categories consider the length of impact, geographic scope of impact, and potential for offsetting the impact.

[1] In order to be conservative, i.e. more likely to overstate impacts than understate them, the analysis determines impacts to employment using anticipated changes in production-related employment in each region. Potential increases in employment demand related to compliance activities may mitigate the adverse impacts associated with production-related employment changes.

[2] "Overall Impact to Socioeconomics" is the expected overall effect on socioeconomic resources, combining the expected impacts to employment and expected impacts to severance taxes

Alternative 1 (No Action Alternative)

The No Action Alternative would allow for mining to continue under existing regulatory requirements. Mining under the No Action Alternative would continue to provide employment, income and tax revenues at current levels and would only due change due to normal market conditions that are applicable to all the Alternatives.

Alternative 2

Alternative 2 is expected to have the largest effect on coal production across the examined Action Alternatives and is therefore generally expected to result in the greatest impacts to employment and coal severance tax revenues.

Appalachian Basin

In the Appalachian Basin, Major Adverse impacts are expected due to decreases in regional employment, labor income, and coal severance taxes. It is worth noting that potentially affected areas under this impact designation include parts of the Appalachian Basin where coal mining provides one of few sources of income.

Illinois Basin and Northern Rocky Mountains and Great Plains

In the Illinois Basin, and Northern Rocky Mountains and Great Plains regions, a Minor Adverse impact is anticipated. Coal severance tax revenues are expected to decrease or be Negligible in both regions and small scale employment losses contribute to this anticipated impact.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest, and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 3

Alternative 3 is expected to result in a moderate decrease in coal production. Compared to Alternative 2, the general direction of impacts remains the same, but the scope is diminished, due primarily to the more moderate decrease in coal production, specifically in the Appalachian Basin.

Appalachian Basin

Due to decreases in employment and coal severance tax revenues in the Appalachian Basin the effects are expected to be Moderate Adverse.

Illinois Basin and Northern Rocky Mountains and Great Plains

Similar to the conditions described under Alternative 2, the Illinois Basin and Northern Rocky Mountains and Great Plains regions are expected to experience Minor Adverse impacts.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 4

Alternative 4 is expected to result in moderate reductions in coal production, and is therefore generally expected to result in similar impacts to socioeconomic resources across the Action Alternatives as described for Alternative 3.

Appalachian Basin

Under this Alternative, the Appalachian Basin experiences negative impacts to employment and coal severance tax revenues; the effects are expected to be Moderate Adverse.

Illinois Basin and Northern Rocky Mountains and Great Plains

As under Alternative 3, Illinois Basin and Northern Rocky Mountains and Great Plains regions are expected to experience Minor Adverse impacts.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest, and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 5

Alternative 5 is expected to result in moderate reductions in coal production, slightly less than those expected to occur under Alternative 4.

Appalachian Basin

These reductions in coal production are expected to occur primarily in the Appalachian Basin region. The Appalachian Basin region is predicted to experience a Moderate Adverse impact under Alternative 5.

Illinois Basin and Northern Rocky Mountains and Great Plains

The Illinois Basin and Northern Rocky Mountains and Great Plains regions are also anticipated to incur Minor Adverse impacts under Alternative 5.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest, and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 6

Alternative 6 is expected to result in the least reductions in coal production across the Action Alternatives (with the exception of Alternative 9 in which no reductions are expected).

Appalachian Basin

In the Appalachian Basin region, employment and coal severance tax revenues are anticipated to be adversely impacted under this Alternative due to reduced coal production resulting in an overall impact assessment of Minor Adverse.

Illinois Basin and Northern Rocky Mountains and Great Plains

The Illinois Basin and Northern Rocky Mountains and Great Plains regions are expected to experience similar impacts as under the other Alternatives. The Illinois Basin is expected to experience adverse impacts to employment and coal severance tax revenues resulting in an overall impact of Minor Adverse. In the Northern Rocky Mountains and Great Plains region, severance tax impacts are expected to be Negligible but adverse impacts to employment result in an overall impact of Minor Adverse.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest, and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 7

Alternative 7 is expected to result in moderate reductions in coal production.

Appalachian Basin

These impacts on coal production are primarily felt in the Appalachian Basin where associated employment numbers and coal severance tax revenues are expected to decrease. As such, this region is predicted to experience Moderate Adverse impacts under this Alternative.

Illinois Basin and Northern Rocky Mountains and Great Plains

In both the Illinois Basin and Northern Rocky Mountains and Great Plains regions, employment is expected to decrease over the No Action Alternative. Severance tax revenues are expected to decrease in the Illinois Basin and have a Negligible effect on the Northern Rocky Mountains and Great Plains region leading to an overall impact assessment of Minor Adverse for both regions.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest, and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 8 (Preferred)

Alternative 8 (Preferred) is expected to result in moderate reductions in coal production, and is therefore generally expected to result in similar impacts to socioeconomic resources across the Action Alternatives as described for Alternative 4.

Appalachian Basin

Under this Alternative, the Appalachian Basin experiences negative impacts to employment and coal severance tax revenues; the effects are expected to be Moderate Adverse.

Illinois Basin and Northern Rocky Mountains and Great Plains

As under Alternative 4, Illinois Basin and Northern Rocky Mountains and Great Plains regions are expected to experience Minor Adverse impacts. This overall impact is driven by adverse employment impacts in the Northern Rocky Mountains and Great Plains region and is a combination of adverse effects to both employment and severance taxes in the Illinois Basin.

Other Regions

Impacts in the Colorado Plateau, Gulf Coast, Northwest and Western Interior regions are expected to be Negligible due to minimal measureable impacts to the socioeconomic resources examined in these regions.

Alternative 9

All Regions

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zone rule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible effects on socioeconomic resources evaluated in this DEIS.

Table 4.3.1-29 presents the overall impacts to socioeconomic resources across regions and Action Alternatives.

Table 4.3.1-29
Summary of Impacts of the Action Alternatives on Socioeconomics Compared to the No Action Alternative

Alternative	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	National
Alternative 2	Major Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Moderate Adverse**
Alternative 3	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 4	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 5	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 6	Minor Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 7	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 8 (Preferred)	Moderate Adverse	Negligible	Negligible	Minor Adverse	Minor Adverse	Negligible	Negligible	**Minor Adverse**
Alternative 9	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**

4.3.1.9 Uncertainties and Limitations

There are a variety of uncertainties and limitations inherent in this analysis, which have been discussed in the text above and are summarized below:

- Labor productivity in the coal mining industry has decreased steadily in recent years, especially in the Appalachian Basin region. The analysis does not account for this trend, and instead assumes that 2010 labor productivity will be maintained throughout the study period. If labor productivity continues to decrease, effects on employment may be greater than those reported above.

- IMPLAN (and input-output models in general) provides a static set of results that does not account for technological shifts, price changes, sectoral growth, or other factors. As such, coefficients for estimating compliance employment impacts, indirect and induced labor impacts, and labor income impacts are constant over the period of study. Changes to the factors listed above could change behavior and affect the long-term impacts of a project.

- In the severance tax analysis, an attempt was made to test the accuracy of using reported tax rates to estimate actual severance tax revenue. Severance tax revenue estimates for 2012 were compared with actual severance tax revenues for 2012 by state to determine the accuracy of the reported tax rate. For states where 2012 revenue estimates differed from actual revenues by more than 10 percent, the tax rate used to forecast future revenues was calculated as 2012 revenues divided by 2012 production.

4.3.1.10 Potential Minimization and Mitigation Measures

Impacts to employment and associated income may be offset by initiating programs aimed at diversifying employment opportunities in areas that rely heavily on coal mining as a source of employment and income. Mine operators could also re-train current employees to fill positions that have been created by complying with the Action Alternatives (excluding Alternative 9). Impacts to state severance tax revenues could be offset by shifting to extraction of other taxed fuel sources within the United States, such as natural gas. Even if this entirely counterbalanced losses in revenue due to decreased coal production, however, a shift to substitute fuel sources would likely affect the state-by-state distribution of tax revenue collected from extractive industries. OSMRE is also authorized to provide Small Operator Assistance Program (SOAP) funding to small coal mine operators (30 U.S.C. § 1257(c)). SOAP grants can provide financial assistance to mine operators in obtaining the scientific and technical information required to apply for a coal mining permit. Although it is not factored explicitly into the analysis, this program has the potential to help minimize the burden of the costs of compliance with the Action Alternatives on small mine operators, perhaps decreasing potential employment impacts of the Action Alternatives.

4.3.2 Land Use, Utilities, Infrastructure, Visual Resources, and Noise

This section considers the potential effects of the Alternatives on changes in land use, utilities, infrastructure, visual resources, and noise. Recreation is treated separately in Section 4.3.3.

Chapter 3 describes general characteristics of the coal regions in relation to land use, utilities, infrastructure, visual resources, and noise at the regional level. This section of Chapter 4 analyzes how these resources are affected by the No Action Alternative and by the Action Alternatives under consideration for the SPR. Various elements of the Action Alternatives may indirectly affect aspects of these topics in the coal mining regions, particularly to the extent that this rule proposed action affects coal production in a particular region.

The discussion is organized as follows:

- It first describes the existing regulatory environment to assist the reader in understanding the impacts of the No Action Alternative on land use, utilities, infrastructure, visual resources, and noise.
- Second, the discussion identifies the aspects of these topics that are most likely to be affected by implementation of the Action Alternatives and the rationale for these findings.
- It then describes the method for assessing the expected magnitude of impact of the Action Alternatives on these resources.
- Next, the results of the quantitative analysis are presented, along with additional qualitative evaluation of other beneficial impacts.
- The section concludes with a summary of the expected effects of the Action Alternatives, characterizing the impacts by coal region and Alternative.

4.3.2.1 Effects of the Current Regulatory Environment (the No Action Alternative)

Section 3.7 characterizes land use, Section 3.11 characterizes visual resources and noise, and Section 3.12 characterizes utilities and infrastructure in each coal region. This section briefly discusses this information in the context of the No Action Alternative.

Land Use

Section 515(b)(2) of SMCRA requires the mining operation to restore affected lands to a condition capable of supporting the uses they were capable of supporting prior to mining, or to a higher or better use if certain criteria are met. 30 U.S.C. 1265(b)(2). The implementing regulations are located at 30 CFR 780.23, 784.15, 816.133, and 817.133.

Postmining Land Use

Paragraphs (a)(2) through (a)(4) of section 508 of SMCRA provide that each reclamation plan submitted as part of a permit application must include a statement of the condition of the land prior to any mining. As implemented through the regulations at 30 CFR 780.23, the application must describe the existing conditions and capabilities of the land under high levels of management. The reclamation plan also must include detailed descriptions of any proposed alternative uses and how they relate to existing land use policies and plans, and must be supported by comments from the surface owner of the permit area.

Section 515(b)(2) of SMCRA (30 U.S.C. § 1265(b)(2)) requires that all surface coal mining and reclamation operations:

> restore the land affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining, or higher or better uses of which there is reasonable likelihood, so long as such use or uses do not present any actual or probable hazard to public health or safety or pose any actual or probable threat of water diminution or pollution, and the permit applicants' declared proposed land use following reclamation is not deemed to be impractical or unreasonable, inconsistent with applicable land use policies and plans, involves unreasonable delay in implementation, or violates federal, state, or local law.

The regulations at 30 CFR 816.133 and 817.133 essentially restate the statutory provisions and add language defining how the premining land uses must be determined; i.e., the premining land uses to which the postmining land use is compared must be those uses that the land previously supported if the land has not been previously mined and has been properly managed. For previously mined land that has not been reclaimed, the premining land use must be the land use that existed before any mining. If the previously mined land cannot be reclaimed to the land use that existed before any mining, the postmining land use must be the highest and best use that can be achieved, that is compatible with surrounding areas, and that does not require the disturbance of areas previously unaffected by mining.

In addition, the regulations at 30 CFR 701.5 define land uses as "specific uses or management-related activities, rather than the vegetation or cover of the land. Land uses may be identified in combination when joint or seasonal uses occur and may include land used for support facilities that are an integral part of the use." The regulations also define "higher or better uses" as "postmining land uses that have a higher economic value or nonmonetary benefit to the landowner or the community than the premining land uses."

If an alternative postmining land use is proposed, the application must contain the information required for approval of that use pursuant to 30 CFR 816.133(c) or 817.133(c), including demonstrations that the proposed use is achievable in a reasonable amount of time, that it would not present any public health or water pollution concerns, that it would be otherwise consistent with applicable land use policies and laws at the federal, state or local level.

Utilities and Infrastructure

Under the No Action Alternative, the existing SMCRA regulatory program provides a number of provisions intended to protect utilities and infrastructure, including features such as public roads, railroads, water and sewage lines, wells (oil, gas, and water), pipelines (oil, gas, and coal slurry), electric and telephone lines, and water supplies (drinking, domestic, or residential)(30 CFR 816.180 and 817.180).

In enacting SMCRA in 1977, Congress specifically mandated that, except under limited circumstances, surface coal mining operations may not be conducted within 100 feet, measured horizontally, of the outside right-of-way of any public road (30 U.S.C. § 1272(e)(4)). The exceptions to this prohibition are described at 30 CFR 761.14. These regulations allow an exception for circumstances where a mine access or haul road joins a public road, lands where an entity can show that it has "valid existing rights" as set forth in 30 CFR 761.16, or where the lands are associated with an operation that was existing prior to the road. Otherwise, regulatory authorities may only approve operations that would propose to relocate or close a public road to accommodate surface coal mining operations after providing for public notice and comment, and making a finding that the interests of the public and affected landowners would be protected. 30 CFR 761.14(c).

Under 30 CFR 816.180 and 817.180, all coal mining operations must be conducted in a manner that minimizes damage, destruction, or disruption of services provided by oil, gas, and water wells; oil, gas, and coal-slurry pipelines; railroads; electric and telephone lines; and water and sewage lines that pass over, under, or through the permit area, unless otherwise approved by the owner of those facilities and the regulatory authority. These regulations do not apply to the area located above underground mining activities if that area is not included within the permit area.

Under 30 CFR 816.62 and 817.62, the owner of any dwelling or structure (including pipelines, cables, transmission lines, and cisterns, wells, and other water systems) located within a half-mile radius of the permit area may request a preblasting survey of surface conditions, which the operator must complete before the initiation of blasting.

Transportation capacity issues are outside the regulatory reach of SMCRA, other than the public road requirements discussed above. For purposes of this DEIS, Section 3.12 provides an overview of each region's transportation methods and also assesses the potential future need for infrastructure expansion.

Visual Resources

The visual quality of areas surrounding coal mining is considered as a resource in this discussion because the visual appeal of surroundings affects the public's quality of life and how people feel about the area in which they live and work, and where they choose to recreate. The analysis described in the following sections assumes that the public would prefer that natural premining conditions be reproduced during reclamation. The analysis takes into account the extent to which reclamation using landforming principles can create greater opportunities to restore the site to its approximate premining condition and decrease adverse impacts on visual resources. The visual impacts that occur during mining are an understood consequence of the activity that the surrounding community weighs in comparison to the benefits of mining to the local economy. Neither SMCRA nor its implementing regulations specifically require the permit applicant to address the visual impacts of proposed operations.

During the active mining process, alterations to the existing vegetation and topography are often visually dramatic. Earthen materials overlying the coal are excavated and moved to various locations around the mine site. Vegetation is removed and portions of the mine site may remain without vegetation for long periods of time.

Once mining is completed, surface mine companies are, with limited exceptions, required to restore the mine site to its AOC via backfilling and regrading. However, in some (steep-slope) terrain, the increase in volume of spoil relative to solid rock results in excess spoil fills outside the mined area, even when the mined area is returned to AOC. In addition, AOC variances are available that can result in altered postmining topography on the mined areas, as well as excess spoil fills outside the mined areas. Access roads and drainage control ponds may be approved as permanent features, altering the visual resources of an area. With the exception of mined areas returned to AOC, all of these features, if present, change the landscape in ways not consistent with the natural topography.

Use of non-native species is virtually always a consequence of conversion of land to new postmining land uses; for example, the conversion of forest to agricultural land and forested areas to grassland grazing areas. The converted site looks visually different and is different in terms of recreational opportunities, land use, and wildlife habitat value.

Visual resource impacts are often considered during preparation of NEPA analysis for mining on federal lands or for mining of coal for which the U.S. holds the mineral rights. The Secretary of the Department of the Interior is responsible for authorizing the mining plan for federal coal leased by the U.S. Bureau of Land Management (U.S. BLM). The requirement for an approved mining plan is set forth under the federal Mineral Leasing Act, which states that before any entity can take action on a federal leasehold that "might cause a significant disturbance to the environment," an operation and reclamation plan must be submitted to the Secretary of the Interior for approval (30 U.S.C. § 207(c)). OSMRE is charged to "prepare and submit to the Secretary a decision document recommending approval, disapproval, or conditional approval of the mining plan" (30 CFR 746.13).

Surface mining results in greatly disturbed landscapes. Reclamation of these landscapes is achieved with varying degrees of success with regard to previous visual character. Regional variations in rainfall and topography require different approaches to reclamation, and affect the amount of effort required to achieve successful reclamation and restoration of the premining appearance of the site. How well the land is returned to the premining condition depends on the regulatory authority's AOC requirements, as well as regional and site-specific conditions.

Impacts to visual resources do occur under the No Action Alternative; they are not completely avoidable unless mining is precluded altogether.

Noise

Mining activities cause noise in and around the mine site. Surface coal mining operations often employ large earth-moving vehicles and other machinery which can produce noise during the mine operation. Surface mining, which relies on blasting to remove overburden, generally creates more noise than underground mining. Underground mining operations often have large ventilation systems that produce noise during mine operation. Depending on the location of the mining activity and its proximity to noise sensitive areas, mining related noise can interfere with human enjoyment of areas immediately surrounding the mining activity.

Blasting operations are sporadic events, but they are of particular concern because of potentially damaging low-frequency noise and pressure waves. Therefore, the regulations require careful planning, control, and monitoring of blasting events to ensure that blasting occurs under safe conditions. Setback requirements from dwellings, public buildings, schools, and churches reduce noise impacts to sensitive receptors under the No Action Alternative, as do existing requirements to conduct blasting between sunrise and sunset unless nighttime blasting is approved by the RA upon a determination that the public will be protected from adverse noise and other impacts. See 30 CFR 816.61 through 816.68 and 817.61 through 817.68.

As noted above, underground mines involve a number of noise-making processes and equipment, most of which produce noise solely underground. However, surface noise from underground mining does result from the use of large intake and exhaust fans that vent methane from underground mine operations, and from conveyor belts or trains, trucks, and dozers used to transport coal and coal mine waste.

The primary responsibility for addressing construction noise, noise from power equipment operated by individuals, and unmuffled industrial noise penetrating residential areas, rests with states and local governments. Thousands of U.S. cities have implemented noise ordinances that give noise control officers and police the power to investigate noise complaints and enforcement power to abate the offending noise source through shutdowns and fines. A typical noise ordinance sets forth clear definitions of acoustic nomenclature and defines categories of noise generation; then numerical standards are established so that enforcement personnel can take the necessary steps of warnings, fines, or other municipal police action to rectify unacceptable noise generation. Under the No Action Alternative, coal mining would continue to produce noise as described above. Noise from coal mining may then affect surrounding communities and wildlife. As seen in Table 4.3.2-1 below, there are no additional measures proposed under any Alternative that would affect the production of noise in comparison to the No Action Alternative to a measurable degree.

4.3.2.5 Action Alternatives and Potential Effects on Land Use, Utilities, Infrastructure, Visual Resources, and Noise

Various elements of the Alternatives may affect land use, utilities, infrastructure, visual resources, and/or noise associated with areas disturbed by mining activities. Each of the rule elements is discussed below. Table 4.3.2-1 summarizes the effects of various elements of the Action Alternatives on these resources.

Table 4.3.2-1
SPR Elements and Potential Effects on Land Use, Utilities, Infrastructure, Visual Resources, and Noise in Coal Mining Regions

SPR Element	Land Use	Utilities	Infrastructure	Visual Resources	Noise	Indirect Impacts Expected
Baseline Data Collection and Analysis						■
Monitoring During Mining and Reclamation						■
Definition of Material Damage to the Hydrologic Balance						■
Corrective Action Thresholds						■
Stream Definitions						■
Mining Through Streams	■			■		
Activities In or Near Streams Including Excess Spoil and Coal Refuse	■			■		
AOC Variances	■			■		
Surface Configuration	■			■		
Revegetation, Topsoil Management, and Reforestation	■			■		
Fish and Wildlife Protection and Enhancement	■			■		

Note: No elements are expected to change noise conditions, utilities, or infrastructure. Impacts to these resources are related changes in coal production that could result from the Action Alternatives.

Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

The elements of the Action Alternatives associated with baseline data collection and analysis serve to direct water sampling procedures. Under the No Action Alternative, the current requirements for the baseline data that must be collected and analyzed will continue, and no impact on the current trends of coal mining, land use, utilities, infrastructure, visual resources, or noise are expected.

The changes in water sampling procedures for baseline data collection and analysis proposed under the Action Alternatives are not expected to directly affect land use and the other subject resources; however, these changes may have indirect impacts.

Monitoring During Mining and Reclamation

As with the collection of baseline data described above, improved monitoring would not alter land use, utilities, infrastructure, visual resources, and noise resources directly. However, the Action Alternatives establish timeframes for data monitoring and review and include additional metrics to be collected. Such changes may, in some cases, have an indirect benefit to land use, utilities, infrastructure, visual resources, and noise resources if planned mining operations are changed. For instance, baseline data collection may highlight a stream segment that contains rock that contains selenium before mining commences. This area could be avoided for mining purposes, reducing the likelihood of release of the contaminant into surface waters, thus minimizing the potential for impacts, particularly with regard to land use.

While the phrase "material damage to the hydrologic balance outside the permit area" appears in in SMCRA and implementing regulations, no federal definition currently exists. Thus, under the No Action Alternative, although surface coal mining operations are required to be designed and performed in a way that prevents material damage to the hydrologic balance outside the permit area, the regulation lacks specificity as to what constitutes material damage to the hydrologic balance outside the permit area. This has led to difficulties in the enforcement of this requirement (Reis, 2010). Without a formal definition of material damage to the hydrologic balance outside the permit area, it may not be possible to prevent its occurrence through regulation and enforcement. Adding a definition would not in and of itself be expected to alter the subject resources; however, its inclusion in some of the Action Alternatives is expected to have indirect effects, particularly with regard to land use.

Corrective Action Threshold

Corrective action thresholds are standards set at lower levels than those for material damage to the hydrologic balance and are designed to act as a warning system to prevent material damage to the hydrologic balance from being reached. Under the No Action Alternative, because no formal definition of material damage to the hydrologic balance exists, no corrective action thresholds exist. Consequently, current coal mining impacts on land use, utilities, infrastructure, visual resources, and noise would be expected to continue. Corrective action thresholds associated with a definition of material damage to the hydrologic balance, as applied in some of the Action Alternatives should have no effect on land use, utilities, infrastructure, visual resources, or noise; however, their inclusion in the Action Alternatives may be expected to have indirect effects, particularly with regard to land use.

Activities In or Near Streams

Stream Definitions

Stream definitions are central to the water quality protection objectives of the Action Alternatives. The No Action Alternative enumerates the elements used to define a general stream as well as an intermittent stream. Retention of the current stream definitions is anticipated to continue current mining effects on land use, utilities, infrastructure, visual resources, and noise. Changes in stream definitions associated with some of the Action Alternatives are expected to have an indirect effect on the respective resources.

Mining Through Streams

Restoration of streams using natural channel design techniques is currently required following coal mining activity, but no requirement to restore stream ecological function is presently in place. For all Action Alternatives, specific performance standards would be required to guide stream restoration, such as the requirement to restore natural hydrologic form and biological function for intermittent and perennial streams and natural hydrologic form for ephemeral streams. Alternatives 2 and 7 explicitly prohibit all mining activities in or within 100 feet of a perennial stream and require that all perennial, intermittent, and ephemeral streams be restored to form. Alternatives 3, 4, 5, and 6 require restoration of the hydrologic form and ecological function of all intermittent and perennial streams and restoration of the form of ephemeral streams to the extent required by geomorphic reclamation. Alternative 8 (Preferred) requires restoration of both the hydrologic form and ecological function of intermittent and perennial streams and requires restoration of the hydrologic form of ephemeral streams. Alternative 9 requires stream restoration using natural channel design techniques. The requirements to limit mining through streams and restore riparian areas would have a beneficial effect on land use and visual resources.

Activities In or Near Streams, Including Excess Spoil and Coal Refuse

Under the No Action Alternative, mining activities in or within 100 feet of perennial or intermittent streams is prohibited unless the regulatory authority finds that the mining activities will not cause or contribute to the violation of state or federal water quality standards and will not adversely affect the quantity or quality or other environmental resources of the stream.

The Action Alternatives (excluding Alternative 9) increase the stringency of the requirements that guide mining activities near streams as well as the placement of excess spoil and refuse. The Action Alternatives (except Alternative 9) also add provisions for allowable fill construction techniques and increased monitoring during fill construction. To the extent that mining avoids areas near streams that otherwise would be affected by mining, benefits to those areas would be expected. Alternative 2 prohibits excess spoil in intermittent and perennial streams. Alternatives 3, 4, and 5 add requirements to mining activities within 100 feet of intermittent and perennial streams. Alternatives 6 and 8 include additional requirements: restoration of ecological function of perennial and intermittent streams; offset of long-term effects in same or adjacent drainage; prohibition of adverse effects to water quality or other environmental resources of the stream when mining activities occur within the buffer zone, but not the stream; and a 100 foot wide riparian border along all streams. Alternative 7 prohibits excess spoils in perennial streams. The requirements of Alternative 9 match those of the No Action Alternative. Overall, land use would benefit from prevention of stream degradation because water-dependent land uses would continue and visual resources would benefit because healthy streams are visually appealing.

Approximate Original Contour

AOC Variances

As discussed in Section 4.2.3.1, SMCRA and the existing regulations (the No Action Alternative) provide several exceptions to the requirement to restore mined land to AOC. Those exceptions include operations with thin or thick overburden, certain remining operations, mountaintop removal mining operations, and steep-slope mining operations. The latter two exceptions apply only when the mountaintop removal mining operation or the AOC variance for a steep-slope mining operation will facilitate one or more specified postmining land uses and certain other requirements are met. These two variances apply only to operations consisting primarily of steep slopes (slopes in excess of 20 degrees), a situation that occurs almost exclusively in Central Appalachia.

Under the No Action Alternative, the most visible impact of AOC variances would be the continued limited creation of flat or gently rolling terrain in areas that previously contained primarily steep slopes. More moderate slopes also may reduce surface runoff because of higher infiltration rates. Alternative 2 would prohibit all AOC variances and would likely require amendment of SMCRA. Alternatives 3, 4, 5, and 8 (Preferred) likely would result in the approval of fewer operations with AOC variances. Therefore, Alternatives 2, 3, 4, 5, and 8 (Preferred) should result in fewer permanent visual effects than would be expected under the No Action Alternative. Alternatives 6, 7, and 9 are similar to the No Action Alternative in terms of AOC variances and, thus, would have similar impacts.

Surface Configuration

As discussed in Section 4.2.3.1, SMCRA requires that the permittee backfill and grade the mined area to its AOC, which means a surface configuration that closely resembles the premining surface configuration and that blends into and complements the drainage pattern of the surrounding terrain. The existing regulations (the No Action Alternative) contain similar provisions. Alternatives 6, 8 (Preferred), and 9 would not alter the existing regulations with respect to surface configuration requirements.

Alternatives 2, 3, and 4 would require that almost all surface mining operations use digital terrain analysis techniques to determine whether AOC restoration requirements have been met. Alternatives 5 and 7 would require use of digital terrain analysis techniques for a smaller subset of operations; e.g., operations that dispose of excess spoil or coal mine waste.

Alternatives 2, 3, and 4 would require use of landforming principles as part of backfilling and grading to prevent the creation of uniform slopes vulnerable to erosion and to promote restoration of topographical features that will re-create microclimates and ecological niches present prior to mining. However, Alternative 3 would not apply those principles to excess spoil fills.

Alternatives 2 and 4 would require that the thickness of backfilled material at any point in the backfilled area not differ from the combined premining thickness of the coal seam and overburden strata at that point by more than ± 20 percent.

Alternatives 2, 3, and 4 would have the greatest impact on topography because they are most likely to ensure that the final surface configuration and landscape features more closely match the premining configuration and landscape features. The greatest impact would occur in regions highly variable premining topography, such as mountainous terrain. Alternatives 5 and 7 would have a lesser impact on topography than Alternatives 2, 3, and 4, but a greater impact than the No Action Alternative. Alternatives 6, 8, and 9 would not differ in impact from the No Action Alternative.

Postmining Land Use and Enhancement

Revegetation, Topsoil Management, and Reforestation

Postmining land cover is directed by the revegetation, topsoil management, and reforestation elements of the Alternatives. Under the No Action Alternative, reforestation is not required, although the establishment of vegetative cover is required. Species native to the area are emphasized for revegetation although introduced species are permitted. Provided the mining operator demonstrates compliance with the regulations, selected overburden materials may be used in place of the topsoil removed from the disturbed area. Finally, use of all available organic materials available within the disturbed areas is not required.

Some beneficial effects on revegetation, topsoil management, and reforestation are anticipated under Action Alternatives 2, 3, 4, 5, 7, and 8 (Preferred). Specifically, the revegetation of reclaimed lands must be completed using only native species unless specifically required to achieve the approved postmining land use; the use of overburden materials as a replacement for, or as a supplement to, topsoil requires greater justification; available organic materials must be incorporated into the revegetation process; and reforestation of previously forested areas is required. In addition, soil handling and redistribution must be done in a manner that limits compaction and provides optimal root development to support the approved revegetation plan and postmining land use. These changes serve primarily to return the postmining land to a native forest ecosystem as quickly as possible. By enhancing the return of the native forest ecosystem expeditiously, this element would be expected to beneficially impact land use and visual resources; it would not be expected to impact infrastructure or noise resources. Alternatives 6 and 9 keep the same requirements as under the No Action Alternative and no change is anticipated for revegetation, topsoil management, and reforestation; hence, no impacts on land use, utilities, infrastructure, visual resources, or noise are expected.

Fish and Wildlife Protection and Enhancement

The Alternatives contain some elements designed to protect and enhance the fauna inhabiting the mine site and adjacent areas, including downstream aquatic life. Under the No Action Alternative and Alternative 9, quantifiable enforcement guidance is lacking (with perhaps the exception of the prohibition of surface mining activity likely to jeopardize endangered or threatened species). The other Alternatives provide qualitative goals, including the enhancement of fish and wildlife resources whenever long term losses result from the mining operations and the avoidance of disturbances to wetlands and riparian vegetation. To the extent that this element discourages disturbance of particular areas of high habitat value, land use and visual resources may be less affected.

4.3.2.6 Assessment of Impacts to Land Use, Utilities, Infrastructure, Visual Resources, and Noise

A qualitative assessment of impacts stemming from the Alternatives is based on the premise that mining itself constitutes a disturbance to land use, utilities, infrastructure, visual resources, and noise. Changes in the quantity of mining will change impacts to land use, utilities, infrastructure, visual resources, and noise. The No Action Alternative, as it leaves current regulations in place, is expected to continue trends of coal mining impacts on these resources. Table 4.2.3-2 in the

Topography, Geology, and Soils chapter of this DEIS presents coal production projections across Alternatives and regions between the years 2020 and 2040. In sum, the following effects are expected:

- There is a decrease in coal production projections for Alternative 2 in the Appalachian and Illinois Basin regions. For all other regions, Alternative 2 is expected to have negligible effects on future coal production;
- Alternatives 3, 4, 5, 7, and 8 (Preferred) are similar to Alternative 2 in their impacts across regions, but with smaller decreases in coal production;
- In the Appalachian Basin under Alternative 2, there would be a minor shift in production from surface mining to underground mining; and
- Alternatives 6 and 9 have negligible effects on coal production across all regions, and as such, would not appreciably affect land use, utilities, infrastructure, visual resources, or noise when compared with the No Action Alternative.

Changes in the area disturbed by coal mining are central to characterizing effects on land use, utilities, infrastructure, visual resources, and noise. The analysis quantifies these changes based on estimated rates of land disturbance per million tons of coal mined. As described in Section 4.2.3, although the techniques applied in the Action Alternatives may have other beneficial environmental impacts, only Appalachian Basin mines exhibit decreased area disturbed per ton mined under the Alternatives. Other regions showed no significant changes in this metric across the Action Alternatives, relative to the No Action Alternative. The general finding is that only Alternative 2will result in less land disturbed per million tons of coal mined, and that will occur only in Central Appalachia.

Land Use

The lack of data on specific areas that will be mined in the future makes a quantitative assessment of changes in land use resulting from the Action Alternatives difficult. Under the No Action Alternative, coal mining operations are a short-term use of the land, which must be restored to a condition capable of supporting the uses which it was capable of supporting prior to any mining or to higher or better uses of which there is a reasonably likelihood. (30 U.S.C. § 1265(b)(2)).

Land use trends are dependent on a number of factors, including prevailing macroeconomic conditions and existing and planned land use regulations and initiatives at the federal, state, and local levels. The Action Alternatives have the potential to reduce impacts to land use by reducing land disturbance from mining activities. However, in some cases, if mining activity is shifted among coal regions, impacts on land use would also be shifted rather than reduced.

The impact of changes from the Action Alternatives on land use also depends on the impacts on the type of mining. If an Action Alternative results in a shift from surface to underground mining, a smaller portion of surface land would be affected, so any change in land use on the disturbed area would affect a smaller site.

Decisions to construct residential land use developments could be affected by the Action Alternatives. Development of surface coal production cannot occur in existing residential areas or other prohibited areas unless homeowners agree to waive the minimum set back distances.

Future development plans, however, may suffer if visual noise and disturbances exist from adjacent mining. To the extent that surface mining shifts to underground mining, surface land in a region may benefit from the improved viewscape and/or reduced ambient noise. Conversely, fortified requirements for restoring AOC (as in Alternative 2) may hamper future development by limiting the extent to which mining operations can prepare postmining landscapes that facilitate development.

The changes proposed in the Action Alternatives (excluding Alternative 9) would improve compliance with the conditions for approval of higher or better uses under section 515(b)(2) of SMCRA (30 U.S.C. § 1265(b)(2)) and the AOC restoration requirements of section 515(b)(3) of SMCRA (30 U.S.C. § 1265(b)(3)). Specifically, all of the Action Alternatives (except Alternative 9) would require that the applicant document a reasonable likelihood of achieving the higher or better use through submission of real estate and construction contracts, plans for installation of any necessary infrastructure, procurement of any necessary zoning approvals, landowner commitments, economic forecasts, and studies by land use planning agencies, as applicable.

An assessment of impacts stemming from the Action Alternatives was conducted for land cover and land use using Geographic Information Systems (GIS) land cover data.[45] Specifically, the study area for analysis, which includes areas that produced coal in the past five years and which fall within potentially mineable coal reserves (see Section 3.7.2), was overlaid with National Land Cover Dataset data (2011). From these data, the total percent of major land cover types across the seven coal regions in the study area were determined.[46] Table 4.3.2-2 provides a brief summary of land cover types across coal regions in the study area.

Table 4.3.2-2
Land Cover Types by Coal Region in Study Area

Coal Region	Forest	Grass	Shrub	Cropland	Other[1]	Total
Appalachian Basin	91%	0.1%	0.0%	8%	0.6%	100%
Colorado Plateau	39%	6%	52%	1%	1%	100%
Gulf Coast	41%	41%	8%	9%	0.6%	100%
Illinois Basin	12%	0.2%	0.4%	86%	1%	100%
Northern Rocky Mountains	3%	49%	31%	17%	0.4%	100%
Northwest	41%	28%	21%	4%	5%	100%
Western Interior	18%	7%	0.3%	73%	2%	100%

Source: USGS, 2011c.
[1] The “Other” category includes the following categories from the original land use dataset: “Consolidated Rock Sparse Vegetation”, “Unconsolidated Material Sparse Vegetation (old burnt or other disturbance)”, “Urban and Built-up”, “Water bodies”, and “Wetlands”. Areas unlikely to be mined, such as urban areas, national parks, and lakes and ponds were excluded from the study area; however, the land use data comes from a different dataset than the datasets used for this exclusion process, and there is therefore some residual error generated by this process such that these calculations show some area under these categories.

[45] This analysis also borrows from the same dataset and method as the analysis done in 4.2.2 Biological Resources. USGS’s National Land Cover Dataset (2011) was used for the land cover analysis.

[46] Section 3.7 and Section 4.2.2 discuss the variations in land cover among the seven different regions outlined in the study. Coal-producing counties were identified from the MSHA Coal Production 2012 dataset (2008-2012).

Land cover indicates the vegetative cover found in any particular area and often indicates the land use of that particular area. Unless clearly beneficial, to the degree that coal mining alters the premining land use, it is assumed to have an adverse effect. Insofar as the Action Alternatives improve mine site restoration, they are assumed to reduce the adverse land use impacts on agriculture and residential and commercial development. If Action Alternatives reduce mining or shift mining underground, they are assumed to reduce the adverse impacts of mining on land use.

Utilities

Among utilities, the Action Alternatives are expected to primarily affect electric utilities.[47] Since coal is used throughout the U.S. in electricity generation, analysis of the Action Alternatives requires a national perspective. The U.S. Energy Information Administration (U.S. EIA) provides monthly electricity production and price data by generation source. The contribution of coal to electricity generation varies across regions and states. Section 3.12 outlines the relative dependence of each coal region on coal as an energy source. As described, states vary in terms of dependence on coal from as little as zero percent in Rhode Island and Vermont to as much as 95.3 percent in West Virginia (U.S. EIA, 2013f). Similarly, electricity prices within the 48 contiguous states vary from a low of $0.0697 per kilowatt hour (kWh) in Washington to a high of $0.1589 per kWh in California (U.S. EIA, 2014c). If states that are heavily dependent on coal for electricity production lose supply due to the implementation of the Action Alternatives, costs per kilowatt hour may rise. Cost effects, however, would also be influenced by other market factors, such as the ability to substitute competitively priced alternative electricity generation sources and coal production changes amongst the regions. In contrast, if states dependent on coal for electricity gain supply, costs may decrease holding constant other factors. Overall, utilities are assumed to benefit from increased supply and decreased costs of coal as shown in Table 4.2.3-2. However, in the context of the total coal supply and demand for utilities, the forecasted changes in production are expected to have a minimal measurable impact on utilities across the Action Alternatives.

Some of the Action Alternatives would affect utilities if there is a change to the cost or availability of coal in a particular region. For instance, if states dependent on coal for electricity generation face decreased coal supply due to the Action Alternatives, electricity costs per kilowatt hour may rise. In addition to the influence of coal availability, electricity costs would also be influenced by other market factors such as the availability of substitute electricity sources and trends in consumer demand and conservation.

Infrastructure

Transportation infrastructure projects in certain regions may benefit from various elements of the Action Alternatives. As discussed earlier, effects of the Action Alternatives on transportation infrastructure are expected to follow the trends associated with changes to coal production. If mining operations shift regionally because of the Action Alternatives, new infrastructure development may be necessary in some regions. For example, as outlined in Section 3.12, if production increases in the Northern Rocky Mountains and Great Plains region, the region would

[47] Improvements in water quality may benefit public drinking water suppliers by reducing pollutant levels and therefore costs of water treatment. This is discussed further in Section 4.2.1 and 4.3.4.

likely require investment in railroad projects to transport additional reserves to market without delay from congestion.[48] Currently, areas such as the Northern and Central Appalachian areas are estimated to be operating at near to full capacity, and would require rail and road infrastructure development in the event more mining occurs. The Illinois Basin would also require improvements in rail capacity in the event mining increases within the region. However, in any of these regions, roads and railways may suffer less wear in the event that Action Alternatives limit or shift coal production away from the area as shown in Table 4.2.3-2.

Visual Resources

Effects on visual resources are influenced by the extent of mining, the prevalence of surface mining, and postmining reclamation. Alternatives 2, 3, 4, 5, 7, and 8 require reforestation of previously forested land and decrease postmining impacts to visual resources. Alternatives 2, 3, 4, 5, and 8 require more stringent reforming of AOC than Alternatives 6, 7, or 9, leading to a greater reduction in postmining impacts to visual resources relative to those Alternatives. Overall changes in the volume of regional coal extraction and the ratio of surface to underground mining, as shown in Table 4.2.3-2, also influence visual resources.

Noise

Short-term impacts from noise are assumed to be directly related to the total volume of coal mining (Section 4.1 describes forecasted production under the Alternatives). As such, noise impacts would likely decrease under all the Action Alternatives, but to varying degrees. The greatest noise reductions would likely be realized under Alternative 2, followed by Alternatives 3 and 7. In addition, Alternative 2 involves shifts from surface to underground mining in the Appalachian Basin region; this change could also reduce noise impacts.

4.3.2.7 Summary of Effects

As noted throughout, the No Action Alternative, which leaves current regulations unchanged, is expected to continue current trends of coal mining impacts on the resources discussed in this section. Also, in the context of the total coal supply and demand for utilities, the forecasted changes in production due to the Action Alternatives are expected to have a minimal impact, resulting in changes in electricity costs ranging from a 0.08 percent increase under Alternative 4 to a 0 percent change under Alternative 9, nationally. However, because increased utility prices are expected to be passed through to consumers, impacts to utilities for all Action Alternatives are classified as negligible. The analyses of the impacts of the No Action Alternative are presented in Sections 4.3.2.1 through 4.3.2.4.

Alternative 2 is anticipated to result in Minor Beneficial results to land use, utilities, infrastructure, visual resources, and noise at the national scale when compared to the No Action Alternative. Other Alternatives are anticipated to result in Negligible impacts at the national scale.

At a regional scale, Moderate Beneficial impacts to land use, utilities, infrastructure, visual resources, and noise are anticipated in the Appalachian Basin under Alternatives 2, 3, 4, 5, 7, and

[48] See Section 3.12 for a full discussion of current and future projections of transportation infrastructure.

8. Effects on land use, utilities, infrastructure, visual resources, and noise are anticipated to be Minor Beneficial or Negligible in other regions when compared to the No Action Alternative.

Alternative 2

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region, coupled with a minor shift towards underground mining. Such changes would decrease the total area of affected land use and reduce adverse impacts on visual resources, infrastructure, and noise. This would be largely due to a reduction in the area disturbed per million tons of coal mined. Improved reforestation under Alternative 2 would create beneficial impacts on land use and visual resources in areas that are disturbed, as would strengthening requirements to achieve AOC. Taken together, this Alternative is anticipated to have long–term, and medium scope beneficial impacts on land use, visual resources, and noise. It is therefore classified as having an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Colorado Plateau Region and Gulf Coast Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Illinois Basin Region

Analysis indicates that this Alternative would slightly decrease total coal production in this region, thereby slightly decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impacts and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northern Rocky Mountains and Great Plains Region

Analysis indicates that this Alternative would slightly decrease total coal production in this region, thereby slightly decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impacts, and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northwest Region and Western Interior Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Alternative 3

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region. Such changes would decrease the total area of affected land use, reduce infrastructure demands, and lessen adverse impacts on visual resources and noise. In addition, the area disturbed per million tons of coal mined would decrease. Improved reforestation under Alternative 3 would create beneficial impacts on land use and visual resources. Taken together, this Alternative is anticipated to have a long term and medium scope impact and, thus, is classified as an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Colorado Plateau Region and Gulf Coast Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Illinois Basin Region

The analysis indicates that this Alternative would slightly decrease total coal production in this region, thereby slightly decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impacts and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northern Rocky Mountains and Great Plains Region, Northwest Region, Western Interior Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions, and, therefore, negligible impacts are anticipated.

Alternative 4

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region, coupled with a minor shift towards underground mining. Such changes would decrease the total area of affected land use, reduce infrastructure demands, and lessen adverse impacts on visual resources and noise. In addition, the area disturbed per million tons of coal mined would decrease. Improved reforestation would create beneficial impacts on land use and visual resources. Taken together, this Alternative is anticipated to have a long term and medium scope impact and, thus, is classified as an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Colorado Plateau Region and Gulf Coast Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Illinois Basin Region

Analysis indicates that this Alternative would slightly decrease total coal production in this region, thereby slightly decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impacts, and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northern Rocky Mountains and Great Plains Region, Northwest Region, Western Interior Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Alternative 5

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region, coupled with a minor shift towards underground mining. Such changes would decrease the total area of affected land use, reduce infrastructure demands, and lessen adverse impacts on visual resources and noise. In addition, the area disturbed per million tons of coal mined would decrease. Improved reforestation would create beneficial impacts on land use and visual resources. Taken together, this Alternative is anticipated to have a long term and medium scope impact and, thus, is classified as an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

All Other Regions

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Alternative 6

All Regions

The analysis for this Alternative shows minimal measurable impacts to the resources examined and therefore, negligible impacts are anticipated.

Alternative 7

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region, coupled with a minor shift towards underground mining. Such changes would decrease the total area of affected land use, reduce infrastructure demands, and lessen adverse impacts on visual resources and noise. In addition, the area disturbed per million tons of coal mined would decrease. Improved reforestation would create beneficial impacts on land use and visual resources. Taken together, this Alternative is anticipated to have a long term and medium scope impact and, thus, is classified as an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Colorado Plateau Region and Gulf Coast Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Illinois Basin Region

Analysis indicates that this Alternative would slightly decrease total coal production in this region, thereby slightly decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impact, and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northern Rocky Mountains and Great Plains Region, Northwest Region, Western Interior Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Alternative 8 (Preferred)

Appalachian Basin Region

Analysis suggests that this Alternative would cause a slight decrease in total coal production for this region. Such changes would decrease the total area of affected land use, reduce infrastructure demands, and lessen adverse impacts on visual resources and noise. In addition, the area disturbed per million tons of coal mined would decrease. Improved reforestation would create beneficial impacts on land use and visual resources. Taken together, this Alternative is anticipated to have a long term and medium scope impact and, thus, is classified as an overall Moderate Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Colorado Plateau Region and Gulf Coast Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Illinois Basin Region

Analysis indicates that this Alternative would decrease total coal production in this region, thereby decreasing the total area of affected land use, reducing infrastructure demands, and lessening adverse impacts on visual resources and noise. Therefore, this Alternative would likely have long term and small scope impacts, and, thus, is classified as an overall Minor Beneficial effect on land use, utilities, infrastructure, visual resources, and noise.

Northern Rocky Mountains and Great Plains Region, Northwest Region, Western Interior Region

The analysis for this Alternative shows minimal measurable impacts to the resources examined within these regions and therefore, negligible impacts are anticipated.

Alternative 9

All Regions

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zonerule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible on land use, utilities, infrastructure, visual resources, and noise evaluated in this DEIS.

Table 4.3.2-3
Summary of Impacts of the Action Alternatives on Land Use, Utilities, Infrastructure, Visual Resources, and Noise Compared to the No Action Alternative

Alternative	Metric	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior	National
Alternative 2	Classification	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible	Negligible	**Minor Beneficial**
	Rationale	LT, MS	MMI	MMI	LT, SS	LT, SS	MMI	MMI	
Alternative 3	Classification	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible	**Negligible**
	Rationale	LT, MS	MMI	MMI	LT, SS	MMI	MMI	MMI	
Alternative 4	Classification	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible	**Negligible**
	Rationale	LT, MS	MMI	MMI	LT, SS	MMI	MMI	MMI	
Alternative 5	Classification	Moderate Beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**
	Rationale	LT, MS	MMI	MMI	MMI	MMI	MMI	MMI	
Alternative 6	Classification	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**
	Rationale	MMI	MMI	MMI	MMI	MMI	MMI	MMI	
Alternative 7	Classification	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible	**Negligible**
	Rationale	LT, MS	MMI	MMI	LT, SS	MMI	MMI	MMI	
Alternative 8 (Preferred)	Classification	Moderate Beneficial	Negligible	Negligible	Minor Beneficial	Negligible	Negligible	Negligible	**Negligible**
	Rationale	LT, MS	MMI	MMI	LT, SS	MMI	MMI	MMI	
Alternative 9	Classification	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Negligible**
	Rationale	MMI	MMI	MMI	MMI	MMI	MMI	MMI	

Notes:
LT = Long-term impact; MS = Medium scope impact; SS = Small scope impact; MMI = Minimal measurable impact.
Please see Section 4.0 for a definition of negligible, minor, and moderate impact terms used above.
For a discussion of the impacts of the No Action Alternative (Alternative 1), see Section 4.2.3.1.

4.3.3 Recreation

Recreational resources are those features that support activities pursued for enjoyment, leisure, pleasure, or relaxation. For example, rivers and streams may support boating and fishing, and forested landscapes may provide opportunities for hunting or hiking. Changes to these resources alter the recreational activities they sustain. While such activities vary extensively, recreation is characterized, in the context of this analysis, in terms of outdoor activities occurring within a natural landscape. Specifically, this chapter explores the impacts of the Action Alternatives on land- and water-based recreational opportunities within each of the seven coal regions compared to the No Action Alternative. These recreational activities, including hunting, wildlife viewing, trail use, boating, and fishing, may occur on both public and private lands within the study area.

The discussion of recreational impacts is organized as follows:

- The first subsection reviews the existing regulatory environment and its implications for recreation. It identifies specific elements of the Action Alternatives that could affect recreational opportunities, contrasting these elements to requirements under the No Action Alternative.
- Next, the discussion considers existing recreational resources in the region and quantifies the extent to which the Action Alternatives could enhance or degrade those resources.
- The final subsection summarizes the impacts of the Action Alternatives, characterizing these impacts by region.

4.3.3.1 Effects of the Current Regulatory Environment (the No Action Alternative)

<u>Current Restrictions on Coal Mining Location</u>

Section 522(e) of SMCRA (30 U.S.C. § 1272(e)) requires that certain recreational resources not be disturbed by mining. Specifically, surface coal mining operations must not be permitted "within the boundaries of units of the National Park System, the National Wildlife Refuge Systems, the National System of Trails, the National Wilderness Preservation System, the Wild and Scenic Rivers System, including study rivers designated under section 5(a) of the Wild and Scenic Rivers Act and National Recreation Areas designated by Act of Congress" (30 U.S.C. § 1272(e)(1)). In addition, mining is not allowed on any federal lands within the boundaries of any national forest; in areas that would adversely affect any publicly owned park or place on the National Register of Historic Places; or within 300 feet of a public park (30 U.S.C. § 1272(e)(2), (3), and (5); *see also* 30 CFR Part 761. The exception would be where the operation qualifies as existing under 30 CFR 761.12 or an applicant has valid existing rights under 30 CFR 761.16. However, since the enactment of SMCRA over three decades ago, the frequency of valid existing rights claims is declining.

30 CFR 761.11(c) specifies that if a proposed surface coal mining operation would have an adverse impact on a publicly owned park or place in the National Register of Historic Places, the

proposed operation cannot be authorized unless both the SMCRA regulatory authority and the agency with jurisdiction over the park or place jointly approve the operation. In essence, if adverse impacts are identified, under 30 CFR 780.31(a) or 784.17(a) the applicant must prepare a plan to prevent adverse impacts, or (if approved by both agencies) to minimize adverse impacts.

Section 522 of SMCRA also establishes a process for designating areas as unsuitable for surface coal mining operations. For example, areas may be designated unsuitable if the operations would "affect fragile or historic lands in which such operations could result in significant damage to important historic, cultural, scientific, and esthetic values and natural systems" (30 U.S.C. § 1272(a)(3)(B); *see also* 30 CRF Part 762). Such "fragile or historic lands" might include recreational resources. Under Section 522(b) of SMCRA, before mining is allowed to occur, all federal lands must be evaluated using the unsuitability criteria (30 U.S.C. § 1272(b)). Finally, SMCRA allows anyone with an interest that is or may be adversely affected to petition the appropriate SMCRA regulatory authority to have certain lands, including fragile or historic lands, designated unsuitable for mining under the unsuitability criteria (30 U.S.C. § 1272(c) *see also* 30 CFR Parts 764 and 769). Numerous petitions have been filed under this process. Some have been denied, some approved and some partially approved. Most of the petitions have been filed in primacy states, and OSMRE does not maintain records of the number of petitions nationwide, the primary concerns that form the basis of these petitions, or the number of acres ultimately designated as a result.

Understanding recreational resources and the existing level of recreational activity in each of the coal regions provides context for assessing the Action Alternatives. Table 4.3.3-1 characterizes the abundance of recreational land and water resources in the coal regions. These figures were estimated using GIS analyses and data procured from the USGS website (USGS, 2012; USGS, 2013b). Designations of hunting permissions are assigned to different federal and state land areas based on general classifications for each land type. For example, National Forests, U.S. Bureau of Land Management (BLM) lands, and National Recreation Areas are assumed to allow hunting. Although hunting is permitted on some National Park Service land, National Park Service land is excluded from the reported hunting acreage for the purposes of this analysis. Approximately 60 percent of U.S. Fish and Wildlife Service (U.S. FWS) land allows hunting, so 60 percent of the acreage designated as U.S. FWS land and 60 percent of state fish and game lands are included as potential hunting land.

Public resources such as these are often popular destinations for recreators due to the relatively natural and undeveloped quality of the land. While many people may choose to recreate on private resources, data on privately owned recreational resources are sparse and are not included in this analysis.

The 2011 edition of the U.S. FWS's *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* provides comprehensive data at the state level characterizing participation in hunting, wildlife viewing, and fishing. The survey reports the total number of hunter-days, wildlife viewing-days, and fishing-days for each state.[49] Activity levels within each coal region

[49] Activity levels are measured as the activity of one participant over the course of one day. For example, two individuals hunting for a total of three days together would generate six hunter-days.

are scaled based on the spatial extent (i.e., land area or stream length) of recreational resources. The analysis first estimates the ratio of recreational resource within the coal region of each state to the total recreational resource within that state. This ratio is applied to the corresponding state-level recreational value. This method assumes that the level of recreational activity is distributed uniformly within the available land or water areas. The analysis further assumes that all freshwater fishing occurs in rivers and that all wildlife-viewing trips occur on federal or state protected lands. These assumptions may overstate the specific level of recreation occurring but are helpful in providing a relative sense of activity levels across the coal regions.

Table 4.3.3-1
Recreational Resources Available Within the Study Area, by Coal Region

Coal Region	Federal and State Lands With Hunting Access (acres)	Total Federal and State Lands (acres)	Rivers (miles)
Appalachian Basin	1,500,000	3,000,000	46,000
Colorado Plateau	3,400,000	3,400,000	3,900
Gulf Coast	35,000	71,000	7,200
Illinois Basin	110,000	410,000	14,000
Northern Rocky Mountains and Great Plains	1,800,000	1,800,000	7,400
Northwest	6,300	240,000	240
Western Interior	81,000	220,000	3,400

Source: Acres of land and miles of river calculated using GIS analyses on databases provided by USGS (USGS, 2012; USGS, 2013b).

Note: Recreational resources listed above are restricted to those that fall within the study area in each region. As detailed in Section 4.0, the study area represents areas where future coal mining is expected to occur based on past mining activity. Values have been rounded to two significant digits. Note that the limited extent of land and river resources available in the Northwest region result because of the small size and remoteness of coal region lands in Alaska.

For this analysis, the study area encompasses all geographic areas likely to be affected by the Action Alternatives. The total value of recreational activity in each coal region is estimated based on average, per-day value parameters in the economics literature. Adjusted to 2013 dollars,[50] these consumer surplus[51] values per person, per day of activity are estimated at $54.05,

[50] Values were adjusted using the Bureau of Labor Statistics' CPI Inflation Calculator. www.data.bls.gov/cgi-bin/cpicalc.pl.

[51] Consumer surplus is the difference between the maximum amount that an individual would be willing to pay for a day of recreation and the price that the individual actually pays (in the form of recreational expenditures). Natural

$48.80, and $54.33 for hunting, wildlife viewing, and fishing, respectively (Loomis, 2005).[52] By multiplying these value estimates by the total activity level for each recreational opportunity in all coal regions, the total annual economic value of the recreational activities is determined. Comparisons of results generated for hunting, wildlife viewing, and fishing in each of the seven coal regions are provided in Tables 4.3.3-3 and 4.3.3-4. Specifically, these tables characterize the relative importance of the coal mining regions in providing recreational opportunity using two indicators: (1) the level of recreational activity on the available public lands within the coal regions; and (2) the total value of these recreational opportunities.

Table 4.3.3-2
Annual Recreational Activity Levels Within the Study Area, by Coal Region

Coal Region	Annual Hunting Days (thousands)	Annual Wildlife Viewing Days (thousands)	Annual Freshwater Fishing Days (thousands)	Total Activity Days (thousands)
Appalachian Basin	2,500	8,000	5,800	16,000
Colorado Plateau	180	660	1,500	2,300
Gulf Coast	24	160	440	630
Illinois Basin	220	2,100	1,800	4,200
Northern Rocky Mountains and Great Plains	100	180	600	880
Northwest	1	14	43	58
Western Interior	91	300	430	820

Source: Activity levels derived from state estimates in the 2011 edition of the U.S. FWS's *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*.

Activity levels are calculated based on the area of protected land or miles of rivers within each coal region within each state, under the assumption that recreational activity is distributed uniformly on the protected land or on the rivers in each state. Values have been rounded to two significant digits. Note that the limited activity in the Northwest region results because of the small size and remoteness of coal region lands in Alaska.

resource economists use consumer surplus as a measure of the net economic welfare that an individual enjoys as a result of a recreational experience.

[52] In his report, Loomis summarizes thirty years of the literature on net economic value of outdoor recreation on public lands at the national level. It is likely that these value estimates for recreational activities vary by region; however, the literature does not currently provide more geographically specific per-day values.

Table 4.3.3-3
Annual Value of Recreational Activity Within the Study Area, by Coal Region

Coal Region	Value of Annual Hunting Activity (thousands of 2013$)	Value of Annual Wildlife Viewing Activity (thousands of 2013$)	Value of Annual Fishing Activity (thousands of 2013$)	Total Value of Recreational Activity (thousands of 2013$)
Appalachian Basin	$140,000	$410,000	$330,000	$870,000
Colorado Plateau	$10,000	$34,000	$84,000	$130,000
Gulf Coast	$1,400	$8,100	$25,000	$34,000
Illinois Basin	$12,000	$110,000	$100,000	$220,000
Northern Rocky Mountains and Great Plains	$5,800	$9,100	$34,000	$49,000
Northwest	$45	$690	$2,400	$3,200
Western Interior	$5,100	$15,000	$24,000	$44,000

Source: Activity values taken from John Loomis's 2005 publication *Updated Outdoor Recreation Use Values on National Forests and Other Public Lands.* Values have been rounded to two significant digits.

These available data support the following comparison or recreational resource availability by coal region:

- **Appalachian Basin Region**: The Appalachian Basin is relatively rich in recreational resources. The region contains the second greatest acreage of federal and state public lands and over three times the river miles as the coal region with the next highest miles of river within the study area (the Illinois Basin region). Fishing is a relatively popular activity in the Appalachian Basin region in comparison to the other coal regions, partly due to the extent of rivers and streams. Hunting and wildlife viewing are also popular; more hunting days and wildlife viewing days occur in the Appalachian Basin region than in any other coal region. Not unexpectedly, the values for these three recreational activities in this region are the highest across all regions, indicating a relatively high level of recreational activity that could be impacted by the Action Alternatives.

- **Colorado Plateau Region**: The Colorado Plateau region encompasses the greatest acreage of federal and state lands across all coal regions. The number of river miles is medium-range compared to the other regions. Perhaps as a consequence of a relatively large amount of public land in this region, activity levels for hunting, wildlife viewing, and fishing in this region are medium to high range. As such, the values for these three recreational activities per recreational resource unit are also medium to high. These factors suggest that the Action Alternatives (excluding Alternative 9) would have a greater effect on recreational activities than in other regions.

- **Gulf Coast Region**: Within the study area, the Gulf Coast region has medium to low quantities of federal and state lands, and medium levels of river miles relative to the other coal regions. Activity levels in the Gulf Coast region are medium-low range for hunting, wildlife viewing, and fishing, when compared across all coal regions. The value of these activities is also medium-low range relative to the other regions. These results indicate that changes in mining activity in this region would likely have a minor to moderate effect on recreational activities relative to other coal regions.

- **Illinois Basin Region**: The Illinois Basin has both sizeable mileage of waterways and high fishing activity levels within the study area, relative to other regions. Participation in hunting and wildlife viewing is also high in this region. The Illinois Basin has a medium-range quantity of federal and state lands relative to other regions, and the value of recreational activities in the region is relatively high. These results suggest that the Illinois Basin has a relatively high level of recreational activity that could be affected by the Action Alternatives (excluding Alternative 9).

- **Northern Rocky Mountains and Great Plains Region**: Among the seven coal regions, the activity levels for hunting, wildlife viewing, and fishing are in the medium range in the Northern Rocky Mountains and Great Plains region study area. The value of these activities is therefore also medium-range. The extent of public land area and river miles on which these activities occur are medium to high range. These results indicate that the Northern Rocky Mountains and Great Plains region have a moderate level of recreational activity.

- **Northwest Region**: The Northwest region has relatively little federal and state land, and relatively few river miles within the study area. Note that, while Alaska and Washington have abundant pristine, natural land that is optimal for these recreational activities, very little coal mining currently occurs in this region, and therefore the recreational resources within the study area that could be affected by the Action Alternatives are limited. The activity levels for each of these pastimes are the lowest among the seven coal regions. This result suggests that the Northwest region has relatively low levels of recreational activity that could be affected by the Action Alternatives (excluding Alternative 9).

- **Western Interior Region**: Similar to the Northwest region, the Western Interior region has relatively little federal and state land within the study area. There are also relatively few river miles within this coal region. The corresponding activity levels and the total value of these activities are medium-range relative to other coal regions. These results indicate that the Western Interior region has minor to moderate levels of recreational activity that could be affected by the Action Alternatives (excluding Alternative 9).

Caveats and Uncertainties

Several constraints limit the analysis of potentially affected recreational resources and activities across regions.

- The U.S. FWS recreation survey only tracks hunting, wildlife viewing, and fishing. Other recreational activities also dependent on forest or water, such as hiking, ATV use, boating, and swimming, may also benefit from the Action Alternatives. No systematic, national data exist to characterize activity levels for these recreational pursuits.
- Currently, SMCRA prohibits mining on certain categories of federal lands, including lands within the National Park System. However, these protected areas may experience

indirect affects by mining activities on adjacent lands, through habitat disruption and visual and noise impairment.

- Private lands supporting mining currently or in the future may also provide recreational opportunities. While not accounted for in the analysis of recreational land, recreation on private land could be affected by the Action Alternatives.
- The quantified results do not capture the occasional practice that occurs under the No Action Alternative, in which reclaimed land is designated specifically for recreational uses. This practice may be accompanied by a conveyance of private reclaimed land to the public. Designating reclaimed land for recreational purposes may increase recreational use after mining relative to premining conditions. No systematic data exist for assessing the frequency of this practice. If mining decreases, however, some land that under the No Action Alternative would have been mined, reclaimed, and converted to a public recreational resource may remain unmined and in private control, unavailable to recreators.
- Finally, the use of national or coal region averages for consumer surplus values or recreational activity levels, respectively, can mask more nuanced variation. For example, the per-day use value of hunting may be greater in the Appalachian Basin than in the Gulf Coast; however, this difference would not be captured in the application of the national average for hunting value to both coal regions.

4.3.3.2 Action Alternatives and Potential Effects on Recreational Resources

Various elements of each Alternative may affect either the quantity or quality of recreational activities within the coal mining regions. Quantity refers to the number of recreational outings taken, while quality refers to the utility (defined by economists as a sense of well-being) that individuals derive from a recreational experience. For example, an increase in the abundance of wildlife may lead to more wildlife viewing excursions (quantity) and may also lead to a greater diversity of species observed during each excursion (quality).

Table 4.3.3-4 summarizes the recreational activities potentially affected by the various elements of the Action Alternatives. The following discussion describes how each of the elements may affect recreation within the coal regions, and why certain elements are not expected to affect recreation. Full descriptions of the elements and how they vary across Alternatives can be found in Chapter 2.

Table 4.3.3-4
SPR Elements and Potential Effects on Recreational Activities

SPR Element	Hiking	ATV Use	Hunting	Wildlife Viewing	Fishing	Swimming	Boating
Baseline Data Collection and Analysis					■	■	■
Monitoring During Mining and Reclamation					■	■	■
Definition of Material Damage to the Hydrologic Balance					■	■	■
Corrective Action Thresholds					■	■	■
Mining Through Streams					■	■	■
Activities In or Near Streams Including Excess Spoil and Coal Refuse	■			■	■	■	■
AOC Variances	■	■		■	■	■	■
Surface Configuration	■			■			
Revegetation, Topsoil Management, and Reforestation	■	■	■	■			
Wildlife Protection and Enhancement			■	■	■		

Table 4.3.3-4 links the elements with popular outdoor activities, both land- and water-based. Land-based recreational activities include hunting, wildlife viewing, hiking, and all-terrain vehicle (ATV) use.[53] These activities may be affected by the Action Alternatives to the extent that the Alternatives: (1) reduce or increase the number of trails or the land area available to support them; (2) result in degraded or improved wildlife habitat and populations; or (3) generate more or less natural, aesthetically-pleasing landscapes. Common water-based activities include boating, swimming, and fishing. These activities may be altered by elements of the Alternatives that affect the quality, quantity, or accessibility of water resources.[54] In addition, to the extent an Alternative reduces coal mining activity in a region recreational areas may be preserved resulting in an indirect benefit to some areas.

Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

The rule elements associated with baseline data collection and analysis serve to specify water sampling and analysis procedures.

[53] Use of all-terrain vehicles is an outdoor activity which has become increasingly popular, particularly in rural areas (Cribari, 2002).

[54] The link between water quality and value of water-based recreational activity has been established in the literature (Koteen, et al., 2002; Hayes, et al., 1992).

- Under the No Action Alternative (Alternative 1) some requirements for baseline data collection and analysis exist, as described in Chapter 2. Data characterizing premining conditions allow mine operators and regulators to identify the incremental effects of the mining activity on monitored water quality parameters.
- The Action Alternatives (excluding Alternative 9) standardize the sampling protocol and increase the assessment and monitoring activities for baseline data collection and analysis, as described in Chapter 2. These changes are not expected to directly affect recreational activities but may lead to indirect effects on recreational resources to the extent that they promote improved water quality in the region.
- The requirements of Alternative 9 with respect to this element are the same as the No Action Alternative and, as such, their effects on recreational resources are the same as the No Action Alternative.

Monitoring During Mining and Reclamation

The Alternatives require the collection and review of stream hydrologic parameters, both during mining and following mining.

- Under the No Action Alternative, the metrics required for monitoring are limited, and the frequencies with which data should be collected are undefined.
- The Action Alternatives establish timeframes for data monitoring and review and include additional metrics to be collected. Such changes are not expected to have a direct effect on recreational opportunities, but could lead to indirect improvements in recreational resources to the extent that they promote improved water quality in the region.
- The requirements of Alternative 9 with respect to this element are the same as the No Action Alternative and, as such, their effects on recreational resources are the same as the No Action Alternative.

Definition of Material Damage to the Hydrologic Balance

Both SMCRA and the implementing regulations use the phrase “material damage to the hydrologic balance outside the permit area,” but they do not define this term.

- The No Action Alternative represents the status quo, which regulates material damage to the hydrologic balance but does not define the term. Without a formal definition of the term or enforcement of the protection of it, negative impacts to either quantity or quality of aquatic recreational resources may occur. Stream loss may directly cause a reduction in boating, swimming, and fishing due to the loss of the recreational resource for streams that supported such uses. Diminished water quality or biological condition (as described in previous sections of this chapter) may adversely affect aquatic habitats and the fish which live in them leading to a reduction in fishing activity or a diminished fishing experience (e.g., due to reduced catch rates). Similarly, such contamination of surface water may lead to a waterway failing to meet the water quality requirements for the designated use of swimming, resulting in fewer swimming trips.

- Alternatives 2, 3, 4, and 8 (Preferred) require a formal definition of material damage to the hydrologic balance outside the permit area. Under this more precise definition, adverse impacts to the quantity or quality of off-site groundwater and surface water would be more quantifiable and demonstrable. As such, water quality impacts could be more readily avoided and water quality standards could be more easily enforced. This increases the likelihood that surface waters would maintain their designated uses under the Clean Water Act, allowing for increased fishing and swimming opportunities as compared to the No Action Alternative. The definition may also help preserve the existence of water bodies, increasing the availability of recreation that is not directly dependent upon water quality, e.g., boating.

- Alternatives 5, 6, and 9 are identical to the No Action Alternative and do not require a formal definition of material damage to the hydrologic balance. As such, the effects on recreational resources are the same as the No Action Alternative.

- Alternative 7 requires a formal definition of material damage to the hydrologic balance on a case-by-case basis whenever enhanced permitting conditions are required.[55] As such, adverse impacts to water resources may be reduced but only at some mining sites under certain circumstances.

Corrective Action Threshold

Corrective action thresholds are standards set lower than those for material damage to the hydrologic balance and are designed to act as a type of early detection system to prevent material damage to the hydrologic balance from occurring.

- Under the No Action Alternative, permit specific monitoring data are used to evaluate hydrologic conditions and to determine the need for corrective action. No requirement for specific corrective action thresholds exists.

- Under Alternatives 2, 3, and 4, the corrective action thresholds may improve the likelihood that material damage to the hydrologic balance is avoided. As discussed above for material damage to the hydrologic balance, the avoidance of impacts to off-site ground and surface water would help maintain and preserve water based recreational opportunities such as fishing, swimming, and boating.

- Alternatives 5, 6, 8 (Preferred) and 9 are the same as the No Action Alternative and do not establish corrective action thresholds. Therefore, the effects on recreational resources are the same as the No Action Alternative.

- Alternative 7 is similar to Alternatives 2 through 4 but the corrective action thresholds and the adaptive management plan drafted to avoid material damage to the hydrologic balance apply only to the designated enhanced permit areas. In some cases, Alternative 7 may result in effects to recreational resources as compared to the No Action Alternative. As described for Alternatives 2 through 4 above, however, impacts stemming from

[55] See Chapter 2 for an explanation of enhanced permit conditions.

corrective action thresholds are considered to be indirect because the purpose of the thresholds is to avoid material damage to the hydrologic balance.

Activities In or Near Streams

Stream Definitions

Alternatives 2, 4, 7 and 8 (Preferred) would change the regulatory definition of streams. Alternatives 3, 5, 6, and 9 would retain the current definition of the No Action Alternative. Current regulations classify all watersheds one square mile or larger in size as intermittent streams; some of the Action Alternatives would delete this provision. To the extent that this change would result in some streams (mostly in the arid and semiarid regions of the West) now protected as intermittent streams being reclassified as ephemeral streams, which lack the protections afforded to perennial and intermittent streams, there could be a direct effect on the water resources and therefore an indirect effect on recreational use of those streams.

Mining through Streams

Under the No Action Alternative, water-dependent recreational activities may be negatively impacted in the event that mining occurs through a stream. Although the quantity of water may remain unchanged in the long-term when mining occurs through a stream,[56] short-term diversions of the stream may change flow volume, limiting the opportunity for and/or utility of downstream boating and swimming. The aquatic habitat of downstream waters may also be negatively altered due to the temporary disruption and diversion of the waterway, leading to suppressed numbers of fish.

Alternatives 2 through 8 (Preferred) add restrictions to the approval process for mining through streams. For each of these Alternatives, specific performance standards would be required to guide stream restoration.[57] The return of natural hydrologic form and biological condition and function of the stream would be required by such restoration.

- Alternative 2 explicitly prohibits all mining activities in or within 100 feet of a perennial stream and require that all ephemeral streams be restored in form. Alternative 7 has the same requirements when enhanced permit requirements are imposed. Under these Alternatives, not only would the restored streams be expected to be of better quality than those under the No Action Alternative, but also fewer streams would be expected to be affected overall. Less disruption of the aquatic resource on-site may yield improved water quality, greater stream flow, and reduced impacts on aquatic habitat downstream, leading to more boating, swimming, and fishing trips.

- Alternatives 3, 4, 5, 6, and 8 (Preferred) allow mining through streams as long as a reclamation plan achieving complete restoration of the hydrologic form and ecological function of perennial and intermittent streams is approved in advance of mining. Further,

[56] Section 404 of the Clean Water Act calls for no net loss of aquatic resources.

[57] For Alternative 5, the application of all element components, including these performance standards, is limited to mining activities that result in placement of excess spoil outside the mined area or coal refuse disposal in perennial or intermittent streams. For Alternative 6, the application of components is limited to stream buffer zones.

some ephemeral streams will require restoration of stream form. These regulations would likely improve water quality and positively impact downstream recreational activities as described above for Alternatives 2 and 7, but not to the same extent as those two Alternatives.

- The requirements for this element under Alternative 9 are not expected to be functionally different from those under the No Action Alternative. Therefore, the effects on recreational resources are the same as the No Action Alternative.

As described above, under the No Action Alternative, restoration occurs for perennial and intermittent streams. The Action Alternatives would require restoration of ephemeral streams as well. Because ephemeral streams are defined by their lack of continuous flow, their value for recreational resources may be less than that of more permanent waterways. Therefore, restoring an ephemeral stream may have less impact recreational resources than restoration of an intermittent or perennial stream.

Activities In or Near Streams, Including Excess Spoil and Coal Refuse

Mining activities in and within 100 feet of streams and the treatment of excess spoil and coal refuse possess the potential to adversely affect the quantity and quality of downstream water. These adverse impacts may result from the diversion of streams as part of the mining process (leading to a change in stream flow as described above) or from the discharge of pollutants into the downstream waters from the placement of spoil and/or refuse near streams.

- Under the No Action Alternative, mining activities within 100 feet of a stream are prohibited unless authorized by the appropriate regulatory authorities. OSMRE and most state regulatory authorities allow the construction of spoil fills in intermittent and perennial streams within the permit area. Additionally, flat decks on top of fills are allowed and there is no requirement for final configuration to incorporate appropriate topography.

- Alternatives 2 through 8 (Preferred) increase the stringency of the requirements that guide mining activities near streams and the placement of excess spoil and refuse. Some of these Alternatives also add provisions for allowable fill construction techniques, increased monitoring during fill construction, and the incorporation of appropriate topography when constructing the fill.[58] Alternatives 2, 3, and 7 specifically reduce the amount of streams filled from underground mining by prohibiting filling of perennial streams. Such standards serve to decrease the likelihood that a stream would be diverted during coal mining, changing its flow and the probability that higher concentrations of pollutants would adversely affect downstream fish populations. With more reliable flow volume and less contaminants, water-based recreational activities such as boating, swimming, and fishing may be enhanced.

[58] The consequences of AOC regulations on recreational resources are discussed in detail in the AOC Variances section below.

- The requirements for this element under Alternative 9 are not expected to be functionally different from those under the No Action Alternative. Therefore, the effects on recreational resources are the same as the No Action Alternative

Approximate Original Contour (AOC)

AOC Variances

AOC variances allow exceptions to the requirement that the landscape be returned to its near original configuration; therefore, this element is particularly relevant for mountaintop removal and steep-slope mining. Currently, for both mountaintop removal and steep-slope mining, beneficial postmining land use (PMLU) must be proposed, with a demonstration of equal or better use. Neither type of mining operation, however, is required to reforest the permitted area during reclamation.[59] For mountaintop removal mining, the natural watercourses below the lowest coal seam mined must remain undamaged. For steep-slope mining, deviations from AOC are limited to circumstances when lands will be improved by issuing the variance. The components encompassed by this element most directly affect land quality available for trails and habitat.

- Under the No Action Alternative, the most discernible consequence of the allowable AOC variances is the alteration of visual resources associated with PMLUs. The utility, or well-being that recreating individuals, be they hikers or wildlife-viewers, derive from the land is diminished after postmining activity. Mountain landscapes are preferred as an environmental land type for recreational opportunities because of their appeal to the aesthetic senses (Raitz and Dakhil, 1988).

- Alternative 2 eliminates AOC variances entirely. This Alternative maintains original mountain and steep-slope landforms.[60] As such, land-based recreational activities, such as hiking, wildlife viewing, and possibly ATV use would be expected to have greater utility for participants. In addition, Alternative 2 would result in fewer impacts to streams which should benefit recreational users. Aesthetic benefits may also result.

- Alternatives 3, 4, 5, and 8 (Preferred) increase the requirements for an AOC variance approval. This means that fewer AOC variances would be granted, reducing adverse impacts to natural watercourses (mountaintop removal), surface water flow (steep-slope), and aquatic ecology (steep-slope), which would result in greater opportunities for boating, swimming, and fishing downstream. This should also result in fewer permanent effects on land use and visual resources.

- Alternatives 6, 7, and 9 do not differ from the No Action Alternative and thus would have the same effects as the No Action Alternative.

[59] The anticipated effects of reforestation on recreational resources are covered in the Revegetation, Topsoil Management, and Reforestation section below.

[60] Landforms are the natural physical features that comprise the terrain of the land, described in terms of elevation, slope, orientation, exposed rock, soil type, water bodies, wetlands, surface drainage pattern, drainageway characteristics, and other physical attributes of the land surface.

In some cases, limitation of AOC variances may curtail the potential for recreational activities that are not nature-based. For instance, leveling the grade of the land may allow for recreational opportunities that would not have otherwise been available in the area, particularly in areas where sloping terrain characterizes the un-mined land area. To the extent that AOC variances are used to prepare land for golf courses or soccer fields, for example, some of the Action Alternatives may reduce recreational opportunities (Minerals Education Coalition, 2014).

Surface Configuration

Surface configuration guides topography requirements both during mining activity and for postmining reclamation. As with the AOC element described above, the effects of reforming the land may most prominently include the aesthetic consequence on appreciative outdoor activities, including hiking and wildlife viewing.

- Under the No Action Alternative, few provisions are in place to guide landscape formation following mining: for example, digital terrain analyses and the use of land forming principles are not required and limits on final elevations are absent.[61]
- Alternatives 2 and 4 add elevation limitations (the backfilled area must not vary from the premining elevation by ±20 percent) and may result in greater beneficial impacts than from the scenarios described for the No Action Alternative. These regulations may more strongly influence the final landforms, leading to better matching of the premining landscape, particularly for sites with topographic variability. This may, in turn, improve hiking and wildlife viewing experiences for recreating individuals.
- Alternatives 2, 3, and 4 would provide the most benefit to recreation from restoration of topography, as described in section 4.2.3, because they are most likely to ensure that the final surface configuration and landscape features more closely match the premining configuration and landscape features. The greatest benefit would occur in regions with highly variable premining topography, such as mountainous terrain. Alternatives 5 and 7 would produce less benefits to topography and consequently aesthetic benefits than Alternatives 2, 3, and 4, but more than the No Action Alternative.
- Alternatives 6, 8 (Preferred), and 9 are identical to the No Action Alternative and would have the same effects.

It should be noted that, for this rule element, the Alternatives 2, 3, 4,5 and 7 would likely have the greatest impact in regions where the premining topography is highly irregular, such as in the Appalachian Basin. The effect of the Action Alternatives on topography is analyzed in Section 4.2.3 Topography, Geology, and Soils.

[61] Land-forming is a design and grading technique that attempts to replicate the appearance of the natural terrain, as well as the water transport and water retention functions of that terrain, by constructing slopes, drainageways, and other surface features that blend with the natural surroundings in an environmentally compatible fashion while meeting any relevant stability requirements.

Postmining Land Use and Enhancement

Revegetation, Topsoil Management, and Reforestation

Postmining land cover is directed by the revegetation, topsoil management, and reforestation regulations. Under the No Action Alternative, reforestation is not required, though the establishment of vegetative cover is. Species native to the area are emphasized for use in revegetation, although introduced (non-native) species are permitted. Provided the mining operator demonstrates compliance with the regulations, selected overburden materials may be used in place of the topsoil removed from the disturbed area. Finally, the use of organic materials available within the disturbed areas is not required.

The absence of a reforestation requirement in the No Action Alternative may be the most pronounced of these conditions in contributing to adverse impacts on recreational opportunities. The natural succession of land cover from bare land to a forest can take between 15 to 20 years (Groninger, et al., 2007); at mining sites, succession can be further delayed by soil conditions, especially compaction. The initial loss of forest habitat or alterations to forest habitat (as the land advances through various successional stages) may have an adverse impact on the wildlife inhabiting these areas.[62] A loss in wildlife may negatively impact the recreational activities reliant on fauna, including hunting and wildlife viewing. Furthermore, during the extended period required for mature forest cover to develop, the utility derived by appreciative outdoor activities such as hiking may be diminished. Indeed, mountain forest landscapes have been demonstrated to be highly ranked in terms of scenic preference (Hammitt, et al., 1994). Reestablishing vegetative cover may benefit terrestrial recreational activities, including wildlife-viewing, hunting, and hiking. Conversely, such activities may be adversely impacted if previously forested land is not reforested following mining activity.

- Under the No Action Alternative, vegetative cover must be established following mining activity in accordance with the approved permit and reclamation plan. This vegetation may include introduced species. Not all soil horizons (i.e., underlying layers) are required to be salvaged and redistributed, and overburden materials may be used as a substitute for topsoil. Additionally, previously cleared land that had returned to forest through natural succession prior to mining activity does not have to be reforested. Under conventional practices, many mined lands are restored to grassland but are not used for hay or pasture. Natural succession of these lands to native forest may take hundreds of years (Angel, et al., 2005). Under favorable growth conditions, forest canopy closure often occurs 15 to 20 years after mine closure (Groninger, et al., 2007).

- Alternatives 2, 4, and 8 (Preferred) specify that the revegetation of reclaimed lands must be completed using only native species; the use of overburden materials as a replacement for, or as a supplement to, topsoil requires greater justification. In addition, the best available organic materials must be incorporated into the revegetation process, and reforestation of previously forested areas is required. These changes serve primarily to return the postmining land area to a native forest ecosystem as quickly as possible. By

[62] In exceptional cases, changes in vegetation may enhance recreational opportunities. For instance, a habitat change may facilitate the return of a species that is appealing for hunting and viewing.

enhancing the return of the native forest ecosystem expeditiously, the requirements for this rule element could enhance hiking, hunting, and wildlife viewing. The more rapid return of mature trees and abundant wildlife may enhance the quality of recreational activities that depend on such resources.

- Alternatives 3 and 5 are very similar to Alternatives 2, 4, and 8 (Preferred), except that salvage and redistribution of organic materials would be in accordance with an approved plan. As such, these Action Alternatives would also be expected to affect recreational activities enhanced by the existence of the native forest ecosystem.

- Alternatives 6 and 9 are identical to the No Action Alternative and no additional impacts are expected.

- Alternative 7 resembles Alternative 2 for this rule element, but applies only where designated enhanced permitting areas are proposed for mining. Therefore, the recreational impacts described for Alternative 2 apply, but under more limited circumstances.

Wildlife Protection and Enhancement

The Action Alternatives contain provisions to enhance fauna inhabiting the mine site and adjacent areas, including downstream aquatic life. Currently, no explicit, quantifiable guidance exists for wildlife protection (with perhaps the exception of the prohibition of surface mining activity likely to jeopardize endangered or threatened species). Current regulations provide qualitative goals, including the enhancement of fish and wildlife resources where practicable and the avoidance of disturbances to wetlands and riparian vegetation. The ambiguity in these standards means that mining activities may affect the aquatic and terrestrial habitats of non-endangered or threatened wildlife. Compromised habitat or complete loss of habitat may reduce the species abundance that the habitat can support. Recreational opportunities dependent on wildlife, including hunting, fishing, and wildlife viewing, may be adversely impacted as a result, either from reduced number of trips taken to areas with low population densities of the desired animals, or from diminished utility of each trip due to lower catch rates, bag rates, and sightings.

- Under the No Action Alternative, disturbances to fish and wildlife resources should be avoided and habitats restored or replaced where practicable. Enhancement of these resources is also required where practicable. In practice, these disturbances have often not been adequately restored, replaced, or enhanced. These requirements offer only general guidance for treatment of riparian habitats and habitats of unusually high value for fish and wildlife; no specific regulations guide these actions.

- Under Alternative 2, enhancement would be required if Clean Water Act mitigation was required, and the mitigation would be incorporated as a condition of the SMCRA permit. This alternative would require enhancement of fish and wildlife resources as well as habitats of unusually high value. For all stream reaches within or adjacent to coal mining operations, a 100-foot riparian buffer would be established. By implementing direct criteria to be met during and after coal mining operations, the likelihood of disrupting habitats and the wildlife that populates them is decreased. As such, the recreational resources supporting hunting, fishing, and wildlife viewing (i.e., fish and wildlife populations) may grow, leading to more trips taken and greater utility gained from each trip (e.g., as a result of increased wildlife sightings).

- Alternatives 3 and 4 would require enhancement measures to offset impacts, but unlike Alternative 2 these requirements would not necessarily have any direct bearing on the Clean Water Act mitigation and vice versa. These alternatives would require a 300-foot buffer zone around intermittent and perennial streams. These Alternatives also specifically detail the scenarios in which enhancement measures for fish and wildlife resources would be mandatory.[63] Similar to Alternative 2, Alternatives 3 and 4 decrease the probability that wildlife habitat, both aquatic and terrestrial, would be negatively impacted as a result of mining activity, though possibly not as strongly. As above, undisturbed habitats may lead to greater numbers of fish and wildlife which in turn would draw greater numbers of recreating individuals interested in hunting, fishing, or wildlife viewing. The quality of visits may also improve as the fulfillment of these activities is necessarily dependent on wildlife abundance.

- Alternative 8 (Preferred) would call for the same 100-foot riparian buffer as Alternative 2. It would also have wildlife enhancement requirements similar to those under Alternative 4, although it would not introduce the authority to prohibit mining of high-value habitats.

- Alternatives 5, 6 and 7 combine components of Alternatives 2 and 4, resulting in more protective measures for fish and wildlife. As detailed above, any action taken to promote or protect wildlife may indirectly improve the wildlife-related recreational activities by fostering improved species populations. Because the regulations under Alternatives 5, 6, and 7 apply only under defined circumstances, their overall impacts may be smaller than those expected under Alternatives 2, 3, 4, and 8 (Preferred).

- The requirements of Alternative 9 with respect to this element are the same as the No Action Alternative and, as such, their effects on recreational resources are the same as the No Action Alternative.

4.3.3.3 Assessment of Impacts to Recreational Activities

Without precise knowledge of future mine locations in relation to land-based recreational areas, modeling mining impacts on wildlife populations and related activities (e.g., hunting, viewing) is difficult. Similarly, the effect that landscape changes will have on the visual component of hiking cannot be characterized without understanding the precise spatial relationship between future mine locations and hiking opportunities. As such, a robust quantitative assessment of effects on land-based recreation is problematic.

Furthermore, sparse data exist to describe the effects of a coal mine, surface or underground, on wildlife populations. In the short term, reducing the availability of habitat through mining activities may result in a greater concentration of wildlife in adjacent hunting areas. The scale of the anthropogenic disruption associated with a coal mine, however, would also be expected to

[63] These include the long-term loss of native forest, loss of native plant communities, or filling of a segment of a perennial or intermittent stream.

disrupt nearby wildlife, leading to a longer-term reduction in the abundance of animals for hunting. This is especially true for surface mines, which generally pose a greater disruption to terrestrial habitat. Ultimately, without precise information describing the locations of mines in relation to existing recreational lands (especially private lands), and without data on how coal mining affects wildlife densities, a quantitative analysis would be highly speculative.

Beyond understanding the prevalence and value of recreational activities across the seven coal regions, it is also necessary to analyze if/how the Action Alternatives would affect recreational resources. The Action Alternatives can affect mining activities, and their associated consequences on recreational resources, in two ways. First, the Action Alternatives can improve mining and reclamation practices as described in Chapter 2, reducing effects on environmental resources such as riparian habitats and streams. Second, the Action Alternatives can change the level of coal production in a given region. Understanding this shift in mining activity allows for a more accurate assessment of the expected effects on recreation (i.e., increased mining may negatively impact recreational resources while decreased mining may have the opposite effect).

Forest loss and impaired stream miles are key causes of mining-related recreational losses. Therefore, a rough analysis of recreational impacts can proceed from an assessment of how the Action Alternatives influence these resources. Forest loss can reduce habitat for existing wildlife species, which in turn can impact the number of trips and quality of those trips taken to hunt or view the wildlife. Forest loss can also directly remove land available for hiking, ATV use, hunting, and wildlife viewing. For appreciative activities, such as hiking, forest loss can negatively impact aesthetic enjoyment. Impaired stream miles can decrease opportunities for fishing, swimming, and boating by decreasing fish populations, decreasing stream flow, and increasing pollution.

Table 4.3.3-5 illustrates the projected changes to forest and stream miles based on anticipated coal production under each of the Action Alternatives and for each coal region, as initially presented in Sections 4.2.1 and 4.2.2, respectively. These estimates provide an additional point of reference for the summary of impacts in the following subsection.

Table 4.3.3-5
Projected Average Annual Effects of the Action Alternatives on Forest Acreage and Stream Miles, Compared to the No Action Alternative

Coal Region	Affected Recreational Resource	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
Appalachian Basin	Forest[1]	1,188	1,402	1,368	1,367	10	1,368	1,365	0
	Stream[2]	184	175	179	179	179	164	179	0
Colorado Plateau	Forest	431	431	431	0	0	259	431	0
	Stream	14	10	10	0	11	12	10	0
Gulf Coast	Forest	483	483	483	0	0	97	483	0
	Stream	48	42	42	0	42	20	42	0
Illinois Basin	Forest	377	378	378	1	1	39	378	0
	Stream	71	62	62	0	62	25	62	0
Northern Rocky Mountains and Great Plains	Forest	105	105	105	0	0	21	105	0
	Stream	37	28	28	0	28	20	28	0
Northwest	Forest	1	1	1	0	0	0	1	0
	Stream	2	2	2	0	2	0	2	0
Western Interior	Forest	67	67	67	0	0	75	67	0
	Stream	3	3	3	0	3	1	3	0

Source: Adapted from results presented in Table 4.2.1-2 and Table 4.2.2-5 in Sections 4.2.1 (Water Resources and Wetlands) and 4.2.2 (Biological Resources), respectively.
[1]Forest refers to acres of forest preserved or improved on an annual basis.
[2]Stream refers to perennial, intermittent, and ephemeral stream miles not filled, ephemeral stream miles restored, and downstream perennial, intermittent, and ephemeral stream miles preserved or improved on an annual basis.

4.3.3.4 Summary of Effects

Table 4.3.3-6 summarizes the impacts to recreational resources under each of the Action Alternatives as compared to the No Action Alternative and classifies the likely impacts on recreational resources based on the considerations discussed above. For each Action Alternative and region, the expected impacts within each of the coal regions are based on relative levels of coal mining activity, relative recreational resource availability, recreational activity levels, and the extent of predicted benefits to water resources and terrestrial area vegetation.

At the national scale, Alternative 2 is anticipated to result in Moderate Beneficial impacts to recreational activities when compared to the No Action Alternative. Alternatives 3, 4, 5, 6, 7, and 8 (Preferred) are anticipated to result in Minor Beneficial impacts to recreation. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on recreational activities.

Table 4.3.3-6
Recreational Resource Impacts of the Action Alternatives on Recreational Resources Compared to the No Action Alternative

Alt.	Analysis	Metric	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Alternative 1	Recreational Resource Findings	Public Land (ac)	Large	Large	Small	Moderate	Large-Moderate	Moderate-Low	Moderate-Low
		River (mi)	Large	Low	Moderate-Low	Moderate	Moderate-Low	Low	Low
		Activity Level	High	Moderate	Low	Moderate	Low	Low	Low
		Value	High	Moderate	Low	High-Moderate	Low	Low	Low
Alternative 2	Environmental Impacts	Forest	Moderate	Moderate-Small	Moderate-Small	Moderate-Small	Small	Negligible	Small
		Stream	Moderate	Small	Small	Small	Negligible	Small	Small
	Scope of Effect	Duration of Effects	Long term	Long term	Long term	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Small scope	Small scope	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	Overall Classification	Major beneficial	Moderate beneficial	Minor beneficial	Minor beneficial	Negligible	Negligible	Negligible
Alternative 3	Environmental Impacts	Forest (ac)	Moderate	Moderate-Small	Moderate-Small	Moderate-Small	Small	Negligible	Small
		Stream (mi)	Moderate	Small	Small	Small	Small	Negligible	Negligible
	Scope of Effect	Duration of Effects	Long term	Long term	Long term	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Small scope	Small scope	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts

Alt.	Analysis	Metric	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
	Impacts to Recreation	**Overall Classification**	Moderate beneficial	Moderate beneficial	Minor beneficial	Minor beneficial	Negligible	Negligible	Negligible
Alternative 4	**Environmental Impacts**	**Forest (ac)**	Moderate	Moderate-Small	Moderate-Small	Moderate-Small	Small	Negligible	Small
		Stream (mi)	Moderate	Small	Small	Small	Small	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Long term	Long term	Long term	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Small scope	Small scope	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Moderate beneficial	Moderate beneficial	Minor beneficial	Minor beneficial	Negligible	Negligible	Negligible
Alternative 5	**Environmental Impacts**	**Forest (ac)**	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
		Stream (mi)	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Moderate beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Alternative 6	**Environmental Impacts**	**Forest (ac)**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
		Stream (mi)	Moderate	Small	Small	Small	Small	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Minor beneficial	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Alt.	Analysis	Metric	Appalachian Basin	Colorado Plateau	Gulf Coast	Illinois Basin	Northern Rocky Mountains and Great Plains	Northwest	Western Interior
Alternative 7	**Environmental Impacts**	**Forest (ac)**	Moderate	Moderate-Small	Moderate-Small	Small	Small	Negligible	Small
		Stream (mi)	Moderate	Small	Negligible	Negligible	Negligible	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Long term	Long term	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Small scope	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Moderate beneficial	Moderate beneficial	Minor beneficial	Negligible	Negligible	Negligible	Negligible
Alternative 8 (Preferred)	**Environmental Impacts**	**Forest (ac)**	Moderate	Moderate-Small	Moderate-Small	Moderate-Small	Small	Negligible	Small
		Stream (mi)	Moderate	Small	Small	Small	Small	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Long term	Long term	Long term	Long term	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Large scope	Small scope	Small scope	Small scope	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Moderate beneficial	Moderate beneficial	Minor beneficial	Minor beneficial	Negligible	Negligible	Negligible
Alternative 9	**Environmental Impacts**	**Forest (ac)**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
		Stream (mi)	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	Scope of Effect	**Duration of Effects**	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
		Area of Effect	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts	Minimal measureable impacts
	Impacts to Recreation	**Overall Classification**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin under Alternative 2. Moderate Beneficial impacts are anticipated in the Appalachian Basin region under Alternatives 3, 4, 5, 7, and 8 (Preferred) and in the Colorado Plateau region under Alternatives 2, 3, 4, 7, and 8 (Preferred). Other effects on to recreational activities are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

No Action Alternative (Alternative 1)

Under the No Action Alternative (Alternative 1), coal mining may negatively impact recreational resources and the activities they support through disruption of terrestrial and aquatic ecosystems. The nature of these impacts is described in Section 4.3.3.1 above. The following summaries of the Alternatives 2 through 9 describe impacts relative to the No Action Alternative.

Alternative 2

Alternative 2 incorporates many elements that provide relatively extensive protection of recreational resources such as forests and streams. For example, Alternative 2 prohibits all mining activities within 100 feet of perennial streams; prohibits filling of perennial streams; eliminates AOC variances; specifies fish and wildlife enhancement metrics; and establishes a 100-foot riparian buffer for all streams. While fewer acres are categorized as improved under Alternative 2 compared with Alternatives 3, 4, 5, 7, and 8 (Preferred), Alternative 2 generates the greatest extent of preserved forest benefits compared with all other Action Alternatives. Preserved forest refers to natural forest landscapes that are untouched by mining and therefore the quantity and quality of recreational opportunities are uninterrupted by mining activity. The preserved acres therefore provide greater benefit to recreational activities than the improved acres, which refer to forest that is cut for the purposes of mining and then reforested. Recreational opportunities on improved acres may be reduced or of lesser quality until the restored forest matures. High levels of recreational activity and high values placed on such activity in the Appalachian Basin region suggest a Major Beneficial impact in that region. In regions where level of recreational activity and the associated value of this activity are lower, either Moderate Beneficial (in the case of Colorado Plateau) or Minor Beneficial (in the case of Gulf Coast and Illinois Basin) effects are expected. In regions where the elements do not directly influence recreational resources, the impacts are likely negligible.

Alternative 3

Alternative 3 has the potential for greater protection of forests and streams than the No Action Alternative but does not deliver protection to the same extent as Alternative 2. For instance, Alternative 3 has less explicit stream restoration requirements and allows mining through streams under certain conditions. For coal regions in which recreational activities are highly valued and activity is extensive, the predicted impact is Moderate Beneficial. For regions where activities have less value and occur with less frequency (Gulf Coast and Illinois Basin), the effects are classified as Minor Beneficial. Negligible effects are anticipated for the coal regions where Alternative 3 provisions suggest minimal change in forest or river protection.

Alternative 4

Alternative 4 is very similar to Alternative 3 in terms of the level of protection afforded to forests and streams. As such, the findings under Alternative 4 are identical to those for Alternative 3, described above.

Alternative 5

By definition, Alternative 5 has little effect on any coal region other than the Appalachian Basin. As such, the predicted impacts for the other six regions are negligible. For the Appalachian Basin region, however, the anticipated level of recreational resource protection coupled with the high values placed on recreational activity in this region result in predicted effects that are Moderate Beneficial.

Alternative 6

Like Alternative 5, Alternative 6 primarily affects the Appalachian Basin region. The findings are similar to those described above for Alternative 5, except that the level of protection of the recreational resources is somewhat lower than that predicted under Alternative 5. In particular, reforestation requirements under Alternative 6 are less extensive than those under Alternative 5. As such, the predicted impact relative to the No Action Alternative is Minor Beneficial.

Alternative 7

Alternative 7 requirements apply only under enhanced permitting conditions. As such, it results in non-negligible protective measures for forests and streams for only three coal regions: Appalachian Basin, Colorado Plateau, and Gulf Coast. Combined with the relative extent of recreational resources and the estimated value of recreational activities in these regions, the expected impacts are Moderate Beneficial (for the Appalachian Basin and Colorado Plateau) or Minor Beneficial (for the Gulf Coast).

Alternative 8 (Preferred)

Alternative 8 (Preferred) offers forest and water quality protections similar to Alternatives 3 and 4. As such, it is classified as having Moderate Beneficial impacts in the Appalachian Basin and Colorado Plateau, and Minor Beneficial impacts in the Illinois Basin and Gulf Coast regions. Impacts in other regions are classified as Negligible.

Alternative 9

Alternative 9 would require the repromulgation of the currently vacated 2008 Stream Buffer Zone rule. This Alternative would require minimization of excess spoil generation, place limits on excess spoil fill capacity to match the anticipated amount of excess spoil to be generated, and prohibit mining activities in or within 100 feet of an intermittent or perennial stream unless the applicant demonstrates and the regulatory authority finds that avoidance is not reasonably possible. The model mines analysis indicates that the impacts of Alternative 9 would not differ significantly from those of the No Action Alternative because the Clean Water Act requirements and policies discussed in the Regulatory Impact Analysis for this rulemaking and the state AOC and excess spoil policies identified in Section 4.2.3.1 of this DEIS have effectively achieved implementation of this Alternative in Central Appalachia, which is the region in which the 2008 Stream Buffer Zone rule would have had its greatest impact if it had remained in effect. Therefore, if repromulgated, Alternative 9 would now have Negligible effects on recreation.

Table 4.3.3-7 summarizes the impacts of the Action Alternatives on recreational resources.

4.3.3.5 Potential Minimization and Mitigation Measures

The Action Alternatives are not expected to result in adverse environmental consequences in the context of recreational resources. Therefore, identifying potential minimization and mitigation measures is inapplicable for this analysis.

Table 4.3.3-7
Summary of Impacts of the Action Alternatives on Recreational Resources Compared to the No Action Alternative

Coal Region	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
Appalachian Basin	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Minor Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Colorado Plateau	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Negligible	Moderate Beneficial	Moderate Beneficial	Negligible
Gulf Coast	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Minor Beneficial	Minor Beneficial	Negligible
Illinois Basin	Minor Beneficial	Minor Beneficial	Minor Beneficial	Negligible	Negligible	Negligible	Minor Beneficial	Negligible
Northern Rocky Mountains and Great Plains	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Northwest	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Western Interior	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
National	**Moderate Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**	**Negligible**

Note: Please see Table 4.0.2-1 for a definition of negligible, minor, and moderate impact terms used above. These impact categories consider the length of impact, geographic scope of impact, available resources to impact, and potential for offsetting the impact.

4.3.4 Public Health and Safety

This section characterizes the impacts to public health and safety under each Action Alternative when compared to the No Action Alternative. The discussion is organized as follows:

- The first subsection discusses the existing regulatory environment relevant to public health and safety under the No Action Alternative;
- The second subsection identifies how key elements of the Action Alternatives could influence health and safety;
- The discussion then reviews qualitative information characterizing health and safety impacts of air and water quality changes, both for miners and for the general public; and

- The final subsection summarizes the overall impacts of each Action Alternative on health and safety.

4.3.4.1 Effects of the Current Regulatory Environment (the No Action Alternative)

Many naturally occurring trace elements can be mobilized during the surface mining process. If not adequately controlled, these trace elements can be released into surface water and groundwater (Water Resources sections of Chapters 3 and 4). Over the past few years, several studies about the relationship between mining operations in West Virginia and the health of nearby residents have been published in peer-reviewed journals. The results of these studies suggest an association between living near mining operations and increased risk of illness and premature death. To better understand the potential implications of these studies, OSMRE has requested that the National Academy of Sciences review this literature.

Studies conducted to date indicate that damage from contaminants released by surface mining persists for decades (Hopkins, et al., 2013; Bernhardt and Palmer, 2011; Lindberg, et al., 2011; Palmer, et al., 2010; Pond, et al., 2008). Key elements may include, but are not limited to, iron, aluminum, nickel, copper, manganese, selenium, arsenic, lead, mercury, cadmium, beryllium, potassium, calcium, magnesium, lithium, rubidium, uranium, and strontium (Lindberg, et al., 2011; Pumure, et al., 2010; Palmer, et al., 2010; West Virginia Geological and Economic Survey (WVGES), 2012; Agouridis, et al., 2012). The level of contamination in surface waters downstream of coal mining activity depends on site-specific factors, such as the composition of parent rock, interactions between elements, presence of other pollutants associated with mine runoff (e.g., sulfates (SO4)), and other physicochemical characteristics of the site such as pH or total organic carbon (TOC) content (Pumure, et al., 2010; Hopkins, et al., 2013).

Coal mining can also introduce contaminants into the air through removal of parent rock and subsequent generation of ambient particulate matter (PM) (Aneja, et al., 2012; Ahern, et al., 2011; Hendryx, 2009). A substantial literature base indicates that increases in ambient PM concentrations (from any source) can adversely affect the health of nearby residents (U.S. EPA, 2009c).

Humans may be exposed to coal mining-related contaminants through several different exposure pathways. For example, after they have been mobilized into air, surface water or groundwater, contaminants can be transported to nearby sources of drinking water and air in residential areas, leading to potential ingestion exposure to contaminants dissolved in water and inhalation exposure to contaminated particles in air.

Health Impacts of Mining-Related Water Quality Changes

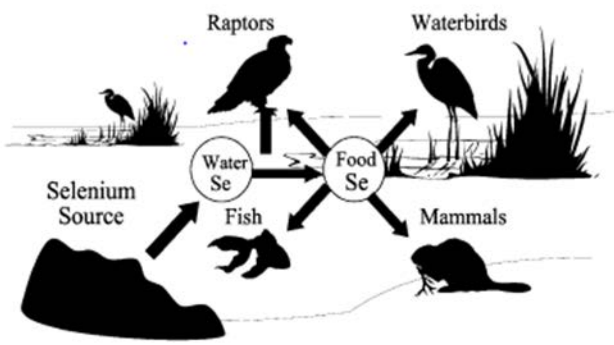
The discussion below examines how mining-related water pollution may potentially affect human health under the No Action Alternative. The discussion first focuses on the example of selenium. It begins by considering the fate and transport of selenium in the environment, illustrating how the risk posed by certain pollutants can magnify over time in the aquatic environment. The discussion also considers specific health effects associated with selenium exposure. Subsequent subsections consider risks posed by other pollutants such as sulfates and arsenic.

Effects of Selenium on Public Health

Fate and Transport of Selenium

Selenium represents a potential human health hazard around coal mines because of its persistence in the environment. Once in the aquatic environment, some coal mining-related selenium can quickly build up (bioaccumulate) and reach levels that are toxic to fish and wildlife (see Figure 4.3.4-1) (Lemly, 2004). Because of bioaccumulation, even a low concentration of selenium in water has the potential to increase by several orders of magnitude in fish and wildlife (Lemly, 2008). This poses additional risk to recreational or subsistence anglers who may consume fish from contaminated waters. A 2011 U.S. EPA report on the effects of surface mining in Appalachia lists elevated selenium concentrations (to levels that are sufficient to cause toxic effects in fish and birds) as one of its major findings (U.S. EPA, 2011b).

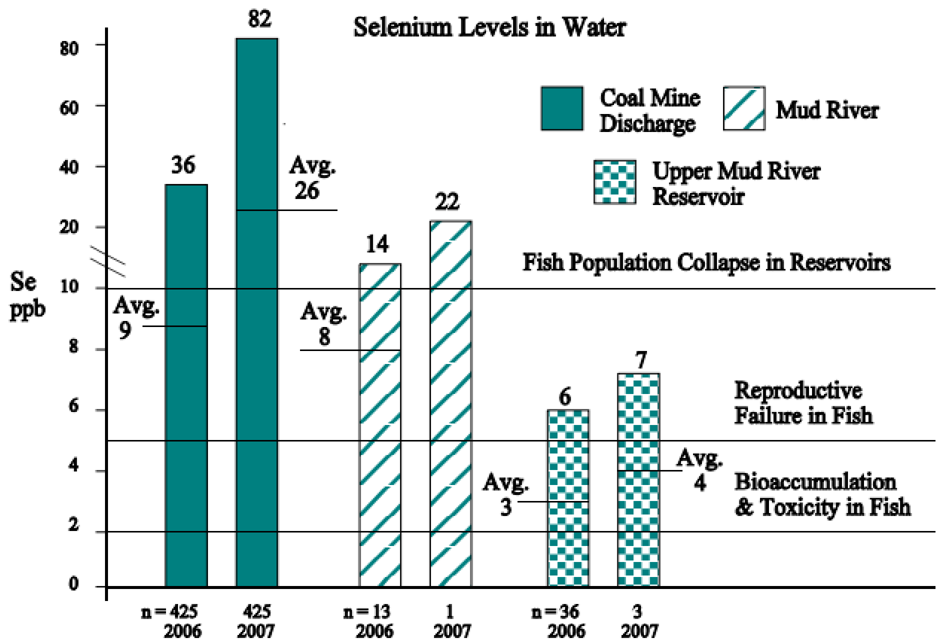
Figure 4.3.4-1 Bioaccumulation pathway of Selenium



Source: Lemly 2004, pg. 45.

The most extensive research on selenium and mining has been conducted in West Virginia. In 2007, the West Virginia Department of Environmental Protection (WVDEP) initiated an aquatic monitoring program as a result of frequent violations of EPA's surface water quality criterion for selenium (5 μgL^{-1}) (WVDEP 2007a). The program is aimed at evaluating the extent and severity of pollution from coal mining (WVDEP, 2007b). This water quality monitoring was conducted as part of mine wastewater discharge permit requirements under the U.S. EPA's National Pollutant Discharge Elimination System (NPDES). Results of this effort in the Mud River watershed in West Virginia indicated that selenium levels in samples of water, fish tissue, and invertebrate food organisms exceeded toxic thresholds for fish (see Figure 4.3.4-2) (Lemly, 2008).

Figure 4.3.4-2 Selenium concentrations (µg/L or parts-per-billion) measured in coal mine discharges and surface waters of the Mud River ecosystem, West Virginia, relative to levels that can bioaccumulate and become toxic to fish.

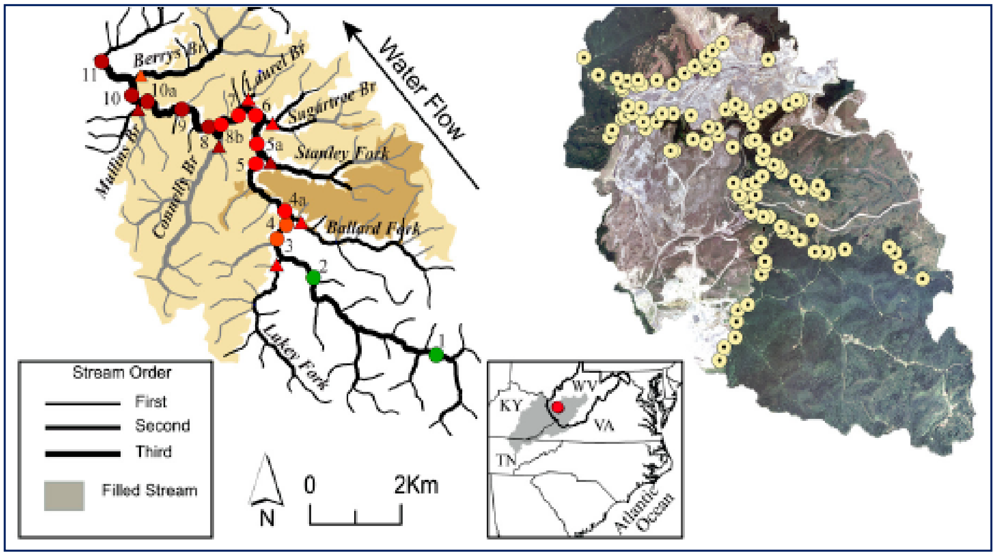


Source: Lemly, 2008, pg. 173.

The monitoring conducted by WVDEP suggests that coal mining can lead to human exposure to selenium through fish ingestion. State advisories are in effect for excessive human consumption of fish from waters downstream of coal mining activities in some areas of West Virginia (Palmer, et al., 2010). The 2012 sport fish consumption advisory press release for West Virginia states that "Low levels of chemicals like PCBs, mercury, selenium and dioxin have been found in some fish from certain waters" (WVDHHR, 2012b). The document "West Virginia Fish Consumption Advisories Available for 2012" indicates that measurable levels of selenium were detected in samples from water bodies that include Upper Mud Lake and Pinnacle Creek (WVDHHR, 2012b), both of which are in watersheds that are heavily mined. Although these state advisories are in effect, exposure through fish consumption may still occur if anglers are unaware of or disregard the advisories.

There are additional studies that have found toxic levels of selenium in surface water near coal mining areas. In 2011, Lindberg, et al. published a study of selenium levels along the Upper Mud River and its tributaries (see Figure 4.3.4-3). The headwaters of the Mud River begin in Boone County, West Virginia, and flow northwest into Lincoln County to the Mud River Reservoir, approximately 25 km downstream. By the time the Upper Mud River exits the active surface mining area following its confluence with Berry's Branch, it has received mining effluent from eight tributaries that contain 68 NPDES permitted discharge points, all of which are for coal mining activities.

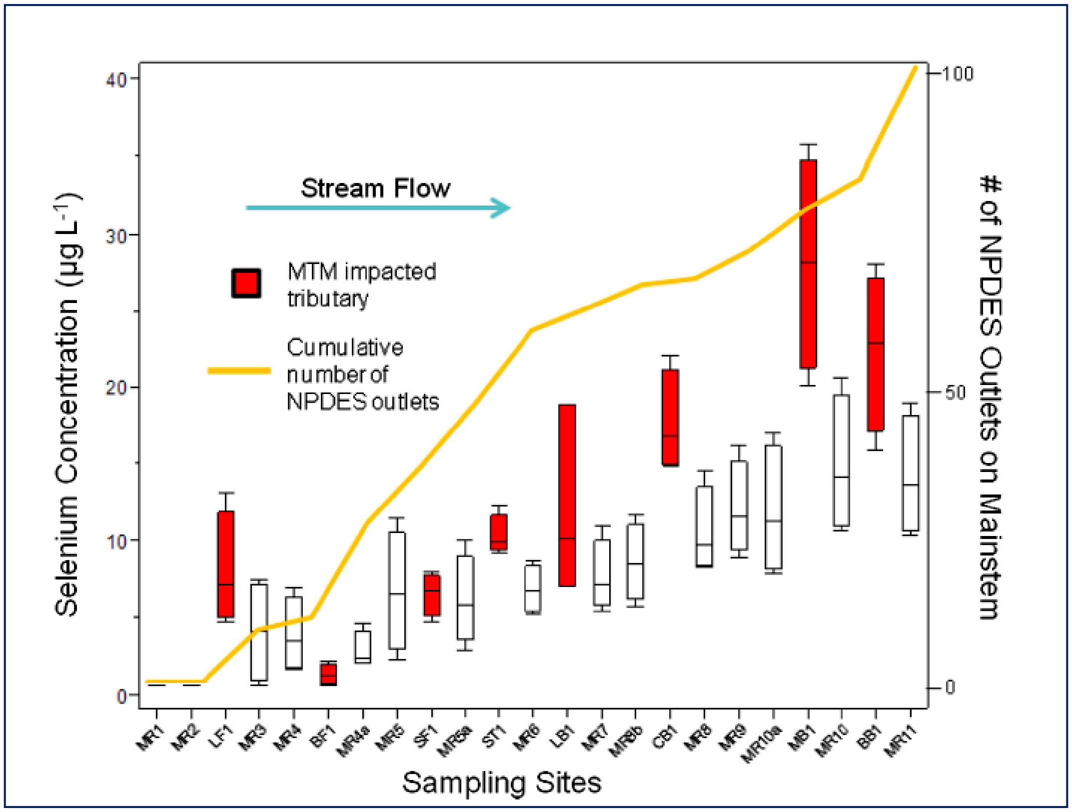
Figure 4.3.4-3 Map of study area depicting Upper Mud River and associated tributaries with aerial photo on right



Note: Sampling sites consisted of 15 mainstream (circles) and eight named tributary locations (triangles). Sites 1 and 2 were located upstream of current and historic coal mining activity. The remaining sites were chosen so as to bracket each confluence of the Upper Mud River and a tributary affected by coal mining. Aerial photo on right shows location of 105 active surface-mining-related outlets within the watershed that are regulated through eight NPDES permits.
Source: Lindberg et al. 2011, Figure 1, p. 2.

Prior to the initiation of surface coal mining in the Lukey Fork watershed, EPA water quality data (see Figure 4.3.4-3) recorded no detectable selenium in the stream (EPA detection limit of 3.0 μgL^{-1}). During the Lindberg, et al. (2011) study, however, selenium concentrations were found in Lukey Fork at levels up to 13.1 μgL^{-1} (see Figure 4.3.4-4). Additional coal mining-impacted tributaries further contributed to selenium contamination, and downstream of the confluence with Berry Branch, selenium concentrations averaged 14.1 μgL^{-1}. The investigators measured selenium concentrations of 6.5 and 4.0 μgL^{-1} in samples taken in September and December of 2010 from an area well below the Hobet mine complex, despite the fact that surface water at that point receives input from multiple unmined tributaries (including the Left Branch of the Mud River) (Lindberg, 2011, p. 4).

Figure 4.3.4-4 Box plot showing range and mean stream selenium concentrations during four surveys in 2010 on the Upper Mud River



Note: The cumulative number of active NPDES permitted outlets is represented by a yellow line with the scale on the right side of the graph. The red box plots denote the selenium concentrations for coal mining-impacted tributaries, with the remainder representing mainstream sampling sites.
Source: Lindberg et al. 2011, Figure S4, p. S2.

A study published by USGS in 2006, entitled "Ground-Water Quality in Unmined Areas and Near Reclaimed Surface Coal Mines in the Northern and Central Appalachian Coal regions, Pennsylvania and West Virginia" (McAuley and Kozar, 2006), provides additional evidence of long-lasting adverse impacts on water quality in surface coal mining areas. This study examined the transport of selenium generated during surface mining activity, and found that under the current regulations, even after mine-site reclamation, groundwater samples from domestic supply wells have higher levels of mine-derived chemical constituents than well water from unmined areas (McAuley and Kozar, 2006). A study published in 2012 sampled the groundwater in 58 wells and springs in West Virginia. The study found elevated levels of selenium in general, and three of the samples tested exceeded EPA's surface water quality criterion for selenium (5 μgL^{-1}) (Brantley, 2012). A number of additional studies that sampled drinking water supplies found metals, including selenium, in domestic wells in coal mining areas at levels that pose human health concerns (Wigginton, et al., 2008; ATSDR, 2005; ATSDR, 2004; Stout and Papillo, 2004).

Effects on Public Health

Although selenium is an essential nutrient for humans, it can have toxic effects as dosage increases. Excessive intake of selenium can result in a condition called selenosis. Clinical signs of selenosis include a characteristic "garlic odor" of excess selenium excretion in the breath and urine, thickened and brittle nails, hair and nail loss, lowered hemoglobin levels, mottled teeth, skin lesions and central nervous system abnormalities (e.g., peripheral anesthesia and pain in the extremities) (ATSDR, 2003; U.S. EPA, 1991). A recent study of patients with colorectal polyps also identified a significantly higher concentration of selenium in polyp versus control tissue (Alimonti, et al., 2008).

Studies of populations in China living in an area with naturally occurring but unusually high environmental concentrations of selenium found that “chronic dietary exposure to excess levels of selenium has been associated with diseased nails and skin and hair loss, as well neurological problems, including unsteady gait and paralysis” (ATSDR, 2003, pg. 15). In 1989, Yang et al. conducted a follow-up study in these areas of China (three geographical areas with low, medium and high selenium levels in the soil and food supply were chosen for comparison). The investigators found that selenium “levels in soil and approximately 30 typical food types commonly eaten by the exposed population demonstrated a positive correlation with blood and tissue selenium levels” (U.S. EPA, 1991). Selenium concentrations of various tissues were associated with alterations in biochemical parameters that are indicative of possible selenium-induced liver dysfunction, as well as clinical signs of selenosis (U.S. EPA, 1991).

According to ATSDR’s toxicological profile of selenium, “some evidence for effects on the endocrine system in humans and rats has also been found following long-term oral exposure to elevated levels of dietary selenium” (ATSDR, 2003). These studies suggest that subsistence anglers and recreational anglers who frequently consume fish from contaminated areas could potentially be at risk from excessive ingestion of selenium.

Effects of Sulfates on Public Health

In recent decades, policymakers have expressed concern over the buildup of sulfate in streams as a result of surface coal mining. The oxidation of pyrite or other iron-sulfide minerals with water creates sulfuric acid, increasing stream acidity. This drainage from coal mines, also called Acid Mine Drainage (AMD), has contributed to the degradation of streams in coal regions, affecting both drinking and industrial water. The AMD chemical reaction may also build up high levels of ferrous sulfate and ferric hydroxide, in addition to sulfuric acid. In addition, sulfuric acid in streams may react with other rocks and minerals in the water, potentially producing high concentrations of zinc, aluminum, and manganese (USGS, 2000c). All of these chemical processes contribute to the accumulation of acid, subsequently decreasing the pH of stream water. Williams, et al. (1996) collected water samples from 270 mine discharges in the Stonycreek River Basin in Pennsylvania, and found that these water samples had high concentrations of acid, aluminum, and sulfate; many of the samples had pH levels less than 3.0. According to the World Health Organization (WHO), lower levels of pH in drinking water may result in irritation to skin and eyes and, at levels below a pH of 2.5, there may be extensive and severe damage to the epithelium (WHO, 2003).

Elevated stream water acidity may adversely impact public health in historic coal mining regions. The health effects of higher levels of sulfate in drinking water have not been extensively studied, however. The primary effect of increased sulfate in drinking water is an increase in diarrhea rates, affecting populations that are more vulnerable to the laxative effects of sulfate, including infants and transients. EPA conducted a study that measured the impact of high sulfate levels on infants and pregnant women and found a weak increase in reports of diarrhea with higher doses of sulfate in drinking water. The WHO conducted a survey in North Dakota and found a slight increase in the percentage of people who had a laxative effect with water containing 500-1000 mg of sulfate (28 percent of those surveyed) as compared to those exposed to drinking water containing less than 500 mg of sulfate (21 percent of those surveyed). For both studies, the researchers were unable to identify a level of sulfate in drinking water that leads to serious human health effects (WHO, 2004).

Effects of Arsenic on Public Health

Surface mining has resulted in elevated levels of arsenic in drinking water in coal mining areas. Arsenic is a mineral that occurs naturally in rocks and coal. Similar to the occurrence of sulfuric acid in stream water, the major source of arsenic is pyrite, which is composed of iron and sulfur. Data collected by the USGS suggest that the average arsenic concentration for U.S. coal is approximately 24 parts per million (USGS, 2005b). High levels of arsenic may affect public health, and this problem has been most prevalent in domestic well waters. Studies have demonstrated that inorganic arsenic in drinking water may play a significant role in cancers, primarily bladder cancers (Shiber, 2005). Shiber (2005) measured the various levels of arsenic in domestic water in the Central Appalachian region, citing coal mining as the major source. The results of this study indicate that over half of the samples collected from tap water in the region contain one part per billion (ppb) or more of arsenic, an amount that is greater than the standards for many other carcinogens found in drinking water. Of the 13 counties studied in Kentucky, the average arsenic level was found to be approximately 2.99 ppb (Shiber, 2005). The National Research Council's 2001 report to EPA reported that the lifetime risk of bladder and lung cancer from water arsenic exposure at three ppb is one in 1,000 (Shiber, 2005).

It is possible that some areas may experience reductions in arsenic exposure in drinking water as coal production decreases. Although public tap water is regulated for arsenic concentrations, users of private wells may benefit from reductions in arsenic concentrations. Chapter 3.5.3 reports the percentage of private well users in each of the coal regions, but proximity of these sources to coal production is not examined. However, any decrease in the concentration of arsenic in private wells may decrease lifetime risks of bladder and lung cancer for well water consumers.

Other Evidence of Potential Public Health Effects of Surface Mining

There is a small but growing body of epidemiological research that suggests an association between adverse health effects and proximity of residence to a coal mining region in the Appalachian Basin. Hendryx, et al. (2008) studied the elevated rates of cancer mortality in the coal mining regions in Appalachia and found that, after controlling for socioeconomic factors including education, smoking rates, and poverty, coal mining in Appalachia was associated with elevated rates of cancer mortality. In a study published in 2010, Hitt and Hendryx extended the work published in 2008 (Hendryx, 2008) by assessing the relationship between the ecological integrity of streams, calculated through environmental quality gradients, and human cancer incidence. The 2010 study found a statistically significant inverse relationship between ecological integrity of streams and mortality rates from certain types of cancer (digestive, breast, respiratory and urinary), and a positive correlation between coal mining intensity and rates of certain types of cancer, including respiratory cancer (Hitt and Hendryx, 2010). In 2010, a cross-sectional retrospective analysis of mothers in West Virginia found that residence in coal mining areas posed a risk of low birth weight, even after controlling for level of coal mining, mother's age, marriage status, drinking during pregnancy, smoking during pregnancy, medical risk, years of education, late prenatal care, no prenatal care, and number of previous pregnancies (Ahern, et al., 2010). A separate 2010 study showed that "proficiency rates for schools in coal-mining counties versus non-coal mining counties were significantly lower in all subject areas . . . and remained significantly lower ($p < 0.0008$ or better) after adjusting for county high school education rates, percent of low-income students, percent of highly qualified teachers, number of students tested, and county smoking rates" (Cain and Hendryx, 2010).

A 2012 retrospective cross-sectional study of county-level cancer mortality rate data from the Center for Disease Control (CDC) compared age-adjusted cancer mortality rates in Central Appalachian mountaintop mining counties versus Central Appalachian counties with other types of mining and counties with no mining.[64] After controlling for covariates, the study found that lung cancer mortality rates were significantly associated with the presence of mountaintop mining in a community. The study also found evidence that mortality from leukemia, lung, bladder, and colorectal cancer were higher in mountaintop-mining areas compared to other mining areas, although the associations were not statistically significant. The magnitude of the association between mountaintop mining activity and cancer mortality was greater in more recent years (Ahern and Hendryx, 2012), reflecting the fact that some adverse health effects are not observed until years after exposure. In a 2011 retrospective analysis of 2006 self-reported data on health-related quality of life indicators, residents of mountaintop mining communities in Appalachia reported significantly more days of poor physical, mental, and activity limitation and poorer self-rated health, when compared to residents of counties with other types of coal mining and to residents of non-mining counties (Zullig and Hendryx, 2011). Other recent epidemiological studies have also found associations between adverse health effects (such as increased incidence of birth defects and increased adult mortality from cancer, heart, respiratory, and kidney disease) and residence in coal mining counties in Appalachia, after controlling for other risk factors (Ahern, et al., 2011; Esch and Hendryx, 2011; Hendryx, et al., 2010; Hendryx, 2009; Hendryx and Ahern, 2009; Hendryx and Ahern, 2008).

Although these studies do not control for occupational exposure, the authors assert that because they have found positive associations in both men and women between proximity to mining operations and adverse health impacts, the effects are not strictly due to direct occupational exposure of coal miners, who are predominantly male (Ahern, et al., 2010; Hendryx, 2009; Hendryx and Ahern, 2008). This assertion is supported by a U.S. Department of Labor 2011

[64] Mountaintop Mining (MTM) is defined as a surface mining site crossing a ridge or mountain peak, and either (a) spanning a minimum of 210 acres including 40 acres of removed ridge top, or (b) spanning 40 to 320 acres and containing a minimum of 10 to 40 acres of ridge top.

report which states that of the 94,000 people employed by the coal mining industry in 2010, only six percent were women (U.S. BLS, 2011b).

Studies conducted to date attempt to control for other risk factors but more rigorous epidemiological studies are required to investigate these associations (e.g., long term prospective cohort follow up studies). In general, epidemiological studies are limited in their ability to prove a causal relationship, but continued positive findings obtained through a variety of study designs can provide a substantial weight of evidence in support of a causal relationship. The current body of evidence, while it does not reach that level, does suggest that further research on impacts of coal mining operations on nearby residents is warranted.

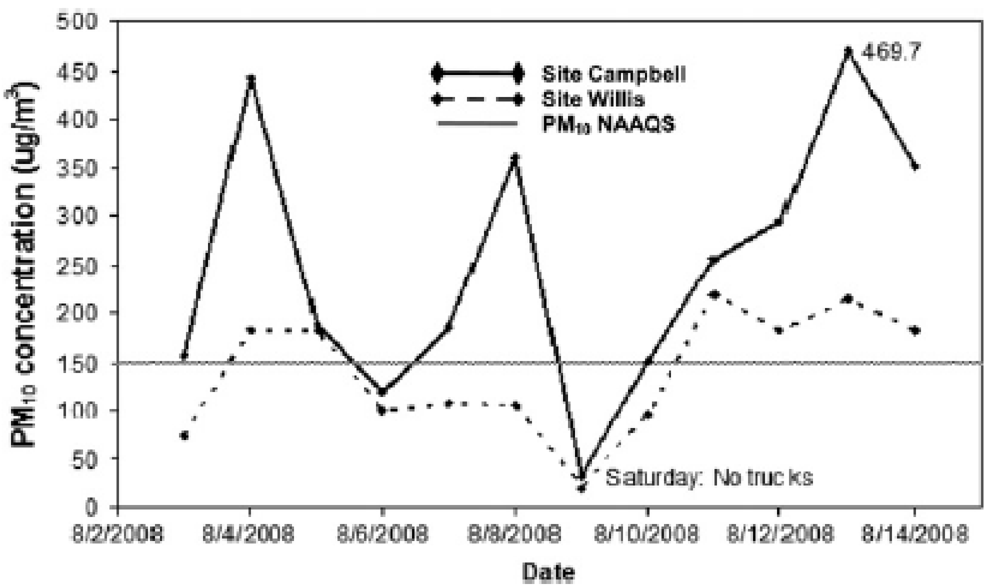
Health Effects of Mining-Related Air Quality Changes

Less empirical evidence is available with respect to the effects of coal mining on air quality, although this topic is a focus of current research. One recently published study of surface coal mining in the Appalachian Basin provides quantitative evidence of adverse effects on air quality in residential areas. The study was done in Roda, Virginia, in close proximity to surface coal mining operations where residents reported a high volume of truck traffic and significant dust problems (Aneja, et al., 2012). In August 2008, for a period of twelve days, two PM_{10} (i.e., particulate matter with particle size of ten micrometers or less) air samplers were placed on residential properties located near a road that terminates at the entrances to several mines.[65] The sites were selected to be representative of exposure for local residents. One residence, ("Site Campbell") was located very close to the entrance to the coal mines, and the other, ("Site Willis") was located one mile away. Results of this study suggest that residents of Roda may frequently be exposed to PM_{10} concentrations that exceed EPA's 24-hour health-based national ambient air quality standard (Figure 4.3.4-5).

Analysis of the composition of the air samples in this study identified the presence of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium, which are all known components of coal. While ambient background concentrations of selenium in the air were below 10 ng/m^3 (ASTDR, 2003), Aneja, et al. (2012) found levels five to six times higher. These data indicate that activities related to the coal mines are a major contributor to the local air pollution, and that this is likely a chronic problem not only for Roda, but for other similarly situated Appalachian Basin communities.

[65] Inhalation of small particulates like PM_{10} is hazardous because the particles can transport toxins that lodge deep in the lung tissue. Studies have linked particulate exposure to premature mortality (especially in individuals with pre-existing heart or lung disease), heart problems, asthma, and other respiratory conditions (U.S. EPA, 2014f).

Figure 4.3.4-5 Measurements of PM10 24-h concentration at two locations (Site Campbell and Site Willis) in Roda, Virginia, during August 2008.



Source: Aneja et al., 2012, Figure 2, p. 498.

Studies of mining practices in other countries also indicate that levels of particulate matter released from surface mines are greater than those released from underground mining operations. Consequently, in addition to occupational exposure to miners, community-level exposure to increased particulate matter concentrations may occur as a result of increased surface coal mining activity (Ghose and Majee, 2007; Ghose, 2007). Under Alternative 2, there would be a shift from surface mining to underground mining, adverse public health effects from poor air quality resulting from coal mining activity could potentially be reduced on a community level.

Due to anticipated decreases in production levels as a result of the Action Alternatives, air quality for adjacent communities may improve due to a lower overall exposure to coal dust and particulate matter. Underground mining, however, exposes miners to large amounts of coal dust and may have adverse health effects on miners where production methods shift from surface to underground. Extensive exposure to dust may increase miners' risk to various malignant and nonmalignant lung and bladder diseases. A common and well-documented disease, coal workers' pneumoconiosis, is largely caused by exposure to coal dust. The components of coal dust may include various carcinogenic organic and inorganic compounds, including chrysene, benzo(a)pyrene, and silica (Swaen, et al., 1995). These impacts are discussed further below.

Nonmalignant Lung Diseases

While not apparent in overall production forecasts developed for this DEIS, any shift of extraction methods from surface to underground mining in the Appalachian Basin region may increase the risk of disease and lung cancer for miners due to elevated exposure to carcinogenic coal dust. Kuempel, et al. (1995) studied the quantitative relationship between exposure to coal mine dust and mortality from nonmalignant respiratory disease and found that miners who were exposed for a working lifetime to dust levels below the U.S. standard of two milligrams per cubic meter (mg/m^3) are subject to a greater risk of dying from pneumoconiosis, chronic bronchitis, or emphysema. Of the 8,878 miners medically examined from 1969 to 1971 in Kuempel, et al.'s 1995 study, approximately 207 died from pneumoconiosis and 76 died from chronic bronchitis or emphysema. Kuempel, et al.'s 1995 study results show an upper-bound death rate of approximately 1.16 percent from pneumoconiosis, and 0.43 percent from chronic bronchitis or emphysema per year for miners on average. The study calculated lower-bound death rates of 0.087 percent from pneumoconiosis, and 0.012 percent from bronchitis or emphysema. Of note, however, this study relies on miners' exposure and respiratory illnesses from more than four decades ago. Subsequent regulations focused on miner safety may have since reduced the calculated rates.

Lung Cancer

Prolonged exposure to dust particles increases cancer risks for miners. Many studies have demonstrated that poorly soluble particles of low toxicity (such as coal mine dust) have caused lung cancer in rats (Borm, et al., 2004). Although these studies are not conclusive regarding the susceptibility of humans to lung cancer as a result of prolonged exposure to coal dust, there is concern over this issue, especially for underground mining. It is currently difficult to quantify the exact impact of changes in production level or mine type on the risk of lung cancer, however. This is due to the lack of data on the differences in coal mine dust exposure for underground and surface mines, as well as the lack of a clear relationship between production level and dust exposure.

Gastric Cancer

Studies have also explored the relationship between gastric health and underground coal mining. The coal dust to which underground miners are exposed may contain carcinogenic elements and these compounds may enter the miners' digestive systems. The coal dust may interact with agents in the acidic environment of the stomach, such as nitrite, to form mutagenic compounds (Swaen, et al., 1995). Swaen, et al. (1995) studied a sample of 3,790 coal miners that had abnormal chest x-ray films (suggesting pneumoconiosis) and found that deaths from gastric cancer were higher than expected, at 120 deaths. The fatality rate of pneumoconiotic coal miners due to gastric cancer resulted in a standardized mortality ratio of 147.5 (point estimate). Overall, their results suggest that pneumoconiotic coal miners have an approximately 22.5 percent to 76.3 percent higher gastric cancer fatality rate than the general population.

Other Public Health Effects

Coal mining contributes to rising greenhouse gas emission levels and releases large amounts of coal dust particles into the air. The release of particulates and other emissions that deteriorate ambient air quality may affect public health. As underground mining contains (i.e., controls) most of the dust particle byproducts from mining, one possible consequence of a shift in surface mining to underground mining is a decrease in dust release.

Hendryx and Ahern (2008) found that residential proximity to coal mining areas was associated with a higher risk for hypertension, kidney disease, chronic lung disease, and cardiopulmonary disease. Previous studies have found that exposure to coal byproducts is linked to kidney disease and hypertension (Hendryx and Ahern, 2008). While the study highlights the potential for public health impacts with increases in coal production volume in the future, it does not establish a clear causal relationship between coal production and these health effects.

Studies of mining practices in other countries, however, indicate that levels of particulate matter released from surface mines are higher than those released from underground mining operations. Consequently, in addition to occupational exposure to miners, community-level exposure to increased particulate matter concentrations may occur as a result of increased surface coal mining activity (Ghose, 2007; Ghose and Majee, 2007). With any shift from surface mining to underground mining, adverse public health effects from poor air quality resulting from coal mining activity could potentially be reduced on a community level. However, additional research addressing differences in mining practices in the U.S. versus practices in other countries would be needed to better understand the potential for health improvements related to improved air quality.

As a greenhouse gas, methane emissions contribute to the creation of ozone, potentially affecting global climate patterns. Higher methane emissions due to an increased number of underground mines or an increased level of production may also affect the air quality of surrounding communities. Both global warming and deteriorating air quality may have public health implications; however, there is currently little information on the exact impact of methane gas emissions on public health.

4.3.4.2 Action Alternatives and Potential Effects on Public Health and Safety

The Action Alternatives may yield water quality improvements relative to the No Action Alternative. Nearly all the elements of the Action Alternatives (except Alternative 9) have potential to benefit water quality, including improved baseline data and monitoring; material damage to the hydrologic balance definitions and corrective action thresholds; limitations on fill placement and mining through streams; improved reforestation; and introduction of riparian buffers. Section 4.2.1 describes all of these elements and potential benefits in greater detail. In addition, reduced coal production and shifts in the balance of surface and underground production may have coincident benefits to air quality (as described in Section 4.2.4).

Qualitative Analysis of Public Health and Safety Impacts

As stated above, the Action Alternatives may affect public health and safety by improving water quality and air quality relative to the No Action Alternative. Nearly all the elements of the Action Alternatives (except Alternative 9) have potential to benefit water quality, including improved baseline data and monitoring; material damage to the hydrologic balance definitions and corrective action thresholds; limitations on fill placement and mining through streams; improved reforestation; and introduction of riparian buffers. Section 4.2.1 describes all of these elements and potential benefits in greater detail. In addition, reduced coal production and shifts in the balance of surface and underground production may have coincident benefits to air quality (as described in Section 4.2.4).

The evaluation of potential impacts on public health relies on qualitative information regarding potential effects of the Action Alternatives. This analysis finds that the primary public health benefits of the Action Alternatives are associated with the expected improvements to water resources, as described in Section 4.2.1. By improving baseline monitoring, establishing corrective action thresholds to prevent damage, requiring mandatory evaluation of monitoring data, and improving techniques to better restore sites to premining conditions, the Action Alternatives may benefit water quality. In addition to benefits to individuals, these improvements in water quality may benefit public drinking water suppliers by reducing pollutant levels and therefore costs of water treatment. Ideally, this analysis would combine information on the expected water quality benefits in each region, with information on the potentially vulnerable population (e.g., exposed via the pathways described in Section 4.3.4). Absent specific information on the locations of future mines, this analysis is not able to forecast the size of the population benefitting from improved water quality via the exposure pathways described (i.e., groundwater consumption, fish and wildlife consumption, etc.). In addition to water quality benefits, the Action Alternatives may result in indirect benefits to air quality, primarily as a result of reducing coal production and subsequent coal burn. However, the specific response of the energy market to changes in coal production is uncertain. As a result, the determination of impacts of each Action Alternative in each region relies primarily on the assessed benefit to water resources described in Section 4.2.1.

4.3.4.3 Summary of Effects

This section summarizes impacts to public health and safety by Action Alternative and region as compared to the No Action Alternative. Impacts are forecasted from 2020 to 2040. As described in Section 4.0, this analysis categorized impacts as either negligible, minor, moderate, or major, and either beneficial or adverse.

Generally, major effects are expected to result from significant changes in water quality that are persistent over the long-term, and cover a broad geographic area. Moderate effects are less significant water quality improvements that persist over the long-term but cover a more limited geographic area. Minor effects are when there are limited changes to water quality, and when these effects pertain to a limited geographic area.

Table 4.3.4-4 describes the rationale used to classify the effects of each Alternative and region. Table 4.3.4-5 summarizes this information for overall public health and safety impacts. As identified in Table 4.3.4-5, at the national scale, Alternatives 2, 3, 4, and 8 (Preferred) are anticipated to result in Major Beneficial impacts to public health and safety when compared to the No Action Alternative. Alternatives 6 and 7 are anticipated to result in Moderate Beneficial impacts to public health and safety. Alternative 5 is anticipated to result in Minor Beneficial impacts to public health and safety at the national scale. Alternative 9 is anticipated to be functionally similar to the No Action Alternative and is anticipated to result in Negligible effects on public health and safety.

At a regional scale, Major Beneficial impacts are anticipated in the Appalachian Basin and Illinois Basin regions under Alternatives 2, 3, 4, and 8 (Preferred). Major Beneficial impacts are also anticipated in the Appalachian Basin under Alternative 7. Moderate Beneficial impacts are expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains regions under Alternatives 2, 3, 4, 6, 7, and 8 (Preferred). Moderate Beneficial impacts are also anticipated in the Appalachian Basin for Alternatives 5 and 6, and in the Illinois Basin for Alternatives 6 and 7. Other effects on public health and safety are anticipated to be Minor Beneficial or Negligible at the regional scale when compared to the No Action Alternative.

The subsections below discuss each Action Alternative individually.

Table 4.3.4-4a
Impacts of Alternative 2 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4b
Impacts of Alternative 3 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4c
Impacts of Alternative 4 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4d
Impacts of Alternative 5 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Colorado Plateau Region	Negligible	• Imperceptible effect
Gulf Coast Region	Negligible	• Imperceptible effect
Illinois Basin Region	Negligible	• Imperceptible effect
Northern Rocky Mountains and Great Plains Region	Negligible	• Imperceptible effect
Northwest Region	Negligible	• Limited coal mining activity • Imperceptible effect
Western Interior Region	Negligible	• Limited coal mining activity, • Imperceptible effect

Table 4.3.4-4e
Impacts of Alternative 6 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4f
Impacts of Alternative 7 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4g
Impacts of Alternative 8 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Colorado Plateau Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Gulf Coast Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Illinois Basin Region	Major Beneficial	• Long-term • Relatively great water quality change • Broad geographic scope
Northern Rocky Mountains and Great Plains Region	Moderate Beneficial	• Long-term • Relatively moderate water quality change • Limited scope
Northwest Region	Negligible	• Limited coal mining activity
Western Interior Region	Negligible	• Limited coal mining activity

Table 4.3.4-4h
Impacts of Alternative 9 on Public Health Compared to the No Action Alternative

Regulatory Alternative and Coal Region	Impact to Public Health and Safety	Rationale
Appalachian Basin Region	Negligible	• Imperceptible change
Colorado Plateau Region	Negligible	• Imperceptible change
Gulf Coast Region	Negligible	• Imperceptible change
Illinois Basin Region	Negligible	• Imperceptible change
Northern Rocky Mountains and Great Plains Region	Negligible	• Imperceptible change
Northwest Region	Negligible	• Imperceptible change
Western Interior Region	Negligible	• Imperceptible change

Table 4.3.4-5
Summary of Impacts of the Regulatory Alternatives on Public Health and Safety

Coal Region	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8	Alt. 9
Appalachian Basin	Major Beneficial	Major Beneficial	Major Beneficial	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Major Beneficial	Negligible
Colorado Plateau	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Gulf Coast	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Illinois Basin	Major Beneficial	Major Beneficial	Major Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Major Beneficial	Negligible
Northern Rocky Mountains and Great Plains	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible	Moderate Beneficial	Moderate Beneficial	Moderate Beneficial	Negligible
Northwest	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Western Interior	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
National Effect	**Major Beneficial**	**Major Beneficial**	**Major Beneficial**	**Minor Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**	**Major Beneficial**	**Negligible**

Note: See Table 4.0.2-1 for a definition of negligible, minor, and moderate impact terms used above. These impact categories consider the length of impact, geographic scope of impact, and potential for offsetting the impact.

Alternative 1 (No Action Alternative)

While existing research indicates a correlation between mining activities and public health effects, limited data are available to estimate a functional relationship between mining-related air and water quality effects and health issues in exposed populations.

Alternative 2

As described in more detail in Section 4.2.1, Alternative 2 provides major benefits to water resources. This finding is driven by expected improvements to water resources in the Appalachian Basin, and to a slightly less extent, in the Illinois Basin. These benefits extend beyond the mine sites and are expected to persist over time due to the improved water quality management practices at the mines under Alternative 2. Absent information on the magnitude of the population benefitting from this improvement, this analysis assumes the relative effect of the

Alternative on water quality (i.e., minor, moderate, major) similarly benefits public health within the region.

Alternative 3

For similar reasons to Alternative 2, Section 4.2.1 indicates that Alternative 3 provides major benefits to water resources, and therefore supports improvements in public health. This finding is driven by expected improvements to water resources in the Appalachian Basin, and to a slightly less extent, in the Illinois Basin. Moderate benefits are also expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains, where improvements are moderate but pertain to smaller geographic areas.

Alternative 4

Alternative 4 provides major benefits to water resources and, by extension, conditions to support public health improvements, in the Appalachian and the Illinois Basins. As with Alternative 3, moderate benefits are also expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains.

Alternative 5

Water quality benefits under Alternative 5 are likely moderate in the Appalachian Basin, due to a relatively limited geographic scope as compared with Alternatives 2, 3, and 4. This Alternative is not expected to benefit water quality (and public health) in other coal regions.

Alternative 6

Benefits to water resources (and public health) are Moderate Beneficial across all regions except the Northwest and Western Interior, where effects of the Alternative are Negligible.

Alternative 7

Impacts on water resources are beneficial and concentrated in the Appalachian Basin, consistent with the findings in Section 4.2.1. Benefits to water resources (and public health) are moderate across all other regions, except the Northwest and Western Interior where the Alternative has Negligible effects.

Alternative 8 (Preferred)

Alternative 8 (Preferred) provides major benefits to water resources (and public health) in the Appalachian and the Illinois Basins. As with Alternative 3, Moderate Beneficial effects are also expected in the Colorado Plateau, Gulf Coast, and Northern Rocky Mountains and Great Plains.

Alternative 9

Alternative 9 considers a scenario in which the 2008 Stream Buffer Zone rule is re-promulgated and fully implemented across the timeframe of this analysis. Engineering analysis of current coal industry practices finds that, during the period that the 2008 rule was in place, the permits issued in the Appalachian Basin changed in response to EPA review of Clean Water Act permits such that they serve as models for best practices for future permits. Accordingly, Alternative 9, which is effectively limited to Appalachia, would now not be expected to be functionally different than the No Action Alternative. Alternative 9 is therefore anticipated to have Negligible effects on public health and safety as evaluated in this DEIS.

4.3.4.4 Potential Minimization and Mitigation Measures

As the expected effects of the rule are generally beneficial, minimization and mitigation measures are not necessary.

4.3.5 Archaeology, Paleontology, and Cultural Resources

This section of Chapter 4 analyzes how the No Action Alternative and the Action Alternatives would affect paleontological and cultural resources. The discussion in this section is brief because none of the Action Alternatives include any proposed changes within the regulations that directly address these resources. Any effects would be indirect and would occur only as a result of effects on other resources, specifically to geology and soils, and then only if paleontological and cultural resources are present in the disturbed area. Therefore much of the subsequent discussion in this section relies on the analysis of soil and geology impacts contained in section 4.2.3 and the potential for additional effects from the proposed action is very limited.

The following content is structured as follows:

- It begins with a description of the existing regulatory environment to assist the reader in understanding the impacts of the No Action Alternative on paleontological and cultural resources.
- It concludes with a summary of the expected effects of the elements of the Action Alternatives. All effects would be negligible so the discussion does not provide a by Alternative comparison in relation to these resources.

4.3.5.1 Effects of the Current Regulatory Environment (the No Action Alternative)

This section provides an overview of the major federal statutes and implementing regulations relating to paleontological and cultural resources to provide an understanding of the coordination and oversight that currently exists when impacts would occur. Many of the existing regulations apply only to federal actions, actions on federal lands, or actions occurring on lands held in trust by the federal government. OSMRE is a regulatory authority on Indian lands.

Section 3.13 describes generally where and under what conditions cultural and paleontological resources are expected to occur within the coal-bearing regions. These resources do not occur in all areas that are mined, and where they do occur it is also possible that the permit applicant would choose to avoid mining in the specific area to avoid the resources and associated regulatory requirements for coordination and mitigation.

Coal mining can affect cultural resources in a number of ways. Mining can impact archaeological artifacts and fossils (paleontological resources) due to the disturbance of the materials in which they lay. This disturbance can occur during earth moving activities associated with removal of the vegetation and roots prior to mining, or during removal of the materials (overburden) overlying the coal seam. Subsidence from underground mining can also impact cultural resources by disrupting the vertical position and alignment of artifacts; this can cause some of the information associated with the site to be lost. Subsidence is typically predictable and adverse effects can be planned for and mitigated in advance. Coal mining activities may also require the removal of historic properties during site preparation. Disturbance of these resources can destroy them or adversely affect their integrity to the extent where they are no longer significant on a national, state, or local level. As described below, statutes and regulations are in place to address these impacts during the permit process through identification of resources and coordination to develop and implement required protective measures. However, it is still possible that undiscovered resources may exist and be disturbed by mining activity.

Paleontological Resources

Existing federal laws that may affect the consideration and management of paleontological resources specifically during mining include SMCRA, NEPA, the Antiquities Act, and the Paleontological Resources Preservation Act. The discussion below focuses on the federal laws with most impact and applicability to surface mining effects on paleontological resources.

Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1201 et seq.)

As discussed in Section 3.13, coal mining activities are known to coincide with areas known for fossil remains. Paleontological resources are not afforded specific protection under our existing regulations and OSMRE does not collect data on impacts to paleontological resources from coal mining. Given the intensive site disturbance associated with surface coal mining it is reasonable to assume that scientifically insignificant sites are impacted when they coincide with mining activity. Impacts to paleontological resources from coal mining would include physical damage, destruction, or other loss of fossils, or alteration or loss of contextual information. On the other hand, it is well documented that the excavation activities and subsidence associated with coal mining have resulted in the discovery of important paleontological sites. Mining exposes sediments that often have preserved organisms or casts within them (Parker and Balsley, 1989). Requirements to reclaim the site after mining can in fact conflict with the opportunity to leave the site open for further investigation. This was the case at the Steven C. Minkin Paleozoic Footprint Site in Alabama, formerly the Union Chapel Mine Site, at which more than 4000 fossil specimens have been collected (Geological Survey of Alabama State Oil and Gas Board, 2006).

Nothing in existing SMCRA regulations would preclude issuance of a permit to conduct mining that would impact paleontological resources, except where the SMCRA regulatory authority has designated the area as unsuitable for mining as discussed below or where a state with primacy has implemented additional regulations. Existing federal laws that may affect the consideration and management of paleontological resources during mining are summarized in the text below. Some states may have additional requirements, such as those in Montana, to consider impacts to paleontological resources on state lands.

The regulatory authority is authorized by section 522(e) of the SMCRA (30 U.S.C. § 1272(e)) to prohibit or limit surface coal mining operations on or near certain private, federal, and other public lands, subject to valid existing rights and except for those operations which existed on August 3, 1977. The implementing regulations require the regulatory authority, upon petition, to designate an area unsuitable for surface coal mining if mining there would affect fragile or historic lands in which the operations could result in significant damage to important historic, cultural, scientific, or esthetic values of natural systems (30 CFR 762.11). The definition of "fragile lands" per 30 CFR 762.5 specifically includes paleontological sites as an example. To date, OSMRE is unaware of any petition decisions that have designated areas as unsuitable for coal mining based partially or entirely on the need to protect paleontological resources.

Otherwise, neither SMCRA nor the current implementing regulations contain any requirement to identify, inventory, avoid, protect, or mitigate paleontological resources on federal or non-federal lands. On federal lands, the Antiquities Act applies, and, in practice, the regulatory authority sometimes addresses paleontological resources as part of the National Historic Preservation Act (NHPA) consultation where those resources are considered important as cultural markers in the discussion of traditional cultural value.

National Environmental Policy Act of 1969, as amended (42 U.S.C 4321, 4331-4335)

NEPA requires consideration of adverse effects to significant scientific, cultural or historical resources (40 CFR 1508.27(b)(8)). As such federal agencies are required to consider effects to scientifically or culturally important paleontological resources in evaluating actions to determine if the action would significantly impact the human environment. Paleontological resources are often included as a resource for consideration when federal agencies prepare NEPA documentation. Impacts to paleontological resources may differ between alternatives and in these instances these differences would be part of the information the decision maker has available for comparison of the reasonable alternatives and to determine the significance of impacts of the alternatives on the environment. However, NEPA applies only to federal actions (40 CFR 1500.1).

OSMRE would prepare NEPA documentation when the proposed mining activity would occur on federal or Indian lands, and for mining on all lands in the coal-producing states where OSMRE retains the role of regulatory authority (Tennessee and Washington). NEPA does not apply to state actions, including state permitting for mining on private lands. However individual states may have regulations and guidance that apply to actions affecting paleontological resources on state lands.[66]

Antiquities Act of 1906 as amended (54 U.S.C. §§ 320301 - 320303)

The Antiquities Act protects sensitive cultural resources on land owned or controlled by the federal government, and criminal penalties have been established for the removal, damage, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity that is situated on lands owned or controlled by the Federal Government, without the permission of the head of the Federal agency having jurisdiction over the lands on which the object is situated" (18 U.S.C. § 1866). Though paleontological resources are not specifically mentioned, "objects of antiquity" has often been interpreted to include fossils and other paleontological resources (Harmon, et al., 2006). If the paleontological resource was considered to be an "object of antiquity", the removal of any objects would require a permit under the Antiquities Act (43 CFR 3.1).

[66] Montana, for example, requires state agencies to include consideration of adverse effects on paleontological resources within state Environmental Impact Statements prepared for actions on state lands (MT Code § 22-3-433).

Paleontological Resources Preservation Act of 2009 (16 U.S.C §§ 470aaa-470aaa-11)

In 2009, the Paleontological Resources Preservation Act (PRPA) was signed into law as part of the Omnibus Public Land Management Act. The requirements of the law have limited applicability to our responsibilities and authorities under SMCRA. The PRPA requires, in part, the Secretary of the Interior to manage and protect paleontological resources on lands "controlled or administered by the Secretary of the Interior, except Indian land" (16 U.S.C. §470aaa-1). The PRPA therefore applies to lands managed by the Bureau of Land Management, National Park Service, Bureau of Reclamation and the Fish and Wildlife Service. OSMRE is under the Department of the Interior but does not control or administer land.

The PRPA prohibits collection of paleontological resources from federal land without a permit, with some exceptions (16 U.S.C. § 470aaa-3), and prescribes civil penalties for acts such as damaging or removing paleontological resources located on federal lands (16 U.S.C. § 470aaa-5). However, the PRPA specifically clarifies that nothing in the law should be construed as invalidating, modifying, or imposing any additional restrictions or permitting requirements on any activities permitted at any time under the general mining laws, or laws providing for the management or regulation of these activities including SMCRA (16 U.S.C. § 470aaa-10). Under existing SMCRA regulations OSMRE (or a delegated state regulatory authority) would continue to be responsible for consulting with the federal land management agency with respect to any special requirements necessary to protect non-coal resources (such as paleontological resources) in the areas affected by surface coal mining and reclamation operations (30 CFR 740.4(c)(2)).

Cultural Resources

Existing federal laws that may affect the consideration and management of archaeological and historic resources specifically during mining include SMCRA; the NHPA; the Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. § 470aa-470mm) (ARPA); the Antiquities Act, as amended (54 U.S.C. §§ 320301 – 320303); the Historic Sites Act of 1935, as amended (54 U.S.C. §§ 32101) (HSA); NEPA; the Historic and Archaeological Preservation Act of 1974, as amended (16 U.S.C. § 469; 54 U.S.C. §§ 312501-312508); the American Indian Religious Freedom Act of 1978, as amended (42 U.S.C. §§ 1996 and 1996a) (AIRFA); and the Native American Graves Protection and Repatriation Act of 1996 (25 U.S.C. §§ 3001-3013) (NAGPRA). The discussion below focuses on the federal laws with most impact and applicability to surface mining effects on cultural resources.

Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. § 1201 et seq.)

As discussed in previous sections, most coal mining states have approved state programs for those states to regulate coal exploration and surface coal mining and reclamation operations on non-federal and non-Indian lands within their boundaries. The state, and not OSMRE, issues the mine permit where there is an applicable approved state regulatory program. State-issued permits under SMCRA are not federal undertakings for purposes of the NHPA.

While state issued permits are not federal undertakings afforded consideration under the NHPA, existing SMCRA-implementing regulations in 30 CFR 731.14(g)(17) require that state programs seeking federal approval include a process for consulting with state, federal and local agencies having responsibilities for historic, cultural, and archaeological resources. OSMRE's role in accordance with 30 CFR Part 732 is to ensure that implementation of approved state programs is no less effective than federal regulations.

Additionally, cultural resources are considered during review of amendments to state regulatory programs. The states are required to provide their proposed amendments to the State Historic Preservation Officer (SHPO) and Advisory Council on Historic Preservation (ACHP) for comment if those amendments would have an effect on historic properties (30 CFR 732.17(h)(4)).

Information regarding cultural resources is also required of permit applicants for specific proposed operations. For example, permit application packages for surface coal mining must contain descriptions of any cultural or historical sites listed on the National Register of Historic Places NRHP within the permit and adjacent areas of the proposed surface coal mining and reclamation operation (30 CFR 779.12(b)(1) and 783.12(b)). The regulatory authority may require the applicant to protect historic or archaeological properties on or eligible for listing on the NRHP through appropriate mitigation and treatment measures (30 CFR 780.31(b)).

Where OSMRE is the regulatory authority (e.g., on Indian lands, and in states without approved programs) or where federal lands are involved, the full federal agency requirements of the NHPA would apply in addition to the requirements of SMCRA. Where the proposed mining would occur on Indian lands the permit must also address compliance with federal laws aimed at protecting cultural resources on Indian lands in addition to compliance with the NHPA. On Indian lands, OSMRE is responsible for determining if the materials provided in the application are sufficient to determine possible adverse impacts on cultural resources (30 CFR 750.12(c)(3)(ii)(B)).

Gathering this information is important for the protection of these resources and also to determining whether existing prohibitions of 30 CFR 761.11(c) apply. With the exception of areas subject to valid existing rights (valid and existing rights are described at 30 CFR 761.16), surface coal mining is prohibited on any lands where mining will adversely affect any publicly owned park or any places included in the NRHP, unless jointly approved by the regulatory authority and the federal, state, or local agency with jurisdiction over the park or place (30 CFR 761.11(c)). Surface coal mining operations are also prohibited within 100 feet of cemeteries, although the regulations do allow for relocation of cemeteries to allow mining if authorization is granted by applicable state law or regulations (30 CFR 761.11(g)).

The information required in application packages can include information from the SHPO or Tribal Historic Preservation Officer (THPO) and from local archaeological, historical, and cultural preservation agencies. The regulatory authority can require the applicant to provide additional information including through further field investigation (30 CFR 779.12(b)).

Upon agreement of all parties that the operation can move forward despite adverse effects on listed or eligible historic or archaeological properties, the regulatory authority may require the applicant to protect historic or archaeological properties listed on or eligible for listing on the NRHP through appropriate mitigation and treatment measures (30 CFR 784.17(b)). Appropriate mitigation and treatment measures may be implemented after permit issuance, provided that the required measures are completed before the properties are affected by any mining operation (30 CFR 780.31(b) and 784.17(b)).

As discussed above, the regulatory authority can designate lands where mining would have an adverse effect on a publically owned park or any place included on the NRHP (not just eligible for it) as unsuitable for mining in coordination with the federal, state, or local agency with jurisdiction over the park or place (30 CFR 761.11(c)). However, permit applications that involve adverse impacts on these resources are not uncommon, and regulatory authorities routinely grant approval of these operations once consultation requirements are successfully completed.

Under all regulatory programs, consultations with the SHPO or THPO during the permit process allow for avoiding impacts to these resources where possible, and where not possible, help to identify requirements for minimization and mitigation if the mining is allowed to move forward. Applicants sometimes choose to avoid the effect so that there is no need to pursue approval or to bear the cost or time delay associated with implementing mitigation required to resolve the effect.

National Historic Preservation Act of 1966 (54 U.S.C. § 300101 et seq.)

The NHPA requires federal agencies to take into account the effects of their undertakings on historic properties,[67] and to afford the ACHP a reasonable opportunity to comment 36 CFR 800.1(a). This procedure is commonly known as the "Section 106" process and the goal of consultation under this section is to identify historic properties potentially affected by the undertaking, assess its effects and seek ways to avoid, minimize or mitigate any adverse effects on historic properties (*Id*.). For specific properties, the federal agency taking the action determines eligibility of the resource in consultation with the appropriate SHPO or THPO (36 CFR 800.4).

The criteria for evaluation are broad so that a diversity of resources may be found eligible if they meet the criteria. To be eligible, properties must display significance in American history, architecture, archaeology, engineering, and culture and possess integrity of location, design, setting, materials, workmanship, feeling and association (36 CFR 60.4). In addition, eligibility for listing on the NRHP is determined with consideration to the following criteria (36 CFR 60.4):

- **Criterion A:** Properties associated with the events that have made a significant contribution to the broad patterns of American history; or
- **Criterion B:** Properties associated with the lives of persons significant in our past; or
- **Criterion C:** Properties that embody the distinctive characteristic of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction; or
- **Criterion D:** Properties that have yielded or may likely yield information important in prehistory or history.

[67] Historic properties as defined under the NHPA are any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion on the NRHP (36 CFR 800.16(l)). Historic properties under the NHPA may also include traditional cultural properties listed on the NRHP. This term "historic properties" corresponds to the phrase used in SMCRA and the implementing regulations "historic or archaeological resources listed or eligible for listing" (30 CFR 779.12b(1)).

The responsibilities of the SHPO or THPO under the NHPA extend to undertakings funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including those carried by or on behalf of a federal agency; those carried out with federal financial assistance; and those requiring a federal permit, license or approval (36 CFR 800.16(y)). The ACHP recognizes that federal agency influence on activities that take place on non-federal lands is generally limited to conditioning the assistance, permit, or license with stipulations setting what the recipient will do, not necessarily how the applicant will do it (ACHP, 2006).

The NHPA requires federal agencies to consult with federally recognized Indian tribes that attach religious or cultural significance to historic properties (54 U.S.C. § 302706(b)). The NHPA requires tribal consultation not only for tribal lands but also for ancestral homelands of an Indian tribe or tribes (36 CFR 800.2(c)(2)). Properties with traditional cultural significance may be eligible for inclusion in the NRHP. The National Register Bulletin 38 (Parker and King, 1992) justifies their inclusion by defining a traditional cultural property (TCP) as one that is "eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community." Such properties may be a simple, unmodified location, a mountain peak, a rural community, an urban neighborhood, or any other place that holds important meaning for a community. TCPs may be encountered across the country. States with extant Native American lands and populations might be expected to contain more TCPs than other parts of the country. The extremely variable nature of TCPs, and their often secret nature and poor documentation, makes it impracticable to learn or describe the TCP resources of each state here in this DEIS.

Methodologies for cultural resource evaluations and treatment of artifacts retrieved from archaeological sites are contained in the implementing regulations for the NHPA at 36 CFR Part 63 (Determination of Eligibility for Inclusion in the National Register) and 36 CFR Part 79 (Curation of Federally-Owned and Federally Administered Archaeological Collections). Artifacts recovered from private lands during archaeological surveys and excavation during the course of Section 106 review are usually the property of the landowner, unless state or local law mandates otherwise. Human remains are generally covered under specific laws. On federal land, human remains are addressed under NAGPRA (43 CFR Part 10); on non-federal lands, state laws would apply.

The NHPA requires resolution of adverse effects only for impacts to resources listed or eligible for listing on the NRHP, as discussed in the implementing regulations at 36 CFR 800.6. Despite data from cultural resources inventories, sites and resources remain unknown, and it is therefore possible that inadvertent impacts could occur to previously unidentified sites during mining. The NHPA recognizes this possibility and includes procedures to address post discovery situations as they arise (36 CFR 800.13).

Archaeological Resources Protection Act (16 U.S.C. § 470aa-470mm)

The ARPA and its implementing regulations at 43 CFR Part 7, addresses legitimate archaeological investigation on public lands and provides for enforcement actions against vandals and looters of these resources. Section 9 of ARPA specifically prohibits the release of information concerning the nature and location of archaeological sites excavated or removed under an ARPA permit unless the federal land manager determines that releasing the information furthers the purposes of ARPA and will not create a risk of harm to the resources (16 U.S.C. § 470hh). The purposes of ARPA as set out at 16 U.S.C. § 470aa are: "to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands, and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals. . ." Therefore, information from archaeological sites on private lands or non-federal public lands is protected under ARPA.

4.3.5.2 Action Alternatives and Potential Effects on Archaeological, Paleontological and Cultural Resources

Additional impacts to cultural and paleontological resources from the rule elements would only occur if the element increases the area of ground disturbance related to the mining operation or shifts the operation from one area to another area of differing probability for containing these resources. Therefore, the majority of the discussion of impacts of the rule elements on topography, geology and soils also applies to the discussion of impacts on cultural and paleontological resources. To the extent that any particular rule element reduces the extent of ground disturbance associated with mining, it would also reduce the disturbance of cultural resources located within that ground. Therefore cultural resources may benefit from some or all of the rule elements.

Protection of the Hydrologic Balance

Baseline Data Collection and Analysis

Baseline data collection has the potential to affect cultural and paleontological resources under all of the Alternatives under consideration; collection of this data is required under the No Action Alternative and would be expanded under most (all but Alternative 9) of the Action Alternatives. However, the likelihood of effects of this activity on cultural and paleontological resources is reduced due to the fact that direct impacts would be limited to the area of disturbance associated with the sampling, and in order for a direct impact to occur the sampling location would have to coincide with the location of the resources themselves. The regulatory authority would review these proposed activities during the permit process. The permit application package must identify cultural resources, and the location of the baseline data sampling activity could be adjusted to avoid impacts in most instances.

Monitoring During Mining and Reclamation

It is unlikely that activities related to this element would affect paleontological or cultural resources. Hydrologic monitoring itself requires little or no ground disturbance other than the installation of monitoring wells as discussed above, and avoidance of important resources should be possible in almost all circumstances.

Groundwater data is required under existing regulations of the No Action Alternative; several of the Action Alternatives (all but Alternative 9) would increase the list of analytes required and the frequency of data collection. Increasing the list of analytes and the frequency of collection would not increase the number of wells installed. However, the proposed revisions would also further clarify the findings that must be made based on this data, and as a result the number of wells installed on any particular mine site may increase under these Action Alternatives. The area of disturbance associated with a monitoring well is generally small-consisting of the roadway used to haul equipment to the well site, the area used during drilling, and the final installed well.

Increased monitoring requirements would also potentially increase impacts to paleontological and cultural resources as a result of changes to the mining operation that the improved data may show as necessary. The remedy to the problem may require a change to the ongoing mining operation, such as the rerouting of a drainage system or the construction of a new treatment pond, which would increase the area of disturbance. However, as with existing regulations, the regulatory authority would review these changes to the mining plan under existing SMCRA regulations that require identification of impacts to cultural resources and allow the regulatory authority to require mitigation.

Definition of Material Damage to the Hydrologic Balance

As with the collection of baseline data and subsequent monitoring, the result of the definition of material damage to the hydrologic balance could induce indirect effects on the area of disturbance. Alternatives 2, 3, 4, and 8 (Preferred) would therefore have a slightly increased risk of disturbance of these resources in comparison to Alternatives 1 (No Action), 5, 6, 7 and 9. However the requirements of the existing regulations pertaining to consideration of impacts at the permitting stage would continue to apply regardless; the regulatory authority would review these changes to the mining plan under existing SMCRA regulations, and would require mitigation identified through consultation as required.

Corrective Action Threshold

Corrective action thresholds are impact standards set lower than those established for material damage to the hydrologic balance and are designed to act as a warning system to prevent material damage to the hydrologic balance outside the permit area. Under the No Action Alternative, no corrective action thresholds exist and also are not proposed in Alternatives 5, 6, 8 (Preferred) and 9. The establishment of corrective action thresholds, as proposed in Alternatives 2, 3, 4, and, in certain circumstances, Alternative 7, could trigger a redesign in the mining operation. As described above for the other components of the elements related to protection of the hydrologic balance, the additional requirement of a corrective action threshold may introduce additional potential for ground disturbance and additional risk of impacts to cultural and paleontological resources.

Activities in Or Near Streams

Stream Definitions

Modifying the definition of streams may affect paleontological or cultural resources. Our existing regulations (the No Action Alternative) classify all watersheds one square mile or larger in size as intermittent streams. Alternatives 3, 5, 6 and 9 would make no change to this definition. However, Alternatives 2, 4, 7 (when warranted by the operation) and 8 (Preferred) would replace the watershed component of the definition with other determining characteristics. To the extent that this change would result in some streams (mostly in the arid and semiarid regions of the West) now protected as intermittent streams being reclassified as ephemeral streams, which lack the protections afforded to perennial and intermittent streams, there could be a direct effect on aquatic resources and the riparian zone associated with the stream through increased disturbance (as discussed in the other sections of this chapter). If those newly disturbed areas also contained paleontological or cultural resources this redefinition could result in an effect.

Mining through Streams

The predominant interpretation of the existing regulations (No Action Alternative) allows diversion and mining through intermittent and perennial streams when the regulatory authority makes a finding that diversion of the stream would not adversely affect water quantity, water quality, and related environmental resources of the stream (30 CFR 816.43(b) and 817.43(b)). Alternatives 2 and 7 (when enhanced permitting conditions apply) explicitly prohibit all mining activities in or within 100 feet of perennial streams but, with certain additional requirements as described elsewhere, allow mining through intermittent and ephemeral streams. However each of the Action Alternatives includes additional requirements related to restoration of mined through streams, and these additional requirements may deter some applicants from proposing these activities and therefore reduce the amount of disturbance of resources through avoidance.

Impacts to paleontological and cultural resources would occur during the excavation of the streambed for the mining through activity, and due to the disturbance associated with creating a diversion channel to receive the water that would otherwise have flowed through the mined through stream. Mining through streams may have a higher risk of impact on cultural resources in comparison to mining in upland areas. Streams and stream side areas are attractive for many human uses and cultural practices; these areas may have a higher probability of containing artifacts than other areas that are farther from water. However, this probability must be evaluated carefully on a case-by-case basis because erosion and human manipulation may have changed the location and course of the water body substantially over time. As with the No Action Alternative, if proposed impacts to the stream would affect NRHP eligible resources, consultation requirements under NHPA and SMCRA would apply.

Activities in or Near Streams, Including Placement of Excess Spoil and Coal Refuse

Under the No Action Alternative, mining activities within 100 feet of intermittent or perennial streams are prohibited unless the regulatory authority specifically authorizes activities closer to or through the stream. Such authorization requires a finding that the mining activities would not cause or contribute to the violation of applicable state or federal water quality standards and would not adversely affect the water quantity or quality or other environmental resources of the stream.

The Action Alternatives would increase the stringency of the requirements governing mining activities near streams as well as the placement of excess spoil and coal refuse at these locations. All Action Alternatives would require minimization of excess spoil creation. The proposed new requirements would potentially indirectly benefit paleontological and cultural resources because the requirements to minimize excess spoil creation would result in less area needed to accept the excess spoil, thereby potentially reducing the likelihood of impacted areas containing cultural or paleontological resources. The benefits may be minor; not all areas contain these resources, and existing regulations already contain requirements for identification and protection as described previously.

These impacts would continue under all of the Action Alternatives; all of the Action Alternatives allow mining through streams to some extent although Alternatives 2 and 4 (and 7 when special conditions exist) would prohibit mining through perennial streams. However each of the Action Alternatives (excluding Alternative 9) includes additional requirements related to restoration of mined through streams, and these additional requirements may deter some applicants from proposing these activities and therefore reduce the amount of disturbance of resources through avoidance.

Approximate Original Contour (AOC) Variances and Surface Configuration

SMCRA requires that the permittee backfill and grade the mined area to its AOC, which means a surface configuration that closely resembles the premining surface configuration and that blends into and complements the drainage pattern of the surrounding terrain. However, the No Action Alternative contains no numerical standards for use in determining when this requirement has been achieved. SMCRA and the existing regulations (the No Action Alternative) provide for a number of exceptions to the requirement to restore mined land to AOC. Those exceptions include operations with thin or thick overburden, certain remining operations, mountaintop removal mining operations, and steep-slope mining operations.

While the Action Alternatives (excluding Alternative 9) propose changes to these regulations this topic has little relevance to paleontological or cultural resources since it pertains to the return of the land to specified conditions after the mining has occurred; any disturbance of paleontological or cultural resources would have occurred before this point in the operation (e.g., during site preparation and overburden removal).

Postmining Land Use and Enhancement

Revegetation, Soil Management, and Reforestation

This rule element pertains to the handling of soils during overburden removal for the purposes of salvaging their potential as a growing medium during reclamation, and requirements for revegetating after the mining activity. The No Action Alternative emphasizes use of native species in revegetation, although introduced species are permitted under certain conditions. Salvage, storage, and redistribution of topsoil (the A and E soil horizons) are required for all operations with exceptions for prime farmland.

Additional requirements under the Action Alternatives (excluding Alternative 9) for salvage of organic materials and soils (as described in Chapter 2) may have a Minor Beneficial impact on paleontological and cultural resources by increasing the amount of handling of the soil and therefore the potential for discovery of unearthed artifacts that were not known to be in the area. The Action Alternatives (excluding Alternative 9) would pose no additional negative risks because these specific proposed requirements would not increase the area of disturbance. Temporary storage of these materials typically occurs in the areas already disturbed, through phasing of the mining and reclamation activities.

Fish and Wildlife Protection and Enhancement

The No Action Alternative prohibits mining activity likely to jeopardize endangered or threatened species. Likewise, current regulations require the enhancement of fish and wildlife resources where practicable, and contain specific provisions applicable to power lines, haul and access roads, fences, and toxic industrial ponds. Existing regulations also require avoidance of disturbances to, restoration, or replacement of wetlands, riparian vegetation, and other habitats of unusually high value for fish and wildlife.

The Action Alternatives (excluding Alternative 9) contain elements designed to further protect and enhance fish, wildlife, and related environmental resources. The new requirements include establishment or restoration of a minimum 100-foot (Alternatives 2, 5, 6, 7, and 8 (Preferred)) or 300-foot (Alternatives 3 and 4) riparian corridor comprised of native species along intermittent, perennial, and (sometimes) ephemeral streams. To the extent that this element reduces the overall spatial extent of mining it could also in turn reduce the potential for disturbance of paleontological or cultural resources if the avoided areas contain these resources.

4.4 ENVIRONMENTAL JUSTICE

This section of Chapter 4 identifies communities that meet defined environmental justice criteria and explains the potential effects of the Action Alternatives on these communities.

This section:

- Identifies sensitive minority, low-income, and American Indian populations; and
- Discusses the potential impacts of the Action Alternatives on these populations, including impacts on socioeconomic resources, public health and safety, biological resources, water resources, air quality, topography, land use, and recreation.

Environmental justice requires the balanced treatment of all individuals with respect to the development, implementation, and enforcement of environmental regulations, laws, and policies. Likewise, it calls for the meaningful inclusion and representation of all parties in the decision-making process of new environmental statutes (U.S. EPA, 1998). In accordance with Executive Order 12898, the purpose of considering environmental justice in the context of implementing a new regulation is to ensure that adverse human health and environmental effects are not disproportionately experienced by minority and low-income populations. This section addresses potential environmental justice effects emanating from the Action Alternatives as compared to the No Action Alternative.

The intent of an environmental justice evaluation under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low Income Populations" (1994), is to identify communities and groups that meet environmental justice criteria, and suggest strategies to reduce potential adverse impacts of projects on affected groups. The purpose of Executive Order 12898 is to identify and address the disproportionate placement of adverse environmental, economic, social, or health impacts from federal actions and policies on minority and/or low-income communities. This order requires lead agencies to evaluate impacts on minority or low-income populations during preparation of environmental and socioeconomic analyses of projects or programs that are proposed, funded, or licensed by federal agencies.

4.4.1 Identification of Sensitive Minority, Low-Income, and American Indian Populations

According to the Council on Environmental Quality (CEQ) and EPA guidelines established to assist federal and state agencies, a minority population is present in a project area if (1) the minority population of the affected area exceeds 50 percent, or (2) the minority-population percentage of the affected area is meaningfully greater[68] than the minority-population percentage in the general population or other appropriate unit of geographic analysis. By the same rule, a low-income population exists if the project area consists of 50 percent or more people living below the poverty threshold, as defined by the U.S. Census Bureau, or is meaningfully greater[69] than the poverty percentage of the general population or other appropriate unit of geographic analysis.

Per Executive Order 12898, minorities are defined as individuals of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. This analysis also considered the minority groups "Two or More Races" and "Other."

The CEQ guidance indicates that when agencies determine whether environmental effects are "disproportionately high and adverse," they are to consider whether there is or would be an impact on the natural or physical environment (as defined by NEPA) that would adversely affect a minority population or low-income population. None of the published guidelines define the term "disproportionately high and adverse," but CEQ includes a non-quantitative definition stating that an effect is disproportionate if it appreciably exceeds the risk or rate to the general population (CEQ, 1997).

The affected area for this analysis is large and spans a variety of demographic conditions. In total, the affected area contains seven coal regions encompassing 286 counties in 24 states. The

[68] The term "meaningfully greater" is not quantitatively defined and is therefore interpreted independently for each federal analysis that considers environmental justice populations. A survey of eight recent analyses, including several environmental impact statements for coal projects, revealed thresholds for "meaningfully greater" populations ranging from 1.2 to three times larger than the general geographic area. This analysis uses a threshold within this range to identify meaningful environmental justice populations. In the context of this study, a minority population in a study area was considered meaningfully greater if it was greater than or equal to two times (double) the minority population percentage at the state level.

[69] In the context of this study, a low-income population in a study area was considered meaningfully greater if it was greater than or equal to two times (double) the low-income population percentage at the state level.

analysis was conducted at a county level to determine if any of the 286 counties contain populations that meet environmental justice criteria. Indian Tribes are considered as a distinct category in the minority population environmental justice analysis (see Section 4.4.3).

Table 4.4-1 presents those counties that have a minority population that meets the environmental justice criteria. A county was included in Table 4.4-1 if (1) the minority population was greater than 50 percent of the county population, or if (2) the minority population in the county made up a percent of the population that was at least double the percent of the minority population at the statewide level.

Table 4.4-1a
Black or African American Minority Populations within Coal-Producing Counties

County	State	Region	Percent Population Minority (County)	Percent Population Minority (State)	Ratio of County to State Minority Population
McDowell	West Virginia	Appalachian Basin	9.5%	3.4%	2.79
Christian*	Kentucky	Illinois Basin	21.2%	7.8%	2.72
Raleigh	West Virginia	Appalachian Basin	8.2%	3.4%	2.41
Kanawha	West Virginia	Appalachian Basin	7.3%	3.4%	2.15
St. Clair	Illinois	Illinois Basin	30.5%	14.5%	2.10
Kemper*	Mississippi	Gulf Coast	60.1%	37.0%	1.62

Table 4.4-1b
American Indian and Alaskan Native Minority Populations within Coal-Producing Counties

County	State	Region	Percent Population Minority (County)	Percent Population Minority (State)	Ratio of County to State Minority Population
Big Horn	Montana	Northern Rocky Mountains and Great Plains	64.3%	6.3%	10.21
Navajo	Arizona	Colorado Plateau	43.4%	4.6%	9.43
McKinley	New Mexico	Colorado Plateau	75.5%	9.4%	8.03
Kemper*	Mississippi	Gulf Coast	3.7%	0.5%	7.40
Rosebud	Montana	Northern Rocky Mountains and Great Plains	34.7%	6.3%	5.51
La Plata	Colorado	Colorado Plateau	5.8%	1.1%	5.27
San Juan	New Mexico	Colorado Plateau	36.6%	9.4%	3.89
McCreary	Kentucky	Appalachian Basin	0.7%	0.2%	3.50
Barbour	West Virginia	Appalachian Basin	0.6%	0.2%	3.00
Christian*	Kentucky	Illinois Basin	0.6%	0.2%	3.00
Huerfano	Colorado	Northern Rocky Mountains and Great Plains	3.2%	1.1%	2.91
Sebastian*	Arkansas	Western Interior	1.9%	0.8%	2.38
Craig	Oklahoma	Western Interior	20.4%	8.6%	2.37
De Kalb*	Alabama	Appalachian Basin	1.4%	0.6%	2.33
Jackson	Alabama	Appalachian Basin	1.4%	0.6%	2.33
Nowata	Oklahoma	Western Interior	19.1%	8.6%	2.22
Las Animas*	Colorado	Northern Rocky Mountains and Great Plains	2.4%	1.1%	2.18
Crittenden	Kentucky	Illinois Basin	0.4%	0.2%	2.00
Gallia	Ohio	Appalachian Basin	0.4%	0.2%	2.00
Jackson	Ohio	Appalachian Basin	0.4%	0.2%	2.00
Martin	Kentucky	Appalachian Basin	0.4%	0.2%	2.00
Vinton	Ohio	Appalachian Basin	0.4%	0.2%	2.00

Table 4.4-1c
Asian, Native Hawaiian or Other Pacific Islander Minority Populations within Coal-Producing Counties

County	State	Region	Percent Population Minority (County)	Percent Population Minority (State)	Ratio of County to State Minority Population
Monongalia	West Virginia	Appalachian Basin	3.1%	0.7%	4.43
Sebastian*	Arkansas	Western Interior	4.2%	1.4%	3.00

Table 4.4-1d
Hispanic Origin Minority Populations within Coal-Producing Counties

County	State	Region	Percent Population Minority (County)	Percent Population Minority (State)	Ratio of County to State Minority Population
De Kalb*	Alabama	Appalachian Basin	13.6%	3.9%	3.49
Maverick	Texas	Gulf Coast	95.7%	37.6%	2.55
Webb	Texas	Gulf Coast	95.7%	37.6%	2.55
Blount	Alabama	Appalachian Basin	8.1%	3.9%	2.08
Las Animas*	Colorado	Northern Rocky Mountains and Great Plains	41.6%	20.7%	2.01
Atascosa	Texas	Gulf Coast	61.9%	37.6%	1.65

Table 4.4-1e
Other Minority Populations within Coal-Producing Counties

County	State	Region	Percent Population Minority (County)	Percent Population Minority (State)	Ratio of County to State Minority Population
De Kalb*	Alabama	Appalachian Basin	9.9%	2.0%	4.95
Sebastian*	Arkansas	Western Interior	7.4%	3.4%	2.18
Carbon	Wyoming	Northern Rocky Mountains and Great Plains	6.5%	3.0%	2.17
Sweetwater	Wyoming	Northern Rocky Mountains and Great Plains	6.4%	3.0%	2.13
Blount	Alabama	Appalachian Basin	4.1%	2.0%	2.05
Adams	Colorado	Northern Rocky Mountains and Great Plains	14.6%	7.2%	2.03

Notes for tables a through e:
Source: U.S. Census Bureau, 2013. Census 2010; adapted from Table 3.14-2.
*County appears twice in the table set because they meet the criteria for more than one minority group.

American Indians have a greater representation within several coal region counties than they do within the rest of the state in which those counties are located. Most notably, Big Horn and Rosebud counties in the Northern Rocky Mountains and Great Plains region, Navajo, McKinley, and La Plata counties in the Colorado Plateau region, and Kemper County in the Gulf Coast region all have American Indian populations that are at least five times greater, as a percent of the population, than American Indian populations for the states in which the counties are located.

Five counties appear in Table 4.4-1 for at least two different minorities. These are Christian County in Kentucky (Black/African-American and American Indian), De Kalb County in Alabama (American Indian, Hispanic Origin, and Other), Kemper County in Mississippi (Black/African-American and American Indian), Las Animas County in Colorado (American Indian and Hispanic Origin), and Sebastian County in Arkansas (American Indian, Asian, and Other).[70]

Table 4.4-2 presents those counties that have a low-income population that meets the environmental justice criteria. A county was included in Table 4.4-2 if (1) the low-income population was greater than 50 percent of the county population, or if (2) the low-income population in the county made up a percent of the population that was at least double the percent of the low-income population at the statewide level. Using these criteria, no counties in the study area had a low-income population that made up more than 50 percent of the total county population.

[70] It should be noted that "Hispanic Origin" is classified as an ethnicity and not a race. On the U.S. Census form, an individual may self-identify as both a particular race and of Hispanic origin. As such, duplicate representation of counties in the table may be due, in part, to multiple answers supplied by a single individual.

Table 4.4-2
Coal-Producing Counties with Meaningfully Greater Low-Income Populations

County	State	Region	Percent Population Below Poverty Line (County)	Percent Population Below Poverty Line (State)	Ratio of County to State Population Below Poverty Line
Wolfe	Kentucky	Appalachian Basin	42.1%	18.1%	2.33
Buchanan	Virginia	Appalachian Basin	24.0%	10.7%	2.26
Jackson	Illinois	Illinois Basin	29.1%	13.1%	2.22
Owsley	Kentucky	Appalachian Basin	39.3%	18.1%	2.17
Athens	Ohio	Appalachian Basin	31.5%	14.8%	2.14
Lee	Virginia	Appalachian Basin	22.7%	10.7%	2.13
Martin	Kentucky	Appalachian Basin	37.6%	18.1%	2.08
Wise	Virginia	Appalachian Basin	21.6%	10.7%	2.03
Clay	Kentucky	Appalachian Basin	36.5%	18.1%	2.02
Knox	Kentucky	Appalachian Basin	36.4%	18.1%	2.01
Dickenson	Virginia	Appalachian Basin	21.3%	10.7%	2.00

Source: U.S. Census Bureau, 2013. Census 2010; adapted from Table 3.14-5.

As shown, of the 286 counties in the study area, 11 counties have a percent of the population living below the poverty line that is at least twice that of the statewide average. Unlike the minority populations discussed above, the low-income populations of concern are geographically concentrated: of the eleven counties, ten are located in the Appalachian Basin region, five in Kentucky, four in Virginia, and one in Ohio.

Table 4.4-3 summarizes the tables presented above and presents all the counties within the study area that have populations that meet the previously specified environmental justice criteria. This table is organized by region and includes counties identified as environmental justice concerns for either minority or low-income criteria.

Table 4.4-3a
Potentially Affected Environmental Justice Populations in the Appalachian Basin

State	County	Potentially Affected Environmental Justice Population
Alabama	Blount	Hispanic Origin, Other
	De Kalb	American Indian and Alaskan Native, Hispanic Origin, Other
	Jackson	American Indian and Alaskan Native
Kentucky	Clay	Low-income
	Knox	Low-income
	Martin	American Indian and Alaskan Native, Low-income
	McCreary	American Indian and Alaskan Native
	Owsley	Low-income
	Wolfe	Low-income
Ohio	Athens	Low-income
	Gallia	American Indian and Alaskan Native
	Jackson	American Indian and Alaskan Native
	Vinton	American Indian and Alaskan Native
Virginia	Buchanan	Low-income
	Dickenson	Low-income
	Lee	Low-income
	Wise	Low-income
West Virginia	Barbour	American Indian and Alaskan Native
	Kanawha	Black or African American
	McDowell	Black or African American
	Monongalia	Asian, Native Hawaiian or Other Pacific Islander
	Raleigh	Black or African American

Table 4.4-3b
Potentially Affected Environmental Justice Populations in the Colorado Plateau

State	County	Potentially Affected Environmental Justice Population
Arizona	Navajo	American Indian and Alaskan Native
Colorado	La Plata	American Indian and Alaskan Native
New Mexico	McKinley	American Indian and Alaskan Native
	San Juan	American Indian and Alaskan Native

Table 4.4-3c
Potentially Affected Environmental Justice Populations in the Gulf Coast

State	County	Potentially Affected Environmental Justice Population
Mississippi	Kemper	Black or African American, American Indian and Alaskan Native
Texas	Maverick	Hispanic Origin
	Webb	Hispanic Origin
	Atascosa	Hispanic Origin

Table 4.4-3d
Potentially Affected Environmental Justice Populations in the Illinois Basin

State	County	Potentially Affected Environmental Justice Population
Illinois	St. Clair	Black or African American
	Jackson	Low-income
Kentucky	Christian	Black or African American, American Indian and Alaskan Native
	Crittenden	American Indian and Alaskan Native

Table 4.4-3e
Potentially Affected Environmental Justice Populations in the Northern Rocky Mountains and Great Plains

State	County	Potentially Affected Environmental Justice Population
Colorado	Adams	Other
	Huerfano	American Indian and Alaskan Native
	Las Animas	American Indian and Alaskan Native, Hispanic Origin
Montana	Big Horn	American Indian and Alaskan Native
	Rosebud	American Indian and Alaskan Native
Wyoming	Carbon	Other
	Sweetwater	Other

Table 4.4-3f
Potentially Affected Environmental Justice Populations in the Western Interior

State	County	Potentially Affected Environmental Justice Population
Arkansas	Sebastian	American Indian and Alaskan Native, Asian, Native Hawaiian or Other Pacific Islander, Other
Oklahoma	Craig	American Indian and Alaskan Native
	Nowata	American Indian and Alaskan Native

Of the 286 counties in the study area, there are 44 counties that have populations that meet the previously specified environmental justice thresholds. Of the 44 counties, 50 percent of them are in the Appalachian Basin. Of those counties in the Appalachian Basin, nine have been identified as low-income environmental justice communities, 12 as minority communities, and one as both. The minority communities identified as potentially affected environmental justice populations in this region are as follows: Black or African American; American Indian and Alaskan Native; Asian, Native Hawaiian or Other Pacific Islander; Hispanic Origin; and Other.

There were four counties in the Colorado Plateau identified as potentially affected environmental justice populations, all with American Indian and Alaskan Native minority populations. In the Gulf Coast region, four counties had populations that met the criteria for environmental justice minority populations (Black or African American, American Indian and Alaskan Native, and Hispanic Origin).

Four counties in the Illinois Basin also met the criteria for environmental justice populations, for low-income and minority populations. One county was identified for low-income populations and the remaining three for minority populations: Black or African American; and American Indian and Alaskan Native. In the Northern Rocky Mountains and Great Plains region all seven counties identified have environmental justice minority populations: American Indian and Alaskan Native; Hispanic Origin; and Other. In the Western Interior all three counties identified met environmental justice criteria for American Indian and Alaskan Native minority populations.

One of the counties also has minority populations of Asian, Native Hawaiian or Other Pacific Islander and Other that meet environmental justice criteria.

Mining occurs in close proximity to or on a number of tribal reservations. The Northern Cheyenne Indian Reservation is situated in both Big Horn and Rosebud Counties in Montana where five active surface mines exist. In addition, the Crow Indian Reservation covers nearly 65 percent of Big Horn County. San Juan County overlaps both the Navajo Nation Reservation and the Ute Mountain Reservation where one active surface mine and one active underground mine exist. The Zuni Reservation is located primarily in McKinley County where two active surface mines exist. McKinley County also overlaps with the Navajo Nation Reservation. Navajo County in Arizona is comprised of the Navajo Nation Reservation, the Fort Apache Reservation, and the Hopi Reservation where one active surface mine exists.

Of particular note are mines located on (not just near) tribal land. For example, the Navajo Mine and the Kayenta Mine are operated on the Navajo Nation lands and produce about 15 million tons of coal annually (U.S. EIA, 2012c). An additional coal mine, the Absaloka Mine, is located on the Crow Reservation in Montana.

4.4.2 Discussion of Potential Impacts to Minority, Low-Income, and American Indian Populations

As stated previously, the purpose of Executive Order 12898 is to identify and address the disproportionate placement of adverse environmental, economic, social, or health impacts from federal actions and policies on minority and/or low-income communities. Impacts disproportionately experienced by minority and low-income populations may be environmental, economic, social, or human health related. This analysis examines any negative or positive impacts on these parameters resulting from changes to coal mining under the Action Alternatives as compared to the No Action Alternative. In particular, the analysis considers the manner in which impacts of the Action Alternatives may interact with existing cultural, social, occupational, historical, or economic factors defining minority, low-income, and Indian Tribe groups such that the adverse effects are amplified and experienced disproportionately by these environmental justice populations.

4.4.2.1 Socioeconomic Conditions

Overall, coal production is expected to decrease under the implementation of the Action Alternatives (excluding Alternative 9) as compared to the No Action Alternative.[71] The negative economic impacts resulting from this reduced coal production may be disproportionately experienced by the minority, low-income, and American Indian environmental justice populations previously identified. However, the adverse economic effects are not expected to be uniform across coal regions. Section 4.3.1 provides a sense of the socioeconomic impacts of the Action Alternatives by region. Economic impacts would be expected to be especially notable in places in which the identified environmental justice population is particularly dependent on the revenue streams associated with coal production. There may also be more direct effects where

[71] Coal production is unchanged under Alternative 9 when compared to the No Action Alternative.

the coal mine is owned and operated by the minority population. For instance, the Navajo Transitional Energy Company (NTEC), a Navajo Company, is the owner and operator of the Navajo surface coal mine in San Juan County New Mexico.

- Under Alternatives 2, 3, 6, 7 and 8 (Preferred): the Appalachian Basin, Illinois Basin, and Northern Rocky Mountains and Great Plains are expected to incur adverse socioeconomic effects; Negligible effects are expected for all other regions. In the Appalachian Basin, ten counties have populations that meet the criteria for low-income environmental justice communities and 12 for minority populations, with one county falling into both categories. In the Illinois Basin, four counties have an American Indian and Alaskan Native environmental justice population. In seven counties in the Northern Rocky Mountains and Great Plains region there are three environmental justice minority populations: Asian, Native Hawaiian, Pacific Islander, or Other; Hispanic Origin; and Other. Negligible effects on socioeconomic conditions are expected for all other regions.
- Under Alternative 4: the Appalachian Basin and Illinois Basin are expected to incur Moderate and Minor Adverse socioeconomic effects. In the Appalachian Basin, ten counties have populations that meet the criteria for low-income environmental justice communities and 12 for minority populations, with one county falling into both categories. In the Illinois Basin, four counties have an American Indian and Alaskan Native environmental justice population. The Northern Rocky Mountains and Great Plains region is expected to experience Minor Beneficial socioeconomic effects. Negligible effects on socioeconomic conditions are expected for all other regions.
- Under Alternative 5: the Appalachian Basin is expected to incur Moderate Adverse Socioeconomic effects. In the Appalachian Basin, ten counties have populations that meet the criteria for low-income environmental justice communities, 12 meet the criteria for minority populations, and one county falls into both categories. Minor Adverse socioeconomic effects are expected in the Northern Rocky Mountains and Great Plains region, and there are three environmental justice minority populations in that region (as mentioned previously). Negligible effects on socioeconomic conditions are expected for all other regions.
- Under Alternative 9: Negligible effects on socioeconomic conditions are expected for all regions.

4.4.2.2 Public Health and Safety

Across all regions and Alternatives, health impacts are expected to range from Negligible to Major Beneficial; no adverse health impacts are expected. Beneficial impacts to health, such as reduced exposure to contaminants in drinking water would generate an overall beneficial effect on health and safety.

4.4.2.3 Biological Resources, Water Resources, and Air Quality

Under the Action Alternatives, environmental effects, including water quality and forest land restoration are generally expected to be positive (other than under Alternative 9). Depending on the specific environmental resource and the Alternative, the beneficial effects are anticipated to range from minor to major. Under all of the Action Alternatives and across all regions, effects on air quality, greenhouse gas emissions, and climate change are expected to be beneficial or negligible. Therefore, effects on identified environmental justice communities are expected to be beneficial or negligible with respect to biological resources, water resources, and air quality.

4.4.2.4 Topography and Land Use

Topography, geology, and soils are expected to experience beneficial or negligible impacts under the Action Alternatives. Similar impacts are expected for land use, utilities, infrastructure, visual resources, and noise. Across all Action Alternatives and regions, no adverse impacts are expected for these resources. Therefore, effects on identified environmental justice communities are expected to be beneficial or negligible with respect to topography and land use.

4.4.2.5 Recreation

Recreational resources are also predicted to experience beneficial impacts as a result of the Action Alternatives (other than Alternative 9). Participation in hunting, fishing, and wildlife viewing is high among American Indians (U.S. FWS, 2006a), suggesting that positive impacts to such recreational opportunities may be amplified within these communities. Additionally, frequent hunting is closely tied to food consumption in rural Appalachia (Wenrich et al., 2010). To the extent that these communities use areas that benefit from the Action Alternatives, these communities may experience greater positive impacts on wildlife and hunting.

4.4.3 Discussion of Other Effects Specific to Native American Tribes

The U.S. Census identifies 20 “American Indian Areas” and six “Alaska Native Village Statistical Areas” (ANVSA) within the coal-producing regions studied in this DEIS. These include reservations, off-reservation trust lands, and statistical areas that include populations of Native Americans and Alaska Natives. These areas, mapped in Section 3.14, overlap potentially minable coal within coal-producing counties across the U.S., and coal mining often occurs on or in close proximity to a number of reservations.

As mentioned previously and discussed in Section 3.14, this analysis gives particular emphasis to the Navajo, Hopi, Northern Cheyenne, and Crow Tribes, the four tribes listed in the Surface Mining Control and Regulation Act (SMCRA) (30 U.S.C. § 1300(i)). The Navajo Nation Reservation occupies northeastern Arizona, southeastern Utah, and northwestern New Mexico. The Hopi Reservation lies entirely within the Arizona portion of the Navajo Reservation. The Northern Cheyenne Reservation and Off-Reservation Trust Land and Crow Reservation and Off-Reservation Trust Land lie adjacent to one another in southeastern Montana.

In general, the potentially affected Native American tribes are less affluent than the broader national population. Median household income is less than the national statistic in 18 of the 20 examined “American Indian Areas.” Employment by industry for the 20 American Indian areas and six ANVSAs is presented in Table 3.14-20 in Section 3.14. While specific data regarding employment in the coal mining industry is not available for these populations, the Agriculture, Forestry, Fishing, and Hunting, and Mining (including but not limited to coal mining) industries account for 18 percent of total employment in the Uintah and Ouray Reservation and Off-Reservation Trust Land. In the Navajo Nation and Northern Cheyenne Reservations and Off-Reservation Trust Lands, Agriculture, Forestry, Fishing, and Hunting, and Mining account for nearly four percent of total employment. In the Crow and Hopi Reservations and Off-Reservation Trust Lands, these industries make up 14.4 percent and 4.6 percent of total employment. To the extent that the proportion of American Indians working in the coal industry is greater than that of the statewide population, the projected reduction in coal production, under all the Action Alternatives (excluding Alternative 9), would have a disproportionate burden on these environmental justice communities.

There are four primary federal laws applicable to protection of all cultural resources on federal lands: the Antiquities Act of 1906, the National Historic Preservation Act (NHPA), the National Environmental Policy Act (NEPA), and the Paleontological Resources Preservation Act. Nothing in the Action Alternatives alters the protections offered by these public laws or their implementing rules and regulations. Together these four laws and their accompanying rules provide a strong basis for protection for any cultural properties that may be encountered when coal mining occurs on federal lands.

In addition, for all coal mining permit applications (including those on private lands), SMCRA regulations under 30 CFR 761.11(g) require permit applications, reclamation plans, and operations plans to prohibit mining within 100 feet of any cemetery. The identification of important historic and archaeological resources are covered under 30 CFR 779.12(b)(2) and 783.12(b)(2). Lastly, under 30 CFR sections 780.31 (surface mining) and 784.17 (underground mining), for any publicly owned parks or any places listed on the National Register of Historic Places that may be adversely affected by the proposed operation, each reclamation and operation plan must describe the measures to be used to prevent adverse impacts.

Nothing in the Alternatives proposes to alter or change regulations that are protective of archaeological and paleontological resources in any way. Any effects from the Alternatives on cultural, archaeological, or paleontological properties would be indirect and negligible (see Section 4.3.5) and would therefore have minimal potential for additional impacts to any sensitive environmental justice population.

4.5 CUMULATIVE IMPACTS

This section of Chapter 4 presents projected cumulative impacts for the Action Alternatives. This section:

- Describes the background and scope of cumulative impact analyses;
- Identifies and describes past, present, and reasonably foreseeable future actions that could interact with the Alternatives; and
- Presents an assessment of the cumulative impacts by resource and Alternative.

4.5.1 Background and Scope

NEPA requires all environmental impact statements for proposed federal actions to include a cumulative effects analysis that examines the impact of the actions in conjunction with other factors that affect the physical, biological, and socioeconomic resource components of the affected environment (40 CFR 1508.25). NEPA defines a cumulative impact as an "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions" (40 CFR 1508.7). Guidelines for evaluating cumulative effects, prepared by the Council on Environmental Quality (CEQ), emphasize the growing evidence that "the most devastating environmental effects may result not from the direct effect of a particular action, but from the combination of individually minor effects of multiple actions over time" (CEQ, 1997).

The previous sections of Chapter 4 have examined direct and indirect impacts of the Alternatives. This chapter assesses cumulative impacts by considering the direct/indirect impact of the Alternatives in combination with past, present, and reasonably foreseeable future actions as of 2014. Specifically, cumulative impacts are assessed with respect to each of the major resource categories, including:

- Water resources;
- Biological resources;
- Geology, soils, and topography;
- Air quality, greenhouse gas emissions, and climate change;
- Socioeconomic conditions;
- Land use, utilities, infrastructure, visual resources, and noise;
- Public health and safety;
- Archaeological, paleontological, and cultural resources; and
- Recreation.

As described below, this analysis identifies a spatial and temporal boundary for considering cumulative impacts to each resource. Within that boundary, the analysis identifies past, present and reasonably foreseeable future actions that affect the same resources. Finally, the analysis summarizes the impacts of these actions in combination with the proposed action and considers their context and expected intensity in order to characterize potential cumulative impacts.

As established earlier in this document, the overall geographic scope for the analysis in this DEIS includes the seven major U.S. coal mining regions. The spatial boundary for cumulative impact analysis is defined by considering the point where the resource is no longer affected or the effects are no longer significant. This approach facilitates examination of actions that would impact the resources within a resource-specific, meaningful boundary, instead of an arbitrarily defined geographic boundary. The geographic scope of this analysis is at the coal region level.[72] Within this scope, the analysis determines the characteristics of each of the following resources in each region as follows:

- **Water resources**: The analysis evaluates cumulative impacts within a "typical watershed" in each region. For example, considering number and types of streams, and the existing regulatory environment in each region.
- **Biological resources**: The analysis evaluates cumulative impacts at the regional level considering the typical land cover profile of a watershed in the region and the suite of species, including federally listed species, potentially present in any given watershed.
- **Geology, soils, and topography**: This cumulative impact analysis considers typical geologic, soil, and topographic characteristics at a regional level. For example, the existing regulatory environment (e.g., approximate original contour (AOC) requirements), the disposal of coal mine waste, and the treatment of excess spoil are among the factors considered to determine what is typical within a region.
- **Air quality**: The analysis focuses on the emissions profiles, including greenhouse gases, of typical mines within each region and national level regulations governing air quality.
- **Socioeconomic impacts**: Socioeconomic conditions are characterized at the regional level based on county and state specific data on demography, income and employment, and taxes. Evaluation of cumulative impacts considers regional and national trends in these variables.
- **Land use, visual resources, and noise**: To evaluate the cumulative impacts this analysis considers typical land uses, visual resources, and noise levels existing before, during, and after mining operations at a regional scale.
- **Public health and safety**: Potential public health and safety impacts are characterized at regional and national levels.
- **Archaeology, paleontology, and cultural resources**: In practice, evaluation of these resources occurs at the site-specific level. This analysis considers archaeological, paleontological, and cultural resources at a regional level, and notes that these would be relevant to the extent that these resources exist in mining locations.
- **Recreation impacts**: Cumulative impacts consider types and levels of recreation occurring in typical watersheds in each region.

The temporal scope of the cumulative effects analysis was also determined based on the resource under consideration. The analysis presented here seeks to identify past, present, and reasonably foreseeable future actions that interact with the current actions. In some cases, relevant past

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[72] Where the spatial boundary is defined as regional, this refers to the seven major U.S. coal mining regions discussed previously. Where the spatial boundary is defined at a smaller scale, e.g., the watershed, local, or site-specific scale, the analysis was based on a general interpretation of normal circumstances and activities expected to occur in these areas rather than on any specific location.

actions may have been introduced in previous decades, but still have an enduring impact on the management or condition of the resource. The analysis considers only future actions that are reasonably foreseeable, i.e., those that have been explicitly proposed or which are approved but have not yet begun. The analysis avoids speculating on the trajectory or impact of rules and actions that are in formative stages of development.

The diverse set of affected resources, combined with the broad geographic and temporal scope of the SPR, makes cumulative impact analysis highly challenging. Indeed, simply identifying the full suite of past, present, and future actions affecting water resources in coal mining areas in the U.S. is not feasible. For example, dozens, if not hundreds, of federal, state, and local laws and regulations could be perceived as being relevant to protecting the quality of water resources in streams affected by mining. Furthermore, an array of individual projects (e.g., dam construction, dredging), permitting decisions, and economic trends could further influence water quality. Identifying and accounting for all of these factors is not practical, and prediction of cumulative impacts based on such an approach would be speculative. Because it is practically infeasible to characterize every potentially relevant cumulative action in all coal-producing areas in the U.S., the analysis focuses on identifying the primary actions – particularly those that may combine with the Alternatives to produce noteworthy cumulative effects. This approach is consistent with CEQ guidance, which states that "a cumulative effects analysis should 'count what counts,' not produce superficial analyses of a long laundry list of issues that have little relevance to the effects of the proposed action on eventual decisions" (CEQ, 1997).

4.5.2 Past, Present, and Reasonably Foreseeable Actions

A large set of past, present, and reasonably foreseeable future actions could interact with the Alternatives. These include:

- Past mining at sites that have not subsequently been reclaimed (abandoned mine lands)
- Regulatory actions directly related to mining and surface (e.g., stream) water quality;
- Coal-fired power plant rules that could affect coal demand;
- Overall trends in the coal mining industry and energy markets;
- Other trends that affect resources in the study area and that may alter the cumulative impacts of the proposed actions; and
- Other secondary regulatory actions.

Each of these actions has the potential to affect multiple resources. The subsections that follow review these actions and trends and associate them with each of the resource categories under consideration.

4.5.2.1 Regulatory Actions Related to Mining and Surface Water Quality

Several major federal and state laws and regulations currently protect streams from impacts associated with coal mining. First, the Surface Mining Control and Reclamation Act of 1977 (SMCRA) forms the legal backdrop to analyses in this DEIS. A description of relevant SMCRA provisions can be found in Chapter 2, and specific aspects of SMCRA have been discussed here in Chapters 3 and 4. Apart from SMCRA, several additional statutes and regulations figure directly into the discussion of mining and its influence on surface water quality:

Past and Present Actions

- SMCRA: Title IV of the SMCRA (as implemented through regulations contained at 30 CFR Parts 870 – 887) establishes the abandoned mine reclamation program. This program provides for reclamation and restoration of land and water resources adversely affected by past coal mining, including but not limited to reclamation and restoration of abandoned surface mine areas, abandoned coal processing areas, and abandoned coal refuse disposal areas; sealing and filling abandoned deep mine entries and voids; planting of land adversely affected by past coal mining to prevent erosion and sedimentation; prevention, abatement, treatment, and control of water pollution created by coal mine drainage including restoration of stream beds, and construction and operation of water treatment plants; prevention, abatement, and control of burning coal refuse disposal areas and burning coal in situ; prevention, abatement, and control of coal mine subsidence; and establishment of self-sustaining, individual State administered programs to insure private property against damages caused by land subsidence resulting from underground coal mining in those States which have approved programs.

- **Clean Water Act**: Congress passed the Clean Water Act (CWA) in 1972 as amendments to the Federal Water Pollution Control Act. It is the primary legal foundation for restoring and maintaining the chemical, biological, and physical integrity of U.S. waters. Three components of the CWA are most relevant to coal mining operations:

    - **Section 303** of the CWA establishes water quality standards and calls for EPA and the states to identify impaired water bodies not attaining these standards. Those listed waters are subject to Total Maximum Daily Load (TMDL) procedures through which point and nonpoint pollutant sources are assigned allowable loadings of key pollutants. If near a listed stream, any new mining operation must demonstrate that proposed mining activity will not result in exceedance of the applicable TMDL.
    - **Section 402** of the CWA establishes the National Pollutant Discharge Elimination System (NPDES). The NPDES program issues permits to industrial point source and other pollutant dischargers (e.g., municipal stormwater systems). The permits contain numerical limits on the allowed concentration of pollutants; if monitoring indicates that the permit holder has exceeded the concentration (or overall loadings limits), the permit holder is subject to monetary penalties. Existing and new coal mines must obtain a NPDES permit.
    - **Section 404** of the CWA establishes the permit provisions governing dredging and filling of streams and wetlands. Under the program, any discharge of fill or dredge material must be authorized by a permit issued by the U.S. Army Corps of Engineers. Coal mining operations that place spoils in streams or wetlands must hold a Section 404 permit.[73]
- **State Regulatory Authorities**: State regulatory programs implementing the CWA and SMCRA play an important role in managing the water quality impacts of mining. In

[73] EPA issued guidance on implementation of the surface coal mining activities in Appalachia in 2011. The guidance was intended to clarify EPA's roles and expectations in permitting surface coal mining operations under Section 402 and 404 of the CWA. However, in 2013, this guidance was repealed and is not considered in this analysis.

areas where coal mining occurs outside of federal programs, state programs exist that manage coal mining activities and issue SMCRA permits. Some states (e.g., West Virginia) have developed policies that provide protections that may be more stringent than current SMCRA requirements.[74] Some state regulatory authorities currently have clauses in their programs directing authorities to adopt laws or regulations that are "no more stringent than" the federal SMCRA program. EPA authorizes state environmental agencies to administer components of the CWA. For example, all states where coal mining occurs have approval to issue NPDES permits.

Reasonably Foreseeable Future Actions

- **Coal Combustion Residue Placement at Coal Mines Rule**: OSMRE is currently developing specific regulations and preparing an Environmental Assessment under NEPA for protection of the environment when operators or owners place coal combustion residuals (CCRs) at active and abandoned coal mines regulated under the SMCRA. The National Academy of Science published a report in 2006 on managing CCRs in mines that recommended the establishment of enforceable federal standards that provide explicit authority and minimum safeguards for the placement of CCRs in mines.
- **OSMRE Temporary Cessation of Operations Rule**: OSMRE is revising regulations governing the temporary cessation of coal mining. The proposed rule would require regulatory approval of cessation of operations and limit the duration of cessation. The rule would ensure that a temporary cessation of operations is not used to delay reclamation, that safety and environmental controls are in place, and that cessation of operations is well defined.
- Blasting Rule: On April 18, 2014, OSMRE received a petition for rulemaking from WildEarth Guardians requesting that OSMRE "promulgate a rule prohibiting the production of visible nitrogen oxide emissions during blasting at surface coal mining operations in order to protect public and mine worker health, welfare, and safety, and prevent injury to persons, as required by the Surface Mining Control and Reclamation Act of 1977 (SMCRA)." On July 25, 2014, OSMRE published the petition in the Federal Register (79 FR 43326). On February 20, 2015, the Director's decision to grant the petition in principle was published in the Federal Register (80 FR 9256). OSMRE staff are currently developing a proposed rule that would require the regulatory authority to consider protections for persons and private property with regard to fume generation from blasting operations.

4.5.2.2 Rulemakings Related to Coal-Fired Power Plants

Federal regulators are currently engaged in several rulemakings that will directly affect coal-fired electricity generating units (EGUs) in the U.S. To the extent that these rules cause power producers to substitute natural gas and other alternatives for coal, they will reduce future coal consumption and production from baseline levels. Such changes may adversely impact coal jobs

[74] In 2000, West Virginia developed its own policy on AOC and Excess Spoil Disposal (known as the "AOC+" policy), and Kentucky followed suit in 2009 with its Reclamation Advisory Memorandum (RAM) regarding the "Fill Placement Optimization Process" (known as the RAM 145 policy).

while benefiting the environment (as a result of decreased coal mining). As reviewed later in this section, these effects may combine with the Action Alternatives to produce noteworthy cumulative effects. While EPA has published a formal proposal for some of these rulemakings, others are at an earlier stage of development. These rules and their status as of 2015 are as follows:

Past Actions

- **Mercury and Air Toxics Standards**: Intended as a replacement for the Clean Air Mercury Rule, which was vacated in 2008, this rule establishes emission standards for mercury and other hazardous air pollutants from U.S. power plants. EPA issued the final rule in December 2011. In March 2013, EPA finalized updates to certain emissions limits for new power plants. After reviewing public comments and petitions EPA reconsidered the provisions applicable during periods of startup and shutdown. The reconsideration of startup and shutdown provisions was finalized in November 2014.

- **Cross-state Air Pollution Rule (CSAPR)**: This rule requires power plants in 27 states to reduce emissions that contribute to ambient ozone and/or fine particle pollution. EPA finalized the rule on July 6, 2011, replacing the Clean Air Interstate Rule. In a separate, but related, regulatory action, EPA finalized a supplemental rulemaking on December 15, 2011 to require five states (Iowa, Michigan, Missouri, Oklahoma, and Wisconsin) to make summertime NOX reductions under the CSAPR ozone season control program. In December 2011 the rule was stayed prior to implementation and then vacated in 2012. The appeals court lifted the hold in October 2014, allowing EPA to begin rule implementation.

- **Cooling Water Intake Structures Rule**: EPA developed regulations under Section 316(b) of the CWA to limit injury and death of fish and other aquatic life caused by cooling water intake structures at existing power plants. EPA published a proposed rule for these regulations in March 2011 and, after a number of modified settlement agreements, published the final rule in May of 2014.

Clean Power Plan (Proposed Rule): In June of 2014, the U.S. EPA proposed standards for reducing carbon emissions from existing power plants. States are charged with developing plans that will meet the targeted emissions reductions (30 percent by 2030, relative to 2005 levels). EPA and industry analysts anticipate that many of the reductions will be met through retirement of older, less efficient coal-fired power plants. Such a response could reduce demand for coal, particularly coal from Appalachian producers (Ritenbaugh, 2014).

Present Actions

- **Coal Combustion Residuals (CCRs) Rule**: In June 2010, EPA proposed regulations under Resource Conservation and Recovery Act (RCRA) to address the risks from the disposal of CCRs generated from coal combustion at electric utilities and independent power producers. EPA published a final rule in the *Federal Register* on April 17, 2015 (80 FR 21302).

Reasonably Foreseeable Future Actions

- **Greenhouse Gas New Source Performance Standards (NSPS) for EGUs:** This rule is expected to establish the first set of new source performance standards for greenhouse gas emissions, focusing on CO_2 emissions standards for fossil fuel-based electrical generating facilities. EPA concluded the regulatory review in September 2013 and anticipates publication of the rule in the *Federal Register* in August 2015.

As is discussed below, most of these rulemakings focus on air quality improvement; the residuals rule and the cooling water rule target water and biological resource protection. In addition, all of them may have implications for the competitiveness of coal in broader energy markets.

4.5.2.3 Non-Regulatory Trends

Factors affecting the resources are not restricted to laws and regulations, but may also include economic trends, market factors, and litigation outcomes in the coal industry and other industries with intensive land uses.

Trends in Coal Markets and the Coal Industry

The Action Alternatives would interact with ongoing developments in the coal industry, possibly producing noteworthy cumulative effects on the resources under consideration. This is especially true for socioeconomic considerations because employment impacts associated with the Action Alternatives may occur in the context of other industry trends.

Section 4.1 of this DEIS reviews the coal mining industry and discusses trends in production and markets. Major points include the following:

- Underground coal production is expected to grow in coming years, as the industry exploits stores of high-value metallurgical coal (met coal), working seams that would be unprofitable to mine at steam-coal prices.
- Electric power generation is the most important market for domestic coal; the electric power generation sector accounted for 80 percent of U.S. coal production in 2012. U.S. electricity energy demand is expected to grow at a 0.9 percent annual rate through 2040 (U.S. EIA, 2013d). However, small changes in the electricity market can influence both short and long-term demand for domestic coal.
- In 2013, coal was the source of approximately 39 percent of all electricity produced in the U.S. (U.S. EIA, 2014a). Overall, coal use is decreasing because of declines in natural gas prices, giving natural gas-fired combined cycle capacity a cost advantage over coal in many parts of the country.
- Industries, such as steel, iron, and cement manufacture, rely on coal for energy. Thus, fluctuations in these markets can also cause changes in coal demand.
- The EIA reports that U.S. coal exports have grown significantly in recent years, particularly exports of metallurgical coal. From 2000 to 2010, coal producers exported about five percent of their product; in 2012, exports had grown to 12 percent. To the extent that international demand for coal continues to grow, U.S. producers may benefit.

- Coal company consolidation has been a trend in recent years within the coal industry, and additional consolidation is possible, particularly in regions with declining production. The implications of consolidation are unclear, but may signal future production cutbacks.
- In coming years, court decisions or settlements could affect the cost-competitiveness of coal relative to other fuels. In particular, litigation involving compensation for miners experiencing long-term health effects could potentially produce costly settlements.
- Throughout history, the regulatory environment surrounding the coal industry has fluctuated. This environment is likely to continue to experience changes in the coming years. Future regulations may impact production and demand in ways that are impossible to predict.

Other Land Use Trends

Trends in non-mining industries with intensive land uses also represent important actions that could affect cumulative outcomes. The importance of these land use trends for the subject resources is highly region-specific. Drawing on findings presented in Chapter 3, the analysis considers three key land use trends: forestry, agriculture/grazing, and growth/development.

Forestry Trends

Coal mining occurs in a variety of settings, but watersheds affected by coal mining are also commonly affected by forestry activities, particularly in the eastern U.S. (Louisiana Forestry Association, 2011; Piva and Cook, 2011; Texas Almanac, 2014). It is not uncommon for forestry and coal mining activities to occur in the same location as timber often needs to be removed to allow transport of coal mining equipment. Thus, trends in commercial forestry represent land use changes that could interact with the Alternatives to influence cumulative impacts on key resources. Most notably, forestry practices can affect water quality through pollutant runoff and sedimentation of streams. Likewise, the intensity and method of the forestry activities can influence the availability and quality of terrestrial wildlife habitat.

Coal regions where forestry is a significant land use include the following:

- Approximately 60 percent of land in the Appalachian Basin is deciduous forest and several large National Forests exist in the region. While trends vary by sub-region, some portions of the Appalachian Basin have seen increased timber harvests in recent years. For instance, West Virginia production of industrial roundwood roughly doubled from 1979 to 2007, totaling nearly 190 million cubic feet (Piva and Cook, 2011).
- In the Gulf Coast region, Mississippi and Louisiana have extensive commercial forestry operations. Forest products were the highest value crop harvested in Louisiana in 2010, worth over three billion dollars (Louisiana Forestry Association, 2011). In Mississippi, the timber harvest was valued at $1.1 billion in 2013 (Mississippi State University, 2014). In addition, the Texas timber industry is concentrated almost exclusively in the northeast portion of the state (near Louisiana), meaning that it is almost fully contained in the Gulf Coast coal region (Texas Almanac, 2014). The delivered value of Texas timber was roughly $500 million in 2011.

State forestry programs may promote best management practices (BMPs) that are intended to protect water resources, among other resources. For example, Tennessee's BMP guide recommends practices such as establishment of streamside buffer zones, soil stabilization through reforestation, and use of sediment control structures (Tennessee Department of Agriculture, 2003). In conjunction with the proposed action, these BMPs could reduce forestry impacts such as sedimentation and riparian vegetation removal.

Agriculture Trends

Agriculture, including crop cultivation and livestock operations, is a significant contributor to water quality impairment. In EPA's 2000 National Water Quality Inventory, states reported that agricultural nonpoint source pollution was the leading source affecting water quality in rivers and lakes. Runoff of nutrients from cropland can cause eutrophication and oxygen depletion in receiving waters, and excessive pesticide use can also contaminate surface and groundwater. Improperly managed livestock operations can allow nutrients and pathogens to contaminate surface and groundwater. Likewise, excessive grazing can lead to soil erosion and sedimentation of surrounding surface waters.

Coal regions where agriculture and grazing have the greatest potential to interact with mining to affect cumulative impacts include the following:

- Relative to the other coal-producing regions, the Illinois Basin has the greatest amount of cultivated cropland. Cropland accounts for over 48 percent of the land use in this coal region. Illinois had approximately 22 million acres of harvested cropland in 2012, roughly unchanged from 2007. The total value of all agricultural products sold in 2012 was about $17.2 billion, up significantly from 2007 when sales totaled $13.3 billion (USDA, 2014).
- Livestock grazing is common in several coal-producing regions. In the Western Interior region, pasture and grazing operations account for over 38 percent of the land use in Kansas and Oklahoma. Likewise, the Gulf Coast region is over 26 percent pastureland.

Land Use Change

Economic growth can introduce environmental stress that could affect resources in coal-producing regions. Most notably, population growth typically brings increased land clearing and conversion of unimproved lands or croplands to buildings, roads, and other infrastructure. These changes in the landscape reduce the habitat available for wildlife, thereby influencing biological resources. In addition, growth can greatly alter natural water cycles as surface and groundwater is withdrawn for consumptive use, treated, and discharged. Furthermore, urban land uses typically increase impervious surfaces, leading to increased stormwater runoff. This runoff can produce increased loadings of pollutants such as nutrients, sediment, and metals in waterways. As such, growth and urbanization has the potential to interact with coal mining practices to place greater stress on many resources, particularly surface water, groundwater, and biological resources.

Development can also occur through conversion of land that has been farmed for crops or livestock. Because agricultural runoff from agricultural practices may have degraded water quality in these areas, conversions of this type may have fewer adverse effects on local water quality than would conversions of unimproved land.

Population growth is the driver for the land use and water quality changes described above. The socioeconomic section of Chapter 3 describes demographic trends in the coal-producing regions. In the period from 2000 to 2010, the coal regions seeing the greatest growth tended to be those in western states. The Northern Rocky Mountains and Great Plains region showed a 21 percent growth in population during this period, making it the fastest growing coal region. Other rapidly growing regions include the Colorado Plateau and the Gulf Coast regions. In terms of 2010 population, the most populous coal regions are the Appalachian Basin and the Illinois Basin.

4.5.2.4 Other Secondary Regulatory Actions

In addition to the major actions and trends described above, numerous other actions have the potential to produce the types of additive or countervailing effects relevant to assessing cumulative effects. In particular, these may include state and local regulations and ordinances, which vary by location, as well as other federal actions that apply to particular activities at particular geographic locations. As noted, the geographic, temporal, and policy scope of the Alternatives is so great that care must be taken to ensure that additional laws and regulations are considered, while properly bounding the analysis. Relevant laws and regulations were identified through review of past coal mining EISs, other EISs, and on-line resources compiling laws and regulations applicable to coal mining (BIA, 2014). A brief description of each law or regulation is provided in the Table 4.5-1table, which summarizes the actions and trends considered in the cumulative effects analysis.

4.5.2.5 Summary of Actions

Table 4.5-1 briefly summarizes all the actions and trends, both major and secondary, and identifies the resources that each action affects most directly. For each relevant resource/action combination, the table uses a positive sign ("+") to indicate that the action generally tends to benefit the resource, or a negative sign ("-") if the action is more likely to affect the resource adversely. It is important to note that the impact of each action/trend is complex and may have adverse as well as beneficial impacts on resources depending on the particular project or site. Thus, assigning a single positive or negative sign to an action will not fully capture the more nuanced effects of these actions/trends. For example, implementation of CWA initiatives may not universally result in beneficial impacts to biological resources; however, the general conclusion that improvements in water quality should benefit biological resources as well is reasonable for purposes of this analysis. Likewise, CWA initiatives may have negative effects on socioeconomic resources including employment demand. However, these initiatives may also have beneficial socioeconomic effects through increases in compliance-related employment demand and reduced pollution.

Table 4.5-1
Actions and Trends Considered in Cumulative Effects Analysis

Action/Trend	Status*	Relevance	Water	Bio-logical	Geo-logy	Air	Socio-economic	Land Use	Recrea-tion	Archeo-logical	Health
Clean Water Act, Section 303	P	Establishes water quality standards and identifies impaired waters.	+	+			-		+		+
Clean Water Act, Section 402	P	Establishes NPDES permit program for point source discharges to surface waters.	+	+			-		+		+
Clean Water Act, Section 404	P	Establishes permit system governing dredging and filling of streams and wetlands.	+	+			-				
State Mining Regulations and Programs	P	State regulations may supplement SMCRA regulations.					-			+	+
OSMRE Coal Combustion Residue Rules	F	Would establish environmental protections when coal combustion residues are disposed at mines.	+	+							
OSMRE Temporary Cessation of Operations Rule	F	Would better define cessation of mining operations and limit delays in reclamation.	+	+	+			+	+		+
Clean Power Plan	F	Proposed standards for limiting carbon emissions at power plants. Could affect coal demand.				+	-				
Proposed New Source Performance Standards (NSPS) for Greenhouse Gas Regulation	F	EPA proposed standards in 2012 for the regulation of greenhouse gases released by fossil fuel-fired power plants. Final rule projected to be published in January, 2015. Could affect coal demand.				+	-				
Mercury and Air Toxics Standards	P	Establishes emission standards for mercury and other hazardous air pollutants from U.S. power plants. Could affect coal demand.				+	-				
Cross-State Air Pollution Rule	P	Requires power plants to reduce emissions of particulates and ozone precursors. Could affect coal demand.				+	-				
Coal Combustion Residuals Rule (EPA)	P	Would establish new rules for disposal of ash from coal-fired power plants. Could affect coal demand.	+	+			-				

Action/Trend	Status*	Relevance	Water	Bio-logical	Geo-logy	Air	Socio-economic	Land Use	Recrea-tion	Archeo-logical	Health
Cooling Water Intake Structures Rule	P	Establishes rules to limit injury to aquatic species during cooling water intake. Could affect coal demand.		+			-				
Coal Market Trends	P, F	Economic trends and market factors that may affect demand for coal. See text for details.					-				
Forestry Trends	P, F	Commercial timber harvesting can affect water quality, terrestrial wildlife habitat, and soil and erosion patterns.	-	-	-		+		-	-	
Agriculture and Grazing Trends	P, F	Cropping and livestock operations can affect soil erosion, nonpoint source runoff, and water quality.	-	-	-				-	-	
Land Use Change	P, F	Demographic changes and urban land uses can affect wildlife habitat, stormwater runoff, and water quality.	-	-			+	-	-	-	
Mine Improvement and New Emergency Response Act (2006)	P	Calls for mine-specific emergency response plans at underground mines. Could mitigate potential risk associated with increased underground mining.					-				+
Emergency Watershed Protection (EWP) Program administered by the Natural Resource Conservation Service under section 216 of P.L. 81-516	P	Undertakes emergency measures when flood, fire, drought, erosion, etc. cause a sudden impairment of the watershed. 2005 rule expanded the program to include procedures for sediment deposition restoration and conservation.	+	+	+			+	+	+	+
Endangered Species Act (ESA) of 1973	P	Provides for the protection and recovery of imperiled species and their habitat. Permitting and conduct of coal mining under SMCRA must be coordinated with ESA requirements.		+							
Federal Mine Safety and Health Act of 1977	P	Requires the Department of Labor's Mine Safety and Health to inspect mines for worker safety.					-				+
Safe Drinking Water Act (SDWA)	P	Main federal law that ensures the quality of drinking water in the U.S. EPA sets standards for regulating specific contaminants. Part 141 establishes health	+								+

Action/Trend	Status*	Relevance	Water	Bio-logical	Geo-logy	Air	Socio-economic	Land Use	Recrea-tion	Archeo-logical	Health
		standards, maximum contaminant levels (MCLs) and MCL goals for public water systems. Part 143 establishes secondary MCLs for aesthetic standards for public waterway systems.									
OSMRE's Abandoned Mine Land Reclamation Program		The Abandoned Mine Land Reclamation Program is OSMRE's largest program and one of OSMRE's primary responsibilities under SMCRA. Since SMCRA's enactment in 1977, the AML program has collected over $10.1 billion in fees from present-day coal production and distributed more than $7.6 billion in grants to states and tribes, mandatory distributions to the UMWA and OSMRE's operation of the national program to reclaim land and waters damaged by coal mining before the law's passage.	+	+				+	+	+	+
BLM's Abandoned Mine Lands Program	P	Administered by the Bureau of Land Management, protects public safety and water quality by reducing the effects of abandoned hardrock mines. Objectives include restoration of fish and wildlife habitat.	+	+				+	+	+	+
Soil and Water Resources Conservation Act of 1977	P	Provides for the U.S. Department of Agriculture to possess information, technical expertise, and a system for conservation and use of soils, plants, woodlands, and watersheds.	+	+	+			+		+	
Wild and Scenic Rivers Act (WSR)	P	Protects rivers and riparian areas that possess important scenic, recreational, fish and wildlife, and geologic values.	+	+	+			+	+		
Forest Service Manual (FSM) 2520, Watershed Protection and Management	P	USFS's program for maintaining or improving watershed conditions in National Forests. Activities include monitoring, riparian management,	+	+	+				+	+	

Action/Trend	Status*	Relevance	Water	Bio-logical	Geo-logy	Air	Socio-economic	Land Use	Recrea-tion	Archeo-logical	Health
		floodplain management, and emergency response.									
Forest Service Manual (FSM) 2380, Forest Service Scenery Management System of 2003	P	Any long term impacts on USFS visual resources fall under these standards which require the use of best management practices (BMPs) to mitigate impacts; USFS may require that some areas be returned to planned visual quality objectives within a certain time frame.						+	+	+	
National Trail System Act	P	Provides for preservation of, public access to, travel within, and enjoyment of outdoor areas through a national trail system. Jointly managed by the Bureau of Land Management, National Park Service, and USFS.						+	+		
National Wildlife Refuge System Administration Act (NWRSA)	P	Legislation establishing the National Wildlife Refuge System overseen by the U.S. Fish and Wildlife Service.		+					+		
Wilderness Act of 1964	P	Legislation establishing the National Wilderness Preservation System managed by the Bureau of Land Management.	+	+	+				+	+	
Noise Control Act of 1972 and EPA Noise Control Regulations	P	Federal legislation for regulation of noise pollution in order to protect human health. Administered through noise control regulations originally promulgated by EPA and now overseen by state and local governments.						+			+
State Water Quality Regulations (examples)											
Pennsylvania's "The Clean Streams Law" Act of 1937, P.L. 1987	P	Protects public health, animal and aquatic life, industrial use, and recreational use of water by regulating supply and quality of Pennsylvania waters.	+	+					+		+
Kentucky Wild Rivers Act of 1972	P	Establishes the Wild Rivers Program to protect and preserve the scenic, fish and	+	+					+	+	+

Action/Trend	Status*	Relevance	Water	Bio-logical	Geo-logy	Air	Socio-economic	Land Use	Recrea-tion	Archeo-logical	Health
		wildlife, geological, cultural and recreational values of Kentucky rivers.									
Ohio Coastal Nonpoint Pollution Control Program Plan 2000	P	Ohio’s plan to reduce runoff from cropland, parking lots, lawns, mines, and septic systems into surface and groundwater.	+	+					+		+

It is essential to note that these designations do not indicate long-term anticipated trends in the quality or health of the resource. For instance, while a permit program such as NPDES may be designed to improve long-term water quality, the permits themselves explicitly allow the discharge of pollutants to water bodies. While the NPDES program may produce a long-term benefit relative to a scenario where discharges occur without regulatory controls, some pollution of surface water will continue. This same observation is true for several of the regulatory programs identified as past and present actions, including those related to filling and dredging (CWA Section 404), and air emissions.

4.5.3 Assessment of Cumulative Impacts by Resource

The following discussion describes the cumulative impacts of the Action Alternatives when combined with other past, present, and reasonably foreseeable future actions. The analysis recognizes that in most cases the contribution to the cumulative impacts for a given resource from implementing the Action Alternatives would be difficult to discern, at a broad programmatic level across the U.S., given the context and intensity of impacts from the other past, present, and future actions. In most situations, implementation of one of the Action Alternatives would likely help reduce long-term adverse impacts on the resource by providing a certain level of offsetting benefits. This is especially true when the Action Alternatives are considered in combination with other actions of similar intent (e.g., point source discharge permitting, river conservation initiatives, etc.).

Given the scope of the Action Alternatives, their cumulative effects are best considered in a qualitative framework. Table 4.5-2 addresses each affected resource, summarizing the likely cumulative effects. First, the table notes the direct and indirect effects that each Action Alternative has on the identified resources, as determined in the resource-specific sections of Chapter 4. The table then identifies the relevant set of past, present, and future actions associated with the resource, as discussed above. Finally, the table designates, for each Action Alternative, the likely cumulative effect. Essentially, the cumulative impact designation can be considered as the outcome of adding the direct and indirect effects of the Action Alternative to the impacts of a set of past, present, and reasonably foreseeable actions relevant to the resource. Adding these effects yields a basic characterization of potential cumulative impacts of all relevant actions on the resource. Each of the resource-specific subsections below applies this structure in considering cumulative effects.

The analysis designates several cumulative effect classifications:

- "Beneficial or countervailing cumulative effect" means that, in combination with other actions and trends, the Alternative is expected to result in either a net increase in beneficial impacts or a net reduction in adverse impacts to the resource.

- "Negative cumulative effect" means that, in combination with other actions and trends, the Alternative is expected to result in a net increase in adverse effects to the resource.

- "Neutral cumulative effect" means that, in combination with other actions and trends, the Alternative is expected to produce little or no discernible effect on the resource.

- “Indeterminate cumulative effect” means that the combined effect of the Alternative, in combination with other actions and trends, is difficult to characterize with confidence given the mix of countervailing influences.

Table 4.5-2a
Cumulative Effects on Water Resources

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Major Beneficial	• OSMRE Temporary Cessation of Operations Rule • Clean Water Act, Section 303 • Clean Water Act, Section 402 • Clean Water Act, Section 404 • Safe Drinking Water Act • Abandoned Mine Lands Program • Soil and Water Resources Conservation Act • Wild and Scenic Rivers Act • Forest Service Manual (FSM) 2520, Watershed Protection and Management • NRCS Emergency Watershed Protection Program • OSMRE Coal Combustion Residue Rules • State water quality regulations • General coal market trends • Regional forestry trends • Regional agriculture and grazing trends • Regional growth and development trends	Beneficial or countervailing cumulative effect
3	Major Beneficial	See above	Beneficial or countervailing cumulative effect
4	Major Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
6	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
7	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
8	Major Beneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2b
Cumulative Effects on Biological Resources

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Moderate Beneficial	• OSMRE Temporary Cessation of Operations Rule • Clean Water Act, Section 303 • Clean Water Act, Section 402 • Clean Water Act, Section 404 • Endangered Species Act • Cooling Water Intake Structures Rule • Abandoned Mine Lands Program • Soil and Water Resources Conservation Act • Wild and Scenic Rivers Act • Forest Service Manual (FSM) 2520, Watershed Protection and Management • National Wildlife Refuge System Administration Act • Wilderness Act • State water quality regulations • General coal market trends • Regional forestry trends • Regional agriculture and grazing trends • Regional growth and development trends	Beneficial or countervailing cumulative effect
3	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
4	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
6	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
7	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
8	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2c
Cumulative Effects on Topography, Geography, and Soils

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Minor Beneficial	• OSMRE Temporary Cessation of Operations Rule • Emergency Watershed Protection (EWP) Program • Soil and Water Resources Conservation Act of 1977 • Wild and Scenic Rivers Act (WSR) • Forest Service Manual (FSM) 2520, Watershed Protection and Management • General coal market trends • Regional forestry trends • Regional agriculture and grazing trends	Beneficial or countervailing cumulative effect
3	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
4	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
6	Negligible	See above	Neutral cumulative effect
7	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
8	Minor **B**eneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2d
Cumulative Effects on Air Quality Greenhouse Gas Emissions, and Climate Change

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Minor Beneficial	• Clean Power Plan • Proposed New Source Performance Standards (NSPS) for Greenhouse Gas Regulation • Mercury and Air Toxics Standards • Cross-State Air Pollution Rule	Beneficial or countervailing cumulative effect
3	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
4	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
6	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
7	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
8	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2e
Cumulative Effects on Social and Economic Resources

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Moderate Adverse	• Clean Water Act, Section 303 • Clean Water Act, Section 402 • Clean Water Act, Section 404 • State mining regulations • Clean Power Plan • Proposed New Source Performance Standards for Greenhouse Gas Regulation • Mercury and Air Toxics Standards • Cross-State Air Pollution Rule • Coal Combustion Residuals Rule • Cooling Water Intake Structures Rule • Mine Improvement and New Emergency Response Act • Federal Mine Safety and Health Act • General coal market trends • Regional growth and development trends	Negative cumulative effect[2]
3	Minor Adverse	See above	Negative cumulative effect[2]
4	Minor Adverse	See above	Negative cumulative effect[2]
5	Minor Adverse	See above	Negative cumulative effect[2]
6	Minor Adverse	See above	Negative cumulative effect[2]
7	Minor Adverse	See above	Negative cumulative effect[2]
8	Minor Adverse	See above	Negative cumulative effect[2]
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2f
Cumulative Effects on Land Use, Utilities, Infrastructure, Visual Resources, and Noise

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Minor Beneficial	• Emergency Watershed Protection (EWP) Program • Soil and Water Resources Conservation Act of 1977 • Wild and Scenic Rivers Act (WSR) • Forest Service Manual (FSM) 2380, Forest Service Scenery Management System of 2003 • National Trail System Act • Noise Control Act of 1972 and EPA Noise Control Regulations • Regional growth and development trends	Indeterminate cumulative effect
3	Negligible	See above	Indeterminate cumulative effect
4	Negligible	See above	Indeterminate cumulative effect
5	Negligible	See above	Indeterminate cumulative effect
6	Negligible	See above	Indeterminate cumulative effect
7	Negligible	See above	Indeterminate cumulative effect
8	Negligible	See above	Indeterminate cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2g
Cumulative Effects on Public Health and Safety

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Moderate Major Beneficial	• State mining regulations • Mine Improvement and New Emergency Response Act • Federal Mine Safety and Health Act • Safe Drinking Water Act • Abandoned Mine Lands Program • Noise Control Act and associated regulations (federal and local) • State water quality regulations • Clean Water Act Section 303 permitting • Clean Water Act Section 402 permitting • Emergency Watershed Protection Program • General coal market trends	Beneficial or countervailing cumulative effect
3	Major Beneficial	See above	Beneficial or countervailing cumulative effect
4	Major Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
6	Moderate Beneficial	See above	Beneficial or countervailing cumulative effect
7	Moderate Major Beneficial	See above	Beneficial or countervailing cumulative effect
8	Major Beneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2h
Cumulative Effects on Archaeological, Paleontological, and Cultural Resources

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Negligible	• Antiquities Act of 1906 • Paleontological Resources Preservation Act of 2009 • National Historic Preservation Act • Historic Sites Act of 1935 • Historic and Archaeological Preservation Act of 1974 • Archaeological Resources Protection Act of 1979 • American Indian Religious Freedom Act of 1978 • Native American Graves Protection and Repatriation Act of 1996 • Regional growth and development trends • Regional forestry trends • Regional agriculture and grazing trends	Neutral cumulative effect
3	Negligible	See above	Neutral cumulative effect
4	Negligible	See above	Neutral cumulative effect
5	Negligible	See above	Neutral cumulative effect
6	Negligible	See above	Neutral cumulative effect
7	Negligible	See above	Neutral cumulative effect
8	Negligible	See above	Neutral cumulative effect
9	Negligible	See above	Neutral cumulative effect

Table 4.5-2i
Cumulative Effects on Recreation

Alternative	Direct and Indirect Effects[1]	Past, Present, and Reasonably Foreseeable Future Actions	Cumulative Effect
2	Moderate Beneficial	• Wild and Scenic Rivers Act • Forest Service Manual (FSM) 2380, Forest Service Scenery Management System of 2003 • National Trail System Act • National Wildlife Refuge System Administration Act • State water quality regulations • Clean Water Act Section 303 permitting • Clean Water Act Section 402 permitting	Beneficial or countervailing cumulative effect
3	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
4	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
5	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
6	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
7	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
8	Minor Beneficial	See above	Beneficial or countervailing cumulative effect
9	Negligible	See above	Neutral cumulative effect

Notes for tables a through i: [1] These findings are consistent with those reported in previous sections of this chapter.
[2] Negative effects anticipated from the Alternative in combination with other mining regulations, regulations on coal-fired power plants, and overall energy market trends.

4.5.3.1 Water Resources

As discussed in Section 4.2.1, the direct and indirect effects of the Action Alternatives on water resources are expected to be beneficial (except in the case of Alternative 9 where impacts are Negligible). These benefits occur as a result of improved baseline data collection; the use of enhanced water quality monitoring; improved definitions of material damage to the hydrologic balance; identification of corrective action thresholds; reduced stream filling; improved riparian buffer practices; and limitations on approximate original contour (AOC) variances. While the mix and nature of these requirements varies across the Action Alternatives, all are designed to yield benefits to water quality.

Second, the suite of other relevant past, present, and reasonably foreseeable future actions is complex, but the actions generally represent measures designed to benefit water resources. These include CWA permit programs; mining rules intended to improve or expedite restoration activities; stream conservation and management initiatives; and forestry and agricultural programs designed to limit water quality impacts. Water quality also is influenced by non-regulatory factors, such as trends in commercial forestry, crop cultivation, livestock operations, and urbanization associated with population and economic growth. The cumulative impact assessment incorporates these trends and acknowledges that they could run counter to the beneficial influence of regulatory and conservation initiatives. This is particularly true at a regional or local level where a particular trend (e.g., rapid growth in commercial forestry) is especially pronounced. However, at a national level, the regulatory and conservation initiatives may mitigate and outweigh the effect of specific trends adversely affecting water resources.

The Action Alternatives (excluding Alternative 9), in combination with other actions and trends, are likely to reduce adverse cumulative impacts on water resources. Therefore, Table 4.5-2 identifies the Alternatives as having a beneficial or countervailing cumulative effect, depending on local, regional, and site-specific factors. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.2 Biological Resources

As discussed in Section 4.2.2, the direct and indirect effects of the Action Alternatives on biological resources are expected to be beneficial (except in the case of Alternative 9 where impacts are Negligible). Requirements related to expanded data collection, improved monitoring, materials damage definitions, and corrective action levels are expected to benefit instream and riparian habitat, as well as the species dependent upon that habitat. Furthermore, restrictions on activities in or near streams as well as improvements to postmining restoration would benefit terrestrial and aquatic habitat.

The suite of past, present, and reasonably foreseeable future actions is similar to those noted for water resources. These include water quality programs; mining rules intended to improve or expedite restoration activities; habitat conservation and management initiatives; and forestry and agricultural programs designed to conserve watershed integrity. Biological resources are influenced by non-regulatory factors, such as trends in commercial forestry and land use changes associated with increased population and urbanization. The cumulative impact assessment incorporates these trends and acknowledges that they could partially reverse the beneficial influence of regulatory and conservation initiatives. This is particularly true at a regional or local level where a particular trend (e.g., rapid growth in commercial forestry) is especially pronounced. However, at a national level, the regulatory and conservation initiatives likely mitigate the effect of specific trends affecting biological resources.

The Action Alternatives (excluding Alternative 9), in combination with other actions and trends, are likely to reduce adverse cumulative impacts on biological resources. Therefore, the analysis designates the Alternatives as having a beneficial or countervailing cumulative effect, depending on local, regional, and site-specific factors. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.3 Geology, Soils, and Topography

As discussed in Section 4.2.3, the direct and indirect effect of the Action Alternatives on topography, geology, and soils is expected to be beneficial, except in the case of Alternatives 6 and 9 for which impacts are Negligible. Restrictions on activities in or near streams (e.g., mining through streams, spoil management) as well as limitations on AOC variances and improved surface configuration techniques would have direct benefits for natural topography and geological resources under most of the Action Alternatives. Likewise, requirements for improved topsoil management and revegetation would benefit this resource category directly. Requirements related to improved monitoring, material damage to the hydrologic balance definitions, and corrective action levels are expected to indirectly benefit geology and soil resources.

For geological resources, the relevant past, present, and reasonably foreseeable future actions include erosion control programs, watershed protection programs, and habitat conservation programs. Geological resources also are influenced by non-regulatory factors, such as land use activities with extensive impacts on soils; these include commercial forestry, agriculture, and livestock grazing. In some coal-producing regions, these non-regulatory activities may partially counteract the beneficial influence of regulatory and soil conservation initiatives.

Overall, most of the Action Alternatives, in combination with other actions and trends, are likely to reduce adverse cumulative impacts on geology, soils, and topography. Therefore, the analysis designates the Alternatives as having a beneficial or countervailing cumulative effect, depending on local, regional, and site-specific factors. Alternatives 6 and 9 are anticipated to have Negligible direct implications for geology, soils, and topography; therefore, the analysis classifies the cumulative impact as neutral.

4.5.3.4 Air Quality, Greenhouse Gas Emissions, and Climate Change

As discussed in Section 4.2.4, the Action Alternatives are anticipated to have Minor Beneficial (Alternatives 2 through 8) or Negligible (Alternative 9) implications for air quality at the national scale. Implementation of individual elements of the Action Alternatives may have either beneficial or adverse effects on air quality. On the beneficial side, the Action Alternatives may increase carbon sequestration potential due to reforestation and riparian corridor requirements of Action Alternatives (except for Alternative 9) and reduce fugitive methane emissions from coal extraction due to reductions in overall production levels (with the exception of Alternatives 2 and 9). However, requirements for improved spoils management and surface configuration, as well as limits on AOC variances, may increase the use of equipment and vehicles to haul materials and therefore marginally increase greenhouse gas emissions from these sources. These potential adverse effects are, however, most likely neutral to minor and outweighed by the benefits of increased carbon sequestration and reduced methane emissions. While data are not available to quantify the net effect of the Action Alternatives on emissions or ambient air quality, the net effects to air quality, greenhouse gas emissions, and climate change are likely to be Minor Beneficial at the national scale (with the exception of Alternative 9).

A multitude of other past, present, and future actions affect air quality and greenhouse gas emissions. Coal mining generally negatively affects air quality due to air emissions emanating from vehicle engines or explosives detonation, erosion and wind transport of dust, and release of fugitive methane emissions during mining activities. In a national-scope rulemaking such as the SPR, however, numerous other regulatory and non-regulatory actions influence air quality. While some air quality issues are local (toxic releases during blasting activities), others, such as greenhouse gas emissions and their relationship to climate change, have implications at the global scale. Air pollutant emissions are generally regulated and managed at both national and local scales, to minimize the effects of coal mining activity on air quality and global climate change. The effects of coal mining and coal combustion on air pollutant emissions are primarily regulated under the Clean Air Act; additionally, performance standards targeting reducing toxic emissions from blasting is managed under section 515 of SMCRA (30 U.S.C. § 1265). Furthermore, permit programs for stationary sources, including federal requirements and state variations on those requirements, affect emissions of a range of pollutants. Regulations are also emerging to address limiting carbon emissions from power plants. Additional programs focused on promoting the recovery and use of coal mine methane may further reduce mining-related air pollutant emissions. On the other hand, continued population and economic trends will greatly affect air quality in any given region. Increased economic growth, population growth, expansion of road and highway systems, residential and commercial construction, and numerous other factors will affect air quality outcomes. A comprehensive accounting of factors affecting air quality in the coal regions is beyond the scope of this analysis.

Overall, the cumulative air quality impact of the Action Alternatives, in combination with other actions and trends such as those described above, is beneficial or countervailing, depending on local, regional, and site-specific factors. While the Action Alternatives (excluding Alternative 9) have Minor Beneficial impacts, the complexity of other actions and trends make it difficult to predict with confidence the combined effect on air resources. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.5 Socioeconomic Conditions

As discussed in Section 4.3.1, at the national level, the Action Alternatives (excluding Alternative 9) are expected to produce Minor or Moderate Adverse impacts on the coal mining industry and the communities that depend upon it. Alternative 9 is expected to have Negligible impacts on socioeconomic conditions. The adverse effects primarily stem from anticipated job losses associated with decreased production, particularly in the Appalachian Basin, the Illinois Basin, and the Northern Rocky Mountains and Great Plains regions. Furthermore, the analysis shows the potential for reduced growth in severance tax collections over time. While these impacts are forecasted for all the Action Alternatives (except Alternative 9), they are most prevalent under Alternative 2.

The cumulative effects analysis considers these direct socioeconomic impacts in combination with various other trends and actions. Relevant actions include regulations with a direct effect on coal mining, as well as actions and trends that are likely to affect the demand for coal over time. For instance, established mining safety rules may continue to affect the profitability of mining while forthcoming rules on greenhouse gas emissions from coal-fired power plants may encourage a transition away from coal to substitute fuels. These changes are occurring in the context of other energy sector trends such as decreasing natural gas prices resulting from growth in domestic production. On balance, the coal mining industry faces economic and regulatory challenges in the domestic market.

As discussed in Section 3.14 coal mining accounts for 0.1 percent of national employment and 0.1 percent of national income (U.S. Census Bureau, 2011b; U.S. EIA, 2012a). Additionally, a shift toward the more labor-intensive underground mining in the Appalachian Basin region, combined with an overall depletion of the most readily accessed surface reserves, has led to an offsetting increase in coal mining employment in recent years. For context, EIA estimates that 2012 coal industry employment was approximately 90,000 employees (U.S. EIA, 2013h). This analysis projects that coal industry employment will decrease by over 15,000 full-time equivalents (FTEs) under baseline conditions from 2020 to 2040. This decrease in employment demand is consistent with the declining demand for U.S. coal from retiring coal-fired power plants and is expected to occur primarily in the Appalachian Basin, the Illinois Basin, and the Northern Rocky Mountains and Great Plains regions. The following summary of expected effects helps to illustrate anticipated impacts:

- Under Alternative 2, annual impacts to production-related employment are expected to range from a reduction in demand for 1,100 FTEs to a reduction of 130 across all regions, with an average reduction in annual demand of 590 FTEs.[75] Annual impacts to compliance-related employment are expected to range from a gain of 470 FTEs to a gain of 630 across all regions, with an average increase in annual demand of 580 FTEs;
- Under Alternative 3, annual impacts to production-related employment are expected to range from a reduction in demand for 660 FTEs to a reduction of 78 across all regions, with an average reduction in annual demand of 360 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 310 FTEs to a gain of 390 across all regions, with an average increase in annual demand of 370 FTEs;

[75] The range of annual impacts to employment represents the minimum and maximum effect in any year in the study period. The average effect is the average annual effect on employment of the Alternative over the 21 year study period.

- Under Alternative 4, annual impacts to production-related employment are expected to range from a reduction in demand for 580 FTEs to a reduction of 62 across all regions, with an average reduction in annual demand of 310 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 310 FTEs to a gain of 390 across all regions, with an average increase in annual demand of 370 FTEs;
- Under Alternative 5, annual impacts to production-related employment are expected to range from a reduction in demand for 530 FTEs to a reduction of 48 across all regions, with an average reduction in annual demand of 260 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 120 FTEs to a gain of 150 across all regions, with an average increase in annual demand of 140 FTEs;
- Under Alternative 6, annual impacts to production-related employment are expected to range from a reduction in demand for 340 FTEs to a reduction of 14 across all regions, with an average reduction in annual demand of 160 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 110 FTEs to a gain of 150 across all regions, with an average increase in annual demand of 140 FTEs;
- Under Alternative 7, annual impacts to production-related employment are expected to range from a reduction in demand for 680 FTEs to a reduction of 65 across all regions, with an average reduction in annual demand of 330 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 180 FTEs to a gain of 220 across all regions, with an average increase in annual demand of 210 FTEs;
- Under Alternative 8 (Preferred), annual impacts to production-related employment are expected to range from a reduction in demand for 590 FTEs to a reduction of 41 across all regions, with an average reduction in annual demand of 260 FTEs. Annual impacts to compliance-related employment are expected to range from a gain of 210 FTEs to a gain of 270 across all regions, with an average increase in annual demand of 250 FTEs; and
- Under Alternative 9, no changes in either production-related or compliance-related annual employment are expected.

While the socioeconomic implications of the Action Alternatives are minor or moderate, they would be added to existing and anticipated adverse conditions in the coal mining industry. Therefore, the cumulative impact of the Action Alternatives (excluding Alternative 9), in combination with other actions and trends, is classified as negative. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.6 Land Use, Utilities, Infrastructure, Visual Resources, and Noise

As discussed in Section 4.3.2, the Action Alternatives are anticipated to have either Minor Beneficial or Negligible impacts on land use, utilities, infrastructure, visual resources, and noise. Minor Beneficial outcomes are anticipated for all Action Alternatives except 6 and 9 and are achieved primarily as a result of forecasted reductions in coal production and/or increased underground production. These changes could limit land clearing, landscape alteration, and noise impacts to a minor degree, particularly in the Appalachian Basin and Illinois Basin regions.

As with air impacts, a multitude of other past, present, and future actions could affect land use, utilities, infrastructure, visual resources, and noise in the coal-producing regions. This analysis explicitly accounts for several national conservation programs and noise control regulations that could influence cumulative effects. However, the scope of the Action Alternatives and the diverse collection of landscape and aesthetic considerations in this resource category render a full accounting of possible influences impossible. For instance, local land use and noise ordinances will influence key outcomes. Furthermore, the land clearing and construction activities that influence land use, infrastructure, and visual resources are themselves the result of complex local trends. Increased economic growth, population growth, transportation demand, housing demand, and numerous other factors play a role in overall impacts on this category of resources.

While the Action Alternatives have Negligible or Minor Beneficial direct impacts, the complexity of other actions and trends make it difficult to predict with confidence the combined effect on land use, utilities, infrastructure, visual resources, and noise. Therefore, the analysis designates the cumulative effect as indeterminate. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.7 Public Health and Safety

Potential public health benefits from improved drinking water for all Action Alternatives, except for Alternative 9, lead to the net direct effects to be classified as beneficial or countervailing for Alternatives 2 through 8 (Preferred).

A variety of other actions influence outcomes with respect to mining safety and public health. State and federal mining safety regulations are designed to limit both the risk of chronic illness (e.g., respiratory conditions) as well as catastrophic outcomes (e.g., mine collapse). Litigation focusing on miner health and safety may further refine and extend existing regulations. Rules and actions governing general public health are obviously numerous, with the most relevant focusing on drinking water protection, surface water quality protection, and reclamation of abandoned mines. Beyond these actions, numerous other public health programs exist (e.g., vaccination programs, smoking cessation programs, counseling programs, etc.) and would affect the well-being of citizens living in the coal-producing regions.

The Action Alternatives, in combination with other actions and trends, are likely to reduce adverse cumulative impacts on public health and safety. Therefore, this analysis identifies the Alternatives (excluding Alternative 9) as having a beneficial or countervailing cumulative effect. Alternative 9 is anticipated to have a neutral cumulative effect.

4.5.3.8 Archaeology, Paleontology, and Cultural Resources

As presented in Section 4.3.5, all Action Alternatives are expected to have Negligible impacts on archaeology, paleontology, and cultural resources on both the regional and national level. However, to the extent that any particular element of an Alternative reduces the extent of ground disturbance associated with mining, it would also reduce the disturbance of cultural resources located within that area. Therefore cultural resources may benefit from some or all of the rule elements.

Other regulatory actions that occurred in the past, present, or are expected to occur in the future may also affect the archaeological, paleontological, and cultural resources of a specific area. A number of federal regulations have been put in place to protect these resources, such as the Antiquities Act of 1906, the Paleontological Resources Preservation Act of 2009, and the National Historic Preservation Act. Additionally, state mining regulations and programs that supplement SMCRA may benefit these resources to the extent that they identify areas which contain these resources as unsuitable for mining practices.

When considered together, the Negligible direct effect of all the Action Alternatives and the other actions and trends that affect cultural resources are anticipated to have a neutral cumulative effect on these resources, across all Alternatives.

4.5.3.9 Recreation

The analysis presented in Section 4.3.3 determined that the Action Alternatives would likely have beneficial implications for recreational resources (except in the case of Alternative 9 which has Negligible impacts). These beneficial impacts accrue to instream recreational activities such as fishing and swimming, which are enhanced as a result of anticipated water quality improvements. Terrestrial recreational resources are also enhanced through proposed improvements in spoil management, surface configuration, reforestation, and wildlife protection.

Other past, present, and future actions to protect and enhance recreational resources are myriad. Conservation programs such as Wild and Scenic Rivers, the National Trails System, and the National Wildlife Refuge system have explicit recreational objectives. Likewise, water quality regulations recognize recreational objectives and expressly classify waters as fishable or swimmable. Apart from these relatively recent actions, the U.S. has a long historical tradition of designating, protecting, and enhancing recreational resources through the National Park System and National Forests; likewise, states have designated numerous other recreational areas through state parks systems. Collectively, these actions work to preserve and expand access to recreational resources.

The Action Alternatives, in combination with other actions and trends, are likely to reduce adverse cumulative impacts on recreational resources. Therefore, this analysis identifies the Alternatives (excluding Alternative 9) as having a beneficial or countervailing cumulative effect. Alternative 9 is anticipated to have a neutral cumulative effect.

4.6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES AND ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

This section of Chapter 4 identifies resource commitments that could be irreversible or irretrievable as a result of the Action Alternatives, and it describes potential adverse environmental effects which cannot be avoided. This section is organized as follows:

- First it describes the NEPA requirements of "irreversible or irretrievable commitments of resources" and "adverse environmental effects which cannot be avoided";
- Then it identifies and explains each type of potential effect by resource and Alternative.

NEPA regulations require a discussion of "any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented" (40 CFR Part 1502.16). An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be recovered or reversed. Irreversible is a term that describes the loss of future options where the loss is permanent. It applies primarily to the effects of use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity, that are renewable only over long periods of time. Irretrievable is a term that applies to the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a winter sports site. The timber production lost is irretrievable, but the action is not irreversible; if the use changes, it is possible to resume timber production.

NEPA regulations also require a discussion of "any adverse environmental effects which cannot be avoided should the proposal be implemented" (40 CFR 1502.16). Unavoidable adverse impacts are those that would occur after implementation of any of the Action Alternatives as compared to the No Action Alternative as well as after the implementation of all existing mitigation measures and best management practices. Unavoidable adverse impacts do not include temporary or permanent impacts which would be mitigated. Instead, unavoidable adverse impacts are defined as those that meet the following two criteria:

- There are no reasonably practicable mitigation measures to eliminate the impacts; and
- There are no reasonable alternatives to the proposed project that would meet the purpose and need of the action, eliminate the impact, and not cause other or similar adverse impacts.

Under the Action Alternatives, changes in future coal production are anticipated as a result of changes in the costs of production and associated changes in coal prices. This analysis also considers the potential for coal "stranding" (also referred to as "reserve sterilization"). "Stranding" of coal refers to the situation in which coal that would be economical to mine and technically feasible to mine is made unavailable for extraction as a result of the requirements of the rule. This analysis indicates that there will be no increase in stranded reserves under any of the Alternatives. Under Alternative 2, it is possible that reserves could be stranded in Central Appalachia if disposal capacity is unavailable for excess spoils. We identified no information suggesting that adequate disposal capacity would be unavailable, therefore this analysis assumes no stranding of reserves will occur under Alternative 2.

Tables 4.7-1 through 4.7-8 describe the irreversible, irretrievable, and unavoidable adverse environmental effects of the Action Alternatives on each affected resource, as compared to the No Action Alternative. The reader is referred to the appropriate resource-specific section of Chapter 4 more details in support of the rationale for the findings.

Alternative 2: Irretrievable and unavoidable adverse effects (short-term and long-term) are expected for socioeconomic conditions under Alternative 2. Irretrievable, irreversible, and unavoidable (short term and long term) impacts are expected for public health and safety. No irreversible, irretrievable, or unavoidable impacts are expected for the following resources–air quality, greenhouse gas emission, and climate change; biological resources; topography, geology, and soils; water resources; land use, utilities, infrastructure, visual resources, and noise; and recreation.

Alternatives 3 through 8: Irretrievable and unavoidable adverse effects (short-term and long-term) are expected for socioeconomic conditions under these Alternatives. No irreversible, irretrievable, or unavoidable impacts are expected for the following resources–air quality, greenhouse gas emission, and climate change; biological resources; topography, geology, and soils; water resources; land use, utilities, infrastructure, visual resources, and noise; public health and safety; and recreation.

Alternative 9: Alternative 9 considers a scenario in which the 2008 Stream Buffer Zone rule is repromulgated and fully implemented across the timeframe of this analysis. Engineering analysis of current coal industry practices finds that, during the period that the 2008 rule was in place, the permits issued in many state programs including those in the Appalachian Basin changed in response to EPA review of Clean Water Act permits such that Alternative 9 would no longer be expected to be functionally different than the No Action Alternative. Alternative 9 is therefore anticipated to have no irreversible, irretrievable, or unavoidable impacts evaluated in this DEIS.

Table 4.6-1
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 2 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources are expected. While the production shift to underground mining in Appalachia could cause some short-term or long-term impacts to groundwater, these are not expected to be irreversible or irretrievable. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	Yes	Yes	Short-term and Long-term	The slight increase in missed worker days and worker deaths due to the shift from surface to underground mining is considered an irretrievable and irreversible loss of human resources. Other impacts to these resources are beneficial, such as reduced exposure to contaminants in drinking water. The shift in coal mines from surface to underground may result in a slight increase in missed worker days and worker deaths. Other impacts to these resources are beneficial.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-2
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 3 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to this resource are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources to surface water, wetlands or groundwater are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-3
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 4 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-4
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 5 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-5
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 6 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources to surface water, wetlands or groundwater are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-6
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 7 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of this resource, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-7
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 8 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.
Water Resources	No	No	No	Negligible irreversible or irretrievable impacts for water resources are expected. Impacts are anticipated to be beneficial to these resources. This Alternative is not expected to result in unavoidable adverse environmental effects on these resources. Impacts are anticipated to be beneficial to these resources.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	Yes	Short-term and Long-term	Adverse impacts to employment and associated income resulting from decreased coal production represent an irretrievable commitment of socioeconomic resources and an unavoidable adverse effect. Impacts to employment and income may be beneficial in some areas, where benefits to employment from new compliance-related work requirements more than offset production-related employment impacts. Adverse impacts to severance tax revenue resulting from decreased coal production represent an irretrievable and unavoidable loss in revenue for local and state governments.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources, such as reduced exposure to contaminants in drinking water.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts are anticipated to be beneficial to these resources.

Table 4.6-8
Irreversible and Irretrievable Commitment of Resources and Adverse Environmental Effects under Alternative 9 Compared to the No Action Alternative

Resource	Irreversible	Irretrievable	Unavoidable	Explanation
Air Quality, Greenhouse Gas Emissions, and Climate Change	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Biological Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Topography, Geology, and Soils	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Water Resources	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Land Use, Utilities, Infrastructure, Visual Resources, and Noise	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Socioeconomic Conditions	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Public Health and Safety	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.
Recreation	No	No	No	This Alternative is not expected to result in irreversible or irretrievable commitment of these resources, or in unavoidable adverse effects on these resources. Impacts to these resources are expected to be negligible.

Chapter 5
Consultation and Coordination

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Chapter 5
Consultation and Coordination

5.0 INTRODUCTION

To comply with the National Environmental Policy Act (NEPA), and Council on Environmental Quality (CEQ), and Department of Interior regulations implementing NEPA, the Office of Surface Mining Reclamation and Enforcement (OSMRE) has consulted and coordinated with federal and state agencies, organizations, tribes, interested groups, and individuals during the development of the proposed action and this Draft Environmental Impact Statement (DEIS). This chapter provides a summary of the interaction that has occurred up to the publication of the DEIS. Public participation and interagency coordination/consultation efforts will be ongoing throughout this process to ensure that the best available data is used in preparing this draft and the final document; and that agency and public concerns and comments are identified, addressed, and incorporated into the planning and decision making process.

5.1 RULEMAKING COORDINATION

5.1.1 Memorandum of Understanding – June 2009

On June 11, 2009, the Department of the Interior entered into a Memorandum of Understanding (MOU) with the Environmental Protection Agency (EPA) and the U.S. Army (representing the U.S. Army Corps of Engineers). The MOU can be viewed on the OSMRE website at http://www.osmre.gov/resources/mou/ASCM061109.pdf. The MOU established an Interagency Action Plan (IAP) to reduce the environmental impacts of mountaintop coal mining in the six Appalachian states of Kentucky, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The IAP elements included short term actions to minimize the adverse environmental effects of Appalachian surface coal mining; a commitment to undertake longer term regulatory actions related to Appalachian surface coal mining; coordinated reviews of permit applications under the Clean Water Act (CWA) and the Surface Mining Control and Reclamation Act (SMCRA); and a commitment to engage in robust public participation. The proposed action, the Stream Protection Rule, addresses one objective of the MOU, which was for the signing agencies to consider revisions to key provisions of current SMCRA regulations, including those provisions related to buffer zones around streams and approximate original contour (AOC) requirements.

5.1.2 Advance Notice of Proposed Rulemaking – November 2009

On November 30, 2009, OSMRE published an Advance Notice of Proposed Rulemaking (ANPR) soliciting comments on ten potential rulemaking alternatives (74 FR 62664). OSMRE also invited the public to identify other rules that it should consider revising and announced its intent to prepare an environmental impacts statement (EIS) to supplement the 2008 Stream Buffer Zone Rule EIS. OSMRE received approximately 32,750 comments during the 30-day comment period for the ANPR.

After evaluating the comments, the OSMRE determined that development of a comprehensive stream protection rule was needed, and that the scope of the proposed action required a new EIS rather than a supplement to the one prepared for the 2008 Stream Buffer Zone Rule.

5.2 INTERAGENCY CONSULTATION AND COORDINATION ON EIS

OSMRE is the lead agency (see 40 CFR 1508.16) for this EIS. In 2010, OSMRE invited all state SMCRA regulatory authorities, tribal governments with an interest in coal lands, and various other state and federal agencies with special expertise or jurisdiction by law to participate in the NEPA process as a cooperating agency (40 CFR 1508.5). Many invitees declined to participate, primarily due to lack of funding and staff or due to other higher priority workload. The U.S. Army Corps of Engineers was one of the federal agencies that declined to participate formally as a cooperating agency. Nevertheless, OSMRE has conducted briefings with the Corps of Engineers to assist in the development of the proposed rule.

The following federal and state agencies accepted invitation to participate as cooperating agencies in the development of the draft EIS (DEIS):

Federal Agencies:

- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service

State SMCRA Regulatory Authorities:

- Utah Division of Oil, Gas and Mining
- New Mexico Mining and Minerals Division
- Kentucky Department for Natural Resources
- Railroad Commission of Texas
- Montana Industrial & Energy Minerals Bureau
- Wyoming Department of Environmental Quality
- West Virginia Department of Environmental Protection
- Alabama Surface Mining Commission
- Indiana Department of Natural Resources
- Virginia Department of Mines, Minerals and Energy
- Ohio Division of Mineral Resources Management

State Historic Preservation Offices:

- Wyoming State Historic Preservation Office
- Virginia Department of Historic Resources

State Wildlife Agency:

- West Virginia Department of Natural Resources

OSMRE met with the federal cooperating agencies in August 2010 and with several of the state cooperating agencies in September 2010 to discuss the DEIS review process and the roles of cooperating agencies. OSMRE and the cooperating agencies subsequently developed an MOU outlining each agency's role in the NEPA process and identifying specific points of contact within OSMRE and the cooperating agencies.

In late 2010 and early 2011, OSMRE provided all of the cooperating agencies listed above, and the Council on Environmental Quality, the opportunity to review and comment on Chapters 2 through 4 of the first working draft of the DEIS that had been developed by OSMRE's consultant. In October 2010, OSMRE hosted a conference call with the cooperating agencies to discuss their comments on the draft of Chapter 2. A similar conference call was held in January 2011 to discuss comments received on Chapters 3 and 4, with particular emphasis on Chapter 4.

As a result of the preliminary reviews and coordination with the cooperating agencies through early 2011, and consistent with the comments from numerous cooperating agencies that questioned the quality of the analysis and the accuracy of information, OSMRE determined that the preliminary DEIS was insufficient and in need of significant revisions, which OSMRE began in fall 2011. OSMRE retained the comments received previously from the cooperating agencies and ensured that they were considered during the preparation of the current DEIS. These comments were very informative as to the scope and content of the analysis needed for the DEIS. The current DEIS retains very little content from the original preliminary draft; however, OSMRE considered those comments in revising the Alternatives, methodology and content of the current DEIS. The cooperating agencies have not yet reviewed the new materials contained in the DEIS and, therefore, have not provided their concurrence or endorsement of the content of this DEIS.

On February 23, 2015, OSMRE received a letter signed by the eleven state regulatory authority cooperating agencies, expressing concern that OSMRE did not provide the cooperating agencies with adequate opportunities to participate in the development of the DEIS since the spring 2011. Further the letter notified OSMRE of the intent of several states to terminate their participation, and most states subsequently did so—Alabama, Kentucky, West Virginia, Utah, Montana, Texas and New Mexico. Others expressed their continued concern with the process and their role as cooperating agencies but did not formally withdraw their participation.

OSMRE met with the state SMCRA regulatory authority cooperating agencies on April 27, 2015, to discuss how their comments on the preliminary drafts were used in preparation of the DEIS and the overall structure of the proposed rule and the analysis of impacts. The meeting included a discussion of the methodology that OSMRE used in the current DEIS analysis but did not specifically describe the Alternatives or present any findings since the proposed rule was still being edited through the interagency process.

OSMRE intends to meet with the cooperating agencies after publication of the DEIS to discuss the specifics of the preferred alternative in order to facilitate their review of both the proposed rule and the DEIS. OSMRE intends to work with the cooperating agencies to address their comments on the document, to ensure that the final document provides the best available data related to state programs, and to seek their expertise where needed to address public comments that pertain to their special expertise and jurisdiction. As a proposed rule, OSMRE anticipates feedback from all stakeholders and will provide adequate review time for comment.

5.3 TRIBAL CONSULTATION

The Department of the Interior Policy on Consultation with Indian Tribes (DOI, 2011) and OSMRE Directive Reg-18 (OSMRE, 2013), set forth considerations and guidelines for consultation and collaboration between the U.S. government and American Indian and Alaska Natives. Due to the extensive coal reserves on tribal lands, OSMRE invited the Hopi, Navajo, Crow, and Ute Mountain Ute Tribes to be cooperating agencies in the EIS preparation; the tribes declined.

On May 12, 2010, OSMRE's Director met with the Chairmen of the Hopi and Crow Tribes and the President of the Navajo Nation to initiate tribal consultation on the SPR rulemaking and EIS development. The tribes in attendance requested to be kept informed as the rulemaking process and EIS development progressed. The OSMRE Director again met with tribal leaders in Washington, DC on December 1, 2011. At that time, OSMRE provided additional information on the elements under consideration for the Alternatives in the DEIS and discussed the expected impacts to the Indian Lands SMCRA regulatory program. Upon publication of this DEIS, OSMRE intends to meet with the Hopi, Navajo, Crow, and Ute Mountain Ute Tribes Indian Tribes to ensure that they are well-prepared to review and comment on the rule and DEIS.

5.4 PUBLIC INVOLVEMENT SPECIFIC TO THIS EIS

On April 30, 2010, OSMRE published notice of its intent (NOI) to prepare a new EIS to analyze the effects of potential revisions to its rules and regulations under SMCRA to improve the protection of streams from the adverse impacts of surface coal mining operations (75 FR 22723). In this notice, OSMRE set forth eleven principal elements under consideration as part of its revisions to various SMCRA regulations. OSMRE received 25 comments during the 30-day comment period ending June 1, 2010.

On June 18, 2010, OSMRE re-opened the scoping period in order to offer the public additional opportunities to provide comment (75 FR 34666). The reopening allowed an additional 45 days for scoping, which then ended on July 30, 2010. The reopened NOI expanded on the eleven principal elements by including possible alternatives for each element. At that time, the NOI also announced OSMRE's intent to hold public scoping meetings and provided information on how the public could provide comments. OSMRE held nine scoping open houses in coal-producing regions across the U.S.

5.4.1 Scoping Open Houses

Because of the complex nature of the issues for which OSMRE sought input, OSMRE elected to use an open house format for the scoping opportunities rather than a public meeting or public hearing format. OSMRE selected nine cities for the open houses based on their location in or near 95 percent of the coal-producing regions of the U.S. The open houses were held in Beckley, WV; Birmingham, AL; Carbondale, IL; Evansville, IN; Fairfield, TX; Farmington, NM; Gillette, WY; Hazard, KY; and Morgantown, WV between July 19-29, 2010. Open house venues were selected based on estimated interest in the area, facility size, ease of access and parking, availability, and recommendations of the local OSMRE field office.

In addition to the *Federal Register* notice, OSMRE announced the open houses on OSMRE's website (www.osmre.gov) and published display ads in local and regional newspapers for 2-4 days, two weeks before each open house. The open houses were set up as 12 poster stations that depicted the NEPA process and the eleven principal elements of the proposed action and possible Alternatives, as described in the June NOI. Handouts of the poster, along with a brief introductory explanation, were positioned at each poster station. Comment forms that stated the various mechanisms for submitting comments were made available at each open house. These forms were also set out at each poster station and centrally located to facilitate public participation. OSMRE personnel were available to answer questions and hear attendees concerns. A court reporter was available to take oral comments at all locations, and, in Farmington, NM, a Navajo translator was also available to assist.

5.4.2 Results of Public Scoping

The number of comments received by source is summarized in Table 5.2-1.

Table 5.2-1
Distribution of Comments Received by Source

Source	Number
Open House – Written	374
Open House – Oral	71
Email at sra-eis@osmre.gov	20,011
Courier or Surface Mail	111
Electronically at www.regulations.gov	4
Total	**20,571**

Most commenters provided specific comments regarding each of the principal elements and possible Alternatives set out in the June 18, 2010 NOI. Some commenters recommended clarifications to existing rules instead of a new rulemaking, made suggestions pertaining to specific elements or Alternatives within the proposed rulemaking, or raised new issues or rule elements for consideration.

Comments were generally divided into two categories: (1) comments in support of rule revisions that would provide greater environmental protection for streams and other natural resources; and (2) comments that support the adequacy of the existing regulations.

Some commenters favoring greater environmental protections advocated interpretation of the 1983 Stream Buffer Zone Rule as an absolute prohibition on stream impacts. This group of comments described the 1983 rules as a bright-line prohibition against any adverse impacts within the stream buffer zone. Other comments suggested that the DEIS assess the effects of an Alternative that would ban surface mining of coal.

Commenters from the Midwest and West also questioned the efficacy of promulgating a nationwide rule when regional differences made many provisions inapplicable or potentially cumbersome, costly, or impractical to apply across the country. They noted that the impetus for OSMRE's action grew from concerns about surface mining operations in the Appalachian region. Table 5.2-2 depicts the numbers of commenters by principal element, as well as by other issues raised.

Table 5.2-2
Distribution of Comments by Principal Element and Other Issues

Principal Element/Other Topics	Number of Comments
Collection of Baseline Data	10,622
Definition of "Material Damage to Hydrologic Balance"	18,628
Mining Activities in or near Streams	10,943
Additional Monitoring Requirements	9,137
Corrective Action Thresholds	583
Landforming and Fill Optimization	10,340
Approximate Original Contour Exceptions	164
Reforestation	304
Financial Assurances for Long-Term Discharges of Pollutants	18,543
Permit Coordination	9,739
Stream Definitions	18,583
NEPA Process	9,114
Justification for Stream Protection Rule (SPR) Lacking	28
Overreaches Statutory Authority	36
Regulations Will Adversely Affect Jobs/Economy/Energy Costs	1,328
Enforcement and Monitoring	18,575
Longwall Mining	5
Additional Research Needed	5
Mining Destroys Cultural Resources	2
Impact of Invasive Species on Ecosystem	3
National Security Concerns	6
Mountaintop Removal Mining Concerns	1

Substantive comments collected during the scoping process were assessed by the EIS team and incorporated into the scope and content of the DEIS.

Chapter 6
Preparers and Contributors

6.0 INTRODUCTION

Chapter 6 contains the list of persons involved in the preparation of this DEIS. The list includes OSMRE staff and contractors and is found below.

6.1 OFFICE OF SURFACE MINING RECLAMATION AND ENFORCEMENT

List of Preparers

Name	Title	Education	Experience
John Ahlbrandt	Surface Mining Reclamation Specialist	B.S. Wildlife Conservation and Management, University of Wyoming	18 years with BLM; 2 years with OSMRE
Arielle Avishai	Physical Scientist, Appalachian Region	B.A. Environmental Studies, GIS, University of Pittsburgh	7 years with OSMRE (GIS and Technology Transfer)
Alex Birchfield	Ecologist, Western Region	B.S. Zoology, magna cum laude; M.S. Restoration Ecology, both from Colorado State University; A.S. Business from Community College of the AF	Over 16 years of experience: 3 years with OSMRE; 8 years with BLM; 5 years with NPS and private consulting
Frank Bartlett	Program Analyst (GIS/Environmental Protection)	B.S. Range Management, Chadron State College; M.S. Range Ecology and Watershed Management, University of Wyoming	<1 year with OSMRE; 2 years with Bureau of Land Management
Tom Bovard	Assistant Solicitor, DMR/BSM, Headquarters	J.D., University of Virginia	22 years with SOL on SMCRA issues
Marcelo Calle	Hydrologist, Western Region	B.S. Watershed Science, Colorado State University	1 year with OSMRE; 6 years with State of Wyoming Abandoned Mine Land and Coal Regulatory Programs
Paul Clark	Hydrogeologist, Western Region	B.A. Geology 1995 Hanover College, M.S. Hydrogeology Wright State University	Panterra Corp, Dayton OH; Tetra Tech EMI, Denver CO; OSMRE
Jeffrey A. Coker	Physical Scientist	B.S. Forest Resource Management, University of Tennessee	24 years with OSMRE; 9 years with the State of Tennessee

List of Preparers

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Debbie Dale	Hydrologist, Mid-Continent Region	B.S. Geology, Nicholls State University; M.S. Geoscience, Univ. of Nevada, Las Vegas	13 years state/federal SMCRA experience; Private environmental consulting
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Paul Ehret	Chief, Technical Services Branch, Mid-Continent Region	B.S. and M.S.: Southern Illinois University - Edwardsville	2 years with OSMRE; 29 years with state SMCRA programs in Illinois, Indiana and Kentucky
Robin Ferguson	Environmental Protection Specialist, Headquarters	B.S. Virginia Polytechnic Institute and State University	2 years with OSMRE, 15 years with the Department of the Navy in National Environmental Policy Act work
Kevin Garnett	Mining Engineer P.E.,	B.S. Univ. of Missouri - Rolla	7 years OSMRE Mid-Continent Engineer
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Mark Gehlhar	Senior Economist, Headquarters	PhD, Economics, Purdue M.S. Purdue B.S. University of Wisconsin	4 years with OSMRE, 16 with USDA
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William Joseph	Chief, Program Support Division, Mid-Continent Region	B.S. Reclamation, University of Wisconsin - Platteville	20 years with OSMRE; 6 years with Kansas Department of Health and Environment
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Dave Kovaluk	Visual Information Specialist (Intern)	B.A. Photographic and Electronic Media	1 year with OSMRE Mid-Continent

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Name	Title	Education	Experience
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Daniel McKinnon	Natural Resources Specialist, Western Region	BS in Biology, Wake Forest University MS in Ecology, Colorado State University	3 years with OSMRE
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Harry Payne	Chief, Regulatory Support Division, Headquarters	A.S. Wildlife Management, Hocking College, Ohio	29 years State of Ohio SMCRA Regulatory Authority; 8 years with OSMRE
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George Popper	Geologist, Physical Scientis	B.S., Geology, CCNY M.S., Geology, Univ. Mass. Ph.D., Geology, Lehigh University	College Professor (3 years); Israeli Geologic Survey (2 years); Bendix Field Eng. (5 years); Bureau Mines (2 years); OSMRE (28 years)
Dennis Rice	Regulatory Analyst, Headquarters	V.S., Resources Management (Forestry), State University of New York College of Environmental Science and Forestry	35 years in the regulatory program with OSMRE
Mike Richmond	Civil Engineer	B.S. Civil Engineering, West Virginia Institute of Technology	5 years with OSMRE Charleston Field Office
Kathleen Sheehan	Environmental Protection Specialist	J.D., Duquesne University School of Law B.S. Envrionmental Studies, Univserity of Pittsburgh	6 years with OSMRE, 10 years experience total
Cecil Slaughter	Hydrologist	M.S., Water Resources, Iowa State University B.S., Geology, University of Missouri	3 years with OSMRE, 23 years with USGS
Cheryl Sylvester	Attorney-Advisor, DMR/BSM	J.D., Columbia University School of Law	28 years with SOL on SMCRA issues
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List of Preparers

Name	Title	Education	Experience
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David Henry	Associate Consultant	M.E.Sc., Yale University; B.A. Mathematics and Economics, Haverford College	4 years
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6.3 MORGAN WORLDWIDE

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Name	Title	Education	Experience
John Morgan	Principal Consultant	B.Sc. Mining Engineering (Upper Second), Royal School of Mines, University of London	37 years
Garrie Krueger	Senior Mining Engineer	B.S. Mining Engineering, University of Wisconisn-Platteville	17 years
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6.4 ENERGY VENTURES ANALSIS

List of Preparers

Name	Title	Education	Experience
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6.5 PEER REVIEWERS

List of Preparers

Name	Title	Education	Experience
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W. Douglass Shaw	Professor, Department of Agricultural Economics; Texas A&M University	Ph.D. Economics, University of Colorado; B.A. Geography, University of Colorado	36 years

6.6 OTHER CONTRACTORS

Polu Kai Services, LLC worked on previous drafts of the EIS between June 15, 2010 and February 10, 2011.

Chapter 7
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Chapter 8
Acronyms

ACA	Alabama Coal Association
ACHP	Advisory Council for Historic Preservation
ACW	Alpha Coal West, Inc.
A.D.	Anno Domini
ADA	Americans with Disabilities Act
ADD	Area Development Districts
ADHS	Appalachian Development Highway System
ADNR	Alaska Department of Natural Resources
AFB	Air Force Base
AFC	Armored Face Conveyor
AIRFA	American Indian Religious Freedom Act
AKCA	Alaska Coal Association
ALOSH	Appalachian Laboratory for Occupational Safety and Health
AMA	Alaska Miners Association
AMD	Acid Mine Drainage
AMEC	AMEC America Limited
AML	Abandoned Mine Lands
AMSL	Above Mean Sea Level
ANFO	Ammonium Nitrate and Fuel Oil
ANPR	Advance Notice of Proposed Rulemaking
ANVSA	Alaska Native Village Statistical Areas
AOC	Approximate Original Contour
AP	Associated Press
APTA	American Public Transportation Association
ARA	Alabama Rivers Alliance
ARPA	Archaeological Resources Protection Act
ARRI	Appalachian Region Reforestation Initiative
ASCE	American Society of Civil Engineers
ASLM	Assistant Secretary, Land and Minerals Management
ASMR	American Society for Surface Mining and Reclamation
ATSDR	Agency for Toxic Substances and Disease Registry
ATTAINS	Assessment TMDL Tracking and Implementation System
ATV	All Terrain Vehicle
AWF	Appalachian Wildlife Federation
AWQC	Ambient Water Quality Criteria
BACT	Best Available Control Technology
B.C.	Before Christ
BEA	Bureau of Economic Analysis
BGEPA	Bald and Golden Eagle Protection Act
BHP	BHP Billiton
BIA	Bureau of Indian Affairs

BLM	Bureau of Land Management
BLM	Biotic Ligand Model
BLS	Bureau of Labor Statistics
BMI	Benthic Macroinvertebrate Index
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe
BO	Biological Opinion
BOM	Bureau of Mines
BOR	Bureau of Reclamation
BTU	British Thermal Unit
BWRk	Black Warrior Riverkeeper
CAA	Clean Air Act
CASPR	Cross-state Air Pollution Rule
CAT	Commercial Activity Tax
CCC	Criteria Continuous Concentration
CCR	Coal Combustion Residual
CDA	Conservation and Development Areas
CDC	Center for Disease Control and Prevention
CEC	Commission for Environmental Cooperation
CEDS	Comprehensive Economic Development Strategies
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CHIA	Cumulative Hydrologic Impact Assessment
CIA	Cumulative Impact Area
CMA	Colorado Mining Association
CMC	Criteria Maximum Concentration
CMD	Coal Mine Drainage
CMOP	Coalbed Methane Outreach Program
CMR	Compensatory Mitigation Rule
CN	Curve Number
CO_2e	Carbon Dioxide Equivalent
COI	Conflict of Interest
CSX	CSX Corporation (Railroad)
CWA	Clean Water Act
CWHSP	Coal Workers' Health Surveillance Program
CWP	Coal Workers' Pneumoconiosis
DA	Drainage Area
DBPs	Disinfection By-Products
DCRT	Department of Culture Recreation and Tourism
DEC	Department of Environmental Conservation
DED	Department of Economic Development
DEIS	Draft Environmental Impact Statement
DEP	Department of Environmental Protection
DMC	Dana Mining Company
DMLW	Division of Mining, Land, and Water
DNR	Department of Natural Resources

DOC	Dissolved Organic Carbon
DOD	Department of Defense
DOF	Division of Forestry
DOH	Department of Highways
DPC	Desirable Plant Community
DPEIS	Draft Programmatic Environmental Impact Statement
DPT	Department of Parks and Tourism
DRB	Demonstrated Reserve Base
DRDS	Division of Respiratory Disease Studies
DT	Department of Travel
DTD	Department of Tourist Development
DWPT	Department of Wildlife, Parks, and Tourism
EA	Environmental Analysis
ECSI	Engineering Consulting Services, Inc.
EGU	Elictricy Generating Unit
Eh	Anaerobic or of Low Oxidation/Reduction Potential
EIS	Environmental Impact Statement
EMT	Emergency Medical Technicians
EO	Executive Order
EPT	Ephemeroptera, Plecoptera and Tricoptera
ERR	Estimated Recoverable Reserve
ESA	Endangered Species Act
ESAL	Equivalent Single Axle-Load
ESRI	Environmental Systems Research Institute
FACES-FL	Federation for American Coal, Energy, and Security (FACES) Form Letter
FC	City of Fairfield, Fairfield, TX
FCC	Fairfield Chamber of Commerce, Fairfield, TX
FCLAA	The Federal Coal Leasing Amendments Act
FCMSA	The Federal Coal Mine Safety Act
FEIS	Final Environmental Impact Statement
FMSHRC	Federal Mine Safety and Health Administration
FPOP	Fill Placement Optimization Process
FR	Federal Register
FRA	Forestry Reclamation Approach
GBCC	Greater Bluefield Chamber of Commerce, Bluefield, WV
Gg	Gigagrams
GHG	Greenhouse Gases
GHGRP	Greenhouse Gas Reporting Program
GIS	Geographic Information System
GMP	Growth Management Plan
GVW	Gross Vehicle Weight
GW	Groundwater
GWP	Global Warming Potential
HACC	Henderson Area Chamber of Commerce, Henderson, TX
HAP	Hazardous Air Pollutant
HAPA	Historic and Archeological Preservation Act

HBI	Hilsenhoff Biotic Index
HEDC	Henderson Economic Development Corporation, Henderson, TX
HSA	Historic Sites Act
HUD	Housing and Urban Development
IAP	Interagency Action Plan
IARC	International Agency for Research on Cancer
ICA	Illinois Coal Association
ICC	Indiana Coal Council
ICG	International Coal Group, Inc.
IDNR	Indiana Department of Natural Resources
ILM-FL	I Love Mountains.org Form Letter
IMC	Interwest Mining Company
IMDA	Indian Minerals Development Act of 1982
IRMA	Intensive Recreation Management Area
KCA	Kentucky Coal Association
KDFWR	Kentucky Department of Fish and Wildlife Resources
KDOW	Kentucky Department of Water
KDP	Kentucky Division of Planning
KFTC	Kentuckians for the Commonwealth
Km	Kilometer
KRC	Kentucky Resources Council
KWA	Kentucky Waterways Alliance
KYDNR	Kentucky Department of Natural Resources
LA	Louisiana
LAER	Lowest Achievable Emission Rate
LBA	Lease-by-Application
LC	Limestone County, TX
LC50	Lethal to 50% of Test Organisms
LLC	Limited Liability Company
LOS	Level of Service
LTER	Long Term Ecological Research
LUM	Luminant
MATS	Mercury and Air Toxics Standards
MBTA	Migratory Bird Treaty Act
MC	Mincorp, Inc. (Severstal)
MC-FL	Amfire Mining Company et. al Form Letter
MCLs	Maximum Contaminant Levels
MEC	Murray Energy Corporation
MESA	Mining Enforcement and Safety Administration
MGD	Millions of Gallons per Day
mg/L	milligrams per liter
MINER	Mine Improvement and New Emergency Act
MLA	Mineral Leasing Act for Acquired Lands of 1947
MM	Million
MMCF	Million Cubic Feet
MMI	Multi-Metric Index

MMton	Million Short Tons
$MMtCO_2e$	Million Tons of Carbon Dioxide Equivalents
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPDD	Mine Plan Decision Document
MSA	Metropolitan Statistical Area
MSHA	Mine Safety and Health Administration
MSL	Mean sea Level
MTM	Mountaintop Mining
MTR	Mountaintop Removal Mining
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAICS	North American Industry Classification System
NAMD	Neutral/Alkaline Mine Drainage
NCSU	North Carolina State University
NED	National Elevation Dataset
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NETL	National Energy Technology Laboratory
NHD	National Hydrography Dataset
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
NMA	National Mining Association
NMA-FL	National Mining Association Form Letter
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
N-PAH	Nitro-Polycyclic Aromatic Hydrocarbons
NPDES	National Pollutant Discharge Elimination System
NPR	National Public Radio
NPS	National Park Service
NRA	National Recreation Area
NRC	National Research Council
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NS	Norfolk Southern
NSR	New Source Review
NWI	National Wetland Inventory
NWP	Nationwide Permits
NWRS	National Wildlife Refuge System
NWS	National Weather Service
OCA	Ohio Coal Association
ODFW	Ohio Department of Fish and Wildlife
OEDT	Office of Economic Development and Tourism
OHEPA	Ohio Environmental Protection Agency
OHICI	Ohio's Invertebrates Community Index

ONRR	Office of Natural Resources Revenue
OSHA	Occupational Safety and Health Administration
OSMRE	Office of Surface Mining Reclamation and Enforcement
OSRW	Outstanding State Resource Waters
OT	Office of Tourism
OTD	Office of Tourism Development
PAC	Pennsylvania Anthracite Council
PA DCED	Pennsylvania Department of Community and Economic Development
PA DEP	Pennsylvania Department of Environmental Protection
PAHs	Polycyclic Aromatic Hydrocarbons
PC	Private Citizens
PCA	Pennsylvania Coal Association
PEP	Protection and Enhancement Plan
PHC	Probable Hydrologic Consequences
PM	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter
PM_{10}	Course Particulate Matter
PMLU	Postmining Land Use
PNC	Potential Natural Communities
PRB	Powder River Basin
PRBRC	Powder River Basin Resource Council
PRD	Parks and Recreation Department
PRPA	Paleontological Resources Preservation Act
PSD	Prevention of Significant Deterioration
RA	Regulatory Authority
RAM	Reclamation Advisory Memorandum
RBP	Rapid Bioassessment Protocols
RCRA	Resource Conservation and Recovery Act
RDPC	Reclaimed Desired Plant Community
RIA	Regulatory Impact Assessment
RISD	Rockdale Independent School District
RMP	Resource Management Plan
ROM	Run-of-Mine
RRC	Railroad Commission
SBZ	Stream Buffer Zone
SC-FL#1	Sierra Club Sponsored Form Letter #1
SC-FL#2	Sierra Club Sponsored Form Letter #2
SCS	Soil Conservation Service
SC-WV	Sierra Club – West Virginia Chapter
SDI	Slake Durability Index
SDWA	Safe Drinking Water Act
SDWIS	Safe Drinking Water Information System
SEDCAD	Sediment, Erosion, Discharge by Computer Aided Design
SELC	Southern Environmental Law Center
SF	Safety Factor
SH	State Highway

SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SMCRA	Surface Mining Control and Reclamation Act
SPR	Stream Protection Rule
SRA	State Regulatory Authority
SW	Surface Water
SWROA	Surface Water Runoff Analysis
TBEL	Technology Based Effluent Limitation Guideline
TCP	Traditional Cultural Property
TCR	Total Coliform Rule
TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TFG	Teacher-Friendly Guide
THPO	Tribal Historic Preservation Officer
TMA	Tennessee Mining Association
TMDL	Total Maximum Daily Load
TMRA	Texas Mining and Reclamation Association
TPWD	Texas Parks and Wildlife Department
TRD	Tourism and Recreation Department
TSP	Total Suspended Particles
TSS	Total Suspended Solids
TWDB	Texas Water Development Board
TWF	Tennessee Wildlife Federation
TWRA	Tennessee Wildlife Resources Agency
UCM	Usibelli Coal Mine
UP	Union Pacific
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USCB	United States Census Bureau
USDA	United States Department of Agriculture
U.S. DHEW	United States Department of Health, Education, and Welfare
U.S. DOC	United Stated Department of Commerce
U.S. DOE	United States Department of Energy
U.S. DOI	United States Department of the Interior
U.S. DOL	United States Department of Labor
U.S. DOT	United States Department of Transportation
U.S. EIA	United States Energy Information Administration
U.S. EPA	United States Environmental Protection Agency
USFS	United States Forest Service
U.S. FWS	United States Fish and Wildlife Service
U.S. GAO	United States Government Accountability Office
USGS	United States Geological Survey
UV	Ultraviolet
VDGIF	Virginia Department of Game and Inland Fisheries
VER	Valid Existing Rights
VF	Valley Fills

VMA	Virginia Mining Association
VOCs	Volatile Organic Compounds
VPD	Vehicles Per Day
VRAP	Visual Resource Assessment Procedure
VRM	Visual Resource Management
WBR	Western Business Roundtable
WDEQ	Wyoming Department of Environmental Quality
WHO	World Health Organization
WKU	Western Kentucky University
WMA	Wyoming Mining Association
WOTUS	Waters of the U.S.
WQBEL	Water Quality Based Effluent Limitation Guideline
WRCC	Western Regional Climate Center
WRP	Wetland Reserve Program
WSA	Wadeable Streams Assessment
WVCA	West Virginia Coal Association
WVDCH	West Virginia Division of Culture and History
WVDEP	West Virginia Division of Environmental Protection
WVDHHR	West Virginia Department of Health and Human Resources
WVDNR	West Virginia Division of Natural Resources
WVDOH	West Virginia Department of Highways
WVGES	West Virginia Geological and Economic Survey
WVSCI	West Virginia Stream Condition Index
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter

Chapter 9
Glossary

Affected Environment: In the context National Environmental Policy Act (NEPA), the environment of the area(s) to be affected or created by the Alternatives under consideration (40 CFR 1502.15).

Allochthonous: Refers to something formed elsewhere rather than its present location.

Alluvial: Pertaining to or composed of alluvium, or deposited by a stream or running water.

Alluvium: A general term for clay, silt, sand, gravel, or other similar material deposited in a streambed, on a flood plain, delta, or at the base of a mountain during comparatively recent geologic time.

Alternative: A combination of management prescriptions applied in specific amounts and locations to achieve a desired management emphasis as expressed in goals and objectives. One of several policies, plans, or projects proposed for decision-making. An Alternative need not substitute for another in all respects.

Alternative, No Action: An Alternative that maintains established trends or management direction.

Anadromous Fish: Fish that are born in fresh water, spend most of their life in the sea, and which return to fresh water to spawn. Common examples include salmon, smelt, shad, striped bass, and sturgeon.

Anaerobic: A situation in which molecular oxygen is virtually absent from the environment.

Angle of repose: Angle between the horizontal and the maximum slope that a particular soil or geologic material assumes through natural processes.

Annual Plants: Plants living for only one growing season and then seeding to form the next generation.

Anthracite Coal: A hard, black lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile matter. Commonly referred to as hard coal, it is mined in the United States, mainly in eastern Pennsylvania, although in small quantities in other states.

Anthropogenic: Of or relating to anthropogenesis; caused by humans.

Anticline: A fold, generally convex upward, whose core contains the stratigraphically older rocks.

Approximate Original Contour (AOC): The surface configuration achieved by backfilling and grading of the mined area so that the reclaimed area, including any terracing or access roads, closely resembles the general surface configuration of the land prior to mining and blends into and complements the drainage pattern of the surrounding terrain, with all highwalls and spoil piles eliminated (SMCRA Section 701(2)). All mined areas are to be returned to AOC, unless they receive a variance from the AOC requirement (SMCRA Sections 515(b) (3) and (c)).

Approximate Original Contour (AOC) Variance: A regulatory authority may grant a variance or waiver from the requirement to restore a site to AOC if certain specified conditions are satisfied.

Aquifer: (a) A layer of geologic material that contains water. (b) A zone, stratum, or group of strata that can store and transmit water in sufficient quantities for a specific use.

Area Mining: Area mining takes place over a ridge or mountainside and is not restricted, as is contour mining, to the side of a mountain. Area mining occurs in locations where lower slopes and the presence of multiple coal seams produce mining ratios that allow for coal extraction across topography rather than around it (as in contour mining). Although area mining may affect a larger area than contour mining, with coal extraction across an entire ridge or mountaintop, it is not considered "mountaintop removal mining", because all the coal seams may not be recovered and the mining area must be restored to AOC.

Augering: A method of mining coal at a cliff or highwall by drilling holes into an exposed coal seam from the highwall and transporting the coal along an auger bit to the surface.

Autochthonous: Formed in its present position.

Backfill: Refilling an excavation. Also, the material placed in an excavation in the process of backfilling.

Badlands: A type of dry terrain where softer sedimentary rocks and clay-rich soils have been extensively eroded by wind and water.

Bank Cubic Yards: The volume of overburden material in the ground before it has been excavated and expanded by swell.

Baseflow: That portion of a stream's discharge that comes from groundwater; ground water seepage into a stream channel.

Bench: Specific to surface mining, this refers to the floor(s) of mining excavation areas where backfilling will occur.

Benthic: Relating to or occurring at the bottom of a body of water.

Best Technology Currently Available: Equipment, devices, systems, methods, or techniques which will (a) prevent, to the extent possible, additional contributions of suspended solids to stream flow or runoff outside the permit area, but in no event result in contributions of suspended solids in excess of requirements set by applicable state or federal laws; and (b) minimize, to the extent possible, disturbances and adverse impacts on fish, wildlife and related environmental values, and achieve enhancement of those resources where practicable. The term includes equipment, devices, systems, methods, or techniques which are currently available anywhere as determined by the Director, even if they are not in routine use. The term includes, but is not limited to, construction practices, siting requirements, vegetative selection and planting requirements, animal stocking requirements, scheduling of activities and design of sedimentation ponds in accordance with 30 CFR parts 816 and 817. Within the constraints of the permanent program, the regulatory authority shall have the discretion to determine the best technology currently available on a case-by-case basis, as authorized by the Act and this chapter (30 CFR 701.5).

Biological Diversity: The relative abundance of wildlife species, plant species, communities, habitats, or habitat features per unit of area.

Biological Opinion: Document stating the U.S. Fish and Wildlife Service (U.S. FWS) and/or the National Marine Fisheries Service opinion as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

Bituminous Coal: (1) Coal that ranks between subbituminous coal and anthracite and that contains more than 14 percent volatile matter (on a dry, ash-free basis) and has a calorific value of more than 11,500 Btu/lb. (moist, mineral-matter-free) or more than 10,500 Btu/lb. if agglomerating (American Society for Testing and Materials classification). It is dark brown to black in color and burns with a smoky flame. Bituminous coal is the most abundant rank of coal; much is Carboniferous in age.

Blackwater Stream: Streams that do not carry sediment, are tannic in nature, and which often flow through peat-based areas. Black waters are much more acidic than that of the more neutral waters.

Blanket Drain: Porous zone of large rock formed beneath a valley fill by rolling segregation during wing dumping.

Boreal: Relating to or characteristic of the climatic zone south of the Arctic, esp. the cold temperate region dominated by taiga and forests of birch, poplar, and conifers.

Box Cut: A mining cut excavated into the slope of a hillside, resulting in highwalls on three sides of the cut, or through a mountaintop or ridge crest, resulting in highwalls on two sides of the cut. This type of cut is used to initially open a hillside or mountaintop or ridge crest to all initiation of spoil casting by equipment or explosives.

Bryophyte: Refers to all land plants that do not have true vascular tissue and are therefore also called non-vascular plants.

British Thermal Unit (BTU): A measure of the heat content; the heat required to raise the temperature of one pound of water by one degree Fahrenheit.

Buffer Zone: An area between two different land uses that is intended to resist, absorb, or otherwise preclude developments or intrusions between the two use areas.

Bulking Factor: The net expansion of overburden material resulting from excavation and subsequent backfilling, usually referred to in the mining industry as the swell factor.

Center Ditch: Rock-lined ditch used to carry runoff from the surface of a valley fill down its face to its toe.

Cumulative Hydrologic Impact Assessment (CHIA): Before a Surface Mining Control and Reclamation Act (SMCRA) permit can be approved, an assessment of the cumulative hydrologic impacts of all anticipated mining on the hydrologic balance in the cumulative impact area is performed. Before a SMCRA permit can be approved, the CHIA must find that the proposed operation has been designed to prevent material damage to the hydrologic balance outside the permit area. CHIA preparation is an integrated process which embodies a specific application of hydrologic information management at each step of the process. The scope of a CHIA may initially include all components of the ground water and surface-water systems in the cumulative impact area. This initial scope can be systematically and logically reduced to those concerns of quantity and quality considered significant to maintaining the hydrologic balance of the area. The process focuses on those aspects of the hydrologic balance that are likely to affect designated uses of water. A sample is available at the Office of Surface Mining Reclamation and Enforcement website.

Coal Seam: A layer, vein, or deposit of coal.

Coal Mine Waste: Coal processing waste and underground development waste (30 CFR 701.5).

Coal Processing Waste: Earth materials which are separated and wasted from the product coal during cleaning, concentrating, or other processing or preparation of coal (30 CFR 701.5).

Colluvium: Earth material that has accumulated at the base of a hill, through the action of gravity, as piles of talus, avalanche debris, and sheets of detritus moved by soil creep or frost action.

Confining layer: A layer of earth material that restricts the movement of ground water; material of low hydraulic conductivity.

Coniferous: Of or relating to, or part of, trees or shrubs bearing cones and having evergreen leaves.

Conglomerate: A coarse-grained clastic sedimentary rock, composed of rounded to subangular fragments larger than two millimeters in diameter set in a fine grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

Contour Mining: Surface mining that progresses in a narrow zone following the outcrop of a coal seam in mountainous terrain, and in which the overburden, removed to gain access to the mineral commodity, is immediately placed in the previously mined area, so that reclamation is carried out contemporaneously with extraction.

Core Drain: Central column of porous large rocks in a valley fill formed by rolling segregation and convergence of materials at the valley fill center during wing dumping.

Council on Environmental Quality (CEQ): An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effort on the environment, conducts environmental studies, and advises the President on environmental matters.

Cover Type: The plant species of a given area, usually described in terms of the dominant species (e.g., oak-hickory, northern hardwood, maple-birch, etc.).

Cross Ridge Mining: Surface mining associated with ridges in steep slope terrain in which the entire coal is extracted by parallel cuts that progress perpendicular to topographic contour and spoil is returned to the mined out area to simulate the approximate premining topography.

Cultural Landscape: A cultural landscape is a geographic area, including both cultural and natural resources and the wildlife and domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values. There are four general types of cultural landscapes, not mutually exclusive: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes.

Cultural Resources: For purposes of historic preservation, all of the physical manifestations of archeology and history. Cultural resources include archeological sites, structures and objects significant to American history and prehistory. They may include battlefields, ships, places where treaties were signed, places of significant events. They are important for their representation of cultures, lifestyles, people, architecture, engineering, arts and events, or for the information they contain, or for associations they have with past people or events. Cultural resources are considered fragile and nonrenewable resources, because once they are removed, lost, or destroyed, they are gone forever.

Cumulative Impact: The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Cut: An excavation, generally applied to surface mining; to make an incision in a block of coal; in underground mining, that part of the face of coal that has been undercut.

Cyanobacteria: A division of microorganisms that are related to bacteria but are capable of photosynthesis.

Cyclothem: A series of beds deposited during a sedimentary cycle of the type that prevailed during the Pennsylvanian Period. Non-marine sediments often including bituminous coal commonly occur in the lower half of a cyclothem, marine sediments in the upper half.

Deciduous: A tree, shrub, or plant that sheds its leaves annually.

Deltaic: Pertaining to or characterized by a delta.

Demographics: Statistical data characterizing the population of a region and the culture of the people, including such information as age, race, gender, income, education, employment status, etc.

Dendritic: The dendritic drainage pattern is characterized by irregular branching in all directions with the tributaries joining the main stream at all angles. Resembling the vein patterns in a tree leaf.

Detritus: Waste or debris.

Diatom: A major group of algae which are one of the most common types of phytoplankton.

Digital Terrain Model (DTM): A topographic surface or computer representation of terrain stored in a digital data file as a set of three-dimensional (x, y, z) coordinates. The image may be displayed on a computer monitor or portrayed on a map.

Disturbed Area: An area where vegetation, topsoil, or overburden is removed or upon which topsoil, spoil, coal processing waste, underground development waste, or noncoal waste is placed by surface coal mining operations. Those areas are classified as disturbed until reclamation is complete and the performance bond or other assurance of performance is released.

Durable Rock: Naturally formed aggregates that will not slake in water or degrade to soil material. Federal law provides that durable-rock fills must consist of at least 80 percent durable rock (30 CFR 816.73 and 817.73).

Ecological Province: Distinct subdivisions of the landscape containing ecologically related sub-basins. The provinces are distinguished primarily on patterns related to hydrology, climate and regional geology.

Ecohydrological Season: For the purpose of this rule, means a regional specific, annually reoccurring period in which major hydrological and consequent ecological events take place. Specifically in reference to seasonal stream flow, an ecohydrological season is marked by the beginning and end of prolonged periods of presence or absence of flowing water, (i.e. wet and dry seasons) which perpetuate considerable and predictable changes in stream flora and fauna. These periods vary in duration and frequency with respect to region but are always predictable within a typical year.

Effects: Effects include direct effects and indirect effects. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effect and impacts . . . are synonymous. Effects includes ecological such as the effects on natural resources and on the components, structures and functioning of affected ecosystems, aesthetic, historic, cultural, economic, social or heath, whether direct, indirect, or cumulative. Effects may also include those resulting from actions which may have both beneficial and detrimental effects; even if in balance the agency believes that the effect will be beneficial (40 CFR 1508.8).

Effluent: Partially or completely treated wastewater flowing out of a treatment facility, reservoir, or basin.

Endangered Species: Federally listed endangered species include any species of animal or plant in danger of extinction throughout all or a significant portion of its range; state (group I): species whose prospect of survival or recruitment in the state are in jeopardy in the foreseeable future; state (group II): species whose prospect of survival or recruitment within the state may become jeopardized in the near future.

Endemic Species: Being unique to a particular geographic location, such as a specific island, habitat type, nation or other defined zone. To be endemic to a place or area means that it is found only in that part of the world and nowhere else.

Environmental Assessment (EA): A concise public document prepared to provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact. An EA includes a brief discussion of the need for a proposal, the Alternatives considered, the environmental impacts of the proposed action and Alternatives, and a list of agencies and individuals consulted.

Environmental Impact Statement (EIS): A document prepared to analyze the impacts on the environment of a proposed project or action and released to the public for comment and review. An EIS must meet the requirements of NEPA, CEQ, and the directives of the agency responsible for the proposed project or action.

Ephemeral Stream: A stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table (30 CFR 701.5).

Epilithic Algae: Algae that grows on rock or stone surfaces.

Escarpment: A cliff or steep slope that separates two level or gently sloping areas. Cliff or steep slope edging higher land.

Eutrophic: Of a lake or other body of water. Rich in nutrients and so supporting a dense plant population, the decomposition of which kills animal life by depriving it of oxygen.

Evapotranspiration: The sum of evaporation and transpiration.

Excess Spoil: (1) Spoil in excess of that necessary to backfill and grade affected areas to the approximate original contour. The term may include box-cut spoil where it has been demonstrated for the duration of the mining operation, that the box-cut spoil is not needed to restore the approximate original contour. (2) Overburden material that is disposed of in a location other than the mine pit (30 CFR 701.5).

Extirpated Species: A species that has become extinct in a given area, although it may exist elsewhere.

Exotic: Those species that occupy habitats in which they did not evolve and in which they often have no natural enemies to limit their reproduction and spread frequently at the expense of native plants and animals and, sometimes, of entire ecosystems. The words exotic, invasive, and non-indigenous are often used synonymously.

Face: The working surface of a coal seam where it is being excavated, usually applied to underground mining. Also, the front of the downstream end of a valley fill.

Factor of Safety: Engineering term expressed in a ratio, used to evaluate slope stability in valley fills with regard to rotational sliding and failure; greater values for a factor of safety indicate greater slope stability.

Fauna: The animals of a particular region or habitat.

Fills: Fill structures that are created by the placement of excess spoil in valleys, on hill sides, or on preexisting benches. Although most excess-spoil fills are commonly referred to as valley fills, most mountaintop-removal and steep-slope mining operations today involve the construction of durable-rock fills (30 CFR Sections 816.71 and 817.71).

Fines: Very fine-grained coal materials or dust typically generated as residue from coal processing facilities.

Flood frequency: Refers to the probability (in percent) that a flood will occur in a given year.

Floodplain: The land adjacent to a stream that is periodically flooded by high water.

Flora: The plants of a particular region or habitat.

Flow Regime: The pattern of stream discharge over time.

Flume: see Core Drain.

Fluvial: Of or pertaining to rivers; produced by the action of a stream or river.

Footwall: The mass of rock beneath a fault, orebody, or mine working; especially the wall rock beneath an inclined vein or fault.

Forb: Any herbaceous plant that is not a grass or grass-like in nature; leafy soft-stemmed plants.

Fragile Lands: Means areas containing natural, ecologic, scientific, or esthetic resources that could be significantly damaged by surface coal mining operations. Examples of fragile lands include valuable habitats for fish or wildlife, critical habitats for endangered or threatened species of animals or plants, uncommon geologic formations, paleontological sites, National Natural Landmarks, areas where mining may result in flooding, environmental corridors containing a concentration of ecologic and esthetic features, and areas of recreational value due to high environmental quality.

Fragipan: A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Fugitive Dust: The particulate matter not emitted from a duct or stack that becomes airborne due to the forces of wind or surface coal mining and reclamation operations or both. During surface coal mining and reclamation operations it may include emissions from haul roads; wind erosion of exposed surfaces, storage piles, and spoil piles; reclamation operations; and other activities in which material is either removed, stored, transported, or redistributed.

Geomorphic: Of or relating to the form or shape of the earth.

Geomorphology: The study of landscapes and the processes that change them

Glaciated: Said of an area that is: (1) scoured and worn down by glacial action, or strewn with ice-laid drift; or (2) covered by and subjected to the action of a glacier.

Glacial Deposits: Earth materials deposited as a result of glacial activity.

Glaciation: Alteration of the Earth's solid surface through erosion and deposition by glacier ice.

Glochidium: A parasitic larva of certain freshwater bivalve mollusks, which attaches itself by hooks and suckers to the fins or gills of fish.

Graminoid: Herbaceous plants with narrow leaves growing from the base. They include the "true grasses", of the Poaceae (or Gramineae) family, as well as the grasslike plants such as the sedges (Cyperaceae) and the rushes (Juncaceae).

Groin Ditch: Rock-lined ditch used to carry runoff from slopes surrounding a valley fill to the toe of the valley fill.

Ground Water: Subsurface water that fills available openings in rock or soil materials to the extent that they are considered water saturated.

Hanging Wall: The overlying side of an orebody, fault, or mine working; especially the wall rock above an inclined vein or fault.

Haul Road: (1) A road built to carry heavily loaded trucks at a good speed. The grade is limited on this type of road and usually kept to less than 17 percent of climb in direction of load movement. (2) Road from pit to loading dock, tipple, ramp, or preparation plant used for transporting mined material by truck.

Head (hydraulic): Differential of pressure causing flow in a fluid system, usually expressed in terms of the height of a liquid column that pressure will support. The difference, usually measured in feet, between two water surface elevations; height of water above a specified point.

Head-of-Hollow Fill: A fill structure consisting of any materials, other than a coal processing waste or organic material, placed in the uppermost reaches of a hollow where side slopes of the existing hollow measured at the steepest point are greater than 20 degrees, or the average slope of the profile of the hollow from the toe of the fill to the top of the fill is greater than ten degrees. In fills with less than 250,000 cubic yards of material, associated with steep slope mining, the top surface of the fill will be at the elevation of the coal seam. In all other head-of-hollow fills, the top surface of the fill will be at approximately the same elevation as the adjacent ridge line, and no significant area of natural drainage will occur above the fill, draining into the fill areas.

Headwater: The source (or sources) and upper part of a stream, including the upper drainage basin.

Herbaceous: Term for soft-stemmed grass and forb plant species.

Herpetofauna: A collective term used to describe both amphibians (e.g. frogs, toads, salamanders, newts) and reptiles (e.g. snakes, lizards, turtles).

Higher or Better Uses: Means postmining land uses that have a higher economic value or nonmonetary benefit to the landowner or the community than the premining land uses (30 CFR 701.5).

Historic Property or Historic Resource: Any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. The term "eligible for inclusion in the national Register of Historic Places" includes both properties formally determined as such by the Secretary of the Interior and all other properties that meet the National Register listing criteria.

Highwall: The unexcavated face of exposed overburden and coal or ore in an opencast mine; or the face or bank on the uphill side of a contour strip mine excavation.

Highwall Limits: The maximum economical mining depth for a coal seam as established by its stripping ratio and market value.

Highwall Mining: Removal of coal from beneath a standing highwall without excavation of the overburden, using augers or continuous highwall mining machines.

Historic Lands: Means areas containing historic, cultural, or scientific resources. Examples of historic lands include archeological sites, properties listed on or eligible for listing on a State or National Register of Historic Places, National Historic Landmarks, properties having religious or cultural significance to Native Americans or religious groups, and properties for which historic designation is pending.

Hummock: A general geological term referring to a small knoll or mound above ground. The term hummock, or hummocky, is also applied to extremely irregular surfaces. An earlier use of this term also refers to lumpy terrain; or land that has an irregular shape.

Hydraulic Conductivity: A coefficient of proportionality describing the rate at which water can move through a permeable medium.

Hydric Soil: A soil that is sufficiently wet in the upper part to develop anaerobic conditions during the growing season.

Hydrologic Balance: The relationship between the quality and quantity of water inflow to, water outflow from, and water storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake, or reservoir. It encompasses the dynamic relationships among precipitation, runoff, evaporation, and changes in ground and surface-water storage (30 CFR 701.5).

Hydrology: The science that relates to the water systems of the earth, or the principles of water flow, or the presence of surface or ground water.

Hypolimnion: The lower layer of water in a thermally stratified lake, typically cooler than the water above, noncirculating, and thus relatively stagnant and perpetually cold.

Hyporheic Zone: A region beneath and alongside a stream bed, where there is mixing of shallow groundwater and surface water.

Impounding Structure: A dam, embankment or other structure used to impound water, slurry, or other liquid or semi-liquid material (30 CFR 701.5).

Impoundments: All water, sediment, slurry or other liquid or semi-liquid holding structures and depressions, either naturally formed or artificially built (30 CFR 701.5).

Interburden: Rock strata between two coal seams to be mined. Both interburden and overburden are often referred to collectively as overburden.

Interfluve: A region between the valleys of adjacent watercourses, especially in a dissected upland.

Intermittent Stream: (a) A stream or reach of a stream that drains a watershed of at least one square mile, or (b) A stream or reach of a stream that is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and ground-water discharge (30 CFR 701.5).

Invasive: Those species that colonize natural or semi-natural ecosystems, are agents of change, and threats to native biodiversity. The words exotic, invasive, and non-indigenous are often used synonymously.

Karst: A type of topography that is formed over limestone, dolomite, or gypsum by dissolution, and that is characterized by sinkholes, caves, and underground drainage.

Lacustrine: Pertaining to, produced by, or inhabiting a lake or lakes.

Land Use: means specific uses or management-related activities, rather than the vegetation or cover of the land. Land uses may be identified in combination when joint or seasonal uses occur and may include land used for support facilities that are an integral part of the use. Changes of land use from one of the following categories to another shall be considered as a change to an alternative land use which is subject to approval by the regulatory authority.

- Cropland - Land used for the production of adapted crops for harvest, alone or in rotation with grasses and legumes, that include row crops, small grain crops, hay crops, nursery crops, orchard crops, and other similar crops.
- Pastureland or land occasionally cut for hay - Land used primarily for the long-term production of adapted, domesticated forage plants to be grazed by livestock or occasionally cut and cured for livestock feed.

- Grazingland - Land used for grasslands and forest lands where the indigenous vegetation is actively managed for grazing, browsing, or occasional hay production.
- Forestry - Land used or managed for the long-term production of wood, wood fiber, or wood-derived products.
- Residential - Land used for single-and multiple-family housing, mobile home parks, or other residential lodgings.
- Industrial/Commercial - Land used for:
    - Extraction or transformation of materials for fabrication of products, wholesaling of products, or long-term storage of products. This includes all heavy and light manufacturing facilities.
    - Retail or trade of goods or services, including hotels, motels, stores, restaurants, and other commercial establishments.
    - Recreation - Land used for public or private leisure-time activities, including developed recreation facilities such as parks, camps, and amusement areas, as well as areas for less intensive uses such as hiking, canoeing, and other undeveloped recreational uses.
    - Fish and wildlife habitat - Land dedicated wholly or partially to the production, protection, or management of species of fish or wildlife.
    - Developed water resources - Land used for storing water for beneficial uses, such as stock ponds, irrigation, fire protection, flood control, and water supply.
    - Undeveloped land or no current use or land management - Land that is undeveloped or, if previously developed, land that has been allowed to return naturally to an undeveloped state or has been allowed to return to forest through natural succession (30 CFR 701.5).

Land Reclamation (Mining): The process of creating useful landscapes that meet a variety of goals, typically creating productive ecosystems (or sometimes industrial or municipal land) from mined land. It includes all aspects of this work, including material placement, stabilizing, capping, regrading, placing cover soils, revegetation, and maintenance.

Land Restoration: The process of ecological restoration of a site to a natural landscape and habitat, safe for humans, wildlife, and plant communities.

Lentic: Non-flowing aquatic systems such as ponds.

Lignite Coal: Often referred to as brown coal, this soft brown fuel with characteristics that put it somewhere between sub-bituminous coal and peat. It is considered the lowest rank of coal. In British Thermo Units (BTU's) lignite coal generally ranges between 4,300 to 8,600 BTU's per pound. In the United States, it is mined primarily in the Gulf Coast coal region and in the state of North Dakota in the North Rocky Mountain and Great Plains coal region.

Lithology: The description of rocks, especially in hand section and in outcrop, on the basis of such characteristics as color, mineralogic composition, and grain size.

Littoral Zone: That part of a sea, lake or river that is close to the shore. In coastal environments the littoral zone extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged.

Longwall Mining: A form of underground coal mining where a long wall of coal is mined in a single slice (typically one to two meters thick). The longwall *panel* (the block of coal that is being mined) is typically three to four kilometers long and 250 - 400 meters wide.

Loose Cubic Yards: The volume of overburden material after it has been excavated.

Lotic: Flowing aquatic systems such as streams.

Macroinvertebrate: Animals without backbones, generally visible with the naked eye and associated with freshwater systems. Common examples include insect larvae and crayfish.

Macrophyte: Aquatic plants, growing in or near water that are either emergent, submergent, or floating.

Mesophytic: Being or growing in or adapted to a moderately moist environment.

Mesic: A type of habitat with a moderate or well-balanced supply of moisture.

Metallurgical: Bituminous coal used in a beehive coke oven.

Mine Mouth: The entrance to a mine, or the point of shipping of raw coal from a surface or deep mine operation.

Mineral Extraction Area: Portion of a mine permit where coal will actually be extracted.

Mitigation: Mitigation includes: (a) Avoiding the impact altogether by not taking a certain action or parts of an action. (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation. (c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environments. (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action. (e) Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20).

Morphology: The science of form and structure.

Mountaintop Mining/Valley Fill (MTM/VF) Mining: Surface coal mining occurring on mountaintops, ridges, and other steep slopes (by definition those of 20 degrees or more). Removal of overburden from coal on mountaintop mining sites may result in generation of excess mine spoil in quantities that may not allow regrading of a mine site to its approximate original topographic contours or that must otherwise be disposed of to allow for regrading of a mine site to its approximate original topographic contours or that must otherwise be disposed of to allow for efficient and economical coal extraction. One method of disposing of this excess spoil is to place it the heads of hollows or valleys of streams, a practice often referred to as valley fill. For the purposes of this EIS, steep slope surface coal mining operations that produce excess spoil and dispose of it in heads of hollows or valleys of streams shall be referred to collectively as mountaintop mining/valley fill (MTM/VF) operations, in recognition that repetitive discussion of individual mining methods would be cumbersome.

Mountaintop-Removal Operation: According to SMCRA, a type of surface-mining operation that extracts an entire coal seam or seams running through the upper fraction of a mountain, ridge, or hill. Coal extraction must be accomplished by removing all of the overburden and creating a level plateau or a gently rolling contour that both has no highwalls remaining and is capable of supporting certain postmining land uses.

Mudstone: An indurated mud having the texture and composition of shale but lacking its fissility; a blocky fine-grained sedimentary rock in which the proportions of clay and silt are approximately equal.

Multiple Seam Mining: Surface mining in areas where several seams are recovered from the same hillside.

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking, and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under Sections 307, 402, 318, and 40 of the CWA (40 CFR 122.2).

Nationwide Permits: A type of general permit giving authorization under 33 CFR Part 330 for specified activities nationwide. If certain conditions are met, the activities can take place without the need for an individual or regional permit (33 CFR 325.5(c) (2)).

NeoTropical: Of, relating to, or denoting a zoogeographical region comprising Central and South America, including the tropical southern part of Mexico and the Caribbean.

The National Environmental Policy Act (NEPA) of 1969: Declares the national policy to encourage a productive and enjoyable harmony between man and his environment. Section 102 of that Act directs that "to the fullest extent possible: (1) The policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the federal government shall insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations" (42 U.S.C. §§ 4321-4347; See 33 CFR Part 325, Appendix B).

Noxious Weeds: An invasive species of plant that has been designated by country, state or provincial, or national agricultural authorities as one that is injurious to agricultural and/or horticultural crops, natural habitats and/or ecosystems, and/or humans or livestock.

Oligotrophic: Of a lake or other body of water. Relatively low in plant nutrients and containing abundant oxygen in the deeper parts.

Ordinary High Water Mark: That line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas (33 CFR 328.3(e)).

Outcrop: (a) The part of a rock formation that appears at the surface of the ground. (b) A term used in connection with a vein or lode as an essential part of the definition of apex. It does not necessarily imply the visible presentation of the mineral on the surface of the earth, but includes those deposits that are so near to the surface as to be found easily by digging. (c) The part of a geologic formation or structure that appears at the surface of the earth; also, bedrock that is earth's surface; to crop out.

Outslope: The face of the spoil or embankment sloping downward from the highest elevation to the toe (30 CFR 701.5).

Overburden: Material of any nature, consolidated or unconsolidated, that overlies a coal deposit, excluding topsoil (30 CFR 701.5).

Oviposition: The process of laying eggs by oviparous animals.

Palustrine: Of or pertaining to, or living in, a marsh or swamp; marshy.

Perennial Plants: Plants that live for more than one growing season.

Perennial Stream: A stream or part of a stream that flows continuously during all of the calendar year as a result of ground-water discharge or surface runoff. The term does not include intermittent streams or ephemeral streams.

Periphyton: Freshwater organisms attached to or clinging to plants and other objects projecting above the bottom sediments.

Permeability: The measure of the flow of water through soil. The ease (or measurable rate) with which gasses, liquids, or plant roots penetrate or pass through a layer of soil or porous media. The capacity or ability of a porous rock, sediment, or soil to allow the movement of water through its pores.

Permit: Authorization to conduct surface coal mining and reclamation operations issued by the State Regulatory Authority (SRA) pursuant to a state program or by the Secretary pursuant to a federal program. For purposes of the federal lands program, permit means a permit issued by the SRA under a cooperative agreement or by the Office of Surface Mining Reclamation and Enforcement (OSMRE) where there is no cooperative agreement.

Permit Area: The area of land, indicated on the approved map submitted by the operator with his or her application, required to be covered by the operator's performance bond which includes the area of land upon which the operator proposes to conduct surface coal mining and reclamation operations under the permit, including all disturbed areas; provided that areas adequately bonded under another valid permit may be excluded from the permit area.

Physiographic Province: A region of which all parts are similar in geologic structure and climate and which has had a unified geomorphic history.

Playa: An area of flat, dried-up land; especially a desert basin from which water evaporates quickly.

$PM_{2.5}$: Fine particulate matter which are two and a half micrometers in diameter and smaller.

PM_{10}: Course particulate matter which are smaller than ten micrometers and larger than two and a half micrometers.

Potable Water: Water fit or suited for drinking.

Prime Farmland: Those lands which are defined by the Secretary of Agriculture in 7 CFR part 657 (Federal Register Vol. 4 No. 21) and which have historically been used for cropland (30 CFR 701.5).

Probable Hydrologic Consequences (PHC): A determination of PHC consists of the following steps, repeated as many times as necessary to mitigate adverse impacts: Data collection; Characterization of the premining hydrologic balance; Prediction of mining disturbances; Design of measures to mitigate mining disturbances; and Documentation of residual impacts on the hydrologic balance remaining after implementation of mitigative measures. Any remaining unmitigated impacts must be documented in the PHC determination. The PHC determination process is intended to reduce the predicted adverse impacts on the hydrologic balance to an acceptable level. A sample outline for the PHC determination is available for downloading at the Office of Surface Mining Reclamation and Enforcement website.

Pit: In surface mining, the void left after removal of overburden to expose the coal in a cut.

Plateau: In geology and earth science, also called a high plain or tableland, is an area of highland, usually consisting of relatively flat terrain. A highly eroded plateau is called a dissected plateau. A volcanic plateau is a plateau produced by volcanic activity.

Preparation Plant: A facility where coal is subjected to chemical or physical processing or cleaning, concentrating, or other processing or preparation. A preparation plant's facilities include, but are not limited to, the following: loading facilities; storage and stockpile facilities; sheds, shops, and other buildings; water-treatment and water-storage facilities; settling basins and impoundments; and coal processing and other waste disposal areas.

Production Equipment: Heavy equipment used for primary spoil movement and coal excavation, usually draglines, shovels, hydraulic excavators, or large loaders, the latter three working with haul trucks; also large dozers in the case of cast blasting.

Recharge: In hydrologic terms, rainfall that adds to the residual moisture of the basin in order to help recharge the water deficit (i.e. water absorbed into the soil that does not take the form of direct runoff).

Recovery Rate: The net percentage of the total coal in a reserve that is recovered by mining and not left in the ground. Term can be applied either to the total reserve or to working areas within a reserve.

Reference Area: A land unit maintained under appropriate management for the purpose of measuring vegetation ground cover, productivity and plant species diversity that are produced naturally or by crop production methods approved by the regulatory authority. Reference areas must be representative of geology, soil, slope, and vegetation in the permit area (30 CFR 701.5).

Relief: Difference in elevation between the highest mountaintop, ridge, or hill and the lowest valley within a permit area.

Required Findings: Specific findings that a regulatory authority must make prior to granting a mountaintop-removal or steep-slope AOC variance (Subsections 515(c) and (e) of SMCRA).

Reserve: That portion of the demonstrated coal reserve base that is estimated to be recoverable at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the demonstrated reserve base.

Residuum: Material resulting from the decomposition of rocks in place and consisting of the nearly insoluble material left after all the more readily soluble constituents of the rocks have been removed.

Revegetation: Plants or growth that replaces original ground cover following land disturbance.

Rift Zone: A long narrow continental trough bounded by normal faults.

Riparian; Zone, Habitat or Area: Is the interface between land and a river or stream. Riparian is also the proper nomenclature for one of the fifteen terrestrial biomes of the earth. Plant habitats and communities along the river margins and banks are called riparian vegetation, characterized by hydrophilic plants. Riparian zones are significant in ecology, environmental management, and civil engineering because of their role in soil conservation, their habitat biodiversity, and the influence they have on fauna and aquatic ecosystems, including grassland, woodland, wetland or even non-vegetative. In some regions the terms riparian woodland, riparian forest, riparian buffer zone, or riparian strip are used to characterize a riparian zone. The riparian is an important feature of a wetland because it allows characterization of the wetland's overall health.

Room and Pillar: is a mining system in which the mined material is extracted across a horizontal plane while leaving "pillars" of untouched material to support the roof overburden leaving open areas or "rooms" underground. It is usually used for relatively flat-lying deposits, such as those that follow a particular stratum.

Runoff: That portion of the rainfall that is not absorbed by the deep strata, is used by vegetation or lost by evaporation, or that may find its way into streams as surface flow.

Sandstone: A clastic sedimentary rock composed of sand size set in a matrix of silt or clay and more or less firmly untied by a cementing material.

Scope: The range of actions, Alternatives, and impacts to be considered in an environmental impact statement. The scope of an individual statement may depend on its relationships to other statements (40 CFR 1502.20 and 1508.28). To determine the scope of environmental impact statements, agencies shall consider three types of action, three types of Alternatives, and three types of impacts. They include:

- Actions, other than unconnected single actions, which may be: 1) Connected actions, which means that they are closely related and therefore should be discussed in the same impact statement. Actions are connected if they: (i) Automatically trigger other actions which may require environmental impact statements. (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously. (ii) Are interdependent parts of a larger action and depend on the larger action for their justification. 2) Cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement. 3) Similar actions, which when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography. An agency may wish to analyze these actions in the same impact statement. It should do so when the best way to assess adequately the combined impacts of similar actions or reasonable alternatives to such actions is to treat them in a single impact statement.
- Alternatives, which include: 1) “No Action” Alternative. 2) Other reasonable courses of actions. 3) Mitigation measures (not in the proposed action).
- Impacts, which may be: 1) Direct; 2) Indirect; 3) Cumulative (40 CFR 1508.25).

Sediment: Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sediment Channel/Ditch: See Perimeter Ditch.

Sedimentary Rock: A layered rock resulting from the consolidation of sediment. Examples of such rocks include shale, siltstone, limestone, and sandstone.

Sedimentation: The process of depositing sediments carried by water.

Sedimentation Pond: A reservoir for the confinement and retention of silt, gravel, rock, or other debris from a sediment-producing area.

Severance Tax: A tax levied against coal as it is mined, based either on the value of the coal or at a flat rate per ton, used to compensate federal, state, and sometimes local governments for the value of the portion of the reserve that is extracted.

Shrinkage Factor: Percent decrease in loose material volume resulting from backfilling and subsequent compression by overlying material.

Significantly: "Significantly" as used in NEPA requires consideration of both context and intensity:

- Context - This means that the significance of an action must be analyzed in several contexts, such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
- Intensity - This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:
    - Impacts that may be both beneficial and adverse. A significant effect may exit even if the federal agency believes that on balance the effect will be beneficial.
    - The degree to which the proposed action affects public health or safety.
    - Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, and wild and scenic rivers, or ecologically critical areas.
    - The degree to which the effects on the quality of the human environment are likely to be highly controversial.
    - The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
    - The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
    - Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
    - The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for the listing in the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historic resources.
    - The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
    - Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment (40 CFR 1508.27).

Siltstone: An indurated silt having the texture and composition of shale but lacking its fine laminations or fissility.

Sinuosity (of a stream): The degree of curvature of a stream.

Slake Durability: The ability of rock or spoil materials to resist dissolution or breakdown in water; used for assessing the suitability of spoil material for use in valley fill construction.

Socioeconomic: Relating to social and economic factors of a population or geographic region, such as income, industry structure, employment, health, and general well-being.

Soil: The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (ii) The unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics. Please refer to the Natural Resources Conservation Service website (http://soils.usda.gov/) for more detailed information regarding a specific soil taxa or regime.

Soil Horizons: Contrasting layers of soil parallel or nearly parallel to the land surface. Soil horizons are differentiated on the basis of field characteristics and laboratory data. The four master soil horizons are:

- A horizon - The uppermost mineral layer, often called the surface soil, is the part of the soil in which organic matter is most abundant, and leaching of soluble or suspended particles is typically the greatest;
- E horizon - The layer is commonly near the surface below an A horizon and above a B horizon. An E horizon is most commonly differentiated from an overlying A horizon by lighter color and generally has measurably less organic matter than the A horizon. An E horizon is most commonly differentiated from an underlying B horizon in the same sequum by color or higher value or lower chroma, by coarser texture, or by a combination of these properties;
- B horizon - The layer that typically is immediately beneath the E horizon and often called the subsoil. This middle layer commonly contains more clay, iron, or aluminum than the A, E, or C horizons; and
- C horizon - The deepest layer of soil profile consists of loose material or weathered rock that is relatively unaffected by biologic activity.

Special Handling: General term for methods of blending, isolation, or encapsulation of toxic materials within the backfill to prevent adverse impacts to chemical water quality.

Species Richness: The number of different species in a given area.

Spoil Bank: An accumulation of overburden. Also, underground mine refuse piled outside.

State Program: A program established by a state and approved by the Secretary pursuant to Section 503 of the Act to regulate surface coal mining and reclamation operations on non-Indian and non-federal lands within that State, according to the requirements of the Act and this chapter. If a cooperative agreement under part 745 has been entered into, a state program may apply to federal lands, in accordance with the terms of the cooperative agreement (30 CFR 701.5).

Steep Slope: Any slope of more than 20 degrees or such lesser slope as may be designated by the regulatory authority after consideration of soil, climate, and other characteristics of a region or state (30 CFR 701.5).

Steep-Slope Mining: Type of surface-mining operation where the natural slope of the land within the proposed permit area exceeds an average of 20 degrees.

Storage Capacity: The amount of water that can be store in a specific volume of rock.

Stratigraphic Classification: The arrangement of the sequence of rock strata of the earth's crust into units with reference to the many different characteristics, properties, or attributes which the strata possess.

Stratigraphy: Geology that deals with the origin, composition, distribution, and succession of strata. Study or description of layered or stratified rocks.

Stratum: Geologic term for a sedimentary rock bed, plural strata.

Stripping Ratio: The unit amount of spoil or overburden that must be removed to gain access to a unit amount of coal. It is generally expressed in cubic yards of overburden to raw tons of mineral material.

Sub-Bituminous Coal: Coal of rank intermediate between lignite and bituminous. In the specifications adopted jointly by the American Society for Testing and Materials (D388-38) and the American Standards Association (M20.1-1938), subbituminous coals are those with calorific values in the range 8,300 to 13,000 Btu's calculated on a moist, mineral-mater-free basis, which are both weathering and non-agglomerating according to criteria in the classification.

Support Areas: Portions of a mine permit that are maintained to support the production and development areas, such as haul roads, building facilities, and erosion and sedimentation control facilities.

Substrate: The material that composes the bed or bottom of a stream or lake.

Swale: A low place in a tract of land. A wide, shallow ditch, usually grassed or paved.
A wide open drain with a low center line.

Swell: The tendency of soils and bedrock, on being removed from their natural, compacted beds, to increase or swell owing to the creation of voids or spaces between soil or rock particles. The volumetric increase, normally expressed as a percentage that occurs as the consequence of changing undisturbed overburden (bank) into loose (excavated) material.

Swell Factor: The percentage increase in the volume of rock material as it is broken to form spoil, resulting from the creation of voids between the broken rock fragments that were not present in the original unbroken rock. Also used in industry as the equivalent to the term "bulking factor," or the net percentage increase between the volume of rock material and its resultant spoil after compaction in backfill.

Syncline: A fold in rocks in which the strata dip inward from both sides towards the axis.

Tableland: A broad, high, level region; a plateau.

Taxonomy: The science of categorization, or classification, of things based on a predetermined system.

Terrace: A level or nearly level plain, generally narrow in comparison with its length, from which the surface slopes upward on one side and downward on the other side. Terraces and their bounding slopes are formed in a variety of ways, some being aggradational and others degradational.

Threatened Waters: Waters rated by the states as "threatened" currently support all of their designated uses, but one or more of those uses may become impaired in the future (i.e., water quality may be exhibiting a deteriorating trend) if pollution control actions are not taken.

Thrust Fault: A fault with a dip of 45 degrees or less over much of its extent, on which the hanging wall appears to have moved upward relative to the footwall.

Topography: The general configuration of a land surface, including its relief and the position of its natural and man-made features.

Topsoil: The A, O, and E soil horizon layers of the four master soil horizons.

Toxic Material: Specific to coal mining, this includes overburden strata or coal materials that have been identified as containing materials that may result in adverse impacts to chemical water quality if exposed to air and water.

Transmissivity: The ability of an aquifer to transmit water.

Transpiration: The process by which plants give off water vapor through their leaves.

Underground Mining: Also known as deep mining, a process by which coal is extracted by excavating within the horizon of a coal seam and without removing the overlying overburden for reasons other than primary seam access.

Valid Existing Rights: Means a set of circumstances under which a person may, subject to regulatory authority approval, conduct surface coal mining operations on lands where 30 U.S.C. §§ 1272(e) and 761.11 would otherwise prohibit such operations.

Valley Fill: A fill structure consisting of any material other than coal waste and organic material that is placed in a valley where side slopes of the existing valley measured at the deepest point are greater than 20 degrees, or the average slope of the profile of the valley from the toe of the fill to the top of the fill is greater than ten degrees.

Vascular Plant: Also known as tracheophytes or higher plants. Those plants that have lignified tissues for conducting water, minerals, and photosynthetic products through the plant. Vascular plants include the clubmosses, *Equisetum*, ferns, gymnosperms (including conifers) and angiosperms (flowering plants).

Vector Data: A data model based on the representation of geographical object by Cartesian coordinates, commonly used to represent linear features. Each feature is represented by a series of coordinates which define its shape, and which can have linked information.

Waters of the United States: Those waters included in this term pursuant to 33 CFR Part 328. For purposes of this EIS, OSMRE assumes that this term includes: intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds Final authority regarding determinations as to the status of waters as "waters of the United States" pursuant to the Clean Water Act remains with the U.S. Environmental Protection Agency.

Watershed: An area drained by a single river or river system, defined by a ridgeline

Wetland: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (Section 404 of the Clean Water Act). For resource mapping purposes, the U.S. FWS (Cowardin et al., 1979) has also defined wetlands as follows: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: (1) At least periodically, the land supports predominantly hydrophytes; (2) The substrate is predominantly undrained hydric soils; and (3) The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

Wing Dumping: End dumping of spoil from haul trucks on opposite sides of a valley fill area to create blanket and core drains beneath the fill.

Xeric: Of an environment or habitat containing little moisture; very dry.

Zero-Order Stream: Swales and hollows that lack distinct stream banks but serve as conduits of water, sediment, nutrients, and other materials during rainstorms and snowmelt.

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Appendix A
Common Coal Mine Effluent Standards (NPDES, 40 CFR 434)

40 CFR Part 434 governs coal mine discharges and is broken into various sub-categories. Each category has four types of effluent standards based on the industry's ability to treat the associated effluent and the age of the facility.

Best Practicable Control Technology Currently Available (BPT): Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available.

Best Available Technology Economically Achievable (BAT): Effluent limitations guidelines representing the degree of effluent reduction attainable by application of the best available technology economically achievable.

Best Conventional Pollutant Control Technology (BCT): Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology.

New Source Performance Standards (NSPS): Technology-based standards for facilities that qualify as new sources under 40 CFR 122.2 and 40 CFR 122.29. Standards consider that the new source facility has an opportunity to design operations to more effectively control pollutant discharges.

Table A-1

BPT standards for coal preparation plants and associated areas all with effluent pH < 6.0 S. U. prior to treatment, and acid or ferruginous mine drainage from active mining areas including underground mines until the Surface Mining Control and Reclamation Act of 1977 (SMCRA) bond release

Pollutant or pollutant property	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days (mg/l)
Iron, total	7.0	3.5
Manganese, total	4.0	2.0
Total Suspended Solids (TSS)	70	35
pH	6 to 9 S. U. at all times	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-2

BPT standards for coal preparation plants and associated areas all with effluent pH > 6.0 S. U. prior to treatment, acid or ferruginous mine discharges from active mining areas, alkaline mine discharges from active mining areas including underground mines, and reclaimed underground mines with alkaline discharges

Pollutant or pollutant property	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days (mg/l)
Iron, total	7.0	3.5
TSS	70	35
pH	6 to 9 S. U. at all times	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-3

BPT standards for reclaimed areas until SMCRA bond release

Pollutant or pollutant property	Limitations
Settleable Solids	0.5 ml/l maximum not to be exceeded
pH	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-4

BPT standards for coal remining operations

Pollutant	Requirement
Iron, total	May not exceed baseline loadings
Manganese, total	May not exceed baseline loadings
Acidity, net	May not exceed baseline loadings
TSS	May not exceed baseline loadings

Table A-5

BAT standards for coal preparation plants and associated areas all with effluent pH < 6.0 S. U. prior to treatment, acid or ferruginous mine discharges from active mining areas, and reclaimed underground mines with acid or ferruginous discharges

Pollutant or pollutant property	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days (mg/l)
Iron, total	7.0	3.5
Manganese, total	4.0	2.0

Table A-6

BAT standards for coal preparation plants and associated areas all with effluent pH > 6.0 S. U. prior to treatment, alkaline mine discharges from active mining areas, and reclaimed underground mines

Pollutant or pollutant property	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days (mg/l)
Iron, total	7.0	3.5

Table A-7

BAT standards for mine drainage from reclaimed areas until SMCRA bond release

Pollutant or pollutant property	Limitations
Settleable solids	0.5 ml/l maximum not to be exceeded

Table A-8

BAT standards for coal remining operations

Pollutant	Requirement
Iron, total	May not exceed baseline loadings
Manganese, total	May not exceed baseline loadings
Acidity, net	May not exceed baseline loadings

Table A-9

BCT standards for coal remining operations

Pollutant	Requirement
TSS	May not exceed baseline loadings

Table A-10

NSPS for coal preparation plants and associated areas all with effluent pH < 6.0 S. U. prior to treatment, and acid or ferruginous mine discharges from active and reclaimed underground mined areas

Pollutant or pollutant property	Maximum for any 1 day	Average of daily values for 30 consecutive days
Iron, total	6.0	3.0
Manganese, total	4.0	2.0
TSS	70	35
pH	6 to 9 S. U. at all times	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-11

NSPS for coal preparation plants and associated areas all with effluent pH > 6.0 S. U. prior to treatment, alkaline mine discharges from active mining areas, and reclaimed underground mined areas

Pollutant or pollutant property	Maximum for any 1 day	Average of daily values for 30 consecutive days
Iron, total	6.0	3.0
TSS	70	35
pH	6 to 9 S. U. at all times	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-12

NSPS for reclaimed areas for all mines until SMCRA bond release

Pollutant or pollutant property	Limitations
Settleable Solids	0.5 ml/1 maximum not to be exceeded
pH	6 to 9 S. U. at all times

S. U. = Standard Units

Table A-13

NSPS for coal remining operations

Pollutant	Requirement
Iron, total	May not exceed baseline loadings
Manganese, total	May not exceed baseline loadings
Acidity, net	May not exceed baseline loadings
TSS	May not exceed baseline loadings

Figure A-1

Alternative Storm Limitations for Acid and Ferruginous Mine Drainage

	Dry weather	1yr, 24 hr	2 yr, 24 hr	10 yr, 24 hr
Discharges from underground workings - not comingled	TSS, pH, Fe, Mn	(No Alternative Limitations)		
Discharges from underground workings - comingled	TSS, pH, Fe, Mn			pH
Controlled surface mine drainage	TSS, pH, Fe, Mn			pH
Non-controlled surface mine drainage (except steep slope and mountaintop removal)	TSS, pH, Fe, Mn	SS, pH, Fe	SS, pH	pH
Discharges from coal refuse disposal piles	TSS, pH, Fe, Mn	SS, pH, Fe		pH
Discharges from steep slope and mountaintop removal areas	TSS, pH, Fe, Mn	SS, pH, Fe		pH
Discharges from Preparation Plants and associated areas (excluding coal refuse piles)	TSS, pH, Fe, Mn	SS, pH, Fe		pH
Discharges from reclaimed areas	SS, pH			pH

Appendix B
Biological Assessment of Streams

B.1 INTRODUCTION

Streams have long been used as a measuring stick to determine ecological health. Reasons behind this choice are due to the intimate connection streams have with wildlife, the landscape, and their role within surface and ground water systems. Aquatic bioassessments evaluate the condition of a water body using biological surveys and other direct measurements to the resident biota (Gibson et al., 1996). Bio-monitoring is the systematic use of biological responses to evaluate changes in the environment with the intent to use this information in a quality control program (Rosenberg and Resh, 1993). Stream bioassessments and biomonitoring programs are used throughout the world to evaluate and monitor stream health as well as degradation and/or recovery in response to disturbance. The most common group of organisms used for biological assessment is macroinvertebrates; however, assessment methods are available which incorporate fish and algae as well (Barbour et al., 1999).

B.2 STREAM BIOASSESSMENT METHODS

Throughout the U.S. streams have been given varying degrees of protection from direct and indirect impacts. Impacts can be temporary, such as non-permanent structures (e.g., access roads or sediment ponds that will be reclaimed) or these impacts can be permanent (e.g., significant stream subsidence, stream fills, or stream relocations). The mining of coal can impact streams both directly and indirectly. Mining can contribute indirectly by producing off-site impacts to streams via chemical contamination and directly by producing significant changes to the physical attributes of streams (Barbour et al., 1996; Pond et al., 2008).

Section 303(c) of the Clean Water Act (CWA) outlines the water quality standards program which includes the states' requirement to protect biological integrity. To accomplish this, many states have used the guidance and methods outlined in the U.S. Environmental Protection Agency's (EPA) Rapid Bioassessment Protocol (RBP) (Barbour et al., 1999) for their biological assessment program. The updated RBP is designed to be quick, affordable, understandable, and adaptable to regional differences in the physical and biological structure of streams. The RBP contains single habitat (riffle/run) and multihabitat approaches to sampling which includes surveys of stream biology (e.g., taxa richness, identification of sensitive and tolerant species, number of individuals, critical habitat elements, and observed pathologies) for the biological assessment of aquatic resource quality (Barbour et al., 1999; Gerritsen et al., 2000). Many states have also established numeric biocriteria defining a score that represents the expected biological community of a reference stream. The biocriteria that are used in these assessments are typically based on metrics.

Metrics allow the investigator to use indicator attributes to assess the status of assemblages or communities in response to impacts. Each metric is a characteristic of the organism(s) that changes in a predictable way to disturbance. These relate to the abundance and types of aquatic organisms found in the streams, and the connections between certain groups of organisms.

Individual metrics are often combined to produce multi-metric indices (MMIs), which are single numerical characterizations of communities. MMIs combine metrics from different categories and are sensitive to a wider range of pollution and environmental stressors. MMIs can provide a more accurate indication of biological integrity than individual metrics by capturing a wider range of elements and processes. Metrics and MMIs are further described below.

B.2.1 Biocriteria

The fish, insects, algae, aquatic plants and other biota in a waterbody provide effective information about the condition of that waterbody because the aquatic biota is continuously exposed to the various stressors present (e.g., water quality, clarity, and temperature). Chemical measurements alone only provide information on the condition at the time of sampling, and cannot assess the mid- and long-term effects of habitat degradation. Biological information not only reflects current status but also provides a relevant way to evaluate changes in conditions over time and can help assess cumulative impacts (Barbour et al., 1999). Therefore, biological assessments have become common supplementary information to chemical and physical assessments of water quality.

Biocriteria provide benchmark measurements that describe the desired condition of a system and can serve as a direct comparison of the condition of the biota that lives in the observed aquatic systems to the desired condition. Biological assessment indices are developed as an aggregation of individual metrics that are the most informative and relevant to the ecology of the streams within the area of study or are the most sensitive to a particular stressor of interest. Numeric biocriteria scores may be used depending upon the region, and what questions are being asked within the assessment (Barbour et al., 1999).

Under the CWA, biocriteria are defined as numerical values or narrative statements that define a desired biological condition for a waterbody and are part of the water quality standards. Most state biocriteria were developed according to EPA guidance in the RBP.

According to the RBP, biocriteria development:

- Is developed using data collection at a range of reference sites (which represent the natural range of variation in “minimally” disturbed water chemistry, habitat, and biological conditions) and non-reference (or “test”) sites;
- Uses the classification of streams based on physical, chemical and biological attributes;
- Develops appropriate metrics (indictors) that best discriminate between reference and streams with identified anthropogenic stressors. Candidate metrics should be the most informative and relevant to the ecology of the streams within the ecoregion; and
- Establishes a threshold to differentiate between impaired and non-impaired streams (Barbour et al., 1999).

B.2.2 Metrics

Biocriteria are developed based on biological metrics, which generally fall into five categories; taxa richness, relative abundance, tolerance/intolerance, feeding group, and habit. The most valuable metrics are those that respond predictably to the environmental stressor(s) of interest. When developing biocriteria for stream monitoring programs most states have selected metrics that respond best to general perturbation or anthropogenic disturbance. However, metrics which respond well to specific stressors are also used to more closely examine and monitor a particular impact.

Taxa richness is the number of unique taxa in a standard sample and is a measure of diversity. High levels of diversity suggest that niche space, habitat, and food sources are adequate to support a diverse biological community (Barbour et al., 1999). Examples of taxa richness metrics include total species richness and the number of species found within the insect orders Ephemeroptera, Plecoptera, and Trichoptera (EPT), i.e., the number of mayfly, stonefly, and caddisfly species.

Relative abundance (or composition) metrics provide information on the relative contribution of the various taxa to the total community. For example, the dominance of pollution tolerant taxa (e.g., high value for the Percent Chiromidae metric), suggests stream impairment (Barbour et al., 1999). Other examples of relative abundance metrics include Percent Top Dominant Species and Percent Ephemeroptera.

Tolerance/intolerance metrics are intended to represent the sensitivity of the biological assemblage to disturbance and/or different stressors. Measurements include numbers of pollution tolerant and intolerant taxa and/or their percent abundance. Examples of tolerance metrics include percent intolerant taxa and the Hilsenhoff Biotic Index (HBI). The HBI is based on categorizing macroinvertebrates depending on their response to organic pollution. Macroinvertebrates have an assigned pollution tolerance value ranging from zero to ten (ten being the most tolerant reading). The HBI is calculated as the total sum of the number of specimens in each taxonomic group (n_i) multiplied by its pollution tolerance score (a_i), divided by the total number of organisms in the sample (N): $HBI = \Sigma\, ni\; ai/N$. Although the HBI is calibrated for organic pollution, by adjusting tolerance values it may be adapted to examine biological responses to other stressors such as elevated conductivity and sedimentation (Hilsenhoff, 1987).

Feeding group measures (or trophic dynamic metrics) provide information on the balance of feeding strategies and mechanisms that a macroinvertebrate uses to acquire food (Merritt and Cummins, 1996). Scrapers (e.g., scraping algae from hard surfaces), shredders (e.g., feeding on leaf litter falling into a stream), collectors (e.g., filter feeders and collectors), and predators (e.g., hunters) are common feeding strategies in benthic environments. Stressors that cause instability in food dynamics will cause an alteration in the composition of functional feeding groups from the least disturbed or reference condition (Barbour et al., 1999).

Metrics related to habit (or modes of existence) evaluate the composition of morphological adaptations that allow organisms to attach, move, and/or conceal themselves in their environment (Merritt and Cummins, 1996). Changes in habit metrics can indicate changes in available habitat niches. For example, an increase in the Percent Herptobenthos (i.e., organisms adapted to living in soft substrates such as sand or mud) metric and decrease in Percent Haptobenthos (i.e., organisms adapted to living on hard substrates such as cobble) metric is an expected response to a stream receiving increasing inputs of excessive sedimentation.

A list of commonly used macroinvertebrate metrics is provided in Table B-1 below.

Table B-1
Commonly Used Macroinvertebrate Metrics

Category	Metric	Explanation	Expected Response to Perturbation
Richness Measures	Taxa Richness	Number of macroinvertebrate families	-
	EPT Index	Number of mayfly (Ephemeroptera), stonefly (Plecoperta), and caddisfly (Trichoptera) families	-
	Number of Ephemeroptera (mayfly) Taxa	Number of mayfly families	-
Abundance Measures	Percent EPT	Percent abundance of mayfly nymphs, stonefly nymphs, and caddisfly larvae and pupae.	-
	Percent Dominant Taxon	Percent abundance of the single most abundant taxon	+
	Percent Five Dominant Taxa	Percent abundance of the five most abundant taxa combined	+
	Percent Chironomidae	Percent abundance of larvae and pupae in the non-biting midge family Chironomidae	+
	Simpson Diversity Index	Integrates richness and evenness into a measure of general diversity $\lambda = 1 - \sum_{k=1}^{S} P_k^2$ Where: S = number of taxa P_k = proportion of individuals in taxa k	-
	HBI (Hilsenhoff Biotic Index)	Weighted sum of the total taxa by pollution tolerance $HBI = \sum \frac{x_i t_i}{n}$ Where: x_i = number of individuals within a taxon t_i = tolerance value of a taxon n = total number of organisms in the sample	+

Category	Metric	Explanation	Expected Response to Perturbation
Tolerance Measures	Percent Intolerant	Percent abundance of macroinvertebrates with tolerance values of three or less	-
	Percent Tolerant	Percent abundance of macroinvertebrates with tolerance values of seven or higher	+
	Number of Intolerant Taxa	Number of macroinvertebrate families with tolerance values of three or less	-
Habitat Measures	Percent Haptobenthos	Percent abundance of macroinvertebrates requiring clean, coarse, firm substrates (assigned habitat of clinger or crawler).	-
	Percent Herptobenthos	Percent abundance of macroinvertebrates adapted to living in or on fine, soft substrate or substrate covered with thick, slippery films of algae, bacteria, or fungi (assigned habitat of sprawler or burrower).	+
Trophic (feeding group) Measures	Percent Scrapers	Percent abundance of macroinvertebrates scraping and feeding upon periphyton	-

B.2.3 Development of Multi-metric Indices and Bioassessment Protocols

Metrics can be reviewed either independently or as multi-metric indices (MMIs). Several state water quality programs have developed numeric biocriteria and threshold standards for impairment based on a MMI calibrated and verified for their region(s). Examples of state MMIs include the West Virginia's Stream Condition Index (WVSCI) and Ohio's Invertebrate Community Index (OHICI) (Gerritsen et al., 2000; WVDEP, 2010; OHEPA, 1989; OHEPA, 2013).

Though the details differ, most state water quality programs use calibrated MMIs to establish biocriteria and meet the requirements of the CWA to monitor and protect the biological integrity of its waters. Calibrated indices require strict adherence to designated protocol. Deviating from a specified bioassessment protocol can impact the results greatly and invalidate the resulting data. Accurate application of an index is typically limited by both a specific sampling season and a specific region (e.g., state, ecoregion, or watershed). Adhering to the correct collection method is also important. The WVSCI protocol requires semi-quantitative sampling of riffle habitat using a dip net. In comparison, the OHICI uses quantitative sampling by collecting macroinvertebrates via Hester-Dendy multiple-plate artificial substrate samplers submerged in the run of a target stream for minimum of six weeks (Gerritsen et al., 2000; WVDEP, 2010; OHEPA, 1989; OHEPA, 2013).

Most state CWA Section 303(c) biomonitoring programs use regional reference sites to establish biocriteria for their state's streams. Regional reference data are collected from a population of relatively unimpaired sites within a relatively homogeneous region. The advantages of using regional reference sites for biomonitoring include: broad comparability and extrapolation of measurements; use of a large dataset provides an accurate estimate of variance; and once established, the reference sites should not require continuous sampling. However, establishment of a regional reference standard requires a substantial short-term effort and the measurements may prove too broad to adequately address specific questions about the biological integrity of a particular location. Many state programs and independent researchers often supplement regional reference data with a site-specific reference. A site-specific reference is typically a location upstream of a pollution point source or a nearby “paired” watershed that is not subjected to the point source. If properly selected, the general ecology (minus the source of impairment) of the two sites should be nearly identical, thereby strengthening conclusions about cause and effect. However, the data collected is very site specific and requires continuous sampling of the reference location(s). Additionally, studies employing site-specific reference locations typically have few replicates, so estimates of variance may prove less accurate than necessary (Barbour et al., 1999).

The required sample size and taxonomic precision (i.e., family vs. genus level assessments) varies widely between protocols. Many protocols may use subsampling methods to achieve a roughly standardized sample size and/or assist with making the field collected samples smaller and more manageable for sorting and identification. The WVSCI requires a subsample of 200 individuals identified to family level taxonomy. In comparison, the OHICI protocol requires identification of the entire field collected sample (i.e., no subsampling) to genus level taxonomy. Identification to family level requires less time, less training, is less prone to misidentifications, and produces data with lower variance often making statistical analyses more revealing. Genus level identification requires specialized training, additional equipment, and more time, but provides increased sensitivity to detecting impaired biological conditions and the causes of impairment (Pond et al., 2008; Bailey et al., 2001).

Each MMI is composed of several individual metrics from several categories standardized into a single score designed to represent the condition of the sampled stream community. For example, the WVSCI is composed of six family-level macroinvertebrate metrics from four categories (i.e., Total Taxa, EPT Taxa, Percent EPT, Percent Chironomidae, Percent Top Two Dominant Taxa, and HBI). These six metrics were chosen from a selection of 24 candidate metrics based on their efficiency to discern between known reference sites and known impaired sites. Each metric is converted to a standardized score of 0 (most impacted) to 100 (least impacted). The six scores are then averaged to commute a final single multi-metric index score. Scores greater than 78 are considered highly comparable to reference streams whereas a score of 68 has been established as the threshold for impairment. However, to allow the highest degree of confidence a threshold of 60.6 is used for the purposes of identifying biological impairment within West Virginia’s 303(d) list (Gerritsen et al., 2000; WVDEP, 2010).

Bioassessment and biomonitoring methods provide a holistic approach to gauge and monitor the conditions of a stream. A stream’s biological community reflects the ecological integrity of the stream and its surrounding watershed. Biological communities integrate the effects of multiple stressors to provide an aggregate measurement of their impact. When properly used, biomonitoring methods can assist stream restoration and reconstruction projects by insuring the re-establishment of the stream's ecological integrity (i.e., the chemical, physical, and biological integrity).

Appendix C
Aquatic Systems In Coal Mining Regions

C.1 LOTIC (FLOWING) AQUATIC SYSTEMS

Lotic or flowing aquatic systems are common landscape features in areas where coal mining is conducted. Lotic systems include creeks, springs, streams, rivers, etc. This section will discuss the various lotic systems and their features and functions within the study areaThe descriptions provided here in this section are based on the generally accepted physical and ecological characteristics that define these systems; these definitions will not necessarily be identical to the regulatory definitions used in SMCRA the CWA or elsewhere.

C.1.1 Physical Characteristics

Various physical factors such as stream gradient, light, precipitation, flow volume, substrate, and water chemistry influence the biota of lotic systems (Allan and Castillo, 2007). These physical factors are determined by relief of the landscape, climate, lithology, elevation, and land use in the area within a particular segment of stream.

C.1.2 Stream Classification

Stream ordering has been a traditional method of classifying streams (Strahler, 1957). This classification system uses the size and position of a stream within a drainage network to assign a particular order. A first-order stream does not have tributaries. A confluence of two streams of the same order promotes the system to the next stream order. For example, the union of two first-order streams produces a second-order stream; a joining of two second-order streams creates a third-order stream, and so on. There is no formal definition of a *headwater stream*, but it is often referred as a first- to third-order stream that occurs at the top of a watershed (e.g., U.S. EPA et al., 2003; Levick et al., 2008). Many headwater streams do not show up on 1:24,000 topographic maps published by the U.S. Geological Survey. Cartographers have difficulty seeing and interpreting the character of small streams on aerial photos, especially in forested areas. In addition, cartographers have used different methods and relied on aerial photos of varying quality to determine these first and second order streams. (Colson, et al, 2008). Headwater streams may be perennial, intermittent, or ephemeral (Nadeau and Rains, 2007; Levick et al., 2008).

C.1.3 Ephemeral and Intermittent Streams

A generally accepted way to define an ephemeral stream is as stream or reach of a stream that flows only during and shortly after discrete precipitation events or in response to the melting of snow and ice. The channel bottom is always above the local water table; thus, groundwater is not a source of streamflow in an ephemeral stream. An ephemeral stream typically lacks the biological, hydrological, and physical characteristics commonly associated with the continuous or seasonal conveyance of water; organisms with very short or aestivating aquatic life stages may be present.

Intermittent streams and intermittent stream reaches are below the local water table for part of the year and obtains theirs flow from both surface runoff and groundwater discharge. An intermittent stream possesses the biological, hydrological, and physical characteristics commonly associated with the seasonal conveyance of water. The biological communities of intermittent streams include species that are aquatic during a part of their life cycle, are capable of diapauses or other dormancy periods, or move to perennial water sources in dry conditions.

Often, ephemeral and intermittent streams serve as the headwaters and tributaries for many higher-order streams, but their location and the amount of flow that occurs within them varies among precipitation events (Levick et al., 2008). In addition, ephemeral streams have poorly developed banks or lack them, whereas intermittent streams tend to have moderately developed banks. Literature that discusses the ecological functions of ephemeral and intermittent streams is limited but state that ephemeral and intermittent streams move water, nutrients, sediment, and debris downstream, collect and store water, and provide connectivity within watersheds (Levick et al., 2008; Bernhardt and Palmer, 2011). Ephemeral and intermittent streams also provide habitat for a variety of flora and fauna (Molles, 2005). Many organisms found in ephemeral and intermittent streams live in the streambed substrate, even when surface water is not running (Boulton et al., 1998).

Levick et al. (2008) discussed the functions of ephemeral and intermittent streams:

> Ephemeral and intermittent streams are responsible for a large portion of basin ground-water recharge in arid and semi-arid regions through channel infiltration and transmission losses. These stream systems contribute to the biogeochemical functions of the watershed by storing, cycling, transforming, and transporting elements and compounds. Ephemeral and intermittent streams support a wide diversity of plant species, and serve as seed banks for these species. Because vegetation is more dense than in surrounding uplands, ephemeral and intermittent streams provide habitat, migration pathways, stop-over places, breeding locations, nesting sites, food, cover, water, and resting areas for mammals, birds, invertebrates, fish, reptiles and amphibians. In arid and semi-arid regions, the variability of the hydrological regime is the key determinant of both plant community structure in time and space and the types of plants and wildlife present.

C.1.4 Perennial Streams

A perennial stream is a stream or reach of a stream that flows continuously during the entire calendar year as a result of groundwater discharge or surface runoff. A perennial stream exhibits biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water. The biological communities of perennial streams support aquatic organisms year-round and may support major fisheries. The term does not include any stream or reach of a stream that meets the definition of an intermittent stream or an ephemeral stream. Perennial streams maintain continuous flow by groundwater discharge (baseflow) to the streambed. Flow in first- and second-order perennial streams is relatively low compared to higher order perennial streams. The starting points of perennial streams may fluctuate due to annual precipitation fluctuations. In years with drought, seemingly perennial reaches of a stream can be separated by ephemeral or intermittent segments of flow because of differences in geographic composition along the stream.

C.1.5 Higher-order Streams/Rivers

Higher-order streams tend to be perennial streams classified as fourth-order and above. The U.S. Environmental Protection Agency (EPA) describes fourth-order streams to sixth-order streams as mid-sized, and seventh-order streams and above as larger streams or rivers (U.S. EPA et al., 2003). Nevertheless, higher order streams perform the same critical hydrologic functions as lower order streams: they move water, sediment, nutrients, and debris and provide connectivity within the watershed (Levick et al., 2008).

C.1.6 Habitats in Streams

One of the most influential factors determining the habitat and biota of streams is stream gradient. Stream velocity is directly controlled by gradient and discharge, which also, in part, influences: the types of substrate that occur on the streambed; dissolved oxygen levels in water; and water and terrestrial temperatures. Streams can be divided vertically into three zones: the surface, the water column, and the benthic zone (Molles, 2005). The benthic zone includes the bottom substrates and the depths at which a significant amount of surface water still flows, i.e. the river bed. Below the benthic zone, a transitional area between surface water flow and groundwater flow exists; this is called the hyporheic zone. The area below the hyporheic zone where groundwater flows is called the phreatic zone; during periods of no visible streamflow, interstitial water flows through the material below the stream into the hyporheic zone (U.S. EPA et al., 2003; Molles, 2005). During hyporheic flow, stream water and groundwater mix in the beds and banks of ephemeral, intermittent, and perennial streams and sometimes in regions surrounding stream channels (Findlay, 1995; Levick et al., 2003).

The interstitial spaces among sediment particles in the hyporheic zones of streams are occupied by a diverse array of aquatic invertebrates including crustaceans, flatworms, rotifers, aquatic mites, and larval and juvenile stages of insects (Boulton et al., 1998). Stream alluvium is often looser than the soils or the colluvium of surrounding uplands, which enhances the potential for exploitation by specialized burrowing species (Levick et al., 2008). For example, some macroinvertebrates burrow into the hyporheic zone to continue their life cycles during times of drought (U.S. EPA et al., 2003). Boulton et al. (1998) noted that species of surface invertebrates have been documented to use the hyporheic zone as refugia from floods, droughts, predation, and deterioration of water quality. Some macroinvertebrates are specialized to live solely within the hyporheic zones of streams (Hynes, 1970). Biofilms that accumulate organisms and organic materials on the surface of bottom-substrates are an important source of food for the organisms in the hyporheic zones. Hyporheic organisms also are important in that they break down detritus trapped in the sediment and serve as important links in the food chain (Boulton et al., 1998).

In hyporheic zones, there is substantial biogeochemical cycling of nutrients and trace elements that are essential to aquatic life (Valett et al., 1994; Boulton et al., 1998; Hibbs, 2008; Levick et al., 2008). Boulton et al. (1998) noted that in streams where the flowing water exchanges with the hypoheic zone, nutrient exchange between the zones can promote high levels of productivity. Upwelling of water in desert streams can promote algal growth, thus promoting the uptake of nitrogen (Grimm, 1987).

Ephemeral and intermittent stream channels provide important habitat because they commonly have a higher moisture content and more abundant vegetation than the surrounding areas. In some areas, these streams may have perennial segments or permanent pools, thus retaining the only available water within a catchment area (Levick et al., 2008). These isolated perennial waters can support life not found in an otherwise ephemeral system.

Streams can be divided into the following general characteristics: pools, riffles, runs, and rapids. Pools are depositional areas where flow is slow or stagnant, allowing finer particulate matter to settle onto the stream bottom. Riffles often occur in higher gradient habitats where relatively shallow surface water flows over coarser substrate, creating turbulence within the water column and disturbance on the surface of the water. This increases levels of dissolved oxygen by encouraging the mixing of oxygen in the air with the flowing water. Runs are moderately fast sections of streams where the water surface is not as turbulent as riffles. Rapids are characterized by steep gradients, high water velocity, and turbulence over substrate resistant to erosion. Headwater streams typically consist of alternating riffles and runs; small depositional pools may be present and represent an important microhabitat. Mid-sized and larger rivers typically contain all four features because increased width, depth, and length allow for more variation in flow.

Overhanging vegetation, submerged and floating leaf packs, in-stream vegetation, large woody debris, undercut banks, and exposed tree roots all contribute to the habitat diversity for macroinvertebrates, amphibians, reptiles, mammals, and fish (U.S. EPA et al., 2003; Allan and Castillo, 2007). Levick et al. (2008) noted that ephemeral and intermittent stream channels provide important wildlife movement corridors in arid and semi-arid regions because they contain continuous chains of vegetation that wildlife can use for cover and food. Stream bank and buffer zone material provides shelter for numerous species of wildlife, including reptiles, amphibians, birds, mammals and invertebrates (Levick et al., 2008). Stream features such as littoral areas (zones close to the shore where light may penetrate to the streambed) provide cover and nursery habitat for macroinvertebrates and fish, as well as provide feeding areas for wildlife; these features exist most prominently in depositional systems such as larger-order rivers (U.S. EPA et al., 2003).

Wetlands and riparian zones are transitions between terrestrial and aquatic habitats, and occur along streams and lentic systems (U.S. EPA et al., 2003). Wetlands and riparian zones are used by some stream biota during periods of elevated flow. The Army Corps of Engineers (USACE, 1987) define wetlands as:

> Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Riparian wetlands can typically be found on floodplains along higher order streams. Typical steep geomorphology of headwater streams usually prohibits the formation of a floodplain, so wetlands are usually restricted to small depression areas (U.S. EPA et al., 2003). As stream gradient decreases, the presence of wetlands usually increases. Wetlands associated with streams are forested wetlands, emergent marshes, wet meadows, and small ponds; they all function as habitat for aquatic flora and fauna and other terrestrial wildlife. The unique characteristics and vegetative composition of wetlands provide habitat for a variety of organisms, including amphibians, migratory birds, and smaller organisms such as macroinvertebrates.

C.1.7 Ecological Functions

The ecological functioning of streams is interconnected to the land immediately adjacent to the stream—the riparian buffer zone. Riparian buffer zones provide a number of functions including: sediment control from upland areas; stream-bank stabilization; nutrient addition and extraction; wildlife habitat; temperature moderation; and flood control.

C.1.7.1 Sediment Control from Upland Areas

Natural and anthropogenic erosion from upland areas contributes to sediment in surface water runoff. Generally, as this runoff passes through the riparian buffer zone, increased friction with vegetation and organic litter slows its velocity, thereby allowing increased water infiltration into the soil, larger sediment particles to settle, and an increase in the adhesion of finer clay-like particles to the riparian vegetation and litter. The efficacy to trap sediment is dependent upon many factors, including the: size distribution of incoming sediments; water depth relative to vegetation height; vegetation type; slope; width; and flow characteristics. A more detailed discussion of these factors follows.

As the velocity of runoff entering a riparian buffer zone slows, coarse particles falling from suspension are deposited in the first few feet of the riparian zone, so long as sheet flow is maintained and channelization is avoided. Finer particles are carried further into the riparian zone. While rapid deposition is beneficial in the short term, it may ultimately render the riparian buffer zone ineffective if the sediment buries the riparian vegetation or if a natural barrier forms at the upland area-riparian zone interface. In these situations, channelized flow, as opposed to sheet wash flow, would likely occur and would considerably reduce the efficiency to trap sediment. A riparian buffer zone of a sufficient width is necessary to slow the water velocity enough to allow fine sediment deposition.

More sediment is deposited in the riparian buffer zone when water depths are lower than the height of the riparian buffer zone vegetation. For example, a study of the Black Creek in Indiana found that when surface water flow was lower than grass height, as much as 54 percent reduction in sediment loads were recorded, but when vegetation is clipped to below the surface water level, filtering efficiency ultimately declines to zero (Karr and Schlosser, 1978). In other studies, the interaction between groundwater level and vegetation height seemed to be more complex, with vegetation height, soil type, and type of sediment being significant factors of sediment filtration from shallow flow (e.g., Pearce et al., 1998).

Natural forest buffers are also effective in removing sediments, but, in general when comparing riparian buffer zones of same width, grass filters (and other dense herbaceous vegetation) are more effective in sediment removal than woody vegetation (Neibling and Alberts, 1979; Young et al., 1980; Osborne and Kovacic, 1993; Parsons et al., 1994; Gilliam et al., 1997). Still, the efficiency of forested buffers to control sediment is high. Cooper et al. (1987) found a forested buffer removed 84 to 90 percent of the sediment from cropland runoff. Also, Lowrance et al. (1995) reported similar trapping efficiencies (80 to 90 percent) in forested buffer zones in a Coastal Plain.

Efficiency in trapping sediments is generally greater on gentle slopes than steeper slopes (Karr and Schlosser, 1978; Peterjohn and Correll, 1984; Jordan et al., 1993; and Dillaha and Inamdar, 1997). Steeper topography promotes greater velocities of overland flow, increasing the ability of the flow to transport higher concentrations of sediment and reducing water infiltration time into the ground. Gentle slopes generally have more uniform cover characteristics than steeper slopes, and consequently overland flow on steeper slopes tends to concentrate and form cannels whereas gentle slopes tend to create sheet flow. These factors may contribute to less sediment trapping efficiency on steeper slopes. Some researchers believe that certain slopes are too steep to be effective sediment traps; however, there is no consensus on this critical angle, which is thought to generally range from ten to 40 percent (McNaught et al., 2003). After an extensive review of the literature, Wenger (1999) suggested that the critical angle for an effective buffer was 25 percent.

Early research by the EPA on environmental protection in surface coal mining (Grim and Hill, 1974) suggested a minimum riparian buffer zone width of 100 feet to efficiently trap most of the sediment from an upland area, although the researchers conceded that the required width varies with steepness and length of the outslope between the toe and the drainage channel. More recently, researchers for the Chesapeake Bay Program suggested that as long as sheet wash flow is maintained, a buffer width of 50 to 100 feet is adequate for the removal of sediment (Palone and Todd, 1998). Peterjohn and Correll (1984) studied the effectiveness of a 164-foot riparian zone with a five percent slope in the Mid-Atlantic Coastal Plain and found 94 percent efficiency in sediment removal but also found 90 percent of the sediment was removed in the first 62 feet. Based on research in the 1950s by the U.S. Forest Service in the White Mountains in New Hampshire (Trimble and Sartz, 1957), a simple formula, which included adjustment for slope, was developed as a means to establish a sediment buffer between forest roads and streams:

25 feet + 2.0 feet (slope percent).

Work by Swift (1986) in Nantahala National Forest in North Carolina suggested that slope distance should be adjusted using the following formula:

43 feet + 1.39 feet (slope percent).

Swift also suggested that if a brush barrier was present the formula should be further adjusted to the following:

32 feet + 0.40 feet (slope percent).

After a review of numerous studies and recognizing that vegetated buffer zones as narrow as 15 feet were found to efficiently trap sediment, Wenger (1999) stated that a 100 foot buffer zone is generally adequate for the removal of sediment.

Buffers are most effective when uniform sheet flow through the buffer zone is maintained. Dillaha et al. (1988) studied the efficiency of orchardgrass (*Dactylis glomerata*) plots for controlling sediment and nutrients from feedlots on slopes of 11 to 16 percent. They found that in plots with uniform sheet flow, 81 to 91 percent of sediment and soluble solids were effectively trapped, but the efficiency was much less where concentrated (channel) flow occurred. Channelization of surface runoff is a natural process and has a tendency to occur with increased precipitation, reduced infiltration, lack of or reduced ground cover, increased slope, and distance. Once flow becomes channelized, the ability to trap sediment is significantly reduced (Karr and Schlosser, 1978; Dillaha et al., 1989; Osborne and Kovacic, 1993; Daniels and Gilliam, 1996).

Channelized flow reduces the efficiency of vegetation and litter to slow the runoff velocity to promote suspended particles to settle. It also reduces the time for surface flow to infiltrate into the buffer zone, hindering the filtering of very fine particles. Daniels and Gilliam (1996) reported that ephemeral channels are ineffective sediment traps during high-flow. Lowrance et al. (1995) concluded that buffer zones are most effective in trapping sediment in ephemeral and headwater streams because there is a greater proportion of surface runoff that enters the buffer zone as shallow sheet wash.

C.1.7.2 Stream Bank Stabilization

Another potential source of sediment is from the stream bank. A study by Grissinger et al. (1991) found that more than 80 percent of the total sediment yield for a stream in northern Mississippi originates from channel erosion. Rabeni and Smale (1995), Cooper et al. (1993), and Lowrance et al. (1985) also found that stream channels can be a significant source of sediment.

One of the most important roles of riparian buffer zones is to stabilize stream banks. Beeson and Doyle (1995) found that non-vegetated banks were more than 30 times as likely to suffer severe erosion as fully vegetated banks. Barling and Moore (1994) note that buffers can prevent the formation of rills and gullies in riparian areas that are otherwise highly susceptible to erosion. Vegetation in the riparian area exerts a strong control over the condition and stability of the stream and its banks (Palone and Todd, 1998). In the eastern U.S. trees often define the physical characteristics of stream channels. Trees anchor stream bank soils through dense root masses, and large roots provide physical resistance to water flow. Woody debris anchors channel substrate and determines bar formation, stores large amounts of streambed sediment and gravel, helps control sinuosity, and provides channel structure through pool/riffle or step formation. Until recently, the value of large woody debris was misunderstood and much was removed throughout the country. It is likely that the direct effect of buffer width on this function is limited. Only vegetation within 25 feet of the stream channel would provide a powerful role in stabilization. However, increasing buffer width would indirectly enhance stream stability by providing additional protection during extreme flood events, channel migration, and as a physical barrier to human impact (Palone and Todd, 1998).

To be effective, bank vegetation should have a good, deep root structure which holds soil (Wenger, 1999). Shields et al. (1995) tested different configurations of vegetation and structural controls in stabilizing banks. They found that native woody species, especially willow, are best adapted to re-colonizing and stabilizing banks. Wenger (1999) noted that the persistent exotic vine kudzu is likely the most serious barrier to vegetation restoration because it can out-compete native vegetation, although kudzu can provide some stabilization via its root structure. Artificial methods of stream bank stabilization, such as applying riprap or encasing the channel in cement, are effective in reducing bank erosion on site but could increase erosion downstream and have negative impacts on other stream functions. Artificially stabilized banks lack the habitat benefits of forested banks and are expensive to build and maintain (Wenger, 1999).

Relatively narrow vegetative buffers are effective in the short term (USACE, 1991). As long as banks are stabilized and damaging activities are kept away from the channel, width of the riparian buffer zone would not appear as a major factor in preventing bank erosion. However, it is important to recognize that some erosion is inevitable and stream channels would migrate laterally; therefore, a buffer zone wide enough to permit channel migration is recommended (Wenger, 1999).

C.1.7.3 Nutrient Removal

Riparian buffer zones may also perform the function of removing nutrients, such as nitrates and phosphates, which would otherwise enter streams, rivers, and lakes. Excessive nutrient loads imbalance natural aquatic systems and can produce algal blooms and conditions with little or no oxygen dissolved in the water, leading to fish kills. Removing nutrients is especially important on mine reclamation, agricultural lands, and urban settings where fertilizer is used. In addition, the buffer zones may also help reduce sulfate (Correll and Weller, 1989; Jordan et al., 1993), which is often associated as a pollutant when coal or overburden contains pyrite.

Nutrients may be in suspension or dissolved in water. In suspension, nutrients are often affixed to sediment. As previously discussed, riparian buffer zones are effective in reducing the amount of particulate matter that enters a stream, so these same processes would apply when speaking about the amelioration of nutrients. In a dissolved form, nutrients enter the buffer zone in surface water and/or groundwater. Riparian buffer zones effectively remove nutrients in the dissolved form, but there is no consensus on which mechanisms are most responsible. The mechanisms most often mentioned include: denitrification (microbial reduction of nitrate to nitrogen gas); assimilation and retention by the vegetation; and transformation to ammonium and organic nitrogen followed by retention in the soils of the riparian buffer zones. Few studies have accurately measured the amount of nitrate removed by any of these mechanisms at a given site and no study has measured the removal rate by all of three mechanisms (Correll, 1997). Denitrification is most often invoked as the primary mechanism of nitrate removal; however, the extreme spatial and temporal variability of denitrification rates in riparian buffer zones make it very difficult to determine accurate fluxes (Correll, 1991; Weller et al., 1994). Phosphates are not effectively removed by this process because of the lack of an analogous microbial activity (Lowrance et al., 1997).

Some studies conclude that assimilation by the vegetation is the primary mechanism of nitrate removal (e.g., Fail et al., 1986); this mechanism would also account for the uptake of phosphorus. Studies have shown that the total amount of nitrogen in the biomass only accounts for 30 percent of the nitrate removal (Peterjohn and Correll, 1984; Correll and Weller, 1989). Correll (1997) suggests that the assimilation by vegetation and recycling to the forest floor as litter is important in unraveling the primary mechanism of nitrate removal. This flux of organic nitrogen delivered to the forest floor as litter could be gradually mineralized and denitrified at the soil surface. While vegetation may be very important in explaining nutrient removal within the riparian buffer zone, nutrient removal continues in the winter at sites where hardwood deciduous forests are dormant (Correll, 1997).

Some scientists believe that nitrate removal is accomplished by chemical rather than biological denitrification (Mariotti et al., 1988). The below ground conditions in riparian buffer zones are often anaerobic or of low oxidation/reduction potential (Eh) for portions of the year. The below-ground processes that result in this low Eh are composed of a series of biogeochemical reactions that occur in a defined order (Billen, 1976). These reactions transfer electrons from organic matter, released from the plants, to various terminal electron acceptors. The availability of terminal electron acceptors determines which level in the series would dominate below-ground processes at any one time and place in the riparian zone. Some of the more commonly important reactions are manganate ion reduction, denitrification, ferric iron reduction, sulfate reduction, and methanogenesis. None of these reactions can take place in the presence of molecular oxygen. Despite the relative ease of measuring soil Eh, few studies have reported this critical parameter (Correll, 1997).

Nutrients, especially phosphorus, are likely in solid form and are subjected to the same processes and limitations as other suspended solids. The long-term efficacy of riparian buffer zones to trap phosphorus is highly questionable. Whereas nitrate can be denitrified and released to the atmosphere, phosphorus is taken up by vegetation, adsorbed into the soil or organic matter, precipitated with metals, or released into the stream or groundwater (Lowrance, 1998).

The effectiveness of the riparian buffer zone to trap dissolved nutrients is highly dependent on the hydrology, soils, and vegetation. To illustrate, the volume and pathway of the groundwater passing through the riparian buffer zone would influence its ability to effectively retain nutrients. If the local groundwater passes beneath the riparian buffer zone or the whole system is at too great a depth, the riparian zone and groundwater cannot interact to trap nutrients (Correll, 1997). In diverse topography, in gentle slope areas and broad alluvial floodplains, the depth of groundwater is near the surface where nutrient trapping can be accomplished, but, in steep terrain, the water table in the riparian zone typically is much deeper. In the latter case, the interaction between the saturated zone and the root zone is quite small (Lowrance et al., 1995).

Along with hydrology, soil characteristics are important in determining the potential for removal of nitrogen and pollutants (e.g., phosphorus, pesticides) carried by sediment. Primary considerations are soil texture, depth to water table, microbial activity, and organic matter content. Moderate- to well-drained soils have the greatest permeability and intercept large amounts of water that may enter the buffer zone as surface flow, thus promoting deposition of sediment and related pollutants. Conversely, moderate- to fine-textured soils have superior potential to create conditions favorable for extensive denitrification (Palone and Todd, 1998). Soil microorganisms have the capacity to process nitrate at high concentrations. Riparian buffer zones support a variety of microbial degradation mechanisms, though the specific conditions that promote them are not well understood. Dissolved organic carbon promotes denitrification, and many soils are carbon limited or become carbon limited at high nitrate levels (Wenger, 1999).

Both grass and forested riparian buffer zones are effective at reducing nutrients but there is very little agreement among researchers regarding which is more effective. In situations where groundwater flow is relatively deep, trees would appear to be more effective because their roots would be more likely to penetrate into the zone of lateral groundwater flow.

C.1.7.4 Nutrient Supply

Leaf litter is the base food source in most stream ecosystems and streamside trees are critical in establishing this for the aquatic food web. Leaf litter and other organic matter from riparian forests, including terrestrial invertebrates that drop into the water, are an important source of food and energy to stream systems (Wenger, 1999). Small fish, some amphibians, and most aquatic insects rely primarily on leaf detritus (dead leaf material) from trees as food. Studies have shown that when streamside trees are removed, many aquatic insects decline or even disappear, and with them, the native fish, birds, and other species that may depend on them. Some insects are adapted to specific plant species and are unable to reproduce or even survive when fed the leaves from non-native or exotic species (Palone and Todd, 1998).

C.1.7.5 Flood Control

Palone and Todd (1998) provide a good analysis on this topic. Stream corridors and natural forest vegetation help to reduce the downstream effects of floods by dissipating stream energy, temporarily storing flood waters, and helping to remove sediment loads through their incorporation into the flood plain. A vegetated buffer that resists channelization is effective in decreasing the rate of flow, and in turn, increases infiltration. Forests provide as much as 40 times the water storage of a cropped field and 15 times that of grass turf. These increases in storage are largely due to the forest's ability to: capture rainfall on the vast surface area of the leaves, stems, and branches; the porosity and water holding capacity of organic material stored on the forest floor and in the soil; and the greater transpiration rates common to the community of forest vegetation. Increasing width to incorporate the flood plain also increases the potential efficiency of water storage from upstream flow during storm events. Providing flood storage buffers where possible along smaller streams in a watershed may provide a valuable approach to downstream flood reduction. However, once the entire flood plain is included within the buffer area, the effect of buffer width on flood peak reductions is negligible (Palone and Todd, 1998).

C.1.8 Headwater Streams

Headwater streams can vary in appearance, composition, and biota given their geographical location and position on the landscape. In most cases, headwater streams originate at high elevations and usually consist of alternating riffles and runs through small depositional pools. Boulders, cobble, rubble, and bedrock comprise the larger riffle substrates of headwater streams. The substrate of the small pools of headwater streams is usually finer sediment. Large, woody debris commonly contributes to the substrate complexity in headwater streams. The combination of substrate characteristics, varying flow rates, and other flow characteristics, such as hydrologic cycles, flow patterns, load transport and storage, produces the riffles, runs, and pools than can be found in the channels of headwater streams (U.S. EPA et al., 2003).

Headwater streams are generally shaded by riparian vegetation, and in some cases this vegetation may be so thick that the cover prohibits photosynthesis by aquatic primary producers (Molles, 2005). The extent of shading progressively decreases downstream as stream width increases (Molles, 2005). Data from Stout and Wallace (2005) found that biological communities in the study area's streams were present as soon as there was flowing water. Although intermittent headwater streams tend to go dry for a portion of the year, macroinvertebrate life can exist within their channels. In a study of intermittent and perennial streams in Alabama, macroinvertebrate assemblages of normally intermittent streams did not differ greatly from those of nearby permanent or perennial streams (Feminella, 1996).

C.1.8.1 Function of Headwater Streams

Headwater streams serve numerous ecological functions including attenuating floods, maintaining water supplies, and improving water quality (Levick et al., 2008). A primary function of headwater streams is to ensure continuous flow of water to downstream ecosystems. The water level in headwater streams is often higher than the water table which allows water to flow through the channel bed and banks into the soil and groundwater (Levick et al., 2008). During periods of low to no precipitation (e.g., drought), the flows of some downstream reaches of headwater streams are supported by water flowing from the soil and groundwater through the channel banks and bed of the stream (Levick et al., 2008). This exchange of water from the soil and groundwater into the stream maintains stream flow. However, headwater streams are more prone to drying out than downstream segments because they have smaller drainage areas with less recharge potential and occur at higher elevations (McMahon and Finlayson, 2003; Fritz et al., 2008). Headwater streams provide cover, food, and spawning/breeding habitat for various species and provide cover for species that are colonists when downstream ecosystems are experiencing disturbance (Meyer and Wallace, 2001).

The major functions of headwater streams can be summarized into two categories: physical and biological (U.S. EPA et al., 2003). These functions are described below:

<u>Physical</u>

- Headwater streams tend to moderate the hydrograph, or flow rate, downstream.
- They serve as a major area of nutrient transformation and retention.
- They provide a moderate thermal regime compared to downstream waters—cooler in summer and warmer in winter.
- They provide for physical retention of organic material.

<u>Biological</u>

- Biota in headwater streams influence the storage, transportation, and export of organic matter.
- Biota convert organic matter to fine particulate and dissolved organic matter.
- They enhance downstream transport of organic matter.
- They promote less accumulation of large and woody organic matter in headwater streams.

- They enhance sediment transport downstream by breaking down the leaf material.
- They enhance nutrient uptake and transformation.

C.1.8.2 Energy Sources and Primary Production of Headwater Streams

Headwater streams are primary locations of input, storage, transformation, and export of detritus to downstream reaches (Meyer and Wallace, 2001). The interaction between water and sediments in headwater streams supports nutrient and organic matter storage and processing. The bacteria and fungi in headwater streams are the driving force behind leaf decomposition and are sources of food for benthic invertebrates (Meyer, 1994; Meyer and Wallace, 2001). In headwater streams, leaves and other plant materials (i.e., allochthonous inputs) are the primary sources of energy available to the stream ecosystem. Upon entering the stream, the plant material is broken down by microbes and fungi, which are in turn sources of food for shredding and collecting macroinvertebrates (Meyer and Wallace, 2001; Molles, 2005). Although fungi have higher productivity and often contribute more biomass than bacteria in headwater streams, bacteria are also an important source of carbon for aquatic insects (Meyer and Wallace, 2001). Dissolved organic carbon (DOC) from the catchment and channel supports the growth of bacteria in headwater streams (Meyer et al., 1998; Meyer and Wallace, 2001). Fisher and Likens (1973) explain that over 99 percent of the annual energy inputs to a small forested stream can be attributed to leaf detritus and DOC from the terrestrial environment. Given the unidirectional flow of streams, downstream areas are dependent on upstream areas for portions of their energy (per "River Continuum Concept," Vannote et al., 1980). Production of both primary and secondary consumers is connected to the supply of leaf litter from riparian forests and its retention in the channels of headwater streams (Meyer and Wallace, 2001).

Plant communities of higher-gradient streams live in a physically challenging environment. Overall, floras in close proximity to high-gradient streams are subjected to greater current velocities than downstream plant communities, and the surroundings of high-gradient streams are usually densely shaded. Plant communities occurring in high-gradient streams contain species uniquely adapted to survive in this type of environment. The lack of direct anthropogenic (human-induced) disturbance to watersheds of high-gradient streams likely prolonged the persistence of the endemic flora in these areas (Wilcove et al., 1998). Limitations on the availability of water in arid environments results in patchy, sparse vascular plant cover (Levick et al., 2008). As a result, algal and soil microbial activity is important for nutrient cycling in these environments (Belnap et al., 2005).

The ecological functions of plant communities within ephemeral and intermittent streams are poorly understood (Levick et al., 2008). Plant communities along ephemeral and intermittent streams provide structural elements of food, cover, nesting, and breeding habitat, and movement/migration corridors for wildlife that are often not as readily available in the adjacent uplands. Vegetation in ephemeral stream channels plays a key role in resource retention by protecting soils from wind and water erosion, slowing floodwater velocity, and moderating temperatures (Levick et al., 2008). Ephemeral stream vegetation also influences biogeochemical cycles by providing leaf litter, food, and cover for wildlife. In some cases, vegetation can intercept rainfall, preventing it from infiltrating into the soil, thereby influencing the local water balance and ecosystem processes (Owens et al., 2006; Miller, 2005). Vegetation structure and diversity influence wildlife species diversity and abundance; changes in the abundance of plant species or the composition of the plant community may affect an array of ecosystem functions and processes. Functions of these communities include: moderating soil and air temperatures; stabilizing channel banks and interfluves; seed banking and trapping of silt and fine sediment favorable to the establishment of diverse floral and faunal species; and dissipating stream energy which aids in flood control (e.g., Levick et al., 2008).

C.1.9 The River Continuum Concept

U.S. EPA et al. (2003) provided a detailed description of the River Continuum Concept developed by Vannote et al. (1980); that description is included here because it is relevant to the streams and rivers distributed throughout the coal regions of the U.S.

The River Continuum Concept (Vannote et al., 1980) is a theory that details how differing energy sources are processed efficiently, progressing from headwater streams to large rivers. This theory explains that energy sources are dependent upon geomorphological, chemical, and biological factors that have evolved within the surface water ecosystem to create a balanced energy transport. The general metabolism for the river ecosystem uses energy that is transported downstream from upstream reaches within the system. From the headwaters to the mouth of the river, the river ecosystem is comprised of a balanced, efficient, longitudinal gradient of energy sources and processing in which the particle size of organic matter becomes more refined as the river becomes larger.

In each portion of a river ecosystem, some organic matter is processed, some stored, and some released (Vannote et al., 1980). Organic matter is conditioned by microbes (fungi and bacteria), and some is respired (to carbon dioxide) by microbes and animals, some converted to smaller particles and dissolved organic matter which is exported to downstream communities (Vannote et al., 1980). Macroinvertebrate communities at each section of the river ecosystem have become specifically adapted to maximize the processing of energy available in the form of organic matter. Because macroinvertebrate communities serve as a food base for higher trophic organisms (e.g., fish) in the food web, these higher trophic organisms have also evolved to fit available niches in the stream ecosystem.

Headwater streams harbor primarily benthic macroinvertebrate communities who are specialized to feed on the coarse particulate organic matter (CPOM) deposited in the system. Examples of benthic macroinvertebrates include crayfish, worms, snails and flies. The majority of benthic macroinvertebrates in headwater streams are classified as shredders and collectors who feed on the CPOM and fine particulate organic matter (FPOM), and predators who feed on other macroinvertebrates. Typical benthic macroinvertebrates found in headwater streams include insects such as mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), beetles (Coleoptera), dobsonflies and alderflies (Megaloptera), true bugs (Hemiptera), springtails (Collembola), and true flies (Diptera). Other macroinvertebrates may include crayfish (Decapoda), isopods (Isopoda), worms (Oligochaeta and Annelida) and snails (Gastropoda).

In the southern Appalachian Mountains, macroinvertebrates of several orders including Ephemeroptera, Plecoptera, and Trichoptera have been found to be rich in species, including many endemic species and species considered to be rare. This diversity and unique assemblage of species has been attributed to the unique geological, climatological, and hydrological features of this region (Morse et al., 1993; Morse et al., 1997). Many biologists agree that the presence of a biotic community with such unique and rare populations should be considered a critical resource. Stream macroinvertebrates are typically classified on the basis of their functional feeding group (Cummins, 1973; Cummins and Klug, 1979; Merritt and Cummins, 1984). Insects within a functional feeding group share similarities in their morphology, feeding behavior, and feeding mechanisms (e.g., scraping, collecting, shredding, filtering). Typical functional feeding groups are described below.

C.1.9.1 Scrapers

Scrapers are adapted to scrape materials, such as algae or periphyton and its associated microflora, from rock or organic substrates, such as leaves (Wallace et al., 1992). Typically scrapers include certain taxa of snails, mayflies, caddisflies, beetles, and fly larvae.

C.1.9.2 Shredders

Shredders chew primarily large pieces of decomposing vascular plants (≥1 mm or 0.039 inch in diameter) along with its associated microflora and fauna. They may also feed directly on living vascular hydrophytes or gouge decomposing wood submerged in streams (Wallace et al., 1992). In addition to aquatic insects, many omnivorous crayfish are facultative shredders. Shredders are important because their mode of feeding causes the generation of large quantities of small organic particles. These particles are more easily transported downstream and may be acted on by microbes more easily due to the increase in the surface area to volume ratio. Common shredders are certain taxa of stoneflies, caddisflies, and fly larvae.

C.1.9.3 Collector-gatherers

Collector-gatherers feed primarily on fine pieces of decomposing particulate organic matter (less than or equal to one millimeter or 0.039 inch diameter) deposited within streams (Wallace et al., 1992). Many Chironomidae larvae are collector-gatherers.

C.1.9.4 Collector-filterers

Collector-filterers have specialized anatomical structures (setae, mouthbrushes, fans, etc.) or silk and silk-like secretions that act as sieves to remove particulate matter from suspension (Jorgensen, 1966; Wallace and Merritt, 1980; Wallace et al., 1992). Some mayflies, caddisflies, and fly larvae are collector-filterers.

C.1.9.5 Predators

Predators feed on animal tissues by either engulfing their prey or by piercing prey and sucking body contents (Wallace et al., 1992). Predators include dragonflies, hellgrammites, crayfish, and some taxa of stoneflies, caddisflies, beetles, and fly larvae.

C.1.10 Primary Production Within Headwater Streams

U.S. EPA et al. (2003) provided the following information about primary production within headwater streams of one coal region; it is included here because of its continued relevance to the coal regions covered in this DEIS.

Primary production is the input of energy into a system by the growth of flora living in the system. Primary production in streams is often measured as mass of carbon or ash free dry mass, which is largely carbon, per unit area, per year. Primary production rates in Appalachian streams have been shown to vary with stream order, season, degree of shading, nutrients, and water hardness (Wallace et al., 1992). Although under some circumstances, gross primary production can be high (Hill and Webster, 1982; Wallace et al., 1992), typical primary production inputs appear to range from approximately nine to 446 pounds of carbon per acre of stream per year (Keithan and Lowe, 1985; Rodgers et al., 1983; Wallace et al., 1992).

Levick et al. (2008) noted that plant productivity in arid and semi-arid regions, which include multiple coal regions, is often low most of the year and punctuated by bursts of activity following rain and runoff events. Variations of the patterns of primary productivity and evapotranspiration by plant communities are dependent on their main sources of water: direct precipitation, channel flow, or stored water (de Soyza et al., 2004; Leenhouts et al., 2006; Levick et al., 2008). When stored water is accessible, productivity and evapotranspiration of plant species can be high for much of the growing season (Atchley et al., 1999). De Soyza et al. (2004) found that plants along an ephemeral stream channel responded more to channel flow than direct precipitation, indicating the importance of maintaining intact channel networks throughout a watershed.

C.1.11 Vascular Plants and Bryophytes

Vascular plants (ferns and higher plants) and bryophytes (mosses and liverworts) are common in areas surrounding headwater streams, but the structure and composition is dependent on the relief of the landscape, climate, size of stream, soil chemistry, substrate, and flow patterns (U.S. EPA et al., 2003). In ephemeral and intermittent streams, the structure and composition of the vegetation is related to the size of the stream and patterns of flow, although most of the diversity is comprised of herbaceous species (Bagstad et al., 2005; Levick et al., 2008). Vascular plants found in or near high-gradient streams typically have adventitious roots, rhizomes, flexible stems, and streamlined narrow leaves (Westlake, 1975; U.S. EPA et al., 2003). In contrast, bryophytes contribute the majority of the biomass of primary producers in small streams, and they attach to rocks and boulders and are smaller in size, lack flowering parts, and reproduce by releasing spores. Given their dominance within these areas, bryophytes also provide habitat that supports many aquatic invertebrate species (Meyer et al., 2007). Mosses are most diverse and abundant in headwater streams and seeps, and they can exclusively use carbon dioxide in photosynthesis (Meyer et al., 2007). Heino et al. (2005) noted that bryophyte species richness ranged from 0 to 14 species in small boreal streams. Glime (1968) found that four species dominate the bryophyte flora of small, high-gradient Appalachian streams and that *Fontinalis dalecarlica* and *Hygroamblystegietum fluviatile* are most abundant in first through third-order streams.

In regions subjected to seasonal precipitation, depth to groundwater is particularly important because groundwater is closely coupled with stream flow that maintains a water supply to riparian vegetation (Groeneveld and Griepentrog, 1985; Levick et al., 2008). The species composition of ephemeral and intermittent streams within the arid and semi-arid southwestern U.S. is dependent on species composition of the watershed and floristic province, as well as with drainage size, climatic regime, latitude, longitude, elevation, aspect, and soil characteristics (Levick et al., 2003). As the hydrologic regime shifts from perennial to ephemeral, vegetation composition shifts towards more drought-tolerant species, vegetation cover declines, riparian woodlands give way to riparian shrublands, and canopy height and upper canopy vegetation volume decline (Leenhouts et al., 2006; Stromberg et al., 2007; Levick et al., 2008).

C.1.12 Algae

Algae are prevalent in headwater streams, and multiple species are endemic to specific streams in the U.S. (U.S. EPA et al., 2003; Meyer et al., 2007). As summarized in Wallace et al. (1992), the algae of high-gradient streams are limited to species capable of anchoring to stable substrates, preferably large stationary objects (U.S. EPA et al., 2003). In systems where the headwaters are shaded and low in nutrients, 30 to 60 algal species are commonly encountered (Meyer et al., 2007). During periods of low flow, algae may temporarily colonize smaller objects (U.S. EPA et al., 2003).

C.1.13 Woody Material

Woody material is not just an energy source but also provides other important stream functions involving hydrology and habitat structure. Such functions of woody debris in streams include: contributing to stair-step stream bed profiles that result in rapid dispersion of the stream's energy; forming micro-pools or sieve-like structures that retain other particulate organic material which may influence trophic and nutrient dynamics; providing habitat for aquatic organisms; and functioning as a food source for xylophagous organisms (Wallace et al., 2001; U.S. EPA et al., 2003).

C.1.14 Organic Matter Processing and Nutrient Cycling

The headwater stream (first- through third-order) is the origin for energy processing within the river ecosystem. Headwater streams located in forested areas are characterized by a dense canopy and low photosynthetic production. Allochthonous (coming from outside the system) materials derived from the terrestrial environment are the primary sources of energy for headwater streams. As summarized in U.S. EPA et al. (2003), most allochthonous material arrives in the form of CPOM (greater than one millimeter or 0.039 inch in size). Smaller amounts of other allochthonous materials that are transported to the stream include FPOM (50 µm to one µm in size or 0.0019 to 0.000039 inches in size) and Dissolved Organic Matter (DOM) traveling in surface-water and groundwater flows. Microbes and specialized macroinvertebrates living in headwater streams, called shredders, feed on CPOM, converting it into FPOM and DOM. The FPOM and DOM are carried downstream to mid-sized streams (U.S. EPA et al., 2003).

Because mid-sized streams (fourth- through sixth-order) are wider than headwater streams, the canopy is usually more open and more light is able to penetrate to the stream bottom. As a result, a greater abundance of algae and aquatic plants are able to grow here. In general, the proportion of allochthonous material derived from terrestrial vegetation in mid-sized streams is less than in the headwater streams. Autochthonous material (material that is derived from within the stream) becomes an important component of the energy budget in mid-sized streams. Consequently, mid-sized streams may exhibit a shift from a heterotrophic to an autotrophic system, or one that generates its own energy through photosynthesis. The biological community of mid-sized streams differs somewhat from that in headwater streams in part because of the more diverse types of energy sources that are available. Specialized macroinvertebrates called collectors-filterers and collector-gatherers break down the FPOM carried from upstream reaches into Ultra-fine Particulate Organic Matter (UPOM) (0.5 to 50 nm in size or 0.019 to 1.97 x 10^{-6} inches in size). These macroinvertebrates, as well as microbes, also consume living plant matter (algae and aquatic plants) converting it into additional forms of energy. The UPOM derived from these energy sources is then carried downstream to larger rivers. Interestingly, collectors can also increase particle sizes in some cases by feeding on material in the several micron range and defecating compacted feces of a much larger particle size. These larger particles then become available to larger particle feeding detritivores (Wallace et al., 1992).

As summarized in U.S. EPA et al. (2003), larger rivers (seventh- through twelfth-order) have different biological communities from lower order streams. The increased width, depth, and suspended mineral and organic matter prohibit much light penetration and consequent growth of algae and plants within the main channel. Collectors again become the primary macroinvertebrate community to process the particulate organic material. Larger rivers tend to be heterotrophic systems. Several models have been developed to describe the movement of energy and nutrients in rivers. These theories include the River Continuum Concept (Vannote et al., 1980) and the concept of nutrient spiraling (e.g., Webster, 1975). The development of the River Continuum Concept greatly improved the scientific communities' understanding of the ecosystem-level functions of rivers and provided direction for lotic ecosystem research over the last 30 years.

C.1.15 Invertebrates

Invertebrates form a major portion of Earth's animal diversity, and the emergence of aquatic invertebrates from streams is a significant part of the food chain (Levick et al., 2008). Invertebrate inhabitants of headwater streams are sources of food to fish, mammals, and amphibians within the headwater reach (Meyer et al., 2007). Emerging and flying adults of aquatic insects are often sources of food for terrestrial animals (e.g., spiders, birds, and bats), and they represent an important reciprocal link between streams and terrestrial biota (Baxter et al., 2005; Meyer et al., 2007).

The communities found within streams are dependent upon the stream type and order. Headwater streams harbor primarily benthic macroinvertebrate communities (e.g., crayfish, worms, snails, and insects), which are specialized to feed on CPOM (U.S. EPA et al., 2003). Ephemeral and intermittent streams also harbor diverse invertebrate communities because of their array of microhabitats (Levick et al., 2008). Disturbances caused by intermittent flows may facilitate high food quality and consequently high levels of insect production in warm-temperate desert streams (Fisher and Gray, 1983; Jackson and Fisher, 1986; Grimm and Fisher, 1989; Huryn and Wallace, 2000). Most benthic macroinvertebrates in headwater streams are classified as shredders and collectors that feed on the CPOM and FPOM, and predators that feed on the other macroinvertebrates (U.S. EPA et al., 2003). For example, common benthic macroinvertebrates found in headwater streams of Appalachia include insects such as mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), beetles (Coleoptera), dobsonflies and alderflies (Megaloptera), true bugs (Hemiptera), springtails (Collembola), and true flies (Diptera) (U.S. EPA et al., 2003). Other macroinvertebrates may include crayfish (Decapoda), isopods (Isopoda), worms (Oligochaeta and Annelida) and snails (Gastropoda).

Mollusks have been receiving more research attention, and their importance as a part of stream communities is receiving greater recognition. Mollusks tend to be more diverse in larger, perennial streams but can persist and be present and abundant in headwaters (Meyer et al., 2007). Mollusks such as bivalves and gastropods are common in lotic systems. Mussels are among one of the most diverse groups in North America, especially in the southeast U.S.; however, they are among the most threatened as a result of habitat loss, degradation, and invasive species. Crustaceans, such as amphipods, isopods and crayfish, are prevalent in headwaters. The southeast U.S. also has the greatest crayfish diversity in the world, but many of these species are facing similar dangers to that of freshwater mussels. Microcrustaceans, such as cladocerans, ostracods, and copepods, also live in headwaters, where their populations can attain high densities (>10,000 m^2) (Galassi et al., 2002; Meyer et al., 2007). Small streams support many invertebrate taxa other than insects, mollusks and crustaceans, but these groups have not received much study. A typical headwater stream might contain 30 to 300 species and 20,000 to 2,000,000 / m^2 of these other taxa, such as turbellarians, gastrotrichs, and nematodes (Meyer et al., 2007). Species richness in these groups may be as high in headwaters as in larger streams and many can be found in intermittent streams (Meyer et al., 2007).

C.1.16 Vertebrates

Fish and amphibians are the major groups of vertebrates that inhabit streams, and multiple headwater streams serve as habitat to species that are endemic to specific areas. Fish species present in headwater streams tend to be representative of cold water species (e.g., darters, sculpins, salmonids, cyprinids) and are primarily sustained by a diet of invertebrates (Vannote et al., 1980). Fish populations can be abundant in headwater streams, but their diversity generally increases with increasing stream size, habitat heterogeneity, pool development, and habitat volume. Although fish tend to occupy larger streams, multiple species can use ephemeral and intermittent streams as habitat. Many fishes found in headwaters are unique and likely contribute to network-wide diversity and play a critical role in the genetics of fish populations (Meyer et al., 2007; Palmer, 2009). In mid-sized streams, a shift in the fish community from cold-water to more warm-water fish species usually occurs. Furthermore, the fish community becomes more diverse and more piscivorous species are present (Vannote et al., 1980).

Amphibians, in regions where present, play a critical role in the biodiversity of stream communities. In streams where fish are absent, amphibians tend to be the most common vertebrate and dominant aquatic predators (Bernhardt and Palmer, 2011). Salamanders are the most common amphibians in headwaters (Davic and Welsh Jr., 2004), but frogs, toads, and reptiles (e.g., snakes and lizards) can also be abundant (Meyer et al., 2007). Predation by fish is believed to restrict amphibians to the smaller streams or the banks of large streams (Wallace et al., 1992; Bernhardt and Palmer, 2011). Ephemeral and intermittent streams serve as crucial habitat for amphibians, perhaps because they offer freedom from predators; some of these species are state and/or federally threatened or endangered (Davic and Welsh Jr., 2004; Bernhardt and Palmer, 2011). Amphibian production in first and second order streams is often greater than production within higher-order streams (Wallace et al., 1992). Multiple specialized stream salamanders require headwater seeps and small streams in forested habitats to maintain viable populations (Petranka, 1998). Plethodontids, or lungless salamanders, use small headwater streams as their principal larval habitat, where they spend from a few months to five years (Beachy and Bruce, 1992). Salamander populations from headwater streams influence insect population dynamics by predation, regulate detritus food webs, and link stream and terrestrial food webs (Davic and Welsh Jr., 2004). Reptiles also contribute to the biodiversity of streams. Multiple species of turtles, lizards, and snakes use streams to obtain food. In headwaters, snakes and turtles primarily comprise the reptilian communities (Meyer et al., 2007). Although reptiles are not usually restricted to or most abundant in these habitats (Buhlmann and Gibbons, 1997), species in several genera (e.g., *Nerodia*, *Farancia*, and *Regina*) specialize on aquatic prey items (Meyer et al., 2007).

C.2 LENTIC (NON-FLOWING) AQUATIC SYSTEMS

Lentic aquatic systems are defined as non-flowing water bodies such as natural lakes and ponds or artificial impoundments such as a reservoir. Lentic systems are also referred to as lacustrine habitats, which may include palustrine habitats as described below. Lentic water bodies can be permanently flooded, intermittent (e.g., playa lakes), or have a tidal influence where ocean-derived salinities are below 0.5 percent (Cowardin et al., 1979). Some lentic systems may be fresh water bodies, while others have varying levels of salinity (e.g., Great Salt Lake).

Lakes are generally differentiated from ponds based on their size, with lakes being larger; however, the usage of terminology can differ. Another distinction that can be made between lakes and ponds would be the type of mixing that occurs. Water bodies may be considered lakes when the wind plays the dominant role in mixing (Menzel and Cooper, 1992). Cowardin et al. (1979) indicates that lakes typically have extensive areas of deep water and considerable wave action. In ponds, gentler convective mixing predominates. Ponds can include pools of water such as ephemeral or vernal pools which are formed by winter and spring rains and/or snow melt, and that typically dry up by summer months.

Lacustrine water bodies differ from palustrine (inland wetlands and marshes) in that they are larger (generally greater than 20 acres), deeper (generally deeper than 6.6 feet at low water), and vegetation does not exceed 30 percent aerial coverage. Palustrine systems consist of non-tidal wetlands dominated by trees, shrubs, and other vegetation, and where ocean-derived salinities are below 0.5 percent (Cowardin et al., 1979). Many wetland types are generally grouped within lentic systems where wetlands have constant soil saturation or inundation with distinct flora and faunal communities. Cowardin et al. (1979) distinguishes deepwater habitats from wetlands; however, shallow and permanent or intermittent ponds/pools can be considered to be a type of palustrine wetland.

C.2.1 Physical Characteristics

Natural lakes are formed by many different processes to include catastrophic phenomena (glacial, volcanic, and tectonic forces), rivers, waves, and rock solution. Human constructed lakes are created by dams or excavation of basins. Lake classifications are determined by the method in which they formed and include glacial lakes, tectonic basins, volcanic lakes, landslide solution lakes, plunge pools, oxbow lakes, and beaver-made or human-made lakes (U.S. EPA, 2008). In geological terms, most natural lentic systems are young, dating from the last glacial period (Thorp and Covich, 2001). The source of water for many lentic systems is dependent on surface runoff and by groundwater input; groundwater may provide the majority of the water to some ponds (Menzel and Cooper, 1992). Most natural and man-made lentic systems have average depths of less than 20 meters (Wetzel, 2001).

The structure of a lake or pond is defined by physical, chemical, and biological characteristics. In some instances, landscape position of the watershed basin, characteristics of the watershed, and morphometry of the basin are a more important than basin formation for describing the biological features of a lake (U.S. EPA, 2008). Watershed conditions can greatly affect lakes, ponds, and impoundments to include allochthonous (organic material produced outside the stream such as leaves, wood) and autochthonous (primary production by plants and algae present within the system) material depending on the type of setting. Further, any changes to energy sources (i.e., terrestrial detritus versus algae in more open water bodies) can influence the food base and community structure (Menzel and Cooper, 1992).

Environmental conditions of lentic systems differ greatly with that of lotic systems. Unidirectional water flow is minimal, and lentic waters tend to be warmer than streams and rivers. Oxygen levels in lentic systems are generally lower than lotic systems, but some standing waters may contain enough dissolved oxygen to support the growth of some lotic adapted organisms (Mayer and Laudenslayer, 1988).

The limnology of lakes is dominated by vertical gradients. The vertical distribution of lake organisms is influenced by gradations of oxygen, light, and temperature in addition to currents and seiches (oscillating waves). Light penetration of lentic systems is dependent on turbidity. Temperatures will vary seasonally and with depth. Oxygen content of lakes and ponds is low compared to systems with flowing water as a smaller proportion of surface water is in direct contact with the atmosphere and because decomposition is taking place and using significant portions of the oxygen supply within the system (Mayer and Laudenslayer, 1988). However, lakes and reservoirs may retain some river-like qualities such as longitudinal gradients in channel morphology, flow velocity, water temperatures, bottom substrate type, and biotic community composition. Many biological, chemical, and physical processes in lakes and reservoirs are similar to rivers (Menzel and Cooper, 1992).

C.2.2 Ecological and Biological Functions

Lentic systems provide many functions: providing habitat for organisms, providing drinking water, waste removal, agricultural irrigation, industrial activity, and recreation (Hairston and Fussmann, 2002). Ecological functions of larger lakes and ponds may include flood control and improved water quality of riparian systems downstream through the temporary removal of nutrients and toxic materials by allowing these compounds to settle out of the water column. Ecosystem-level functions occurring within lentic systems include energy flow relationships. Small lentic systems, such as ponds, have a limited ability to cycle nutrients on a watershed scale (Menzel and Cooper, 1992). Due to the high ratio of drainage area to surface area, reservoirs have high annual nutrient loads compared to natural lakes. The movement of nutrients and energy in reservoirs is a major function of these systems and is closely tied to the physical environment (Soballe et al., 1992).

Organic matter inputs enter the reservoir system, which support the growth of bacteria, fungi, and detritivores. Phytoplankton production dominates most impoundments as changing water levels inhibit development of littoral macrophyte and periphyton communities. Sedimentation of detrital aggregates and zooplankton fecal pellets provide an energy source to benthic decomposers which in turn are used by higher level consumers. Nutrient regeneration occurs at most levels of this food web (Soballe et al., 1992).

Lake ecosystems are influenced by their watersheds including the geological, chemical, and biological processes that occur on the surrounding land and within its associated waterways. The open water system, shoreline systems, and upper watershed systems are interrelated and interdependent (Campbell et al., 2006). Lakes are connected to the watershed by the movement of surface water, groundwater, and living organisms. Rivers and streams supply lakes with water and nutrients, and provide spawning and nursery areas for anadromous fish. The health and biodiversity of a lentic system is directly related to the health of each component of the ecosystem. For example, a lentic system can be adversely affected by riparian vegetation removal in the upper watershed, resulting in increased sediment loads and degradation or destruction of anadromous fish spawning habitats (Campbell et al., 2006).

Lentic systems can be divided into several abiotic zones based on distance from shore, light penetration, and temperature change; these zones include photic, aphotic or profundal, and littoral. The photic zone extends to a depth where light penetration is at or above one percent (i.e., the zone where photosynthesis can occur) and where primary producers and most animals live (Thorp and Covich, 2001). The near-shore and shallow area of the photic zone where rooted macrophytes establish is termed the littoral zone. The littoral zone is where the light reaches all the way to the bottom of the lake. Cowardin et al. (1979) defined the littoral zone as the zone that extends from the shoreward boundary to a depth of two meters (6.6 feet) below low water or to the maximum extent of non-persistent emergent vegetation if growing at depths greater than two meters. The littoral zone typically occurs at the edges of lakes and is found throughout most ponds. The photic zone also contains the limnetic zone or open water zone. All water located away from the shore and littoral zone is termed the limnetic or pelagic zone. The limnetic zone is shallower in turbid water than in clear and is a more prominent feature of lakes than of ponds. Below the limnetic zone is the aphotic or profundal zone. The profundal zone has depths beyond which primary producers can live.

Because there is no single, directional flow in a lentic system, stratification may occur. The limnetic zone of a lentic system is classified into thermal layers, depending on the degree of mixing that occurs. The density of water changes with temperature causing lakes to become layered, or stratified, into temperature zones (Dodson, 2005). The temperature of the upper layers will drop as air temperatures drop. As these upper water layers cool they become denser, eventually they becoming dense enough to sink. As the dense layer sinks, it displaces the water at the bottom of the water body, which forces the lower water layers to the surface.

Most lentic systems in North America become stratified during warmer seasons with a layer of lighter water called the epilimnion, which floats over a denser layer (the hypolimnion). During the warmer months the epilimnion is warmer. The two zones are separated by another layer (the metalimnion) where rapid temperature changes occur. Where the shift in temperature changes most rapidly, this layer is called the thermocline (Dodson, 2005).

Oxygen concentrations and stratification depend on the thermal stratification and biological activity within a lentic system and results in three major patterns variation associated with depth: orthograde, clinograde, and heterograde. Oxygen saturation throughout a lake results in an orthograde pattern. Less oxygen is present where water is warmer; oxygen content will be higher in the hypolimnion when the epilimnion is warmer. Bacterial decomposition of organic material in the hypolimnion results in a clinograde pattern where oxygen has been depleted from the hypolimnion layer and respiration and decomposition have increased as lake productivity increases. This is due to the contribution of oxygen to the epilimnion layer from phytoplankton and the removal of oxygen from the hypolimnion layer from decomposition. Algal growth during the summer months will increase productivity which results in turbid conditions, less light penetration, and additional organic material in the hypolimnion layer. The bacterial metabolism of this organic material can reduce oxygen levels in the hypolimnion. The heterograde patterns result from maximum oxygen concentrations at an intermediate depth. This anomaly is found in lakes with low productivity, in which light penetrates into the hypolimnion and algae flourish (Dodson, 2005). Seasonal mixing, as described above, can redistribute these patterns of oxygen concentrations.

Water chemistry plays an important role in lake dynamics, as nutrients influence algal productivity and higher trophic levels (Thorp and Covich, 2001). In deep lakes, the bottom layer has little oxygen when it is not mixing, and few organisms survive there. Similarly, very salty lakes contain only a few highly specialized zooplankton. The hypolimnion is lower in oxygen, higher in nutrients, and has different chemical concentrations due to the minimal exchange of water during stratification. Lake turnover occurs when this stratification breaks down and much or all of the water mass re-circulates (Thorp and Covich, 2001). Some lakes never mix completely, resulting in a circulation only in the upper zones, leaving the lower zones devoid of oxygen where nutrients accumulate over time. Wind easily mixes shallow lakes, so these layers either do not persist or do not develop.

C.2.2.1 Plant Communities, Energy Sources, and Primary Production

Plant communities in ponds and lakes consist of submerged, floating and emergent vascular plants, phytoplankton, and periphyton. Autotrophic bacteria may also occur in lentic systems and contribute to the primary production of these systems. Bacteria and fungi are the major decomposers in smaller lentic systems such as ponds, and, although these organisms may occur as part of the planktonic community, the vast majority of bacteria and fungi are found in or on the sediment layer (Menzel and Cooper, 1992). Phytoplanktons (predominantly filamentous algae) carry on photosynthesis in open water and form the base of a lake's food chain (Mayer and Laudenslayer, 1988). These primary producers fall into five major categories: diatoms

(Bacillariophyta); green algae (Chlorophyta); golden algae (Chrysophyta); blue-green algae (Cyanobacteria); and dinoflagellates (Dinophyta). Very productive lakes are much less clear due to abundant algal blooms (Menzel and Cooper, 1992).

Species distribution of small ponds generally differs from that of large impoundments and lakes. Blue-green algae are often dominant in small lentic systems where nutrient levels are high. In small ponds, benthic algae and periphyton may detach and become part of the planktonic community, and phytoplankton can be reduced greatly depending on surface area coverage by floating macrophytes. This shading effect can also suppress periphyton growth attached to macrophytes or bottom surfaces (Menzel and Cooper, 1992).

Vascular plants in small lentic systems include species with submergent, floating-leaved, or emergent growth forms. Submergent macrophytes are found rooted in benthic sediments at depths from three to 12.5 feet depending on light penetration and may occur in patches or may cover the entire bottom of ponds. Floating or floating-leaved vascular plants may be very abundant in small ponds/impoundments if nutrients are present. Where these plants are found in abundance, they may reduce the photosynthesis in the hypolimnion resulting in an increase in water column respiration. This may result in anoxic conditions (low amounts of oxygen) in the water column, leading to the elimination of fish in the pond (Menzel and Cooper, 1992).

Emergent aquatic and semi-aquatic plants are common along the shoreline of many smaller lentic systems where water depths are shallow (less than one meter) and where sediments have accumulated over time. Common emergent species include cattails (*Typha* spp.), willows (*Salix* spp.), rushes (*Juncus* spp.), and sedges (*Carex* spp.). Emergent plants provide food and habitat for numerous vertebrate wildlife species and are an important energy source for small impoundments (Menzel and Cooper, 1992).

C.2.2.2 Animal Communities

Animal communities in lentic systems live in either the benthos or water column zone and may transition between these two zones during their lifecycle. Groupings of animal communities include invertebrates (e.g., zooplankton, worms, mussels, crustaceans, and insects) and vertebrates (e.g., fish, reptiles, and birds). These groups may heavily use vegetated portions of the benthos for feeding and breeding. Many aquatic animals exhibit complex life cycles and use separate habitats at different stages of their life history (Wilbur, 1980). For example, stream-dwelling fishes may migrate between lotic and lentic habitats to enhance growth or reduce mortality (Dempson et al., 1996; Erkinaro et al., 1998). Movements of stream-dwelling fishes and crayfish between habitats can be affected by various environmental factors such as water levels and temperatures. Movement between habitats can strongly modify population structure, overall density, and the probability of local extinction in both lotic and lentic habitats (Schlosser, 1995).

Major zooplankton assemblages in freshwater systems include rotifers, cladocerans, and copepods (Thorp and Covich, 2001). Rotifers and protozoans comprise a small fraction of total biomass but are numerically abundant and can contribute substantially to energy flow in smaller lentic ecosystems. Zooplankton occupy the regions of high light intensities (i.e., on the surfaces of the pelagic and the littoral zones), feeding on single-celled or small colonial algae. In clear, relatively unproductive lakes, zooplankton consume much of the algae. Some of the zooplankton members also inhabit the benthic zone feeding on detritus and sinking phytoplankton. Zoobenthos greatly increase the secondary productivity in ponds through high growth rates (Menzel and Cooper, 1992).

There are a number of benthic macroinvertebrates found in lentic systems including oligochaetes, crustaceans, and a variety of insects. Macroinvertebrates can be abundant in littoral zones. Those found in the pelagic zone are typically confined to the benthic zone, but some may feed in the water column (Menzel and Cooper, 1992). Small crustaceans, hydras, and snails live in or on surface sediments (Mayer and Laudenslayer, 1988). Macroinvertebrates can greatly increase secondary production in smaller lentic systems (Menzel and Cooper, 1992).

Fishes occupy the littoral, pelagic, and occasionally profundal zones when the dissolved oxygen content is sufficient. Vertebrates in lentic systems may also include various species of frogs, turtles, and water snakes. Survival of many anuran populations depends upon the temporary nature of smaller breeding pools and ponds. Some species do well in relatively deep, permanent ponds (e.g., *Rana catesbeiana*, *Rana palustris*), whereas others require relatively shallow, temporary ponds (e.g., *Bufo* spp., *Hyla chrysoscelis*) (Jansen et al., 2003).

Appendix D
Migratory Birds

D.1 INTRODUCTION

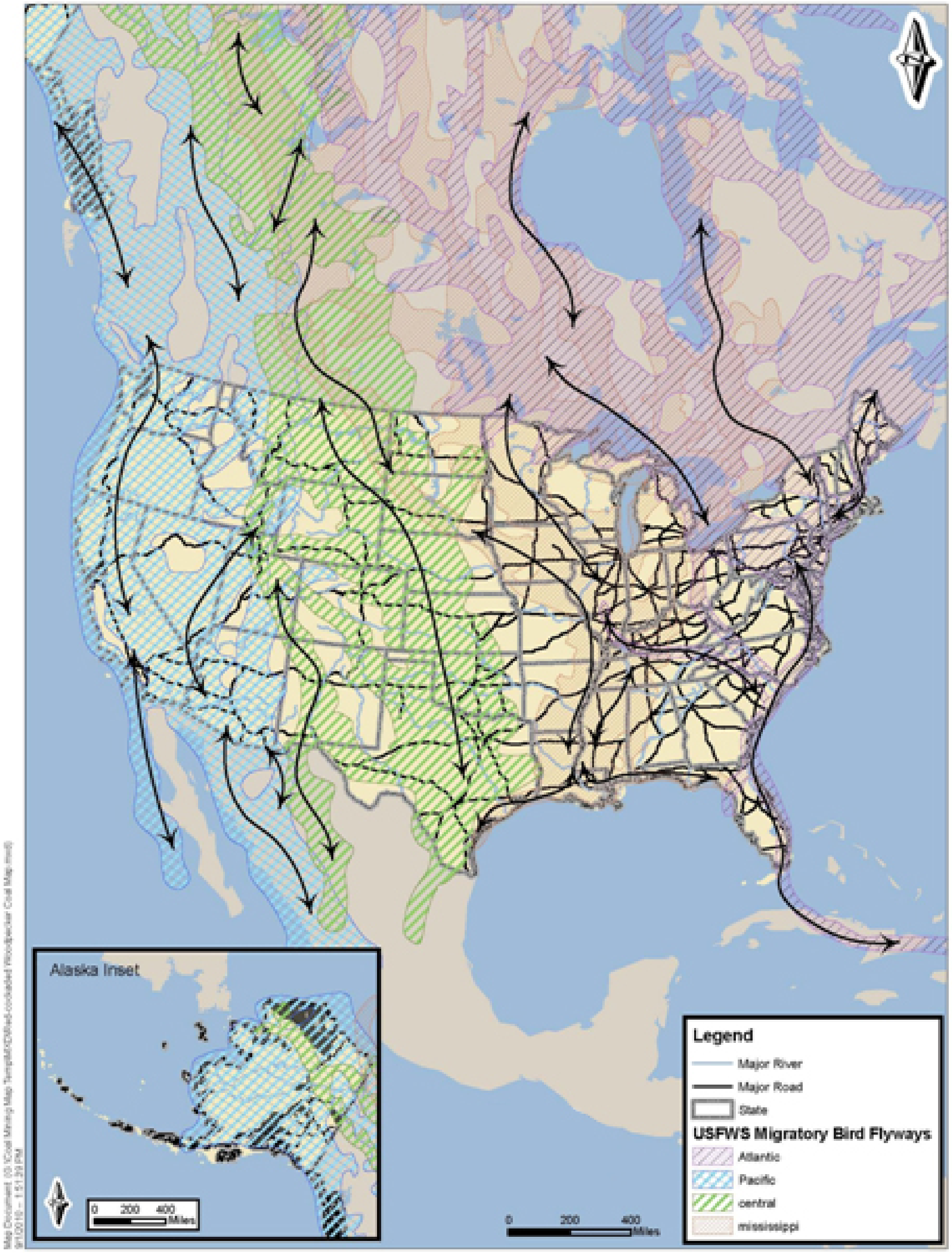
It is estimated that 500 species of birds annually migrate from North American breeding grounds for warmer climes and favorable food conditions farther south. Some species travel only as far as the southern U.S., while others continue to Central or South America. The U.S. Fish and Wildlife Service (FWS) administers a variety of laws protecting wildlife and plant species, including the Migratory Bird Treaty Act, 16 U.S.C. §§ 703-712. Because all coal regions lie within migratory bird pathways, the Office of Surface Mining Reclamation and Enforcement (OSMRE) is entering into a Memorandum of Understanding (MOU) with FWS to strengthen migratory bird conservation through enhanced collaboration. This MOU, in support of Executive Order 13186, focuses on avoiding or minimizing avian stressors on migratory birds with an emphasis on species of concern and their habitats, and by identifying areas of cooperation. The goal of this MOU is to promote migratory bird conservation by incorporating conservation measures into agency actions and planning processes whenever possible.

D.2 MIGRATORY FLYWAYS

As depicted in Figure D-1,there are four major North American flyways (Lincoln, 1935):

- Atlantic;
- Mississippi;
- Central; and
- Pacific.

Figure D-1 North American Flyways



Some of the coal regions are located within more than one flyway. The flyways often overlap in the northern breeding and the southern wintering grounds. Table D-1 reflects the U.S. coal regions and the flyways that occur in each region.

Table D-1
Occurrence of U.S. Coal Regions in Migratory Bird Flyways

COAL REGIONS	Atlantic Flyway	Mississippi Flyway	Central Flyway	Pacific Flyway
Appalachian Basin	X	X		
Colorado Plateau			X	X
Gulf Region	X	X	X	
Illinois Basin		X		
Northern Rocky Mountains and Great Plains			X	X
Northwest				X
Western Interior		X	X	

The four major North American flyways are discussed in greater detail in the following paragraphs.

D.2.1 Atlantic Flyway

Two coal regions are located within the Atlantic Flyway: the Appalachian Basin and the Gulf Region. The Atlantic Flyway can be described as extending from the offshore waters of the Atlantic Coast west to the Allegheny Mountains, then curving northwestward across northern West Virginia and northeastern Ohio, continuing to Canada (the Northwest Territories) and to the Arctic Coast of Alaska. The flyway contains several primary migration routes. The coastal route of the Atlantic Flyway follows the Atlantic shoreline, originating from the north in the eastern Arctic islands and the coast of Greenland. This route from the northwest is important to migratory waterfowl and other birds, including ring-necked ducks (*Aythya collaris*), canvasbacks (*Aythya valisineria*), redheads (*Aythya americana*), and lesser scaups (*Aythya affinis*) (Montalbano et al., 1985). During migration, studies have found that the coastal migration route is predominantly used by many species of songbirds as well as 80% of juvenile raptors and the Appalachian mountains route is used by predominately adult birds although not inclusively, but both routes are of great importance as migration pathways.

D.2.2 Mississippi Flyway

Four coal regions are located within the Mississippi Flyway: the Appalachian Basin, the Gulf Region, the Illinois Basin, and the Western Interior.

The Mississippi Flyway is an important route used by large numbers of ducks, geese, shorebirds, blackbirds, sparrows, warblers, and thrushes. The eastern boundary of the Mississippi Flyway runs through the peninsula of southern Ontario to western Lake Erie, then southwest across Ohio and Indiana and south to the mouth of the Mississippi (U.S. FWS, 2012b). The western boundary is less precise than the eastern boundary of the Flyway and merges into the Central Flyway. The longest migration route of any in the Western Hemisphere is found within the Mississippi Flyway; the northern terminus is on the Arctic coast of Alaska and its southern end is located in Patagonia, Argentina. For more than 3,000 miles, from the mouth of the Mackenzie River in northern Canada to the delta of the Mississippi, this route is uninterrupted by mountains; the greatest elevation above sea level is less than 2,000 feet. The presence of the two rivers (oriented north-south) and the well-timbered land provide ideal conditions to support migrating birds (Weitzell et al., 2003). The Mississippi Flyway is important to the declining American black duck (*Anas rubripes*) population (Brook et al., 2009), the recovering wood duck (*Aix sponsa*) population (Bellrose, 1976), mallards (*Anas platyrhynchos)* (Green and Krementz, 2008), and many other waterfowl and bird species.

D.2.3 Central Flyway

Four coal regions are located in the Central Flyway: the Northern Rocky Mountains and Great Plains, the Colorado Plateau, the Western Interior, and the Gulf Region.

It may be called "the flyway of the Great Plains" as the Central Flyway encompasses the vast central region of the U.S. lying between the valley of the Mississippi River and the Rocky Mountains (U.S. FWS, 2012b). The Central Flyway is relatively simple, as the majority of the birds that use it make direct north and south journeys from breeding grounds in the north to winter quarters in the south. The Central Flyway enters the northern U.S. in Montana and birds travel in the central part of the U.S. (Montana, Wyoming, South Dakota, Nebraska, Kansas, Oklahoma, Colorado, New Mexico and Texas). The Central Flyway then follows the coast of the Gulf of Mexico southward. The western boundary closely follows the eastern side of the Rocky Mountains. However, in western Montana, the continental divide is crossed and the line passes through the Great Salt Lake Valley. The northern end of the Great Salt Lake is also an important breeding area for waterfowl. Waterfowl breeding in Canada and in much of the north central U.S. use the Central Flyway for migratory stopover sites and wintering habitat.

D.2.4 Pacific Flyway

Three coal regions are located within the Pacific Flyway: the Northern Rocky Mountains and Great Plains, the Colorado Plateau, and the Northwest.

The Pacific Flyway enters the U.S. from Alaska through Canada via Washington, Idaho, and Montana, and migratory birds travel through Washington, Idaho, Montana, California, Nevada, Utah, and Arizona (U.S. FWS, 2012b). At the U.S. / Canada border, the flyway routes branch: large flights continue southeastward along the foothills of the Rocky Mountains and into the Central and Mississippi flyways, while other migratory birds turn southwestward across northwestern Montana and the panhandle of Idaho, following the Snake and Columbia River valleys to the interior valleys of California. Suitable winter quarters for birds are found in California from the Sacramento Valley south to Salton Sea and in the tidal marshes near San Francisco Bay. The Central Valley is an important stopover site for migrating shorebirds and waterfowl in the Pacific Flyway (Shuford et al., 1998). The Central Valley supports 20 percent of waterfowl wintering in the U. S. and 60 percent wintering in the Pacific Flyway (Shuford et al., 1998).

D.3 DISCUSSION

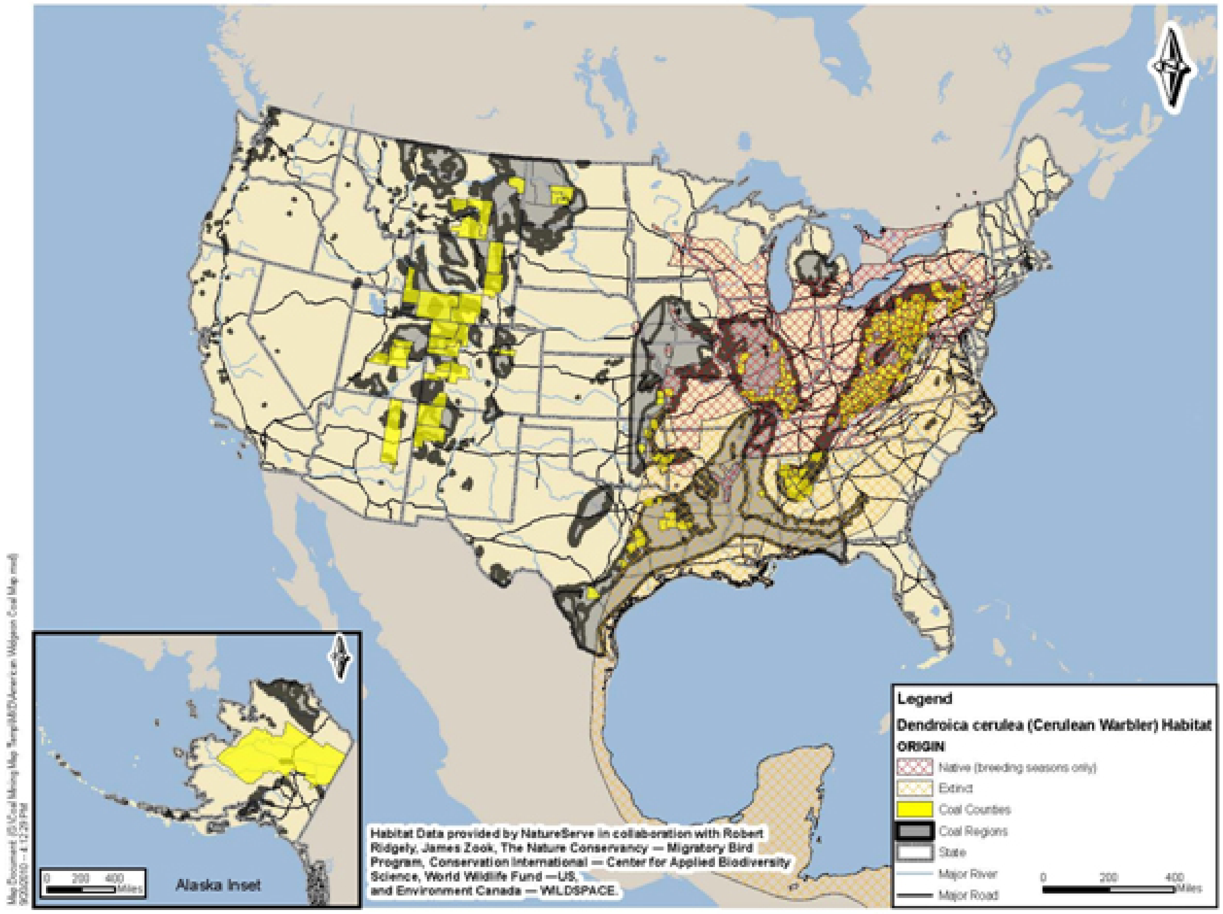
Migrating birds require places along the way that provide an adequate food supply for the quick replenishment of fat reserves, rest and shelter from predators, and water for rehydration. These places are often referred to as stopover sites. A few important general land types that are important are: riparian woodlands and corridors; shelter belts and hedgerows in agricultural areas; desert oases; and mountain meadows. A primary characteristic of these stopover sites is the presence of a water body, which are sometimes on Surface Mining Control and Reclamation Act of 1977 (SMCRA) permitted land. This Draft Environmental Impact Statement (DEIS) covers a broad area which includes many of these stopover sites and other migratory bird habitat; therefore a comprehensive discussion of migratory birds is not realistic. Below, this discussion provides below, this discussion provides a description of just one species example of many species of migratory birds that use one of the four described land types.. Birds from these groups have different habitat types, are protected under the Migratory Bird Treaty Act, and represent a diversity of migratory bird issues.

D.3.1 Songbird - Cerulean warbler (*Dendroica cerulea*)

Unless otherwise referenced, this description comes from U.S. FWS (2007a).

The cerulean warbler is a FWS Species of Special Concern. During migration, cerulean warblers pass through the southern U.S. and then fly across the Gulf of Mexico to Central America and on to South America (Figure D-2) (Ridgely et al., 2003). Their summer range includes the Appalachian Basin, Gulf Coast, Illinois Basin, and Western Interior coal regions. Much of the core breeding area for the cerulean warbler is located within or near the Appalachian coal region (Figure D-2).

Figure D-2 Cerulean Warbler Habitat and Migratory Path



Cerulean warblers are considered area-sensitive because they prefer breeding in large forested tracts. Cerulean warblers nest and raise young in areas with large tracts of mature deciduous hardwood trees. A diversity of vertical structure in the forest canopy and gaps in the forest canopy, or small forest openings, are desired habitat features. Cerulean warblers nest in uplands, wet bottomlands, moist slopes, and mountains from less than 100 feet to more than 3,500 feet in elevation. During the breeding season, males sing high in mature trees, and females build open-cup nests on the middle and upper branches of deciduous forest trees. Habitats for migratory and winter seasons are not well known but appear to be similar to this warbler's breeding habitat (multiple layers of vegetation in the forest canopy being important characteristics).

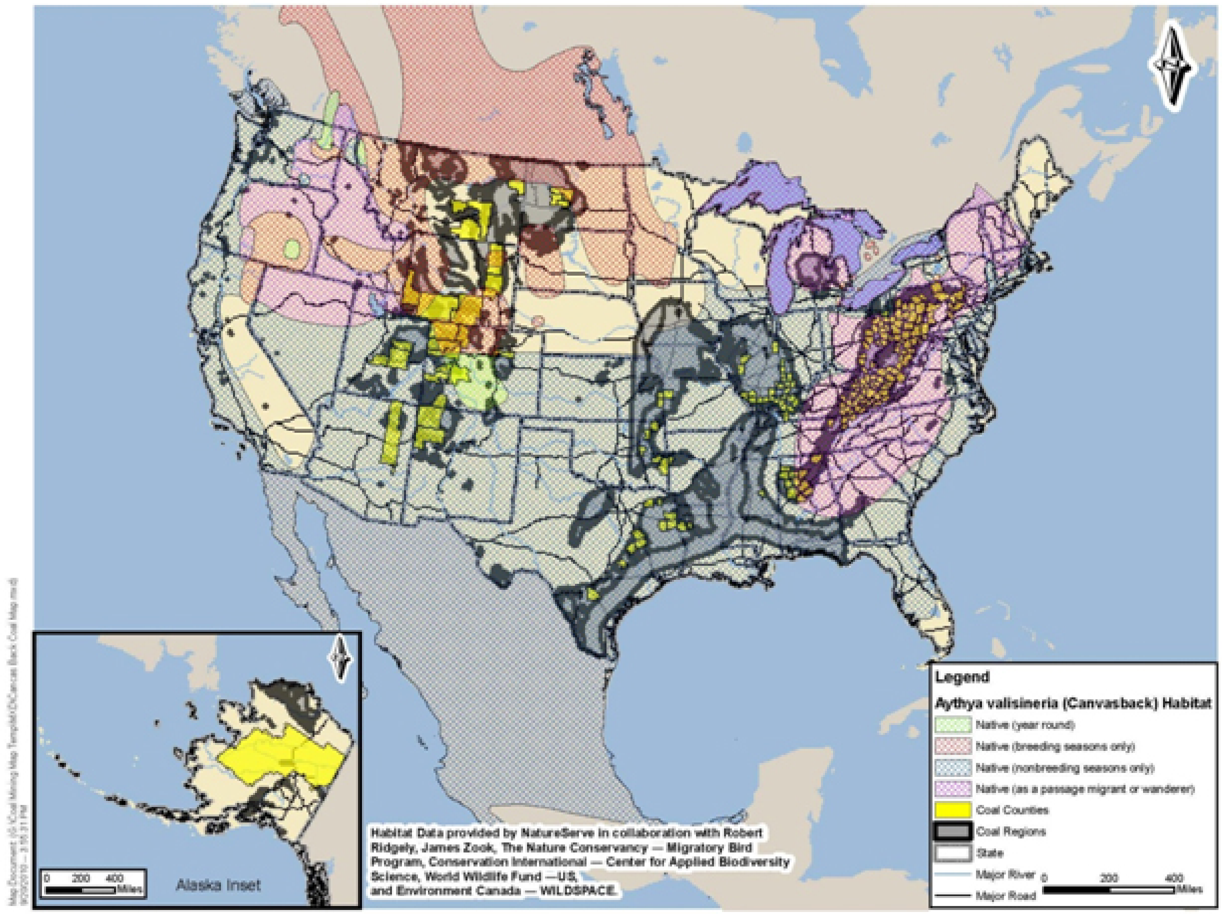
The population of the cerulean warbler has steadily declined at a rate of about three percent per year since 1966. Habitat loss is one of the primary factors contributing to the decrease of the cerulean warbler population. The forests along the Gulf of Mexico used during migration continue to be cleared for coastal development. Within its breeding range, many of the historical forests have been cleared and replaced with farms, cities and suburbs, and many forests tracts that remain are not mature or large enough to support viable populations. Forest management by the removal of the largest trees eliminates the structurally diverse canopy that cerulean warblers prefer, and second-growth stands of similar-sized and relatively young trees do not offer enough structural diversity. Small wooded tracts within a mostly cleared landscape are also unsuitable habitat.

D.3.2 Ground Nester - Mountain plover (*Charadrius montanus*)

The mountain plover is known to occur in Arizona, California, Colorado, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming (Andres and Stone, 2009). The Northern Rocky Mountains and Great Plains, the Colorado Plateau, and the Western Interior coal regions are located within these states. The mountain plover is native during its breeding season in Montana, Wyoming, Colorado, New Mexico, and Texas (Figure D-3) (Ridgely et al., 2003).

The mountain plover is a long distance migrant, and its preferred nesting habitat is relatively specialized, characterized by very short vegetation with significant areas of dry bare ground (e.g., sagebrush/blue gramma habitats in central Montana). Established prairie dog towns offer significant areas of bare ground. The preferred winter habitat of the mountain plover is similar to the nesting habitat: short-grass plains and fields, plowed agricultural fields, sandy deserts, and commercial sod farms. Plovers are also attracted to recent burns (Knopf and Wunder, 2006).

Figure D-3 Mountain Plover (Charadrius montanus) Habitat



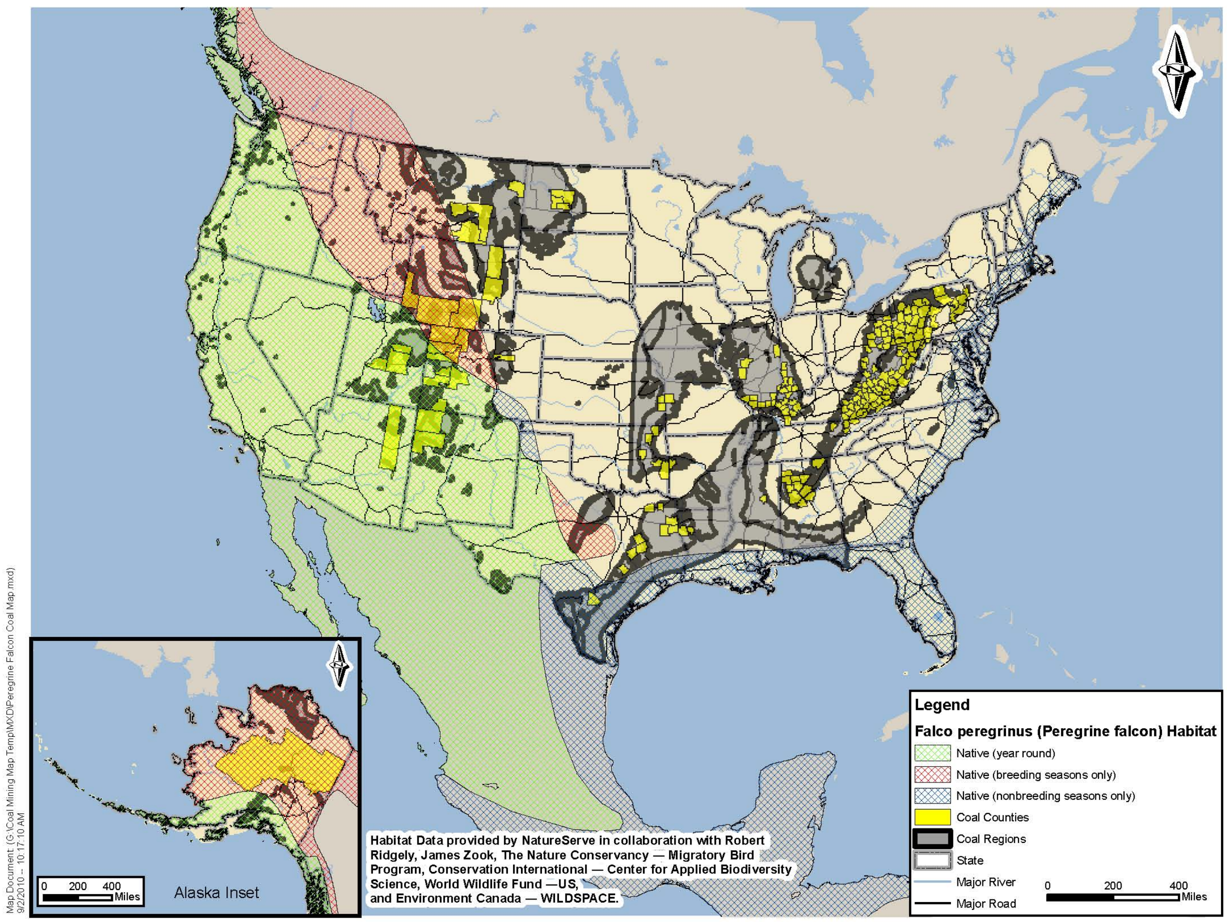
Although there is no chance of restoration to historical population levels due to development of the western Great Plains and California, stewardship habitat management of this species concentrates on maintaining short and sparse vegetation (including the use of grazing), prescribed burning, and protection of prairie dog towns. This type of management will allow for stabilization of the declining population across North America.

An example of stewardship occurs at the Antelope Mine in the Powder River Basin of northeast Wyoming. Surface coal mines have been present in the Powder River Basin since the early 1970s; mines in this area are located within the Northern Rocky Mountains and Great Plains Coal Region and within the Central Migratory Bird Flyway. The Antelope Mine is the only surface mine in that region known to regularly support nesting mountain plovers; nesting pairs have been monitored there annually since 1982 (McKee, 2007). In 2002, the FWS agreed to the restoration of at least 975 acres of mountain plover habitat to mitigate the habitat loss from mining that occurred from 1982 through 2003. Over 20 years of observations have documented that mountain plovers in the vicinity of the mine are most common in black-tailed prairie dog (*Cynomys ludovicianus*) colonies. In 2000, the Antelope Mine proactively initiated a pilot program to establish prairie dogs in reclaimed mining lands to recreate mountain plover habitat. This program was enhanced in 2002 and 2003 to include the construction of artificial colonies in reclamation to support translocated prairie dogs with the purpose of creating mountain plover habitat per the 2002 agreement with the FWS (McKee, 2007).

D.3.3 Raptor - Peregrine falcon (*Falco peregrinus*)

The peregrine falcon was delisted from the Endangered Species List due to recovery in 1999, although it remains listed by some states. The peregrine falcon occurs throughout the continental U.S. (U.S. FWS, 2006b) and, therefore, could be present in all eight coal regions as a native year round (primarily the western U.S.), native during the breeding season (northwestern U.S. and northern Canada), native during the non-breeding (winter) season (Atlantic and Gulf coasts), or as migrants, as reflected in Figure D-4 (Ridgely et al., 2003).

Figure D-4 Peregrine Falcon *(Falco peregrinus)* Habitat



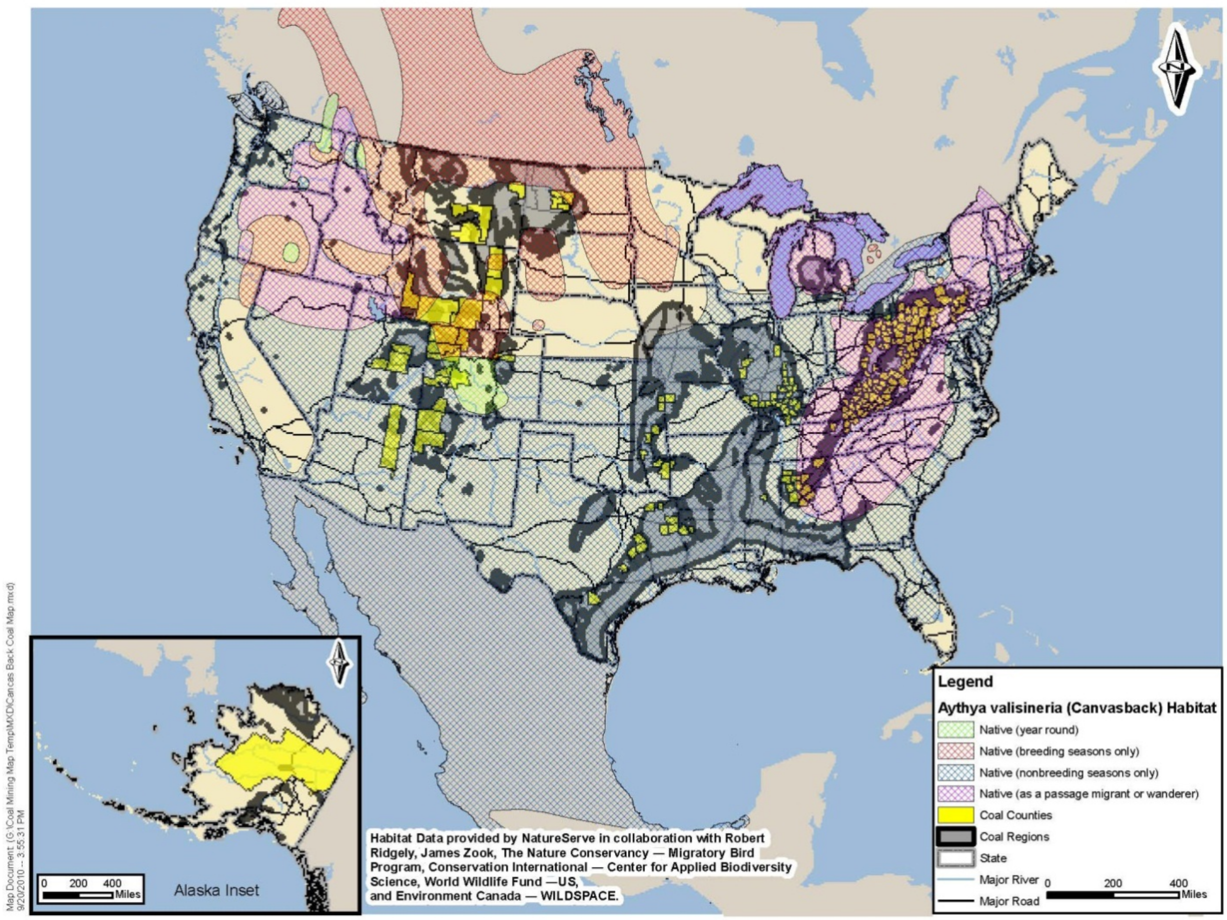
Preferred habitat for the peregrine falcon includes: mountains, forests, tundra, coastlines, and even cities. This bird can live from the tundra to the seacoast, from the high mountains and open forest to the flat savanna. Steep cliffs and rocky ledges are often used as nesting sites. Their nests are shallow scrapes in soil, sometimes taken over from other species. The peregrine wanders widely after the nesting season, regularly following its migrating prey to South America (Alsop III, 2006).

D.3.4 Waterfowl - Canvasback (*Aythya valisineria*)

The canvasback is a duck that uses and is native to areas of the Pacific, Central, and Atlantic flyways. The following U.S. coal regions are located within the flyways traversed by the canvasback for migration: Appalachian Basin, Colorado Plateau, Gulf Coast, Illinois Basin, Northwest, and Western Interior.

The canvasback nests in the prairies of North America, from Minnesota and the Dakotas in the U.S. through Manitoba, Saskatchewan, and Alberta in Canada (Bellrose, 1976; Schroeder, 1984) (Figure D-5) (Ridgely et al., 2003). The prairie wetlands (or potholes) of North America are vital to the canvasbacks, as the open water habitat of this region is its preferred nesting habitat. The female canvasbacks typically occupy floating nests in water six to 24 inches deep, vegetated by bulrush and cattail (Kruse and Takekawa, 1998).

Figure D-5 Canvasback *(Atythya valisineria)* Habitat



As winter approaches and lakes and ponds begin to freeze and harsh weather across the prairies limits food availability, the canvasback migrates to warmer climates using the Pacific Flyway, the Mississippi Flyway, and the Atlantic Flyway. During migration, canvasbacks gather in large groups in the Chesapeake and San Francisco Bays, the Mississippi Delta region and the adjacent Gulf Coast, and interior Mexico (Bellrose, 1976). Twenty five percent of that population uses the Pacific Flyway (Kruse and Takekawa, 1998). Winter habitat for the canvasback in the Mississippi Flyway occurs in the Mississippi River delta and delta lakes in southern Louisiana (Mowbray, 2002). In the Atlantic Flyway, canvasbacks are attracted to flats areas such as the Susquehanna Flats of the Chesapeake Bay. The Susquehanna Flats offer one of the canvasback's preferred food, wild celery.

According to Kruse and Takekawa (1998), the continental population of canvasbacks has fluctuated around 580,000 individuals. A more recent report by the FWS describes the canvasback population in decline, with habitat degradation (wintering, migratory, and summer nesting grounds) the factor with the greatest adverse impact (U.S. FWS, 2011b).

Appendix E
Invasive Species and Noxious Weeds in the Coal States

Over 6,500 nonindigenous species of plants and animals have become established in the U.S. (Williams and Meffee, 1998). Most of these introductions are a result of human activities. They include not only the exotic species that have arrived or been introduced from continents other than North America but also species native to North America that have been introduced to or have colonized locations on the continent outside their native ranges.

Invasive species are a significant threat to natural systems in the U.S. They have adverse economic, environmental, and ecological effects on the habitats and bioregions they invade. While all species compete to survive, invasive species have specific traits or combinations of traits that allow them to out-compete native species. Any non-native species has the ability to become invasive if it can out-compete native species for resources such as nutrients, light, physical space, water, or food. Land clearing and human habitation put significant pressure on local species, and these and other disturbed habitats are prone to invasions that can have adverse effects on local ecosystems and can change ecosystem functions. Disturbed ecosystems may afford invasive species a chance to establish themselves with less competition from native species, which tend to be less adept at competing in these changing ecosystems.

A noxious weed is a term for an invasive plant that is designated and regulated by state and federal laws, such as the federal Plant Protection Act, 7 U.S.C. § 7701 et seq. These noxious weeds are generally detrimental to agriculture, commerce, and/or public health and are recognized as a major threat to ecosystems. Noxious weeds have biological traits that enable them to colonize new areas and successfully out-compete native species. They can transform the structure and function of ecosystems through: direct competition; changes in nutrient cycling, succession, and disturbance regimes; and shifts in evolutionary selection pressures (Mack and D'Antonio, 1998). The spread of noxious weeds threatens the structure and function of many ecosystems worldwide, and certain species have the ability to spread over large areas or acutely threaten an ecosystem over its continental range (Hobbs and Humphries, 1995).

Noxious weeds occur in all states with coal reserves and can be quick to establish on disturbed sites, including land cleared for mining. The following table is a list of federally listed noxious weeds, updated by the U.S. Department of Agriculture on September 30, 2014. Most states also have established their own list of noxious weeds.

Table E-1
Aquatic Noxious Weeds

Latin Name	Common Name(s)
Azolla pinnata	Mosquito fern, water velvet
Caulerpa taxifolia (Mediterranean strain)	Killer algae
Eichhornia azurea	Anchored waterhyacinth, rooted, waterhyacinth
Hydrilla verticillata	Hydrilla
Hygrophila polysperma	Miramar weed
Ipomoea aquatica	Water-spinach, swamp morning glory
Lagarosiphon major	African elodea
Limnophila sessiliflora	Ambulia
Melaleuca quinquenervia	Broadleaf paper bark tree
Monochoria hastata	Arrowleaf false pickerelweed
Monochoria vaginalis	Heartshape false pickerelweed
Ottelia alismoides	Duck lettuce
Sagittaria sagittifolia	Arrowhead
Salvinia auriculata	Giant salvinia
Salvinia biloba	Giant salvinia
Salvinia herzogii	Giant salvinia
Salvinia molesta	Giant salvinia
Solanum tampicense	Wetland nightshade
Sparganium erectum	Exotic bur-reed

Parasitic Noxious Weeds

Latin Name	Common Name(s)
Aeginetia spp.	Varies by species
Alectra spp.	Varies by species
Cuscuta spp.(except for natives)	Dodders
Orobanche spp. (except for natives)	Broomrapes
Striga spp.	Witchweeds

Terrestrial Noxious Weeds

Latin Name	Common Name(s)
Acacia nilotica	Prickly acacia
Ageratina adenophora	Crofton weed
Ageratina riparia	Mistflower, spreading snakeroot
Alternanthera sessilis	Sessile joyweed
Arctotheca calendula	Capeweed
Asphodelus fistulosis	Onionweed
Avena sterilis	Animated oat, wild oat
Carthamus oxyacantha	Wild safflower
Chrysopogon aciculatus	Pilipiliula
Commelina benghalensis	Benghal dayflower
Crupina vulgaris	Common crupina
Digitaria scalarum	African couchgrass, fingergrass
Digitaria velutina	Velvet fingergrass, annual couchgrass

Drymaria arenariodes	Lightning weed
Emex australis	Three-corned jack
Emex spinosa	Devil's thorn
Euphorbia terracina	False caper, Geraldton carnation weed
Galega officinalis	Goatsrue
Heracleum mantegazzianum	Giant hogweed
Imperata brasiliensis	Brazilian satintail
Imperata cylindrica	Cogongrass
Inula britannica	British yellowhead
Ischaemum rugosum	Murainograss
Leptochloa chinensis	Asian sprangletop
Lycium ferocissimum	African boxthorn
Lygodium flexuosum	Maidenhair creeper
Lygodium microphyllum	Old world climbing fern
Melastoma malabathricum	Malabar melastome
Mikania cordata	Mile-a-minute
Mikania micrantha	Bittervine
Mimosa invisa	Giant sensitive plant
Mimosa pigra	Catclaw mimosa
Moraea collina	Cape tulip
Moraea flaccida	One leaf cape tulip
Moraea miniata	Two leaf cape tulip
Moraea ochroleuca	Apricot tulip
Moraea pallida	Yellow tulip
Nassella trichotoma	Serrated tussock
Onopordum acaulon	Stemless thistle
Onopordum illyricum	Illyricum thistle
Opuntia aurantiaca	Jointed prickly pear
Oryza longistaminata	Red rice
Oryza punctata	Red rice
Oryza rufipogon	Red rice
Paspalum scrobiculatum	Kodo-millet
Pennisetum clandestinum	Kikuyugrass
Pennisetum macrourum	African feathergrass
Pennisetum pedicellatum	Kyasumagrass
Pennisetum polystachion	Missiongrass, thin napiergrass
Prosopis alpataco	Mesquite
Prosopis argentina	Mesquite
Prosopis articulata	Velvet mesquite
Prosopis burkartii	Mesquite
Prosopis caldenia	Calden
Prosopis calingastana	Cusqui
Prosopis campestris	Mesquite
Prosopis castellanosii	Mesquite
Prosopis denudans	Mesquite
Prosopis elata	Mesquite
Prosopis farcta	Syrian mesquite
Prosopis ferox	Mesquite

Prosopis fiebrigii	Mesquite
Prosopis hassleri	Mesquite
Prosopis humilis	Algaroba
Prosopis kuntzei	Mesquite
Prosopis pallida	Kiawe, algarroba
Prosopis palmeri	Mesquite
Prosopis reptans	Tornillo
Prosopis rojasiana	Mesquite
Prosopis ruizlealii	Mesquite
Prosopis ruscifolia	Mesquite
Prosopis sericantha	Mesquite
Prosopis strombulifera	Argentine screwbean
Prosopis torquata	Mesquite
Rottboellia cochinchinensis	Itchgrass
Rubus fruticosis	Wild blackberry
Rubus moluccanus	Wild raspberry
Saccharum spontaneum	Wild sugarcane
Sagittaria sagittifolia	Arrowhead
Salsola vermiculata	Wormleaf salsola
Senecio inaequidens	South African ragwort
Senecio madagascariensis	Fireweed
Setaria pumila ssp. pallidefusca (Now ssp. subtesselata)	Cattail grass
Solanum torvum	Turkeyberry
Solanum viarum	Tropical soda apple
Spermacoce alata	Winged false buttonweed
Tridax procumbens	Coat buttons
Urochloa panicoides	Liverseed grass

Appendix F
State and Federally Listed Species from 193 Coal Counties in the U.S.[1]

Table F-1 Species List

Category	Scientific Name	Common Name	Federal Status[2]
Amphibian	*Necturus alabamensis*	Black Warrior Waterdog	C
	Plethodon neomexicanus	Jemez Mountains Salamander	P LE
	Plethodon nettingi	Cheat Mountain Salamander	LT
	Rana chiricahuensis	Chiricahua Leopard Frog	LT
Bird	*Brachyramphus brevirostris*	Kittlitz's murrelet	C
	Charadrius melodus	Piping Plover	LE
	Gavia adamsii	Yellow-billed loon	C
	Mycteria americana	Wood Stork	LE
	Polysticta stelleri	Steller's eider	LT, CH
	Somateria fischeri	Spectacled eider	LT, CH
	Sterna antillarum	Least Tern	LE
	Charadrius melodus	Piping Plover	LT
	Empidonax traillii extimus	Southwestern Willow Flycatcher	LE
	Anthus spragueii	Sprague's Pipit	C
	Aquila chrysaetos	Golden Eagle	BGEPA
	Centrocercus urophasianus	Greater Sage Grouse	C
	Centrocurcus minimus	Gunnison Sage-Grouse	P E
	Coccyzus americanus	Western Yellow-Billed Cuckoo	C
	Empidonax traillii extimus	Southwestern Willow Flycatcher	LE
	Falco femoralis septentrionalis	Northern Aplomado Falcon	XN
	Grus americana	Whooping Crane	LE
	Gymnogyps californianus	California Condor	XN
	Halieaeetus leucocephalus	Bald Eagle	BGEPA
	Picoides borealis	Red-Cockaded Woodpecker	LE

[1] OSMRE is currently underway with ESA Section 7 consultation. This list is the original species list received from the U.S. Fish and Wildlife Service. The final EIS will contain an updated list to reflect changed species status occurring as of the date of publication.

[2] BGEPA = Bald and Golden Eagle Protection Act; C = Candidate; CH = Critical Habitat; DM = Recovered, Delisted, and Being Monitored; E = Endangered; LE = Listed Endangered; LT = Listed Threatened; PCH = Proposed Critical Habitat; PE = Proposed Endangered; PT = Proposed Threatened; P LE = Proposed Listed Endangered; P LT = Proposed Listed Threatened; PXN = Proposed Nonessential Experimental Population; T = Threatened; XN = Nonessential Experimental Population

Category	Scientific Name	Common Name	Federal Status[2]
	Sterna antillarum	Interior Least Tern	LE
	Strix occidentalis lucida	Mexican Spotted Owl	LT
	Tympanuchus pallidinctus	Lesser Prairie-Chicken	PT
Clam	*Lampsilis abrupta*	Pink Mucket Pearly Mussel	LE
Crustacean	*Gammarus acherondytes*	Illinois Cave Amphipod	LE
	Palaemonias ganteri	Kentucky Cave Shrimp	LE
Fern	*Asplenium scolopendrium*	American Hart's Tongue Fern	LT
	Thelypteris pilosa var. alabamensis	Alabama Streak Sorus Fern	LT
Fish	*Acipenser oxyrhynchus desotoi*	Gulf Sturgeon	LT, CH
	Catostomus discobolus yarrowi	Zuni Bluehead Sucker	P LE
	Phoxinus cumberlandensis	Blackside Dace	LT
	Chrosomus saylori	Laurel Dace	LE
	Crystallaria cincotta	Diamond Darter	LE, CH
	Erimonax monachus	Spotfin Chub	LT, XN, PXN
	Erimystax cahni	Slender Chub	LT
	Etheostoma akatulo	Bluemask (Jewel) Darter	LE
	Etheostoma chermocki	Vermillion Darter	LE
	Etheostoma chienense	Relict Darter	LE
	Etheostoma cragini	Arkansas Darter	C
	Etheostoma lemniscatum	Tuxedo Darter	LE
	Etheostoma nuchale	Watercress Darter	LE
	Etheostoma phytophilum	Rush Darter	LE, CH
	Etheostoma rubrum	Bayou Darter	C
	Etheostoma sagitta	Cumberland Arrow Darter	C
	Etheostoma spilotum	Kentucky Arrow Darter	C
	Etheostoma susanae	Cumberland Darter	LE, CH
	Gila cypha	Humpback Chub	LE
	Gila elegans	Bonytail	LE
	Gila robusta	Roundtail Chub	C
	Hybognathus amarus	Rio Grande Silvery Minnow	LE
	Lepidomeda vittata	Little Colorado Spinedace	LE
	Notropis albizonatus	Palezone Shiner	LE
	Notropis cahabae	Cahaba Shiner	LE
	Noturus flavipinnis	Yellowfin Madtom	LT
	Noturus placidus	Neosho madtom	LT
	Oncorhynchus apache	Apache Trout	LT
	Oncorhynchus clarkia stomias	Greenback Cutthroat Trout	LT
	Oncorhynchus gilae	Gila Trout	LT

Category	Scientific Name	Common Name	Federal Status[2]
	Percina aurolineata	Goldline Darter	LT
	Percina aurora	Pearl Darter	C
	Percina tanasi	Snail Darter	LT
	Ptychocheilus lucius	Colorado Pikeminnow	LE
	Scaphirhynchus albus	Pallid Sturgeon	LE
	Scaphyrhincus sutkussi	Alabama Sturgeon	LE, CH
	Thymallus arcticus	Arctic Grayling	C
	Tiaroga cobitis	Loach Minnow	LE
	Xyrauchen texanus	Razorback Sucker	LE
Insect	*Neonympha mitchellii mitchellii*	Mitchell's Satyr Butterfly	LE
	Boloria acrocnema	Uncompahgre Fritillary Butterfly	LE
	Capnia Arapahoe	Arapahoe Snowfly	C
	Hesperia leonardus Montana	Pawnee Montane Skipper	LT
	Lednia tumana	Maltwaterd Lednian Stonefly	C
	Nicrophorus americanus	American Burying Beetle	LE
	Silene spaldinaii	Spalding's Campion Catchfly	T
Mammal	*Corynorhinus townsendii virginianus*	Virginia Big-Eared Bat	LE
	Myotis sodalis	Indiana Bat	LE
	Odobenus rosmarus	Pacific walrus	C
	Ursus maritimus	Polar bear	LT
	Canis lupus	Gray Wolf, Mexican Gray Wolf,	XN
	Canis lupus baileyi	Mexican Gray Wolf	PLE
	Gulo gulo luscus	North American Wolverine	PLT
	Lynx canadensis	Canada Lynx Nm Population	C
	Tamias minimus atristriatus	Penasco Least Chipmunk	C
	Zapus hudsonius luteus	New Mexico Meadow Jumping Mouse	PLE
	Canis lupus	Gray Wolf	LE
	Cynomys gunnisoni	Gunnison's Prairie Dog	C
	Cynomys parvidens	Utah Prairie Dog	LT
	Glaucomys sabrinus fuscus	WV Northern Flying Squirrel	LE
	Gulo gulo luscus	North American Wolverine	PLT
	Lynx canadensis	Canada Lynx	LT
	Lynx canadensis	Canada Lynx NM Population	C
	Mustela nigripes	Black-Footed Ferret	LE, XN
	Myotis grisescens	Gray Bat	LE
	Ursus americanus luteolus	Louisiana Black Bear	LT
	Ursus arctos	Grizzly Bear	LT

Category	Scientific Name	Common Name	Federal Status[2]
	Zapus hudsonius luteus	New Mexico Meadow Jumping Mouse	PLE
	Zapus hudsonius preblei	Preble's Meadow Jumping Mouse	LT
Mollusks	*Alasmidonta heterodon*	Dwarf Wedgemussel	LE
	Cumberlandia monodonta	Spectaclecase	LE
	Dromus dromas	Dromedary Pearlymussel	LE
	Epioblasma torulosa gubernaculum	Green Riffleshell	LE
	Epioblasma torulosa torulosa	Tubercled Blossom	LE
	Hemistena lata	Cracking Pearlymussel	LE
	Lampsilis rafinesqueana	Neosho Mucket	PE, PCH
	Lemiox rimosus	Birdwing Pearlymussel	LE
	Pegias fabula	Littlewing Pearlymussel	LE
	Pleurobema rubrum	Pyramid Pigtoe	LE
	Quadrula cylindrica strigillata	Rough Rabbitsfoot	LE, CH
	Quadrula intermedia	Cumberland Monkeyface	LE
	Quadrula sparsa	Appalachian Monkeyface	LE
	Triodopsis platysayoides	Flat-Spired Three-Toothed Land Snail	LT
	Villosa fabalis	Rayed Bean	LE
Mussel	*Alasmidonta atropurpurea*	Cumberland Elktoe	LE, CH
	Epioblasma brevidens	Cumberlandian Combshell	LE, CH
	Epioblasma capsaeformis	Oyster Mussel	LE, CH
	Epioblasma florentina walkeri	Tan Riffleshell	LE
	Epioblasma metastriata	Upland Combshell	LE, CH
	Epioblasma othcaloogensis	Southern Acornshell	E, CH
	Fusconaia cor	Shiny Pigtoe	LE
	Fusconaia cuneolus	Finerayed Pigtoe	LE
	Hamiota altilis	Finelined Pocketbook	LT, CH
	Hamiota perovalis	Orangenacre Mucket	LT, CH
	Lampsilis virescens	Alabama Lampmussel	LE
	Lexingtonia dolabelloides	Slabside Pearlymussel	PE, PCH
	Medionidus accutissimus	Alabama Moccasinshell	LT, CH
	Pleurobema furvum	Dark Pigtoe	LE
	Pleurobema georgianum	Southern Pigtoe	LE, CH
	Pleurobema gibberum	Cumberland Pigtoe	LE
	Pleurobema perovatum	Ovate Clubshell	LE, CH
	Pleurobema plenum	Rough Pigtoe	LE
	Potamilus inflatus	Inflated Heelsplitter	LT

Category	Scientific Name	Common Name	Federal Status[2]
	Ptychobranchus greenii	Triangular Kidneyshell	LE, CH
	Ptychobranchus subtenum	Fluted Kidneyshell	PE, PCH
	Quadrula c. cylindrica	Rabbitsfoot	PT, PCH
	Toxolasma cylindrellus	Pale Lilliput	LE
	Villosa perpurpurea	Purple Bean	LE
	Villosa trabalis	Cumberland Bean	LE
	Arkansia wheeleri	Oauchita Rock Pocketbook	LE
	Cyprogenia stegaria	Fanshell	LE
	Epioblasma o. obliquata	Purple Catspaw Pearlymussel	LE
	Epioblasma torulosa rangiana	Northern Riffleshell	LE
	Epioblasma triquertra	Snuffbox	LE
	Lampsilis abrupta	Pink Mucket	LE
	Lampsilis perovalis	Orange-Nacre Mucket	LT, CH
	Lampsilis powelli	Arkansas Fatmucket	LT
	Margaritifera hembeli	Louisiana Pearlshell Mussel	LT
	Obovaria retusa	Ring Pink	LE
	Plethobasus cooperianus	Orangefoot Pimpleback	LE
	Plethobasus cyphyus	Sheepnose	LE
	Pleurobema clava	Clubshell	LE
	Pleurobema decisum	Southern Clubshell	LE, CH
	Potamilus capax	Fat Pocketbook	LE
	Quadrula fragosa	Winged Mapleleaf	LE
	Argemone pleiacantha ssp. pinnatisecta	Sacramento Prickly Poppy	LE
	Cirsium vinaceum	Sacramento Mountains Thistle	LT
	Echinocereus fendleri var. kuenzleri	Kuenzler Hedgehog Cactus	LE
	Hedeoma todsenii	Todsen's Pennyroyal	LE
	Helianthus paradoxus	Pecos Sunflower	LT
	Pediocactus knowltonii	Knowlton's Cactus	LE
	Sclerocactus mesae-verdae	Mesa Verde Cactus	LT
	Aconitum noveboracense	Northern Monkshood	LT
	Arabis serotina	Georgia Rockcress	C
	Asclepias meadii	Mead's Milkweed	LT
	Boltonia decurrens	Decurrent False Aster	LT
	Clematis morefieldii	Morefield's Leather-Flower	LE
	Clematis socialis	Alabama Leather Flower	LE
	Conradina verticillata	Cumberland Rosemary	LT
	Dalea foliosa	Leafy Prairie Clover	LE

Category	Scientific Name	Common Name	Federal Status[2]
Plant	*Echinocereus fendleri var. kuenzleri*	Kuenzler Hedgehog Cactus	LE
	Helianthus eggertii	Eggert's Sunflower	DM
	Hymenoxys acaulis var. glabra	Lakeside Daisy	LT
	Ipomopsis sancti-spiritus	Holy Ghost Ipomopsis	LE
	Isoetes louisianensis	Louisiana Quillwort	LE
	Isotria medeoloides	Small Whorled Pagonia	LT
	Lespedeza leptostachya	Prairie Bush Clover	LT
	Lesquerella globosa	Globe Bladderpod	PE
	Lindera melissifolia	Pondberry	LE
	Marshallia mohrii	Mohr's Barbara Buttons	T
	Minuartia cumberlandensis	Cumberland Sandwort	LE
	Platanthera integrilabia	White Fringeless Orchid	C
	Platanthera leucophaea	Eastern Prairie Fringed Orchid	LT
	Ptilimnium nodosum	Harperella	LE
	Sagittaria secundifolia	Kral's Water Plantain	LT
	Sarracenia oreophila	Green Pitcher Plant	LE
	Scutellaria montana	Large-Flowered Skullcap	LT
	Solidago albopilosa	White-Haired Goldenrod	T
	Spigelia gentianoides	Pinkroot Gentian	LE
	Symphyotrichum georgianum	Georgia Aster	C
	Trifolium stoloniferum	Running Buffalo Clover	LE
	Xyris tennesseensis	Tennessee Yellow-Eyed Grass	LE
	Astragalus humillimus	Mancos Milk-Vetch	LE
	Astragalus cremnophylax var. cremnophylax	Sentry Milk-Vetch	LE
	Carex specuicola	Navajo Sedge	LT
	Erigeron rhizomatus	Zuni Fleabane	LT
	Pediocactus peeblesianus fickeiseniae	Fickeisen Plains Cactus	PLE
	Pediocactus peeblesianus var. peeblesianus	Peebles Navajo Cactus	LE
	Asclepias welshii	Welsh's Milkweed	LT
	Apios priceana	Price's Potato Bean	LT
	Scirpus anchistrochaetus	Northeastern Bulrush	LE
	Spiraea virginiana	Virginia Spiraea	LT
	Gopherus polyphemus	Gopher Tortoise	LT
	Graptemys flavimaculata	Yellow Blotched Map Turtle	LT
	Pituophis melanoleucus ssp. lodingi	Black Pine Snake	C
	Pituophis ruthveni	Louisiana Pine Snake	C

Category	Scientific Name	Common Name	Federal Status[2]
Reptile	*Sistrurus catenatus*	Eastern Massasauga	C
	Graptemys oculifera	Ringed Map Turtle	LT
	Sternotherus depressus	Flattened Musk Turtle	LT
	Thamnophis eques megalops	Northern Mexican Gartersnake	PLT
	Thamnophis rufipunctatus	Narrow-Headed Garter Snake	PLT
	Clemmys muhlenbergii	Bog Turtle	LT
Snail	*Anguispira picta*	Painted Tigersnail	LT
	Athearnia anthonyi	Anthony's Riversnail	LE
	Leptoxis ampla	Round Rocksnail	LT
	Leptoxis plicata	Plicate Rocksnail	LE
	Leptoxsis foreman	Interrupted Rocksnail	LE, CH
	Lepyrium showalteri	Flat Pebblesnail	LE
	Lioplax cyclostomaformis	Cylindrical Lioplax	LE
	Oxyloma haydeni kanabensis	Kanab Ambersnail	LE
	Pyrgulopsis chupaderae	Chupadera Springsnail	LE
	Pyrgulopsis neomexicana	Socorro Springsnail	LE
	Pyrgulopsis trivialis	Three Forks Springsnail	LE
	Tryonia alamosae	Alamosa Springsnail	LE
	Astraalus anserinus	Goose Creek Milkvetch	C
	Astragalus humillimus	Mancos Milkvetch	LE
	Astragalus microcymbus	Skiff Milkvetch	C
	Astragalus osterhoutti	Osterhout Milkvetch	LE
	Astragalus schmolliae	Schmoll Milkvetch	C
	Astragalus tortipes	Sleeping Ute Milkvetch	C
	Carex specuicola	Navajo Sedge	LT, CH
	Cycladenia humilis var jonesii	Jones Cycladenia	LT
	Eriogonum corymbosum var. nilesii	Las Vegas Buckwheat	C
	Eriogonum pelinophilum	Clay-Loving Wild Buckwheat	LE
	Eutrema penlandii	Penland Alpine Fen Mustard	LT
	Gaura neomexicana var. coloradoensis	Colorado Butterfly Plant	LT

Category	Scientific Name	Common Name	Federal Status[2]
Vascular Plant	*Geocarpon minimum*	No common name	LT
	Ipomopsis polyantha	Pagosa Skyrocket	LE
	Lesquerella congesta	Dudley Bluffs Bladderpod	LT
	Lesquerella tumulosa	Kodachrome Bladderpod	E
	Pediocactus despainii	San Rafael Cactus	LE
	Pediocactus knowltonii	Knowlton's Cactus	LE
	Pediocactus winkleri	Winkler Pincushion Cactus	LT
	Penstemon debilis	Parachute Beardtongue	LT
	Penstemon grahamii	Graham Beardtongue	P T
	Penstemon haydenii	Blowout Penstemon	LE
	Penstemon penlandii	Penland Beardtongue	LE
	Penstemon scariosus albifluvis	White River Beardtongue	C
	Phacelia argillacea	Clay Phacelia	LE
	Phacelia formosula	North Park Phacelia	LE
	Phacelia submutica	Debeque Phacelia	LT
	Physaria obcordata	Dudley Bluffs Twinpod	LT
	Pinus albicaulis	Whitebark Pine	C
	Platanthera praeclara	Western Prairie Fringed Orchid	LT
	Schoenocrambe barnebyi	Barneby Reed-Mustard	LE
	Sclerocactus glaucus	Colorado Hookless Cactus	LT
	Sclerocactus mesa-verdae	Mesa Verde Cactus	LT
	Sclerocactus wrightiae	Wright Fishhook Cactus	LE
	Spiranthes diluvialis	Ute Ladies' Tresses	LT

Category	Scientific Name	Common Name	Federal Status[2]
	Townsendia aprica	Last Chance Townsendia	LT

Table F-2 Critical Habitat Overlap with Coal Regions

Common Name	Federal Status	Total Critical Habitat	Critical Habitat Overlapping Mineable Coal	Units	Percent Total Critical Habitat Overlapping Mineable Coal
Laurel dace	LE,CH	26.2	26.2	Stream Miles	100.0
Cumberland elktoe	LE, CH	159.8	131.6	Stream Miles	82.4
Spotfin chub	LT, XN, PXN,CH	291.1	158.5	Stream Miles	54.5
Piping plover	LE,CH	1,390,330.1	449,028.4	Acres	32.3
Neosho mucket	LE, CH	483.6	130.4	Stream Miles	27.0
Cumberlandian combshell	LE, CH	492.3	132.4	Stream Miles	26.9
Oyster mussel	LE, CH	492.3	132.4	Stream Miles	26.9
Dark pigtoe	LE, CH	196.1	50.6	Stream Miles	25.8
Diamond darter	LE, PCH	122.1	28.0	Stream Miles	22.9
Orangenacre mucket	LT, CH	701.8	137.4	Stream Miles	19.6
Zuni bluehead sucker	PLE	303.8	55.2	Stream Miles	18.2
Triangular kidneyshell	LE, CH	677.2	120.7	Stream Miles	17.8
Alabama moccasinshell	LT, CH	828.7	137.4	Stream Miles	16.6
Alabama sturgeon	LE, CH	326.3	47.0	Stream Miles	14.4
Ovate clubshell	LE, CH	1,010.8	141.3	Stream Miles	14.0
Purple bean	LE, CH	308.8	40.7	Stream Miles	13.2
Fluted kidneyshell	LE, CH	1,180.2	135.1	Stream Miles	11.5
Finelined pocketbook	LT, CH	652.8	70.1	Stream Miles	10.7
Southern clubshell	LE, CH	894.4	90.7	Stream Miles	10.1
Rush darter	LE, CH	27.4	2.6	Stream Miles	9.5
New Mexico meadow jumping mouse	LE, PCH	14,437.5	1,298.2	Acres	9.0
Humpback chub	LE,CH	13,672.6	1,226.2	Acres	9.0
Gulf sturgeon	LT, CH	1,729.7	148.6	Stream Miles	8.6
Rough rabbitsfoot	LE, CH	277.0	23.7	Stream Miles	8.6
Colorado pikeminnow	LE,CH	65,748.0	3,976.4	Acres	6.1

Common Name	Federal Status	Total Critical Habitat	Critical Habitat Overlapping Mineable Coal	Units	Percent Total Critical Habitat Overlapping Mineable Coal
Rabbitsfoot	LT, CH	1,647.5	95.7	Stream Miles	5.8
Preble's meadow jumping mouse	LT, CH	411.3	17.9	Stream Miles	4.4
Mexican spotted owl	LT,CH	9,869,980.3	412,355.4	Acres	4.2
Slabside pearlymussel	LE, CH	971.8	37.6	Stream Miles	3.9
Slender chub	LT,CH	233.5	5.6	Stream Miles	2.4
Bonytail	LE,CH	57,339.7	1,226.2	Acres	2.1
Gunnison sage-grouse	LT, CH	1,702,756.3	32,590.8	Acres	1.9
Yellow-billed cuckoo	LT	549,849.1	7,844.1	Acres	1.4
Debeque phacelia	LT, CH	25,455.1	281.4	Acres	1.1
Southern pigtoe	LE, CH	384.9	3.9	Stream Miles	1.0
Canada lynx	LT, CH	51,839,118.2	461,968.6	Acres	0.9
Razorback sucker	LE,CH	283,711.7	1,787.5	Acres	0.6
Short's bladderpod	LE, CH	930.1	4.3	Acres	0.5
Southwestern willow flycatcher	LE,CH	208,974.2	687.4	Acres	0.3

Appendix G
Land Use and Land Covers in the U.S.

G.1 TERRESTRIAL COVER TYPES OF THE APPALACHIAN BASIN

G.1.1 Oak-Hickory Cover Type

Vegetation. The oak-hickory cover type varies from open to closed woods with a strong to weak understory of shrubs, vines, and herbaceous plants. By definition, oak (*Quercus sp.*) and hickory (*Carya* sp.) must make up 50 percent of the stand, singly or in combination. Sweetgum *(Liquidambar styraciflua)* and red cedar (*Juniperus virginiana)* are close associates in the southern region of this cover type. Maple *(Acer sp.)*, elm (*Ulmus Americana)*, yellow-poplar (*Liriodendron tulipifera)*, and black walnut *(Juglans nigra)* often are close associates in eastern and northern parts of the oak forest and the oak-hickory-bluestem mosaic. The major shrubs are blueberry (*Vaccinium sp.)*, *Viburnum*, dogwood (*Cornus sp.)*, *Rhododendron*, and sumac (*Rhus sp.)*. The major vines are woodbine (*Parthenocissus sp.)*, grape *(Vitis sp.)*, poison ivy (*Rhus radicans)*, greenbrier (*Smilax sp.)*, and blackberry (*Rubus sp.*). Important herbaceous plants are sedge *(Carex sp.)*, *Panicum*, bluestem (*Andropogon sp.)*, *Lespedeza*, tick clover (*Desmodium sp.)*, goldenrod (*Solidago sp.)*, pussytoes (*Antennaria sp.)*, and *Aster*; many more are abundant locally. Numerous benefits are provided by the oak-hickory land cover type, including wildlife, timber, watershed protection, recreation, and wilderness and achieving a desirable mix of these benefits requires careful management (Skeen et al., 1993).

Fauna. The fauna of the oak-hickory cover type is similar to that of other eastern hardwood and hardwood-conifer areas and varies somewhat from north to south. Important animals in the cover type include the white-tailed deer *(Odocoileus virginianus)*, black bear (*Ursus americanus*), bobcat *(Felis =(Lynx) rufus)*, gray fox (*Urocyon cinereoargenteus*), raccoon (*Procyon lotor*), gray squirrel *(Sciurus carolinensis)*, fox squirrel (*Sciurus niger)*, eastern chipmunk (*Tamias striatus)*, white-footed mouse (*Peromyscus leucopus)*, pine vole (*Microtus sp.)*, short-tailed shrew (*Blarina brevicauda)*, and cotton mouse (*Peromyscus gossypinus)*.

Bird populations are large. The turkey (*Meleagris gallopavo)*, ruffed grouse (*Bonasa umbellus)*, bobwhite (*Colinus virginianus)*, and mourning dove (*Zenaida macroura)* are game birds in various parts of the cover type. Breeding bird populations average about 225 pairs per 100 acres and include some 24 or 25 species. The most abundant breeding birds include the cardinal (*Cardinalis sp.)*, tufted titmouse (*Parus bicolor)*, wood thrush (*Hylocichla mustelina)*, summer tanager (*Piranga rubra)*, red-eyed vireo (*Vireo olivaceus*), blue-gray gnatcatcher (*Potoptila caerulea)*, hooded warbler (*Wilsonia citrine*), and Carolina wren (*Thryothorus ludovicianus)*. The box turtle (*Terrapene sp.)*, common garter snake (*Thamnophis sirtalis)*, and timber rattlesnake (*Crotalus horridus)* are characteristic reptiles.

G.1.1.1 Oak-Pine Cover Type

Vegetation. The Oak-Pine cover type is characterized by forests in which 50 percent or more of the stand is hardwoods, usually upland oaks, but in which southern pines, mainly shortleaf pine (*Pinus echinata)*, make up 25 to 49 percent of the stand. Common associates include sweetgum, hickory, and yellow-poplar.

Fauna. The fauna is similar to that of the adjacent oak-hickory cover type. Animals include the white-tailed deer, fox squirrel, and cottontail (*Sylvilagus sp.)*, and birds include the mourning dove, bobwhite, and turkey. Many small mammals are present, and the avian fauna is quite varied.

G.1.1.2 Maple-Beech-Birch Cover Type

Vegetation. A forest is classified as being of the Maple-Beech-Birch cover type when 50 percent or more of the stand is maple, beech (*Fagus sp.)*, or yellow birch (*Betula alleghaniensis)*, singly or in combination. Common associates include hemlock (*Tsuga sp.)*, elm, basswood (*Tilia Americana)*, and white pine (*Pinus strobes)*. In Virginia and West Virginia, specific species may include: Sugar Maple (*Acer saccharum)*, American Beech (*Fagus grandifolia)*, Yellow Birch, Yellow buckeye (*Aesculus octandra)*, Striped Maple (*Acer pensylvanicum)*, Mountain Maple (*Acer spicatum)*, Smooth Blackberry (*Rubus canadensis)*, and Hobblebush (*Viburnum lantanoides)*.

Herb layers are moderately sparse to moderately dense, with graminoid-rich patches tending to occur on the drier slope convexities (Fleming et al., 2010).

Fauna. The white-tailed deer occurs throughout much of the maple-beech-birch cover type. The hardwood forest and the openings and farms within it provide food and cover for a varied fauna. The black bear is present in many areas. The wolf (*Canis sp.)* is no longer common, but the red fox (*Vulpes vulpes)* and gray fox are rather widespread, as is the bobcat. Several species of squirrels are in the forest, and a number of smaller rodents inhabit the forest floor. The ruffed grouse is widespread, and the bobwhite inhabits the interspersed farmlands and forest openings. Songbirds include the ovenbird (*Seiurus aurocapillus)*, red-eyed vireo (*Vireo olivaceus)*, hermit thrush, scarlet tanager (*Piranga olivacea)*, blue jay (*Cyanocitta cristata)*, black-capped chickadee (*Poecile atricapilla)*, wood pewee (*Contopus virens)*, and magnolia warbler (*Dendroica magnolia)*.

G.1.1.3 Aspen-Birch Cover Type

Vegetation. This cover type is characterized by forest in which 50 percent or more of the stand is aspen (*Populus tremuloides)*, balsam poplar *(Populus balsamifera)*, paper birch *(Betula papyrifera)*, or gray birch *(Betula populifolia)*, singly or in combination. Common associates include maple and balsam fir (*Abies balsamea)*. Other species include *Sassafras*, various maples, and various cherries (*Prunus sp.)* (Fike, 1999).

Fauna. The fauna of the aspen-birch cover type is similar to those of the spruce-fir and white-red-jack pine cover types, with which this cover type is intermingled. The white-tailed deer and black bear are common. The coyote (*Canis latrans)*, bobcat, great horned owl (*Bubo virginianus)*, and other predators feed on a variety of small mammals. The ruffed grouse is present. Among the songbirds are the tufted titmouse (*Parus bicolor)*, blue jay (*Cyanocitta cristata)*, hairy woodpecker (*Picoides villosus)*, downy woodpecker (*Picoides pubescens)*, wood thrush (*Hylocichla mustelina)*, eastern wood pewee (*Contopus virens)*, goldfinch (*Carduelis tristis)*, catbird (*Dumetella carolinensis)*, and red-eyed vireo (*Vireo olivaceous)*.

G.1.1.4 White-Red-Jack Pine Cover Type

Vegetation. Forests in which 50 percent or more of the stand is eastern white pine, red pine, or jack pine, singly or in combination, represent the White-Red-Jack Pine cover type. Common associates include oak, eastern hemlock (*Tsuga Canadensis)*, aspen, birch, northern white-cedar (*Thuja occidentalis)*, and maple.

Fauna. The white-tailed deer and black bear are the most common larger mammals in this cover type, and the moose (*Alces alces)* inhabits the extreme northern portion. The coyote, bobcat, great horned owl, and hawks are among current predators. The snowshoe rabbit (*Lepus americanus)* and other small forest mammals are the main food source of the predators already mentioned. Porcupines (*Hystrix cristata)* inhabit parts of the cover type and become a problem in forest management when they are overly abundant. Breeding bird populations average about 153 pairs per 100 acres. The Blackburnian and black-throated green warblers (*Dendroica fusca* and *Dendroica virens*, respectively) are the most abundant. Other birds include the spruce grouse (*Falcipennis canadensis)*, ruffed grouse, whippoorwill (*Caprimulgus vociferous)*, crested flycatcher (*Myiarchus crinitus)*, wood pewee, white-breasted nuthatch (*Sitta carolinensis)*, veery (*Catharus fuscescens)*, tanagers (*Piranga sp.)*, pileated woodpecker (*Dryocopus pileatus)*, hairy woodpecker, downy woodpecker, blue jay, chickadees, red-eyed vireo, black-and white warbler (*Mniotilta varia)*, ovenbird (*Seiurus aurocapillus)*, redstart (*Setophaga ruticilla)*, black-throated blue warbler (*Dendroica caerulescens)*, hermit thrush, magnolia warbler, Canada warbler (*Wilsonia canadensis)*, yellow-bellied sapsucker *(Sphyrapicus varius)*, olive-sided flycatcher (*Contopus cooperi)*, red-breasted nuthatch (*Sitta Canadensis)*, brown creeper (*Certhia Americana)*, winter wren (*Troglodytes sp.)*, blue-headed vireo (*Vireo solitaries)*, myrtle warbler (*Dendroica coronata)*, slate-colored junco (*Junco hyemalis hyemalis)*, and white-throated sparrow (*Zonotrichia albicollis)*.

G.1.1.5 Loblolly-Shortleaf Pine Cover Type

Vegetation. Loblolly-Shortleaf Pine cover type is characterized by forests in which 50 percent or more of the stand is loblolly pine (*Pinus taeda)*, shortleaf pine (*Pinus edulis)*, or other southern yellow pines (*Pinus palustris)*, singly or in combination. Common associates include oak, hickory, sweetgum, blackgum (*Nyssa sylvatica)*, red maple (*Acer rubra)*, and winged elm (*Ulmus alata)*. The main grasses are bluestems, panicums, and longleaf uniola (*Chasmanthium sessilliflorum)*. Dogwood, viburnum, blueberry, American beautyberry (*Callicarpa Americana)*, yaupon (*Ilex vomitoria)*, and numerous woody vines are common.

Fauna. The fauna varies with the age and stocking of the timber stand, the percentage of deciduous trees, and the proximity to openings, bottom-land forest types, etc. The white-tailed deer is widespread, as is the cottontail. When deciduous trees are present, the fox squirrel is common on uplands. Gray squirrels are found along intersecting drainages. Raccoon and fox are found throughout the cover type and are hunted in many areas.

The eastern wild turkey, bobwhite, and mourning dove are widespread. The most common birds include the pine warbler (*Dendroica pinus)*, cardinal, summer tanager (*Piranga rubra)*, Carolina wren (*Thryothorus ludovicianus)*, ruby-throated hummingbird (*Archilochus colubris)*, blue jay, hooded warbler *(Wilsonia citrine)*, eastern towhee (*Pipilo erythrophthalmus)*, and tufted titmouse.

G.1.2 Terrestrial Cover Types for Colorado Plateau

G.1.2.1 Pinyon-Juniper Cover Type

Vegetation. The name "pygmy forest" characterizes the pinyon pine (*Pinus edulis)* and juniper (*Juniperus sp.)* woodlands of this cover type. The trees occur as dense to open woodland and savanna woodland. Herbaceous production is determined to a large extent by the amount of tree canopy.

Fauna. The major mammalian influents in the pinyon-juniper cover type are mule deer (*Odocoileus hemionus)*, mountain lion (*Puma (Felis) concolor)*, coyote, and bobcat. Elk (*Cervus Canadensis)* are locally important. The less important influents include the wood rat (*Neotoma sp.)*, white-footed mouse (*Peromyscus leucopus)*, cliff chipmunk (*Neotamias dorsalis)*, jackrabbit (*Lepus sp.)*, cottontail, rock squirrel (*Spermophilus sp)*, porcupine, and gray fox. The ring-tailed cat (*Bassariscus astutus)* and spotted skunk (*Spilogale putorius)* occur rarely.

The most abundant resident birds in the pinyon-juniper cover type are the black-billed magpie (*Pica hudsonia*), black-capped chickadee (*Poecile atricapillus*), titmouse, Woodhouse's jay (*Aphelocoma woodhousei)*, western red-tailed hawk (*Buteo jamaicensis)*, golden eagle (*Aquila chrysaetos)*, red-shafted flicker (*Colaptes auratus)*, pinyon jay (*Gymnorhinus cyanocephalus)*, lead-colored bush tit (*Psaltriparus sp.)*, and rock wren (*Salpincttes obsoletus)*. Summer residents include the western chipping sparrow (*Spizella passerine)*, night hawk (*Chordeiles sp)*, black-throated gray warbler (*Dendroica nigrescens)*, northern cliff swallow (*Hirundo sp.)*, western lark sparrow (*Chondestes grammacus)*, Rocky Mountain grosbeak (*Pheucticus melanocephalus)*, desert sparrow (*Passer simplex)*, and western mourning dove. The common winter residents are the pink-sided junco (*Junco hyemalis mearnsi)*, Shufeldt's junco (*Junco hyemalis shufeldti)*, gray-headed junco (*Junco hyemalis caniceps)*, red-backed junco (*Junco hyemalis dorsalis)*, Rocky Mountain nuthatch (*Sitta sp)*, mountain bluebird (*Sialia corrucoides)*, western robin (*Turdus sp)*, and long-crested or Steller's jay (*Cyanocitta stelleri)*. Turkeys are locally abundant during the winter.

Among the common reptiles are the horned lizard (*Phrynosoma sp.)*, sagebrush swift (*Sceloporus graciosus graciosus)*, collared lizard (*Crotaphytus collarix)*, and Great Basin rattlesnake (*Crotalus oreganus lutosus*).

G.1.2.2 Desert Grasslands Cover Type

Vegetation. The grass life form predominates on these plateaus at intermediate elevations, and shrub life forms are dominant at higher and lower elevations. In transition zones, shrubs give way to galleta (*Pleuraphis jamesii)* to black grama (*Bouteloua eriopoda) and* to blue grama (*Bouteloua gracilis)*. Consociations of these species occur, but almost pure stands are the rule. Tobosa replaces galleta in the southern extensions in Texas of this cover type, and three-awn

(*Aristida sp.)* becomes the dominant in the northern extensions in Utah. In its northern extensions, this cover type is more open grassland with low shrubs.

Fauna. Pronghorn (*Antilocapra americana)*, or antelope, are the primary larger mammals in the desert grasslands cover type. Mule deer also occur. The coyote and bobcat are among the chief animal predators. They prey on blacktailed jackrabbits (*Lepus californicus)*, cottontails, wood rats, and a large number of small rodent species, such as the kangaroo rat (*Dipodomys deserti)* and the deer mouse (*Peromyscus maniculatus)*. Scaled quail (*Callipepla squamata)* range into the grasslands, especially where brush has made an invasion. Among the smaller birds of the cover type are the horned lark (*Eremophila alpestris*), several sparrows, the loggerhead shrike (*Lanius ludovicianus)*, and nighthawks (Chordellinae). Avian predators include the golden eagle, great horned owl, and various hawks.

G.1.2.3 Ponderosa Pine Cover Type

Vegetation. By definition, ponderosa pine forest is 50 percent or more of one of these pines: ponderosa pine *(Pinus ponderosa)*, Jeffrey pine (*Pinus jeffreyi)*, sugar pine (*Pinus lambertiana)*, limber pine (*Pinus flexilis)*, Arizona ponderosa pine (*Pinus arizonica)*, Apache pine (*Pinus engelmannii)*, or Chihuahua pine (*Pinus leiophylla)*. The exceptions are those situations where western white pine or sugar pine comprises 20 percent or more of the stand; then these species control the name of the forest. This cover type is idealized as open and park-like, with an excellent ground cover of grasses, sedges, and forbs or with an understory of shrubs of low to medium height.

Fauna. In the ponderosa pine cover type, the major mammalian influents are the Rocky Mountain elk (*Cervus Canadensis nelson)*, mule deer, mountain lion, and coyote. Animals of less importance include the bushy-tailed wood rat (*Neotoma cinerea)*, white-footed mouse, bobcat, rock squirrel (*Otospermophilus variegates)*, cottontail, porcupine, mantled ground squirrel (Sciuridae), and chipmunks (Sciuridae).

The most abundant and important resident birds in the ponderosa pine cover type include the pygmy nuthatch (*Sitta pygmaea)*, long-crested jay, sharpshinned hawk (*Accipiter striatus)*, Rocky Mountain nuthatch (*Sitta carolinensis nelsoni)*, mountain chickadee (*Poecile gambeli)*, Cassin's purple finch (*Carpodacus sp)*, redshafted flicker (*Colaptes auratus cafer)*, red-backed junco, western goshawk (*Accipeter atricapillus striatulus)*, and western red-tailed hawk. Birds that are common during the summer include the chestnut-backed bluebird (*Sialia mexicana bairdi)*, Audubon's warbler (*Dendroica coronate auduboni)*, Natalie's sapsucker (*Sphyrapicus thyroids nataliae)*, western chipping sparrow (*Spizella passerine)*, horned owl, and band-tailed pigeon (*Patagioenas fasciata)*.

G.1.2.4 Sagebrush Cover Type

Vegetation. The sagebrush cover type is characterized by shrubs, principally of the genus *Artemisia*, which are usually one to seven feet high. In some situations, other shrubs are part of the vegetation. In other places, grasses such as those of the genera *Agropyron, Festuca, Poa,* and *Bromus*, as well as broadleaved herbs, are found in the understory.

Fauna. Pronghorn use parts of this cover type as rangeland throughout the year, whereas mule deer prefer to use sagebrush rangeland only as winter or transition range. Other wild mammals that are principal inhabitants of this cover type are the Great Basin coyote, black-tailed jackrabbit, pygmy cottontail, Ord's kangaroo rat (*Dipodomys ordii)*, and Great Basin kangaroo rat (*Dipodomys microps)*.

Bird populations are low during the breeding season, averaging only about 25 pairs per 100 acres. The major influent birds include the marsh hawk (*Circus cyaneus)*, red-tailed hawk (*Buteo jamaicensis)*, Swainson's hawk (*Buteo swainsoni)*, golden eagle, bald eagle (*Haliaeetus leucocephalus)*, Cooper's hawk (*Accipeter cooperii)*, prairie falcon (*Falco mexicanus)*, burrowing owl (*Athene cunicularia)*, and long-eared owl (*Asio otus)*. The sage grouse (*Centrocercus urophasianus)* and chukar (*Alectoris chukar)* are important game birds. More than 50 additional species of birds nest within the cover type.

G.1.2.5 Western Hardwoods Cover Type

Vegetation. This cover type is characterized by forests in which 50 percent or more of the stand is hardwood species, except where western white pine, sugar pine, or redwood (*Sequoia sempervirens)* comprises 20 percent or more of the stand (in such cases the cover type is classified as western white pine or redwood). The vegetation is a forest of low to medium tall, broadleaved deciduous or evergreen trees, sometimes with an admixture of low to medium tall needle-leaved evergreens, often with an understory of grass and shrubs.

The widely scattered Rocky Mountain and Plains states "hardwood" portion of the cover type consists primarily of quaking aspen stands with an understory of grasses, forbs, and shrubs. In many places where the aspen stands are inclusions within areas of sagebrush or conifers, they are important sources of food and cover for wildlife. Cottonwood (*Populus sp.)* becomes dominant on plains, more or less replacing aspen, or in riparian corridors

Fauna. An occasional black bear comes down from forests at higher elevations. Mountain lions are no longer numerous; the largest numerous predatory animals are the coyote and the bobcat. The striped skunk (*Mephistis mephistis)* is widespread. Among the more common small mammals are the kangaroo rat, pocket gopher (Geomyidae), and a number of types of mice. Also occurring in this part of this cover type are additional animal species found in the annual grasslands cover type.

Deer are common. The fauna of the aspen portion of the cover type throughout the Rocky Mountain area is essentially that of the adjacent or surrounding cover types, but the aspen stands serve as important areas of food and shelter for many species of wildlife. Where hardwood stands occur on river bottoms in the plains, they are a home for many arboreal and forest-edge species that are not present in the surrounding open country.

The western aspen hardwood forest provides habitat for large numbers of bird species. Over 100 species of songbirds are known to use these forests (DeGraaf et al., 1991). Raptors and avian predators include eagles, falcons, turkey vulture, many species of owl and hawks (DeGraaf et al., 1991). California quail (*Callipepla californica)* are often abundant at lower elevations, and mountain quail (*Oreortyx pictus)* winter at the higher elevations (McNab et al., 2005). Other game birds in these forests include other species of grouse and quail as well as wild turkey (DeGraaf et al., 2005).

G.1.2.6 Douglas-Fir Cover Type

Vegetation. This cover type is characterized by forest consisting of 50 percent or more Douglas fir (*Pseutotsuga menziesii)*, except where redwood, sugar pine, or western white pine comprise 20 percent or more of the stand. Common shrubs in the cover type are of the genera of maple, rock spirea (*Holodiscus dumosus)*, filbert *(Corylus)*, blueberry (*Vaccinium)*, snowberry (*Symphoricarpos albus)*, barberry (*Berberis sp)*, currant (*Ribes sp.)*, blackberry (*Rubus sp.)*, ninebark (*Physocarpus sp.)*, rose (*Rosa sp.)*, and spirea (*Spiraea sp.)*. Herbage includes grass and other vegetation having a grass-like growth form, especially in the stands in interior states. Here, pinegrass (*Calamagrostis sp.)* and *Carex concinnoides* are present.

Fauna. Common large mammals in this cover type include elk, deer, and black bear. Grizzly bear (*Ursus arctos horribilis)* and moose are in the northern Rockies. Blue and ruffed grouse are present. Most of the northwestern part of the cover type has hawks and owls. Mammalian predators include mountain lions and bobcats. Small mammals include mice, squirrels, marten (*Martes americana)*, chipmunks, and bushy-tailed wood rats (*Neotoma cinerea)*. Some of the more common birds are the chestnut-backed chickadee (*Poecile refescens)*, red-breasted nuthatch, gray jay (*Perisoreus canadensis)*, and Steller's jay.

G.1.2.7 Lodgepole Pine Cover Type

Vegetation. This cover type is characterized by forests in which 50 percent or more of the stand is lodgepole pine (*Pinus contorta)*. Ecologically, lodgepole pine stands are seral to some of the western interior coniferous forests. "Doghair" stands (tree stands of densities greater than those that are optimum for rapid tree growth and shorter rotations) often develop after fires. Understory species, if present, are of about the same genera as found in stands of western larch *(Larix occidentalis), spruce-fir, and interior Douglas fir.*

Fauna. The lodgepole pine cover type has about the same fauna as Douglas-fir, larch, and spruce-fir forests of the same elevational zone. Low productivity of understory flora in many cases limits the number of animals that can be supported. Islands of uncut lodgepole pine provide excellent escape routes and protective refuges or cover for big game animals.

The lodgepole pine forest provides habitat for large numbers of bird species. Over 70 species of songbirds are known to utilize these forests (DeGraaf et al., 1991). Raptors and predators include bald eagles, falcons, turkey vulture, many species of owl, and hawks (DeGraaf et al., 1991). Grouse, mountain quail, doves, and wild turkey are the major game birds (DeGraaf et al., 2005).

G.1.2.8 Fir-Spruce Cover Type

Vegetation. The fir-spruce cover type is characterized by open to dense forests of low to tall needle-leaved evergreen trees and patches of shrubby undergrowth and scattered herbs. Fifty percent or more of the stand is silver fir (*Abies amabilis)*, subalpine fir (*Abies lasiocarpa)*, red fir (*Abies magnifica)*, white fir (*Abies concolor)*, mountain hemlock (*Tsuga mertensiana)*, Engelmann spruce (*Picea engelmannii)*, or blue spruce (*Picea pungens)*, singly or in combination, except where western white pine comprises 20 percent or more of the stand (in which case the cover type would be classified as western white pine). Because of the dense overstory and limited understory, heavily stocked stands are usually not considered a forage resource for domestic livestock unless timber is harvested by patch clearcuts.

Fauna. Seasonally, the fir-spruce cover type and, in particular, the interspersed openings and stream bottoms with broadleaved woody species such as aspen and willows, are used by moose, elk, mule deer, and white-tailed deer. Mountain caribou (*Rangifer tarandus caribou)* originally wintered in Idaho, Washington, and Montana; a few still do. The wolverine (*Gulo gulo),* lynx, black bear, mountain lion, coyote, and wolf (*Canis lupus)* occur in the cover type. The grizzly bear is present, though in a fraction of its original numbers.

Several species that have been mentioned use the fir-spruce cover type only seasonally, primarily as cover or in following migratory routes. This is the case with the mountain sheep and the mountain goat, which occur more commonly in steep rocky areas. Among the birds in the cover type are several blue grouse and spruce grouse groups, ruffed grouse, and various chickadees, nuthatches, bluebirds, robins, and jays. Among the more common rodents and lagomorphs are the porcupine, beaver, snowshoe hare, squirrels, flying squirrels, pocket gophers, chipmunks, and various species of mice.

G.1.2.9 Alpine Tundra Cover Type

Vegetation. Grasses and grass-like species of rather low stature predominate, but the number of associated forbs is large. Dwarf willows occur in some places on the moist soils of protected slopes and valleys.

Fauna. The pika (*Ochotona sp.)*, pocket gopher, and yellow-bellied marmot (*Marmota flaviventris)* are the only permanent mammalian residents of the alpine cover type. Summer visitors include mule deer, elk, mountain sheep (*Ovis canadensis)*, weasels (*Mustela)*, marten, chipmunks, and the golden-mantled ground squirrel. The only nesting birds are the horned lark, water pipit (*Anthus spinoletta)*, black rosy finch (*Leucosticte atrata)*, rock wren (*Salpinctes obsoletus)*, white-tailed ptarmigan (*Lagopus leucura)*, and robin (*Turdus migratorius)*.

G.1.2.10 Chaparral Mountain Shrub Cover Type

Vegetation. The vegetation of the cover type consists of dense to open brush or low trees. Deciduous, semi-deciduous, and evergreen species are represented. Some of the brush types are so dense that understory vegetation is practically eliminated, while other types support a highly productive understory. Recent activities of man have altered the types of vegetation to such a degree that reconstruction of their original state would be difficult.

Fauna. The fauna is quite diverse from north to south in the chaparral-mountain shrub cover type; however, some species are quite widespread. Mule deer throughout the cover type and white-tailed deer in the south are the most important large mammals. Other large mammals, such as the coyote, mountain lion, bobcat, black-tailed jackrabbit, ringtail, striped skunk, and spotted skunk, are widespread in the cover type. Some important species, such as the javelina and the band-tailed pigeon (*Patagioenas fasciata)*, are found only in the southern part of the cover type. The wood rat is one of the most characteristic animals of the cover type. Other small mammals include ground squirrels and mice.

Birds are very numerous in the brush types of the cover type throughout the year. More than a hundred species were identified in the scrub oak type in Utah. More than 40 resident birds were noted in the oak-juniper community. Among the birds in the oak-juniper areas are the golden-fronted woodpecker (*Melanerpes aurifrons)*, turkey, and bobwhite. Reptile species are quite numerous in the southern portion of the cover type.

G.1.2.11 Desert Shrub Cover Type

Vegetation. The vegetation of the cover type is characterized by xeric shrubs varying in height from four inches to many feet. Stands are generally open, with a large amount of bare soil and desert pavement exposed. Some stands, however, may be relatively dense. Understory vegetation is generally sparse. During years of above-average rainfall, annuals may be conspicuous for a short time.

Fauna. There is a great diversity of habitats in the desert shrub cover type. Consequently, the species of the fauna are quite varied. Dominant animals, however, are characteristically species of rats and pocket mice. In the saltbush-greasewood community, the pale kangaroo mouse (*Microdipodops pallidus)* and little pocket mouse (Perognathus *longimembris)* are common. Animals associated with black sagebrush (*Artemesia nova)* are the desert wood rat (*Neotoma lepida)* and Nuttall's cottontail (*Sylvilagus nuttallii)*. The black-tailed jackrabbit is most numerous in the greasewood (*Sarcobatus sp.)* sites. The cactus mouse (*Peromyscus eremicus)* and desert kangaroo rat (*Dipodomys deserti)* are abundant in the saltbush desert. Merriam's kangaroo rat (*Dipodomys merriami)* is strongly associated with creosotebush. Other important species in the cover type are the long-tailed pocket mouse (*Chaetodipus formosus)* and antelope ground squirrel (*Ammospermophilus sp.)*.

Common larger mammals in the desert shrub cover type are the desert kit fox (*Vulpes macrotis)*, coyote, and western spotted skunk (*Spilogale gracilis)*. Many desert birds are very selective in their type of habitat. Greasewood may furnish a permanent residence for the loggerhead shrike (*Lanius ludovicianus)*. Areas where tall cactus is plentiful furnish homes for many birds, including the Gila woodpecker (*Melanerpes uropygialis)*, several species of owl, and the purple martin (*Progne subis)*. Gambel's quail (*Callipepla gambelii)*, the cactus wren (*Campylorhynchus brunneicapillus)*, and the roadrunner (*Geococcyx californianus)* are common in the southern part of the cover type. Reptiles include numerous species of snakes and lizards, including the Gila monster (*Heloderma suspectum)* of the tall cactus areas.

G.1.3 Terrestrial Cover Types for the Gulf Coast

G.1.3.1 Oak-Hickory Cover Type

A summary of the Oak-Hickory Cover type is described in Appalachian Basin.

G.1.3.2 Oak-Pine Cover Type

A summary of the Oak-Pine Cover type is described in Appalachian Basin.

G.1.3.3 Great Plains Grasslands Cover Type

Vegetation. Short, warm-season grasses predominate in this cover type, and there is a minor interspersion of forbs and shrubs. Vast stretches are dominated almost exclusively by blue grama, buffalo grass being a companion in many areas. The eastern part of the cover type, however, is dominated by grasses of medium stature, such as western wheatgrass (*Pascopyrum smithii)* and needlegrass. The occasional shrubs include juniper, silver sagebrush (*Artemisia cana)*, silver buffalo berry *(Shepherdia argentea)*, and skunk bush sumac (*Rhus trilobata)* in the northern reaches and rabbit brush (*Chrysothamnus sp.)* and mesquite in the southern part. Forbs are generally quite common, but many are ephemerals.

Fauna. Huge herds of American bison once migrated with the seasons across the central plains. Currently, the pronghorn, or antelope, is probably the most abundant large mammal, but mule deer and white-tailed deer are often abundant where brush cover is available, as along stream courses. The white-tailed jackrabbit occupies the northern part of the cover type and the black-tailed jackrabbit can be found in the area south of Nebraska. The desert cottontail is widespread. The lagomorphs, the prairie dogs, and a variety of small rodents are preyed upon by the coyote and a number of other mammalian and avian predators.

Sage grouse, greater prairie chickens, and sharptailed grouse are present in the area. Among the many smaller birds are the horned lark (*Eremophila alpestris)*, lark bunting (*Calamospiza melanocorys)*, and western meadowlark (*Sturnella neglecta)*.

G.1.3.4 Prairie Cover Type

Native cover types in highly altered landscapes can be rare. Prairie cover is one such example.

Vegetation. The prairie cover type is known to many as the tall-grass or true prairie. Bluestem grasses constitute about 70 percent of the vegetation and reach heights of five to six feet in lowland areas. Large numbers of flowering forbs are present but are usually overshadowed by the grasses. Most of the plants are classified as warm-season plants. Woody vegetation is rare. Willow occurs in some places in exceptionally moist areas of the northern part of the cover type, and needle-leaved evergreens and broadleaved deciduous trees are scattered in the southern part. Deciduous trees are common along permanent streams in the eastern portion.

Fauna. Bison (*Bison bison)* once grazed at the western margin of the tall-grass prairie, and the pronghorn, or antelope, is still present there. Jackrabbits are common residents of the prairie, and cottontails are present where there are streams and cover. Burrowing rodents include ground squirrels, prairie dogs (*Cynomys sp)*, pocket gophers, and many smaller rodents. Burrowing predators include the badger (Mustelidae) and the black-footed ferret (*Mustela nigripes)*. The coyote is still common.

The northern portion of the prairie cover type is an important breeding area for a number of species of migrating waterfowl. Many migratory species over-winter on the coastal plains of Texas and Louisiana. Mourning doves have become abundant as shelterbelt plantings have developed. Among the gallinaceous birds, the sharp-tailed grouse, greater prairie chicken (*Tympanuchus cupido)*, and bobwhite (*Colinus virginianus)* are present in fair numbers.

G.1.3.5 Loblolly-Shortleaf Pine Cover Type

A summary of Loblolly-Shortleaf Cover type is described in Appalachian Basin.

G.1.3.6 Oak-Gum-Cypress Cover Type

Vegetation. The vegetation of this cover type varies considerably, but the dominants are of tree life form. It is made up of bottom-land forests in which 50 percent or more of the stand is tupelo, blackgum, sweetgum, oak, and bald cypress, singly or in combination—except where pines comprise 25 to 49 percent of the stand (in which case the cover type is oak-pine). Common associates include willow (*Salix sp.)*, maple, sycamore (*Platanus sp.)*, cottonwood, and beech. Most species are broadleaved deciduous trees. Trees of the mangrove swamp are mainly black mangrove (*Avicennia germinans)* and red mangrove (*Rhizophora mangle)*. The vegetation of the cypress savanna is dominated by needle-leaved deciduous trees and some broadleaved evergreen or deciduous trees and shrubs. The trees and shrubs occur in groves surrounded by open grassland dominated mainly by three-awn species. Mangrove swamps are often flooded by tidewater; the cypress savanna is flooded less frequently and only by fresh water. These forests are important in providing mitigating effects to land use activities in upland areas outside of the forest boundaries (Sharitz and Mitsch, 1993).

Fauna. This cover type is the most fertile and productive of southern habitats for wildlife. In times past, large animals, such as the deer, elk, black bear, mountain lion, bobcat, and wolf, inhabited the forest. Presently, the white-tailed deer is common in most areas. Other mammals include the gray fox, gray squirrel, fox squirrel, raccoon, opossum (*Didelphis virginiana)*, striped skunk, eastern cottontail, swamp rabbit (*Sylvilagus aquaticus)*, and many small rodents and shrews.

Birds include wild turkeys and, in the flooded areas, ibises (Threskiornithidae), cormorants (*Phalacrocorax sp.)*, herons (Ardeidae), egrets (Ardeidae), and kingfishers (Alcedinidae). Common mammals in the mangrove area are the fox squirrel and raccoon. Nesting birds include the mangrove cuckoo (*Coccyzus minor)* and various herons and egrets.

G.1.3.7 Longleaf-Slash Pine Cover Type

Vegetation. This cover type is characterized by forests dominated by longleaf pine (*Pinus palustris)* or slash pine (*Pinus elliottii)*, singly or in combination. Common associates include oak, sweetgum, and southern pines. The main grasses are bluestems, panicums, *Paspalum sp*., and dropseeds (*Sporobolus sp.)*. Saw palmetto (*Serenoa repens)*, gallberry (*Ilex glabra)*, wax myrtle (*Myrica cerifera)*, and sumac (*Rhus sp.)* are important shrubs. (McNab et al., 2005)

Fauna. The fauna varies with the age of the timber stand, and other characteristics. The white-tailed deer is widespread. A variety of small mammals are present including: raccoon, opossum, squirrels, rabbits and small rodents.

The eastern wild turkey and bobwhite are widespread. Migratory waterfowl are present in the area. The American alligator (*Alligator mississippiensis)* is an important reptile.

G.1.3.8 Texas Savanna Cover Type

Vegetation. This is a high-shrub savanna cover type with a dense to very open synusia of broadleaved, deciduous and evergreen low trees and shrubs and needle-leaved, evergreen low trees and shrubs. The grass varies from short to medium tall, and the herbaceous vegetation varies from dense to open. Mesquite is the most widespread woody plant. Others are *Acacia spp.,* oaks, juniper, and ceniza (*Agave colorata)* along the Rio Grande valley and bluffs. *Opuntia* cactus species are widespread. The herbaceous plants are mainly bluestems, three-awns, buffalo grass *(Bouteloua dactyloides)*, gramas, and curly mesquite and tobosa (*Hilaria mutica)* on the Edwards Plateau.

Fauna. The Texas savanna cover type is noted for the abundance of white-tailed deer and wild turkeys. The collared peccary is common in some areas along the Rio Grande, where several species of Mexican or tropical distribution make their only entry into the U.S. (*Tayassu sp.)*. Examples are the chachalaca and the coatimundi. The armadillo (*Dasypus novemcinctus)* is present. The fox squirrel is present in wooded areas along streams. Among the fur bearers are the ringtail and the raccoon.

DeGraaf et al. (2005) summarized birds occurring in Great Plains habitats, including those reported from the East Texas prairies, cross timbers, piney woods and post oak savannah. They report that: a variety of waterfowl are known to use these habitats; major upland game birds are the turkey, bobwhite and various doves; over 100 songbird species are known to utilize these habitats; and a wide variety of raptors and avian predators are found in these habitats including vultures, kite, eagles, numerous species of hawks and owls.

G.1.4 Terrestrial Cover Types of the Illinois Basin

G.1.4.1 Oak-Hickory Cover Type

Vegetation. The oak-hickory cover type varies from open to closed woods with a strong to weak understory of shrubs, vines, and herbaceous plants. By definition, oak and hickory must make up 50 percent of the stand, singly or in combination. The cover type includes multiple vegetation communities, including the Coastal Plain in Alabama and Mississippi, the oak-hickory forest and the mosaic of the oak-hickory forest and bluestem prairie communities of the Ozark Plateaus and interior low plateaus and their extensions, the oak forest of the Appalachians, and the Cross Timbers area of Texas.

Sweetgum and red cedar are close associates in the southern region of the cover type. Maple, elm, yellow-poplar, and black walnut often are close associates in eastern and northern parts of the oak forest and the oak-hickory-bluestem mosaic. The major shrubs are blueberry, viburnum, dogwood, rhododendron, and sumac. The major vines are woodbine, grape, poison ivy, greenbrier, and blackberry. Important herbaceous plants are sedge, panicum, bluestem, lespedeza, tick clover, goldenrod, pussytoes, and aster; many more are abundant locally.

The canopy can be dominated by white oak (*Quercus alba*) and mockernut hickory (*Carya alba*), with pignut hickory (*Carya glabra*) and eastern black oak (*Quercus velutina*). Northern red oak (*Quercus rubra*) may be found in the subcanopy of some examples, particularly on north- and east-facing slopes. The subcanopy may also contain red maple (*Acer rubrum*), sugar maple

(*Acer saccharum*), serviceberry (*Amelanchier arborea*), American hornbeam (*Carpinus caroliniana*), blackgum (*Nyssa sylvatica*), and sourwood (*Oxydendrum arboretum*). Hillside blueberry (*Vaccinium pallidum*) may be a prominent low shrub in some examples, along with deerberry (*Vaccinium stamineum*) and maple-leaved viburnum (*Viburnum acerifolium*). The herb dominance may be quite variable depending on aspect. Some other herbs which may be found include slender toothwort (*Cardamine angustata*), wild comfrey (*Cynoglossum virginianum var. virginianum*), and ebony spleenwort (*Asplenium platyneuron*).

Numerous benefits are provided by the oak-hickory land cover type, including wildlife, timber, watershed protection, recreation, and wilderness, and achieving a desirable mix of these benefits requires careful management (Skeen et al., 1993).

Fauna. The fauna of the oak-hickory cover type is similar to that of other eastern hardwood and hardwood-conifer areas and varies somewhat from north to south. Important animals in the cover type include the white-tailed deer, black bear, bobcat, gray fox, raccoon, gray squirrel, fox squirrel, eastern chipmunk, white-footed mouse, pine vole, short-tailed shrew, and cotton mouse.

Bird populations are large. The turkey, ruffed grouse, bobwhite, and mourning dove are game birds in various parts of the cover type. Breeding bird populations average about 225 pairs per 100 acres and include some 24 or 25 species. The most abundant breeding birds include the cardinal, tufted titmouse, wood thrush, summer tanager, red-eyed vireo, blue-gray gnatcatcher, hooded warbler, and Carolina wren. The box turtle and common garter snake are characteristic reptiles.

G.1.4.2 Elm-Ash-Cottonwood Cover Type

Vegetation. The vegetation of this cover type is a tree life form of low to tall broadleaved deciduous trees, varying from open to dense and often accompanied by vines. Cottonwood species usually dominate the cover type and often occur in pure stands. Cottonwood is most common along the streams. Swamp cottonwood (*Populus heterophylla)* is more common in other places. Common associates in the north are willow species and green and white ash (*Fraxinus pennsylvanica and F. Americana)*. Sycamore and sugarberry (*Celtis laevigata)* are common associates in the south. Other common associates are willow, sycamore, beech, and maple. The cottonwood-willow stage is short lived. This stage is followed by the river birch (*Betula nigra)* and silver maple-American elm types in the north and by the sycamore-pecan-American elm or sugarberry-American elm-green ash types in the south.

In Illinois, this cover type includes sugar maple (*Acer saccharinum*), cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), American elm (*Ulmus Americana*), slippery elm (*Ulmus rubra*), black willow (*Salix nigra*), boxelder (*Acer negundo*), river birch (*Betula nigra*), hackberry (*Celtis occidentalis*), and green ash (*Fraxinus pennsylvanica*). Species that may be present in the shrub layer include American beautyberry (*Sambucus Canadensis*) or spicebush (*Lindera benzoin*). Woody and herbaceous vines can be prominent, including, among the woody vines, Virginia creeper (*Parthenocissus quinquefolia*) and riverbank grape (*Vitis riparia*). Herbaceous vines species include groundnut (*Apios americana*), American hogpeanut (*Amphicarpaea bracteata*), and wild cucumber (*Echinocystis lobata*). Herbaceous grasses, forbs, and ferns dominate the ground layer, including calico aster (*Symphyotrichum lateriflorum*), false nettle (*Boehmeria cylindrical*), Virginia wildrye (*Elymus virginicus*), pale touch-me-not

(*Impatiens pallida*), Canadian woodnettle (*Laportea canadensis*), ostrich fern (*Matteuccia struthiopteris*), sensitive fern (*Onoclea sensibilis*), Canadian clearweed (*Pilea pumila*), and stinging nettle (*Urtica dioica*) (Faber-Langendoen, 2001).

Fauna. Because this cover type is far flung and is in the main flood plains of rivers dissecting a number of other, quite different cover types, the fauna is varied and, in many cases, influent from the surrounding cover types. Forest-edge animals and birds are common, and numerous ones include the cottontail, bobwhite, white-tailed deer, raccoon, red fox, coyote, striped skunk, spotted skunk, meadow jumping mouse (*Zapus hudsonius)*, fox squirrel, and ground squirrels. Other birds include the catbird (*Dumetella carolinensis)*, goldfinch (*Spinus tristis)*, yellow-billed cuckoo (*Coccyzus americanus)*, indigo bunting (*Passerina cyanea)*, cardinal, lark sparrow (*Chondestes grammacus)*, mockingbird (*Mimus polyglottos)*, common crow (*Corvus brachyrhunchos)*, blue jay, robin, ruby-throated hummingbird, ruffed grouse and Cooper's hawk.

G.1.4.3 Oak-Pine Cover Type

A summary of the Oak-Pine Cover type is included under the Appalachian Basin.

G.1.4.4 Maple-Beech-Birch Cover Type

A summary of the Maple-Beech-Birch Cover type is included under the Appalachian Basin.

G.1.4.5 Aspen-Birch Cover Type

A summary of the Aspen-Birch Cover type is included above in the Appalachian region.

G.1.4.6 Prairie Cover Type

A summary of the Prairie Cover type is included above in Northern Rocky Mountains and Great Plains.

G.1.4.7 Oak-Gum-Cypress Cover Type

A summary of the Oak-Gum-Cypress Cover type is included in Gulf Coast.

G.1.4.8 Agriculture Cover Type

The agriculture cover type includes land used mainly for production of food crops, such as wheat, corn, soybeans, or commodities such as cotton. This cover type is not restricted to a particular climate, physiography, or soils, but occurs where economic conditions are favorable. The best examples of this type are the former prairies of the Midwestern U.S., which have been replaced with corn and wheat, the Central Valley of California where vegetable crops are grown, and the Mississippi basin where soybeans and other agricultural crops are produced. In other areas, the agriculture cover type is intermixed with natural cover, which provides an idea of natural vegetation that is characteristic of the section.

G.1.5 Terrestrial Cover Types for Northern Rocky Mountains and Great Plains

G.1.5.1 Mountain Grasslands Cover Type

Vegetation. Although the mountain grasslands cover type ranges from foothills at northerly latitudes to high mountain sites, it is characterized throughout by bunchgrasses of the fescue and wheatgrass groups.

Fauna. In the foothills portion of the mountain grasslands cover type, pronghorn, or antelope, are resident and mule deer are winter visitors. Where there is an interface with the sagebrush cover type, common animals are the black-tailed jackrabbit, pygmy cottontail, and various mice. At low to medium elevations, various subspecies of ground squirrels are present, as well as the badger. At medium to high elevations, the grasslands seasonally support Rocky Mountain elk and mule deer. The pocket gopher is well distributed throughout the cover type. Predators, which are well distributed at high elevations, are the bobcat, black bear, and coyote. Two of the more common birds present are the robin and horned lark. Marsh hawks, sparrow hawks, and golden eagles are common raptors.

G.1.5.2 Aspen-Birch Cover Type

A discussion of the Aspen-Birch Cover type is provided above in the Appalachian Region.

G.1.5.3 Prairie Cover Type

Vegetation. The prairie cover type is known to many as the tall-grass or true prairie. Bluestems constitute about 70 percent of the vegetation and reach heights of five to six feet in lowland areas. Large numbers of flowering forbs are present but are usually overshadowed by the grasses. Most of the plants are classified as warm-season plants. Woody vegetation is rare. Willow occurs in some places in exceptionally moist areas of the northern part of the cover type, and needleleaved evergreens and broadleaved deciduous trees are scattered in the southern part. Deciduous trees are common along permanent streams.

Fauna. Bison once grazed at the western margin of the tall-grass prairie, and the pronghorn, is still present there. Jackrabbits are common residents of the prairie, and cottontails are present where there are streams and cover. Burrowing rodents include ground squirrels, prairie dogs, pocket gophers, and many smaller rodents. Burrowing predators include the badger. The coyote is still common.

The northern portion of the prairie cover type is an important breeding area for a number of species of migrating waterfowl. Mourning doves have become abundant as shelterbelt plantings have developed. Among the gallinaceous birds, the sharp-tailed grouse, greater prairie chicken, and bobwhite are present in fair numbers.

G.1.5.4 Pinyon-Juniper Cover Type

A summary of the Pinyon-Juniper Cover type is provided in Colorado Plateau.

G.1.5.5 Ponderosa Pine Cover Type

A description of the Ponderosa Pine cover type is provided in Colorado Plateau.

G.1.5.6 Sagebrush Cover Type

A description of the Sagebrush cover type is provided above in Colorado Plateau.

G.1.5.7 Douglas-fir Cover Type

A description of the Douglas-fir cover type is provided in Colorado Plateau.

G.1.5.8 Lodgepole Pine Cover Type

A description of the Lodgepole Pine cover type is provided in Colorado Plateau.

G.1.5.9 Fir-Spruce Cover Type

A description of the Fir-Spruce cover type is provided in Colorado Plateau.

G.1.5.10 Alpine Tundra Cover Type

A description of the Alpine Tundra cover Type is provided in Colorado Plateau.

G.1.5.11 Great Plains Grasslands Cover Type

A description of the Great Plains Grasslands cover type is provided in Gulf Coast.

G.1.5.12 Chaparral Mountain Shrub Cover Type

A description of the Chaparral Mountain Shrub cover type is provided in Colorado Plateau.

G.1.5.13 Desert Shrub Cover Type

A description of the Desert Shrub cover type is provided in Colorado Plateau.

G.1.6 Terrestrial Resources for Northwest Basin

G.1.6.1 Cover Types in the Alaska Range Humid Tayga-Tundry-Meadow and Coastal Humid Tayga-Meadow Provinces

Vegetation. Vertical vegetational zonation characterizes the Alaska Range and Wrangell Mountains, beginning with dense bottom-land stands of white spruce and cottonwood on the floodplains and low terraces of the Copper and Susitna Rivers. Above the terraces, poorly drained areas up to 1,000 feet support stands of black spruce. Upland spruce-hardwood forests of white spruce, birch, aspen, and poplar, with an undergrowth of moss, fern, grass, and berry, extend to timberline at about 2,500 to 3,500 feet. Tundra systems of low shrubs and herbaceous plants form discontinuous mats among the rocks and rubble above timberline. White mountain-avens may cover entire ridges in the Alaska Range, associated with moss campion, black oxytrope, arctic sandwort, lichens, grasses, and sedges. These tundra systems stop short of the permanent ice caps on the highest peaks.

Throughout the Cook Inlet lowlands, lowland spruce-hardwood forests are abundant. Bottom land spruce-poplar forest adjoins the larger river drainages, along with thickets of alder and willow. Wet tundra communities exist along the Cook Inlet coastline. The Copper River lowland is characterized by black spruce forest interspersed with large areas of brushy tundra. White spruce forests occur on south-facing gravelly moraines, and cottonwood-tall bush communities are common on large floodplains.

Fauna. Caribou and introduced bison inhabit the area, and Dall sheep (*Ovis dalli)* are found in the high mountains. Upland furbearers, such as marten (*Martes americana)*, mink (*Neovison vison)*, and shorttail (*Mustela ermine)* and least weasels (*Mustela nivalis)*, are common. Hoary marmots (*Marmota caligata)* populate mountainous areas, and woodchucks *(Marmota monax)* are found in the lower open woodlands. There is prime habitat for arctic ground squirrels *(Spermophilus parryii)* and northern flying squirrels (*Glaucomys sabrinus)*. The range of the longtail (*Microtus longicaudus)* and yellow-cheeked (*M. xanthognathus)* voles in interior Alaska corresponds closely to this region.

G.1.7 Terrestrial Resources for Western Interior Region

G.1.7.1 Oak-Hickory Cover Type

A description of the Oak-Hickory Cover type is included in Illinois Basin.

G.1.7.2 Oak-Pine Cover Type

A summary of the Oak-Pine Cover type is included in Appalachian Basin.

G.1.7.3 Prairie Cover Type

A summary of the Prairie Cover type is included in Northern Rocky Mountains and Great Plains.

G.1.7.4 Great Plains Grasslands Cover Type

A description of the Great Plains Grasslands cover type is provided in Gulf Coast.

G.1.7.5 Loblolly-Shortleaf Cover Type

A summary of the Loblolly-Shortleaf Cover type is included in Appalachian Basin.

G.1.7.6 Elm-Ash-Cottonwood Cover Type

A summary of the Elm-Ash-Cottonwood Cover type is included in Illinois Basin.

G.1.7.7 Aspen-Birch Cover Type

A summary of the Aspen-Birch Cover type is included in Appalachian Region

Appalachian Basin Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
AL	**0.39%**	**2.83%**	**33.82%**	**0.04%**	**17.63%**	**3.02%**	**0.26%**	**2.15%**	**0.72%**	**9.55%**	**5.41%**	**1.94%**	**11.53%**	**0%**	**7.68%**	**3.03%**
Bibb	0.15%	0.88%	27.63%	0.02%	8.45%	1.92%	0.01%	0.27%	0.10%	15.09%	3.45%	0.74%	6.11%	0.00%	7.45%	4.31%
Cullman	0.26%	5.75%	24.90%	0.02%	19.11%	3.42%	0.21%	1.98%	0.58%	6.26%	5.27%	2.16%	33.22%	0.00%	6.79%	0.74%
Fayette	0.13%	4.46%	36.83%	0.08%	10.36%	1.26%	0.03%	0.26%	0.11%	14.22%	3.68%	0.34%	3.76%	0.00%	9.76%	5.95%
Franklin	0.22%	2.02%	37.99%	0.13%	3.91%	0.68%	0.09%	1.17%	0.26%	5.37%	3.60%	1.93%	18.37%	0.00%	16.39%	1.41%
Jackson	0.07%	6.80%	49.24%	0.02%	18.60%	1.83%	0.13%	0.98%	0.27%	6.03%	2.73%	4.43%	16.99%	0.00%	4.45%	2.11%
Jefferson	0.76%	1.04%	32.37%	0.00%	18.98%	3.67%	1.24%	8.64%	2.98%	6.24%	12.94%	1.29%	5.46%	0.00%	3.87%	0.91%
Marion	0.10%	2.08%	35.82%	0.05%	19.69%	1.99%	0.12%	1.21%	0.49%	7.82%	5.02%	0.53%	9.56%	0.00%	14.29%	1.93%
Shelby	1.08%	3.11%	36.25%	0.00%	19.28%	6.03%	0.24%	3.05%	0.88%	4.89%	6.82%	1.89%	10.17%	0.00%	3.18%	2.73%
Tuscaloosa	0.44%	2.13%	31.53%	0.10%	24.64%	2.24%	0.21%	1.50%	0.64%	14.03%	4.66%	2.20%	5.36%	0.00%	8.00%	7.69%
Walker	0.59%	0.85%	28.01%	0.02%	26.27%	6.04%	0.06%	0.73%	0.35%	11.82%	4.47%	1.59%	10.49%	0.00%	8.19%	2.14%
Winston	0.18%	1.17%	25.37%	0.00%	31.87%	3.91%	0.05%	0.81%	0.12%	15.22%	3.83%	2.72%	11.54%	0.00%	7.35%	1.46%
KY	**1.08%**	**0.21%**	**72.55%**	**0.00%**	**0.66%**	**8.64%**	**0.06%**	**1.73%**	**0.44%**	**4.06%**	**4.39%**	**0.51%**	**5.48%**	**0%**	**0.20%**	**0.00%**
Bell	0.66%	0.00%	75.66%		0.45%	9.20%	0.10%	1.74%	0.53%	5.24%	5.19%	0.34%	0.74%	0.00%	0.15%	
Breathitt	0.77%	0.03%	78.67%		0.61%	8.14%	0.02%	1.03%	0.16%	3.86%	3.75%	0.15%	2.68%	0.00%	0.12%	0.02%
Clay	0.13%	0.09%	78.93%		0.25%	5.72%	0.03%	1.39%	0.23%	2.19%	4.74%	0.36%	5.28%	0.00%	0.66%	0.01%
Elliott	0.04%	0.32%	69.54%	0.00%	2.08%	4.60%		0.77%	0.04%	6.11%	4.35%	0.44%	11.41%	0.00%	0.29%	0.00%
Floyd	0.65%	0.18%	76.68%		0.26%	8.79%	0.10%	2.31%	0.77%	1.16%	4.36%	0.53%	4.17%	0.00%	0.03%	
Harlan	0.84%	0.00%	82.88%		0.22%	5.10%	0.04%	1.49%	0.44%	3.39%	4.87%	0.24%	0.38%	0.00%	0.11%	
Jackson	0.22%	0.06%	67.81%		0.39%	8.27%	0.01%	1.56%	0.09%	3.60%	5.07%	0.13%	12.39%	0.00%	0.42%	0.01%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
Johnson	0.35%	0.28%	74.80%		0.62%	6.08%	0.09%	2.08%	0.66%	4.07%	4.35%	0.66%	5.91%	0.00%	0.06%	0.00%
Knott	3.06%	0.01%	75.42%		0.16%	12.52%	0.03%	1.23%	0.30%	1.88%	4.43%	0.27%	0.67%	0.00%	0.03%	
Knox	0.31%	0.12%	72.19%		0.44%	7.32%	0.09%	2.35%	0.53%	2.03%	5.31%	0.21%	8.62%	0.00%	0.48%	0.00%
Laurel	0.67%	0.09%	38.84%	0.00%	1.06%	9.32%	0.26%	4.43%	1.11%	14.42%	5.54%	1.67%	22.42%	0.00%	0.16%	0.00%
Lawrence	0.15%	0.37%	76.91%		2.32%	5.23%	0.04%	1.18%	0.45%	2.20%	4.57%	1.12%	5.28%	0.00%	0.17%	0.00%
Leslie	1.00%	0.05%	84.58%		0.11%	5.32%	0.01%	0.65%	0.12%	2.35%	4.58%	0.35%	0.32%	0.00%	0.56%	0.00%
Letcher	2.74%	0.00%	74.66%		0.19%	10.44%	0.05%	1.62%	0.40%	4.51%	5.20%	0.08%	0.08%	0.00%	0.02%	
Magoffin	0.24%	0.62%	82.59%	0.00%	0.31%	7.49%	0.01%	0.84%	0.09%	2.17%	2.52%	0.02%	3.08%	0.00%	0.03%	0.01%
Martin	4.13%	0.68%	67.30%		0.36%	16.79%	0.03%	1.83%	0.41%	1.75%	3.80%	0.39%	2.42%	0.00%	0.12%	0.00%
Morgan	0.07%	0.78%	68.51%		1.54%	5.45%	0.01%	1.13%	0.07%	7.68%	2.71%	0.53%	11.46%	0.00%	0.05%	0.01%
Owsley	0.08%	0.08%	74.90%		0.66%	6.71%	0.00%	1.17%	0.07%	3.32%	4.61%	0.27%	7.86%	0.00%	0.25%	0.01%
Perry	3.65%	0.07%	69.41%		0.47%	13.64%	0.10%	1.99%	0.62%	3.34%	5.03%	0.43%	1.10%	0.00%	0.16%	
Pike	2.34%	0.40%	74.54%		0.11%	13.48%	0.11%	1.97%	0.75%	1.66%	2.58%	0.49%	1.50%	0.00%	0.08%	0.00%
Whitley	0.26%	0.21%	57.94%		1.81%	9.16%	0.08%	2.51%	0.71%	8.53%	5.90%	1.41%	11.25%	0.00%	0.23%	0.00%
MD	**0.90%**	**1.57%**	**69.92%**	**0.13%**	**4.47%**	**0%**	**0.11%**	**1.22%**	**0.40%**	**1.60%**	**5.56%**	**1.45%**	**12.44%**	**0%**	**0%**	**0.23%**
Allegany	0.48%	0.81%	74.67%		2.50%	0.28%	2.45%	0.82%	1.46%	5.86%	0.91%	9.72%				0.03%
Garrett	1.15%	2.04%	66.94%	0.21%	5.71%	0.01%	0.45%	0.14%	1.69%	5.37%	1.78%	14.15%				0.36%
OH	**0.19%**	**10.84%**	**55.34%**	**0.03%**	**1.37%**	**2.25%**	**0.36%**	**2.74%**	**0.82%**	**0.04%**	**7.78%**	**1.26%**	**16.36%**	**0%**	**0.27%**	**0.37%**
Belmont	0.37%	5.91%	58.16%	0.04%	0.79%	2.61%	0.22%	1.37%	0.62%	0.01%	7.08%	1.50%	21.14%	0.00%	0.08%	0.11%
Carroll	0.00%	13.98%	53.68%	0.02%	2.13%	2.02%	0.06%	0.71%	0.19%	0.03%	5.86%	1.37%	19.64%	0.00%	0.05%	0.26%
Columbiana	0.10%	19.04%	43.29%	0.01%	1.17%	1.77%	0.32%	2.65%	0.71%	0.01%	10.25%	0.87%	19.46%	0.00%	0.02%	0.34%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
Coshocton	0.03%	15.98%	54.95%	0.04%	0.84%	0.79%	0.15%	0.90%	0.31%	0.01%	6.34%	1.25%	17.76%	0.00%	0.11%	0.54%
Harrison	0.37%	7.87%	61.76%	0.05%	1.78%	2.17%	0.03%	0.50%	0.12%	0.01%	6.40%	2.10%	16.55%	0.00%	0.06%	0.24%
Jackson	0.63%	4.63%	59.52%	0.01%	3.86%	3.70%	0.08%	1.92%	0.41%	0.01%	5.44%	0.49%	17.97%	0.00%	1.32%	0.02%
Jefferson	0.26%	7.13%	64.89%	0.01%	0.61%	1.95%	0.33%	1.95%	0.93%	0.01%	8.25%	1.51%	12.09%	0.00%	0.04%	0.05%
Lawrence	0.10%	2.08%	68.85%		2.19%	3.29%	0.11%	3.06%	0.90%	0.33%	5.06%	0.80%	12.40%	0.00%	0.63%	0.19%
Mahoning	0.07%	16.96%	30.04%	0.03%	0.87%	2.53%	1.23%	12.07%	3.03%	0.04%	12.63%	2.76%	15.17%	0.00%	0.51%	2.04%
Monroe	0.01%	3.97%	74.01%	0.00%	1.62%	1.54%	0.07%	0.35%	0.11%	0.02%	6.76%	0.82%	10.67%	0.00%	0.04%	0.01%
Muskingum	0.08%	7.97%	54.20%	0.03%	0.86%	3.27%	0.25%	1.77%	0.52%	0.04%	7.18%	1.44%	22.04%	0.00%	0.19%	0.17%
Noble	0.29%	5.44%	67.62%	0.01%	0.92%	3.76%	0.02%	0.51%	0.13%	0.00%	6.92%	1.38%	12.58%	0.00%	0.35%	0.05%
Perry	0.15%	15.39%	55.89%	0.01%	1.97%	1.14%	0.06%	0.94%	0.21%	0.01%	6.71%	0.71%	16.18%	0.00%	0.46%	0.18%
Stark	0.07%	23.04%	23.44%	0.05%	0.54%	1.98%	1.96%	10.66%	3.24%	0.03%	14.89%	1.22%	18.08%	0.00%	0.02%	0.80%
Tuscarawas	0.10%	14.95%	52.68%	0.07%	0.93%	1.96%	0.38%	2.55%	1.01%	0.00%	6.99%	1.42%	16.21%	0.00%	0.07%	0.67%
Vinton	0.65%	3.44%	76.89%	0.02%	2.05%	1.68%	0.01%	0.36%	0.06%	0.01%	5.79%	0.42%	7.86%	0.00%	0.69%	0.06%
PA	**0.56%**	**6.18%**	**56.72%**	**0.10%**	**3.85%**	**0.68%**	**0.39%**	**2.61%**	**1.12%**	**6.37%**	**6.47%**	**1.23%**	**12.73%**	**0%**	**0.75%**	**0.24%**
Allegheny	0.23%	1.97%	41.60%	0.01%	0.17%	0.76%	4.17%	17.06%	9.55%	0.08%	19.24%	1.86%	3.28%	0.00%	0.00%	0.02%
Armstrong	0.31%	7.50%	63.33%	0.01%	1.30%	1.08%	0.13%	1.59%	0.48%	0.89%	7.13%	2.22%	14.02%	0.00%	0.00%	0.00%
Beaver	0.05%	4.50%	57.13%	0.02%	0.62%	1.40%	1.39%	5.70%	2.48%	0.04%	13.36%	2.13%	10.97%	0.00%	0.03%	0.19%
Bedford	0.10%	7.43%	65.61%	0.00%	2.22%		0.09%	1.16%	0.28%	1.95%	5.41%	0.43%	15.34%	0.00%		0.00%
Butler	0.11%	13.21%	57.34%	0.04%	0.40%	2.31%	0.42%	3.24%	0.99%	0.77%	8.70%	1.11%	11.22%	0.00%	0.00%	0.13%
Cambria	1.56%	3.91%	59.27%	0.00%	8.90%		0.14%	2.23%	0.69%	2.56%	7.33%	0.96%	12.45%	0.00%		0.00%
Cameron	0.21%	0.10%	64.13%	0.33%	5.70%	0.85%	0.01%	0.20%	0.07%	21.96%	1.11%	0.21%	1.16%	0.00%	3.49%	0.46%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
Centre	0.38%	8.76%	61.98%	0.03%	7.38%	0.01%	0.11%	1.67%	0.37%	6.36%	5.47%	0.55%	6.89%	0.00%	0.04%	0.01%
Clarion	0.19%	12.17%	47.95%	0.04%	4.86%	4.30%	0.07%	0.97%	0.24%	10.22%	6.18%	0.87%	11.35%	0.00%	0.50%	0.07%
Clearfield	1.93%	1.66%	54.89%	0.07%	10.77%	1.26%	0.05%	1.17%	0.25%	9.71%	6.17%	0.60%	9.55%	0.00%	1.76%	0.19%
Columbia	0.18%	12.92%	34.97%	0.30%	5.75%	0.10%	0.13%	1.47%	0.48%	11.76%	6.34%	0.99%	24.17%	0.00%	0.34%	0.10%
Dauphin	0.24%	9.93%	42.20%	0.18%	1.51%		1.25%	7.43%	2.73%	2.02%	7.82%	6.25%	18.15%	0.00%		0.29%
Elk	0.62%	0.63%	57.50%	0.22%	7.70%	1.95%	0.06%	0.55%	0.23%	17.20%	1.86%	0.46%	4.23%	0.00%	6.37%	0.43%
Fayette	0.42%	3.44%	66.68%	0.01%	0.63%	0.04%	0.22%	2.84%	1.17%	0.31%	6.69%	1.42%	16.13%	0.00%		0.00%
Greene	0.12%	2.41%	72.45%	0.02%	0.16%	0.80%	0.13%	0.77%	0.24%	0.01%	7.19%	0.65%	14.98%	0.00%	0.01%	0.06%
Huntingdon	0.08%	6.43%	67.96%		5.21%		0.05%	0.91%	0.19%	3.26%	4.80%	1.99%	9.12%	0.00%		0.01%
Indiana	0.51%	5.94%	62.02%	0.03%	3.32%		0.09%	1.54%	0.46%	1.44%	6.58%	0.67%	17.40%	0.00%		0.00%
Jefferson	0.37%	4.86%	52.68%	0.05%	6.02%	1.07%	0.06%	1.16%	0.27%	10.18%	5.66%	0.39%	15.97%	0.00%	0.95%	0.32%
Lackawanna	0.42%	8.75%	51.56%	0.40%	3.22%	0.85%	1.11%	4.82%	3.65%	6.19%	6.84%	1.79%	4.08%	0.00%	1.84%	4.48%
Luzerne	1.19%	4.03%	55.17%	0.31%	5.09%	0.16%	0.70%	3.35%	2.57%	8.72%	6.71%	2.23%	7.60%	0.00%	0.90%	1.28%
Lycoming	0.15%	5.24%	42.79%	0.27%	4.96%	0.35%	0.10%	1.14%	0.43%	26.68%	3.50%	0.72%	12.41%	0.00%	1.16%	0.11%
Northumberland	0.69%	18.18%	41.47%	0.24%	1.93%	0.03%	0.37%	2.43%	1.11%	2.70%	6.83%	3.99%	19.71%	0.00%	0.19%	0.14%
Schuykill	1.85%	5.77%	62.34%	0.01%	3.86%		0.27%	2.37%	0.88%	3.54%	6.57%	1.30%	11.25%	0.00%		0.00%
Somerset	1.41%	5.32%	62.67%	0.01%	3.68%		0.04%	0.88%	0.24%	1.17%	4.89%	0.94%	18.73%	0.00%		0.02%
Tioga	0.29%	7.65%	49.37%	0.34%	3.34%		0.02%	0.37%	0.12%	14.52%	2.96%	0.49%	17.75%	0.00%		0.07%
Venango	0.02%	6.43%	67.84%	0.11%	2.13%	0.43%	0.06%	1.06%	0.31%	4.80%	5.75%	1.35%	7.16%	0.00%	2.29%	0.43%
Washington	0.23%	7.45%	56.20%	0.00%	0.30%	1.51%	0.44%	3.18%	1.02%	0.06%	8.89%	0.65%	19.92%	0.00%	1.04%	0.04%
Westmoreland	0.52%	4.11%	58.65%	0.01%	0.89%	1.60%	0.52%	6.11%	2.52%	0.28%	7.40%	1.14%	17.84%	0.00%	0.01%	0.00%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
TN	**0.54%**	**0.30%**	**58.21%**	**0.00%**	**2.17%**	**9.18%**	**0.22%**	**2.38%**	**0.72%**	**8.37%**	**5.10%**	**2.01%**	**10.37%**	**0%**	**0.14%**	**0.28%**
Anderson	0.27%	0.17%	56.83%	0.00%	3.08%	4.14%	0.64%	4.63%	1.78%	5.04%	7.28%	2.62%	12.32%	0.00%	0.13%	1.07%
Campbell	0.37%	0.06%	65.68%	0.01%	1.26%	7.78%	0.18%	2.42%	0.64%	6.38%	5.69%	3.54%	5.62%	0.00%	0.19%	0.17%
Claiborne	0.78%	0.07%	53.25%		1.54%	16.95%	0.13%	2.00%	0.46%	5.22%	4.09%	1.81%	13.48%	0.00%	0.14%	0.09%
Fentress	0.69%	0.83%	56.12%		2.99%	7.19%	0.05%	1.12%	0.28%	15.46%	3.91%	0.22%	10.99%	0.00%	0.11%	0.03%
VA	**1.07%**	**0.17%**	**65.33%**	**0%**	**1.87%**	**7.07%**	**0.08%**	**2.02%**	**0.74%**	**2.51%**	**4.29%**	**0.21%**	**14.29%**	**0%**	**0.35%**	**0.01%**
Buchanan	0.60%	0.03%	82.99%		0.54%	4.05%	0.04%	1.56%	0.51%	1.26%	4.34%	0.09%	3.97%	0.00%	0.01%	
Dickenson	0.52%	0.04%	75.87%		0.99%	6.39%	0.02%	1.77%	0.48%	3.13%	4.91%	0.61%	5.27%	0.00%		
Lee	0.70%	0.07%	56.81%		1.22%	17.85%	0.05%	1.66%	0.38%	5.42%	4.87%	0.10%	10.62%	0.00%	0.24%	0.01%
Russell	0.43%	0.36%	52.85%		2.16%	2.74%	0.04%	1.95%	0.52%	1.19%	4.40%	0.29%	32.33%	0.00%	0.74%	0.00%
Tazewell	0.26%	0.35%	59.49%		3.81%	4.16%	0.16%	2.45%	1.36%	1.23%	3.83%	0.06%	21.89%	0.00%	0.91%	0.02%
Wise	4.26%	0.09%	66.17%		2.12%	8.51%	0.15%	2.68%	1.09%	3.60%	3.55%	0.23%	7.54%	0.00%	0.01%	
WV	**0.89%**	**1.29%**	**78.34%**	**0.08%**	**2.12%**	**2.12%**	**0.11%**	**1.40%**	**0.60%**	**1.64%**	**4.80%**	**0.80%**	**5.67%**	**0%**	**0.03%**	**0.09%**
Barbour	0.79%	4.24%	75.74%	0.02%	0.20%		0.02%	0.55%	0.13%	0.56%	4.67%	1.04%	12.04%	0.00%		0.01%
Boone	2.70%	0.42%	83.61%	0.00%	0.13%	8.10%	0.08%	1.08%	0.63%	0.10%	1.85%	0.32%	0.88%	0.00%	0.08%	0.02%
Brooke	0.35%	3.92%	65.32%	0.08%	0.24%	2.12%	1.06%	3.66%	1.69%	0.02%	9.06%	4.00%	8.39%	0.00%	0.01%	0.08%
Clay	0.73%	0.55%	91.25%	0.05%	0.33%	0.76%	0.00%	0.12%	0.03%	0.02%	3.75%	0.61%	1.57%	0.00%		0.23%
Fayette	0.90%	0.36%	82.11%	0.09%	3.09%	2.17%	0.05%	1.70%	0.61%	1.13%	3.37%	1.19%	3.18%	0.00%	0.01%	0.05%
Greenbrier	0.56%	0.86%	77.85%	0.32%	2.75%		0.05%	1.15%	0.28%	1.98%	3.12%	0.45%	10.51%	0.00%		0.14%
Harrison	0.64%	1.57%	70.22%	0.00%	0.06%	0.19%	0.24%	2.57%	1.26%	0.26%	7.52%	0.57%	14.90%	0.00%		0.00%
Kanawha	0.50%	0.21%	82.86%	0.01%	0.52%	1.97%	0.37%	2.87%	1.38%	0.09%	7.09%	0.84%	1.25%	0.00%	0.04%	0.01%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
Lincoln	0.57%	0.88%	82.96%		0.75%	5.21%	0.05%	1.38%	0.22%	0.05%	5.30%	0.27%	2.34%	0.00%	0.01%	0.02%
Logan	1.83%	0.45%	82.49%	0.00%	0.13%	7.48%	0.13%	1.68%	1.25%	0.05%	3.34%	0.29%	0.81%	0.00%	0.07%	0.00%
Marion	0.13%	2.28%	77.09%	0.00%	0.13%	0.62%	0.23%	2.19%	0.99%	0.08%	7.80%	0.99%	7.47%	0.00%	0.00%	0.00%
Marshall	0.03%	1.28%	74.67%	0.02%	0.16%	1.74%	0.34%	1.03%	0.67%	0.01%	6.85%	2.10%	11.04%	0.00%	0.01%	0.04%
Mason	0.10%	5.54%	63.56%	0.01%	3.28%	1.42%	0.07%	1.75%	0.42%	0.19%	5.32%	3.07%	15.17%	0.00%	0.02%	0.09%
McDowell	0.87%	0.01%	84.80%	0.00%	0.98%	2.80%	0.03%	1.62%	0.75%	1.52%	4.58%	0.15%	1.88%	0.00%	0.00%	0.00%
Mineral	0.35%	0.67%	72.51%	0.01%	2.15%		0.08%	1.13%	0.31%	2.15%	6.18%	1.24%	13.20%	0.00%		0.02%
Mingo	1.83%	0.34%	81.87%		0.13%	9.28%	0.04%	1.66%	0.99%	0.11%	2.79%	0.40%	0.55%	0.00%	0.03%	0.00%
Monongalia	0.38%	2.71%	73.92%	0.00%	0.14%	0.68%	0.35%	2.48%	1.38%	0.18%	7.76%	1.89%	8.11%	0.00%	0.00%	0.02%
Nicholas	1.85%	1.54%	81.66%	0.05%	2.27%	0.75%	0.05%	0.82%	0.18%	1.26%	4.83%	1.05%	3.64%	0.00%	0.00%	0.03%
Preston	0.59%	4.24%	74.77%	0.08%	1.49%		0.03%	0.48%	0.24%	0.80%	6.48%	0.69%	10.03%	0.00%		0.08%
Raleigh	0.63%	0.12%	66.10%	0.00%	7.75%	3.46%	0.31%	3.06%	1.52%	0.95%	4.20%	0.70%	11.04%	0.00%	0.15%	
Randolph	0.97%	1.34%	78.66%	0.08%	4.12%		0.04%	0.37%	0.16%	7.16%	3.42%	0.37%	3.25%	0.00%		0.07%
Tucker	1.58%	0.58%	71.76%	1.09%	10.68%		0.01%	0.27%	0.09%	4.47%	4.04%	0.83%	2.97%	0.00%		1.62%
Upshur	1.12%	3.87%	77.04%	0.01%	0.49%		0.07%	0.94%	0.40%	0.96%	6.27%	0.37%	8.47%	0.00%		0.00%
Wayne	0.33%	0.42%	77.69%		0.61%	4.93%	0.09%	2.05%	0.65%	2.08%	5.94%	1.09%	3.73%	0.00%	0.33%	0.06%
Webster	1.08%	0.55%	89.07%	0.03%	0.53%		0.01%	0.19%	0.04%	3.90%	3.53%	0.35%	0.70%	0.00%		0.01%
Wyoming	0.88%	0.02%	78.01%		4.71%	4.68%	0.03%	1.32%	0.51%	3.43%	4.28%	0.37%	1.76%	0.00%	0.01%	

Appalachian Basin Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
REGION AVG.	0.65%	4.05%	60.24%	0.06%	4.65%	2.94%	0.25%	2.16%	0.80%	4.66%	5.74%	1.14%	10.66%	0%	1.41%	0.58%

Colorado Plateau Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
AZ	**1.84%**	**0.08%**	**0%**	**0.09%**	**20.28%**	**13.32%**	**0.00%**	**0.14%**	**0.02%**	**0%**	**0.58%**	**0.05%**	**0.12%**	**0%**	**63.23%**	**0.23%**
Navajo	1.84%	0.08%		0.09%	20.28%	13.32%	0.00%	0.14%	0.02%	0%	0.58%	0.05%	0.12%	0%	63.23%	0.23%
CO	**2.28%**	**0.75%**	**20.28%**	**0.08%**	**33.50%**	**6.50%**	**0.01%**	**0.40%**	**0.09%**	**1.41%**	**0.57%**	**0.30%**	**4.73%**	**0.01%**	**28.06%**	**1.03%**
Delta	1.39%	3.79%	19.89%	0.01%	21.89%	2.93%	0.04%	1.00%	0.25%	1.00%	0.91%	0.44%	10.04%		34.86%	1.56%
Garfield	2.63%	0.02%	24.41%	0.14%	31.64%	9.32%	0.01%	0.46%	0.12%	1.11%	0.45%	0.27%	3.80%		24.57%	1.05%
Gunnison	4.28%		22.11%	0.18%	32.84%	12.72%	0.00%	0.17%	0.03%	1.65%	0.43%	0.56%	1.85%	0.04%	21.55%	1.57%
La Plata	1.48%	0.51%	18.90%	0.01%	36.15%	6.47%	0.00%	0.55%	0.08%	3.02%	0.92%	0.43%	8.78%		21.47%	1.22%
Montrose	1.17%	2.43%	16.95%		38.03%	1.70%	0.03%	0.61%	0.16%	0.20%	0.74%	0.09%	6.63%		30.72%	0.54%
Rio Blanco	1.43%	0.06%	17.77%	0.04%	35.44%	2.15%	0.00%	0.15%	0.01%	1.57%	0.39%	0.11%	3.22%		37.16%	0.49%
NM	**1.01%**	**0.64%**	**0.10%**	**0.02%**	**15.62%**	**24.41%**	**0.01%**	**0.27%**	**0.13%**	**0.00%**	**0.61%**	**0.28%**	**0.63%**	**0%**	**55.96%**	**0.30%**
McKinley	0.80%	0.01%	0.14%	0.03%	23.99%	26.91%	0.00%	0.14%	0.07%		0.34%	0.09%	0.00%		47.46%	0.01%
San Juan	1.21%	1.28%	0.06%	0.01%	7.33%	21.92%	0.02%	0.40%	0.18%	0.00%	0.89%	0.48%	1.26%		64.38%	0.59%
UT	**7.96%**	**0.25%**	**5.76%**	**0%**	**21.17%**	**10.06%**	**0.00%**	**0.35%**	**0.09%**	**1.22%**	**0.74%**	**0.33%**	**2.38%**	**0.00%**	**49.40%**	**0.29%**
Carbon	2.54%	0.03%	11.10%		34.77%	0.68%		0.41%	0.09%	1.23%	0.70%	0.43%	1.75%		45.98%	0.28%
Emery	12.47%	0.06%	1.60%		9.25%	16.43%	0.00%	0.22%	0.05%	0.36%	0.45%	0.26%	2.41%		56.08%	0.36%
Sevier	1.60%	0.86%	11.33%		38.49%	2.44%	0.01%	0.63%	0.18%	3.24%	1.42%	0.41%	2.77%	0.00%	36.47%	0.14%
REGION AVG.	**2.88%**	**0.48%**	**7.81%**	**0.05%**	**23.67%**	**13.26%**	**0.01%**	**0.30%**	**0.08%**	**0.69%**	**0.61%**	**0.24%**	**2.19%**	**0.00%**	**47.20%**	**0.53%**

Gulf Coast Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
LA	**0.21%**	**3.18%**	**5.94%**	**0.96%**	**26.59%**	**3.69%**	**0.03%**	**1.49%**	**0.15%**	**9.30%**	**2.73%**	**2.68%**	**10.85%**	**0%**	**14.31%**	**17.89%**
De Soto Parish	0.27%	0.92%	6.54%	0.72%	28.23%	5.34%	0.02%	1.24%	0.17%	11.37%	2.42%	1.20%	8.27%		13.62%	19.67%
Red River Parish	0.08%	8.25%	4.60%	1.48%	22.93%	0.00%	0.03%	2.04%	0.12%	4.69%	3.40%	5.98%	16.62%		15.85%	13.93%
MS	**0.36%**	**2.94%**	**27.49%**	**0.82%**	**20.60%**	**0.07%**	**0.00%**	**0.12%**	**0.05%**	**12.39%**	**3.89%**	**0.37%**	**7.52%**	**0%**	**10.79%**	**12.57%**
Choctaw	0.36%	2.94%	27.49%	0.82%	20.61%	0.07%	0.01%	0.12%	0.05%	12.39%	3.89%	0.37%	7.52%		10.79%	12.57%
TX	**0.66%**	**3.90%**	**11.21%**	**0.21%**	**7.98%**	**3.37%**	**0.10%**	**2.71%**	**0.29%**	**8.74%**	**3.53%**	**1.50%**	**29.99%**	**0%**	**16.26%**	**9.56%**
Atacosa	0.21%	11.21%	3.02%	0.07%	0.27%	6.77%	0.02%	1.85%	0.27%	0.23%	3.80%	0.11%	22.39%		48.27%	1.52%
Freestone	3.22%	0.41%	9.92%	0.40%	1.73%	7.25%	0.11%	4.00%	0.30%	8.44%	3.74%	2.22%	35.96%		9.23%	13.06%
Harrison	0.07%	0.27%	10.23%	0.16%	22.33%	0.05%	0.24%	3.72%	0.53%	17.75%	4.75%	1.85%	12.09%		14.52%	11.42%
Hopkins	0.05%	8.45%	13.46%	0.02%	0.36%	0.02%	0.13%	4.34%	0.28%	0.06%	1.44%	2.52%	54.92%		3.51%	10.44%
Lee	0.24%	2.50%	15.24%	0.45%	2.69%	1.49%	0.04%	0.45%	0.18%	4.83%	5.10%	0.45%	40.09%		19.84%	6.41%
Leon	1.60%	0.78%	11.58%	0.25%	3.17%	7.82%	0.05%	2.70%	0.20%	13.06%	3.02%	1.19%	33.42%		10.80%	10.37%
Panola	0.11%	0.12%	7.73%	0.09%	23.62%	0.26%	0.06%	1.82%	0.20%	16.85%	3.30%	1.61%	16.93%		11.33%	15.97%
Robertson	0.34%	9.53%	18.28%	0.54%	2.90%	4.36%	0.05%	0.56%	0.12%	8.29%	4.46%	1.00%	32.10%		11.39%	6.09%
Rusk	0.05%	0.42%	10.88%	0.03%	19.14%	0.65%	0.13%	3.21%	0.30%	13.53%	3.43%	1.74%	25.12%		10.58%	10.79%
Titus	0.21%	3.00%	21.85%	0.05%	2.58%		0.26%	5.67%	0.67%	0.12%	1.19%	4.09%	39.62%		6.03%	14.65%
REGION AVG.	**0.59%**	**3.77%**	**11.21%**	**0.32%**	**10.83%**	**3.28%**	**0.08%**	**2.45%**	**0.26%**	**8.96%**	**3.44%**	**1.60%**	**26.67%**	**0%**	**15.79%**	**10.73%**

Illinois Basin Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
IL	**0.06%**	**52.58%**	**20.28%**	**0.16%**	**0.18%**	**0.95%**	**0.17%**	**3.25%**	**0.68%**	**0.03%**	**5.38%**	**2.13%**	**12.86%**	**0%**	**0.00%**	**1.29%**
Gallatin	0.19%	62.56%	19.81%	0.29%	0.56%	0.23%	0.02%	1.21%	0.09%	0.05%	4.40%	2.60%	5.46%		0.00%	2.51%
Jackson	0.05%	24.34%	37.80%	0.34%	0.15%	0.99%	0.06%	3.17%	0.29%	0.16%	5.47%	3.42%	19.81%			3.95%
Macoupin	0.01%	60.38%	22.72%	0.01%	0.00%	0.07%	0.09%	2.67%	0.38%		5.02%	0.81%	7.47%			0.37%
Perry	0.01%	40.72%	22.58%	0.26%	0.01%	5.11%	0.04%	2.20%	0.24%	0.00%	5.61%	2.99%	18.63%			1.61%
Randolph	0.17%	30.87%	24.47%	0.35%	0.02%	2.46%	0.04%	2.92%	0.34%	0.02%	4.32%	4.02%	28.89%			1.10%
Saline	0.11%	44.87%	25.93%	0.31%	0.98%	0.56%	0.10%	2.17%	0.31%	0.13%	6.21%	1.75%	15.23%			1.35%
Sangamon	0.01%	70.60%	7.44%	0.01%	0.00%	0.22%	0.61%	6.16%	2.67%		4.63%	1.11%	5.36%			1.19%
Vermilion	0.07%	77.76%	8.81%	0.00%	0.00%	0.45%	0.21%	3.60%	0.36%		5.08%	0.60%	2.77%			0.31%
Wabash	0.02%	67.99%	12.13%	0.01%	0.00%	0.20%	0.05%	1.71%	0.29%		6.72%	1.94%	8.12%			0.83%
White	0.05%	61.28%	14.87%	0.07%	0.03%	0.08%	0.05%	1.60%	0.16%	0.00%	6.60%	1.53%	12.69%			0.98%
Williamson	0.02%	11.56%	38.10%	0.40%	0.97%	1.13%	0.17%	4.72%	1.04%	0.01%	7.22%	5.41%	28.08%			1.18%
IN	**0.13%**	**55.30%**	**24.12%**	**0.32%**	**1.12%**	**0.90%**	**0.22%**	**1.33%**	**0.48%**	**0.01%**	**6.20%**	**2.33%**	**6.73%**	**0%**	**0.05%**	**0.78%**
Daviess	0.06%	63.61%	17.33%	0.20%	0.24%	0.31%	0.11%	0.67%	0.28%		5.84%	1.82%	9.32%		0.02%	0.20%
Dubois	0.02%	37.29%	36.10%	0.07%	0.54%	1.03%	0.25%	0.94%	0.43%	0.03%	5.83%	1.39%	15.81%		0.17%	0.09%
Gibson	0.21%	68.75%	14.90%	0.18%	0.13%	0.44%	0.24%	1.08%	0.51%	0.00%	6.71%	3.09%	2.44%		0.02%	1.31%
Knox	0.16%	74.05%	11.46%	0.20%	0.10%	0.11%	0.15%	1.14%	0.41%	0.00%	6.31%	2.40%	2.94%		0.01%	0.53%
Pike	0.36%	40.11%	38.73%	0.73%	3.82%	1.77%	0.14%	0.57%	0.25%	0.01%	4.88%	2.12%	5.90%		0.04%	0.58%
Pike	0.36%	40.11%	38.73%	0.73%	3.82%	1.77%	0.14%	0.57%	0.25%	0.01%	4.88%	2.12%	5.90%		0.04%	0.58%
Sullivan	0.07%	58.54%	23.78%	0.33%	1.15%	0.45%	0.05%	0.78%	0.24%	0.01%	5.42%	2.66%	5.68%		0.05%	0.77%
Vigo	0.12%	46.64%	27.18%	0.18%	0.82%	1.84%	0.48%	3.72%	1.19%	0.03%	8.04%	2.33%	6.13%		0.03%	1.24%
Warrick	0.07%	41.59%	32.07%	0.82%	3.33%	1.81%	0.35%	1.86%	0.54%	0.00%	6.32%	2.66%	7.03%		0.05%	1.51%

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
KY	**0.09%**	**35.27%**	**36.07%**	**1.37%**	**2.52%**	**2.75%**	**0.16%**	**0.94%**	**0.35%**	**0.04%**	**4.54%**	**2.24%**	**11.60%**	**0%**	**0.17%**	**1.87%**
Christian	0.02%	30.58%	39.79%	0.08%	3.54%	3.03%	0.21%	1.05%	0.43%	0.06%	4.74%	0.40%	15.94%		0.08%	0.04%
Daviess	0.02%	49.47%	22.47%	0.42%	1.09%	0.78%	0.31%	1.98%	0.73%	0.00%	6.42%	3.16%	11.89%		0.08%	1.17%
Henderson	0.05%	57.03%	16.57%	1.59%	1.17%	0.11%	0.19%	1.52%	0.43%		5.83%	5.91%	6.98%		0.04%	2.58%
Hopkins	0.23%	25.67%	42.97%	3.98%	5.14%	3.68%	0.15%	0.90%	0.34%	0.01%	3.61%	1.40%	8.54%		0.08%	3.30%
Muhlenberg	0.15%	13.90%	48.63%	2.54%	4.49%	6.61%	0.10%	0.65%	0.31%	0.16%	4.01%	1.94%	14.09%		0.13%	2.30%
Ohio	0.17%	18.13%	54.58%	0.68%	0.82%	4.40%	0.05%	0.40%	0.12%	0.05%	3.84%	1.23%	13.06%		0.75%	1.72%
Union	0.00%	60.80%	15.79%	0.79%	0.70%	0.34%	0.11%	0.45%	0.17%		4.01%	4.90%	9.07%		0.03%	2.85%
Webster	0.05%	45.06%	33.41%	1.09%	2.07%	1.19%	0.14%	0.44%	0.23%		3.79%	0.62%	9.72%		0.05%	2.13%
REGION AVG.	**0.09%**	**48.22%**	**25.88%**	**0.55%**	**1.10%**	**1.46%**	**0.18%**	**2.09%**	**0.53%**	**0.03%**	**5.34%**	**2.21%**	**10.92%**	**0%**	**0.06%**	**1.33%**

Northern Rocky Mountains and Great Plains Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
CO	**0.48%**	**8.47%**	**11.78%**	**0.15%**	**14.18%**	**5.86%**	**0.12%**	**0.68%**	**0.33%**	**0.88%**	**1.00%**	**0.33%**	**3.02%**	**0%**	**52.08%**	**0.63%**
Adams	0.07%	57.02%	0.14%	0.48%	0.02%	26.62%	0.82%	3.86%	2.16%	0.00%	4.26%	0.71%	2.71%		0.18%	0.95%
Moffat	0.61%	0.36%	4.91%	0.03%	12.91%	0.73%	0.00%	0.13%	0.02%	0.15%	0.44%	0.24%	1.63%		77.68%	0.16%
Routt	0.44%	0.28%	31.37%	0.22%	23.84%	5.69%	0.01%	0.19%	0.04%	2.80%	0.47%	0.31%	5.95%		26.96%	1.41%
MT	**0.39%**	**12.38%**	**0.28%**	**0.49%**	**12.11%**	**51.72%**	**0.01%**	**0.26%**	**0.07%**	**0.10%**	**0.77%**	**0.32%**	**1.26%**	**0%**	**17.96%**	**1.88%**
Big Horn	0.28%	7.31%	0.64%	0.58%	11.29%	41.32%	0.00%	0.21%	0.05%		0.61%	0.25%	1.31%		33.02%	3.13%
Cascade	0.12%	21.13%	0.03%	0.14%	17.39%	43.23%	0.06%	0.70%	0.34%	0.38%	1.04%	0.40%	2.09%		11.61%	1.34%
Judith Basin	0.50%	19.83%	0.03%	0.64%	23.75%	43.19%	0.00%	0.17%	0.01%	0.30%	0.68%	0.04%	3.07%		6.75%	1.03%
Musselshell	0.17%	8.37%		0.09%	15.38%	62.98%	0.00%	0.11%	0.01%		0.33%	0.01%	0.75%		10.65%	1.14%
Richland	0.96%	31.48%	0.79%	1.14%	0.21%	57.87%	0.00%	0.31%	0.03%	0.38%	2.00%	1.17%	0.59%		1.33%	2.03%
Rosebud	0.46%	3.63%	0.04%	0.40%	9.54%	62.99%	0.00%	0.14%	0.02%		0.48%	0.22%	0.56%		20.03%	1.46%
ND	**0.28%**	**38.57%**	**1.71%**	**2.98%**	**0.01%**	**34.00%**	**0.00%**	**0.24%**	**0.03%**	**0.01%**	**3.49%**	**8.50%**	**8.07%**	**0%**	**0.10%**	**2.02%**
McLean	0.30%	46.59%	0.80%	4.72%	0.00%	23.51%	0.00%	0.22%	0.02%	0.00%	3.80%	11.53%	7.23%		0.01%	1.27%
Mercer	0.31%	27.31%	3.19%	0.50%	0.03%	48.48%	0.02%	0.34%	0.06%	0.03%	2.89%	6.64%	7.45%		0.26%	2.49%
Oliver	0.18%	29.82%	2.36%	1.11%	0.02%	45.78%	0.00%	0.12%	0.02%	0.02%	3.37%	1.55%	11.72%		0.17%	3.76%
WY	**1.04%**	**0.25%**	**0.73%**	**0.62%**	**6.97%**	**22.64%**	**0.00%**	**0.14%**	**0.05%**	**0.10%**	**0.43%**	**0.30%**	**1.15%**	**0.00%**	**65.02%**	**0.55%**
Campbell	1.19%	0.61%	0.01%	0.29%	2.13%	65.81%	0.01%	0.11%	0.11%		0.42%	0.02%	0.15%		28.87%	0.27%
Carbon	0.39%	0.02%	2.09%	1.05%	11.16%	9.19%	0.00%	0.11%	0.02%	0.17%	0.51%	0.43%	2.26%		71.76%	0.83%
Converse	1.25%	0.70%	0.11%	0.62%	7.15%	54.21%	0.00%	0.07%	0.01%		0.43%	0.09%	0.51%		33.92%	0.91%
Lincoln	1.01%	0.41%	1.29%	1.03%	21.39%	11.73%		0.22%	0.02%	0.40%	0.54%	0.30%	2.86%	0.00%	57.89%	0.89%
Sweetwater	1.37%	0.01%	0.04%	0.29%	0.30%	4.59%	0.01%	0.18%	0.06%	0.00%	0.35%	0.43%	0.36%		91.84%	0.18%
REGION AVG.	**0.72%**	**7.44%**	**2.13%**	**0.67%**	**8.99%**	**29.76%**	**0.02%**	**0.25%**	**0.09%**	**0.20%**	**0.81%**	**0.85%**	**1.89%**	**0.00%**	**45.12%**	**1.05%**

Western Interior Land Use

State/County	Barren Land (Rock-Sand-Clay) (%)	Cultivated Crops (%)	Deciduous Forest (%)	Emergent Herbaceous Wetlands (%)	Evergreen Forest (%)	Grasslands/Herbaceous (%)	High Intensity Urban (%)	Low Intensity Urban (%)	Medium Intensity Urban (%)	Mixed Forest (%)	Open Space (%)	Open Water (%)	Pasture/Hay (%)	Perennial Ice/Snow (%)	Shrub/Scrub (%)	Woody Wetlands (%)
AR	**0.14%**	**0.97%**	**30.70%**	**0.23%**	**8.66%**	**10.19%**	**0.55%**	**4.55%**	**1.42%**	**6.61%**	**5.21%**	**2.17%**	**24.83%**	**0%**	**2.65%**	**1.13%**
Sebastian	0.14%	0.97%	30.70%	0.23%	8.66%	10.19%	0.55%	4.55%	1.42%	6.61%	5.21%	2.17%	24.83%	0%	2.65%	1.13%
KS	**0.06%**	**17.15%**	**17.26%**	**0.15%**	**0.04%**	**6.26%**	**0.04%**	**0.89%**	**0.13%**	**0.90%**	**4.16%**	**1.44%**	**49.60%**	**0%**	**0.19%**	**1.72%**
Bourbon	0.04%	14.67%	15.36%	0.02%	0.02%	0.02%	0.04%	0.87%	0.16%	0.95%	3.99%	0.87%	52.84%		0.08%	0.47%
Linn	0.07%	19.78%	19.26%	0.29%	0.06%	0.06%	0.03%	0.92%	0.10%	0.85%	4.33%	2.04%	46.19%		0.32%	3.04%
MO	**0.10%**	**31.37%**	**9.92%**	**0.40%**	**0.01%**	**0.69%**	**0.02%**	**0.65%**	**0.08%**	**0.02%**	**3.97%**	**1.00%**	**46.57%**	**0%**	**0.21%**	**4.97%**
Bates	0.10%	31.37%	9.92%	0.40%	0.01%	0.69%	0.02%	0.65%	0.08%	0.02%	3.97%	1.00%	46.57%	0%	0.21%	4.97%
OK	**0.12%**	**1.81%**	**26.70%**	**0.07%**	**9.60%**	**13.74%**	**0.09%**	**0.67%**	**0.20%**	**3.08%**	**4.42%**	**2.82%**	**35.40%**	**0%**	**0.60%**	**0.68%**
Craig	0.02%	4.06%	13.30%	0.01%	0.14%	16.16%	0.05%	0.48%	0.10%	0.01%	4.26%	0.41%	60.86%		0.06%	0.10%
Haskell	0.50%	0.47%	25.87%	0.19%	3.66%	7.79%	0.02%	0.35%	0.05%	3.79%	2.60%	7.66%	43.55%		1.74%	1.76%
Le Flore	0.12%	0.82%	30.67%	0.03%	24.56%	5.57%	0.03%	0.54%	0.08%	6.92%	3.66%	1.55%	23.40%		0.93%	1.12%
Okmulgee	0.00%	2.26%	36.57%	0.12%	0.08%	24.13%	0.10%	0.66%	0.25%		5.61%	1.11%	29.09%			0.02%
Rogers	0.01%	2.43%	22.79%	0.08%	0.11%	24.68%	0.30%	1.46%	0.63%		6.77%	5.78%	34.96%			0.00%
REGION AVG.	**0.11%**	**7.99%**	**23.34%**	**0.14%**	**6.70%**	**10.58%**	**0.11%**	**1.01%**	**0.27%**	**2.60%**	**4.38%**	**2.31%**	**38.41%**	**0%**	**0.64%**	**1.41%**

Appendix H
WETLAND TYPE AND ACREAGE IN THE U.S.

Table H-1
Summary of Wetland Types and Acreage Found in Coal-Producing Regions of the U.S.

Coal-Producing Region	Wetland Type	Estimated Total Acres
Appalachian Basin	Freshwater Emergent Wetland	51,404
	Freshwater Forested/Shrub Wetlands	258,955
	Freshwater Pond	112,565
	Lake	153,058
	Other	638
	Riverine	149,995
	Total Wetland Acres	**726,615**
	Coal Basin Total Acres	**39,170,512**
	Percent Wetland	**1.86**
Colorado Plateau (Partial Data in CO and UT)	Freshwater Emergent Wetland	9,350
	Freshwater Forested/Shrub Wetland	4,061
	Freshwater Pond	6,412
	Lake	9,470
	Other	184
	Riverine	40,701
	Total Wetland Acres	70,178
	Coal Basin Total Acres	11,305,900
	Percent Wetland	0.62
Gulf Coast (Partial Data in LA)	Freshwater Emergent Wetland	158,048
	Freshwater Forested/Shrub Wetland	2,300,309
	Freshwater Pond	277,500
	Lake	592,865
	Other	156

Coal-Producing Region	Wetland Type	Estimated Total Acres
	Riverine	121,099
	Total Wetland Acres	**3,449,977**
	Coal Basin Total Acres	**51,769,900**
	Percent Wetland	**6.66**
Illinois Basin	Freshwater Emergent Wetland	93,816
	Freshwater Forested/Shrub Wetland	721,885
	Freshwater Pond	166,416
	Lake	267,141
	Other	1,052
	Riverine	72,232
	Total Wetland Acres	**1,322,542**
	Coal Basin Total Acres	**30,703,801**
	Percent Wetland	**4.31**
Northern Rocky Mountain and Great Plains (Partial Data in CO, MT, UT)	Freshwater Emergent Wetland	542,046
	Freshwater Forested/Shrub Wetland	16,970
	Freshwater Pond	76,174
	Lake	547,684
	Other	2,709
	Riverine	58,006
	Total Wetland Acres	**1,243,589**

Coal-Producing Region	Wetland Type	Estimated Total Acres
	Coal Basin Total Acres	**43,069,200**
	Percent Wetland	**2.89**
Northwest (Partial Data in AK)	Estuarine and Marine Deep Water	6,332
	Estuarine and Marine Wetland	10,074
	Freshwater Emergent Wetland	29,281
	Freshwater Forested/Shrub Wetland	96,279
	Freshwater Pond	2,732
	Lake	5,709
	Other	39
	Riverine	8,416
	Total Wetland Acres	**158,862**
	Coal Basin Total Acres	**1,254,818**
	Percent Wetland	**12.66**
Western Interior	Freshwater Emergent Wetland	198,534
	Freshwater Forested/Shrub Wetland	638,347
	Freshwater Pond	306,955
	Lake	384,274
	Other	743
	Riverine	134,419
	Total Wetland Acres	**1,663,272**
	Coal Basin Total Acres	**41,996,200**
	Percent Wetland	**3.96**

Appendix I
Recreation in the U.S.

Table I-1
2008 U.S. National Park Visitation in Coal Mining States

State	Park Visitations (1,000)
AK	2,404
AL	789
AR	2,873
AZ	10,681
CO	5,384
IL	335
IN	2,094
KY	1,709
KS	86
LA	431
MD	3,545
MO	3,436
MS	5,899
MT	3,822
ND	553
NM	1,557
OH	3,121
OK	1,245
PA	9,189
TN	7,734
TX	5,804
UT	8,451
VA	22,543
WV	1,813
WY	5,572

Source: U.S. Census Bureau, 2010b

Table I-2
Economic Contributions and Impacts of Tourism in the United States

State	Tourism and Travel Impact[1]	Tourism and Travel Impact[1]	Food Service and Accommodations Impact[2]	Food Service and Accommodations Impact[2]	Food Service and Accommodations Impact[2]
	Economic contributions (mil. dol.)	Jobs Supported (1,000)	Jobs Supported (1,000)	Payroll (mil. dol.)	Per Capita Expenditure
AK	$2,200	25.9	24	$521	$769.20
AL	$8,200	76.7	152	$1,706	$371.06
AR	$6,000	58.9	90	$960	$341.02
AZ	$15,900	151.4	254	$3,539	$571.54
CO	$15,600	141.9	229	$3,327	$699.97
IL	$31,700	292.0	457	$6,762	$531.69
IN	$9,900	96.0	254	$3,097	$491.46
KY	$7,900	84.5	150	$1,761	$417.36
KS	$6,300	56.5	106	$1,185	$430.02
LA	$9,900	102.8	166	$2,266	$534.39
MD	$14,500	115.1	194	$2,896	$517.34
MO	$12,200	117.5	240	$3,049	$520.17
MS	$5,800	83.2	112	$1,575	$543.64
MT	$3,700	29.2	45	$523	$552.72
ND	$2,600	24.6	29	$314	$493.11
NM	$6,400	55.8	81	$1,042	$536.39
OH	$16,200	164.7	441	$5,011	$436.02
OK	$6,900	78.4	128	$1,377	$385.25
PA	$22,800	208.3	411	$5,420	$434.60
TN	$15,300	143.8	232	$2,964	$486.74
TX	$55,100	555.9	851	$11,408	$488.17
UT	$7,000	71.4	91	$1,115	$431.55
VA	$20,900	211.9	299	$4,239	$554.34
WV	$2,800	27.7	60	$689	$381.25
WY	$2,900	28.9	26	$414	$807.27

Sources:
[1] U.S. Travel Association, 2013
[2] U.S. Census Bureau, 2006

Table I–3
2007 U.S. State Park Visitation in Coal Mined States

State	Park Visitations (1,000)	Park Acreage (1,000s)	Revenue Generated ($1,000)
AK	4,977	3,361	$2,791
AL	5,142	48	$22,567
AR	8,399	54	$22,332
AZ	2,348	64	$9,639
CO	11,834	420	$25,811
IL	45,159	486	$6,804
IN	18,043	179	$41,379
KY	7,082	49	$54,983
KS	6,875	33	$5,998
LA	1,679	43	$7,669
MD	11,330	133	$16,694
MO	15,142	204	$8,095
MS	1,212	24	$8,926
MT	5,333	55	$4,952
ND	879	18	$1,585
NM	4,604	93	$3,904
OH	49,659	174	$27,530
OK	13,485	72	$36,368
PA	33,210	292	$17,176
TN	32,264	174	$37,770
TX	7,142	602	$38,172
UT	4,554	151	$10,694
VA	7,040	68	$14,214
WV	7,324	177	$20,390
WY	2,511	122	$1,371

Source: The National Association of State Park Directors, 2009

Table I–4
Acreages of National Forests - Appalachian Basin

Map Key Number	Name	Acres	State
1	Allegheny National Forest	421,324.16	PA
2	Bankhead National Forest	338,703.49	AL
3	Daniel Boone National Forest	1,530,486.22	KY
4	George Washington & Jefferson National Forest	343,018.07	VA
5	Monongahela National Forest	388,208.26	WV
6	Talladega National Forest	44,409.14	AL
7	Wayne National Forest	853,153.18	OH
	Total	**3,919,302.51**	

Coordinate system used: NAD 1983 UTM Zone 17N

Sources: ESRI, 2015

Table I – 5
Acreages of National Parks - Appalachian Basin

Map Key Number	Name	Type	Acres	State
8	Allegheny Portage Railroad	National Historic Site	1,078.23	PA
9	Big South Fork	National River and Recreation Area	116,309.21	KY & TN
10	Chickamauga and Chattanooga	National Military Park	8,960.38	TN
11	Cumberland Gap	National Historical Park	24,344.95	KY, VA, TN
12	Cuyahoga Valley	National Park	19,018.09	OH
13	First Ladies	National Historic Site	0.46	OH
14	Fort Necessity	National Battlefield	894.47	PA
15	Friendship Hill	National Historic Site	661.44	PA
16	Gauley River	National Recreation Area	4,421.72	WV
17	Johnstown Flood	National Memorial	166.12	PA
18	Little River Canyon	National Preserve	11,001.72	AL
19	New River Gorge	National River	53,589.05	WV
20	Obed	Wild and Scenic River	2,632.18	TN
22	Russell Cave	National Monument	310.45	AL
23	Steamtown	National Historic Site	51.29	PA
	Total		**243,439.76**	

Coordinate system used: NAD 1983 UTM Zone 17N

Source: ESRI, 2015

Table I–6
Acreages of State Parks and Forests - Appalachian Basin

Map Key Number	Name	Total Acres	State
24	Anawalt Public Fishing Area	4,179.17	WV
25	Archibald Pothole State Park	7.56	PA
26	Audra State Park	328.38	WV
27	Babcock State Park	2,802.98	WV
28	Beaver Creek State Park	2,349.02	OH
29	Beech Fork State Park	2,438.09	WV
30	Bendigo State Park	96.09	PA
31	Berwind Lake Public Park Area	31,737.01	WV
32	Black Moshannon State Park	2,289.17	PA
33	Blackwater Falls State Park	1,642.15	WV
34	Bledsoe State Forest	9,400.49	TN
35	Blennerhassett State Park	465.70	WV
36	Blue Rock State Forest	4,648.16	OH
37	Blue Rock State Park	308.06	OH
38	Booker T Washington State Park	4.72	WV
39	Breaks Interstate Park	3,102.80	VA
40	Buckhorn Lake State Resort Park	551.40	KY
41	Bucks Pocket State Park	929.73	AL
42	Bucktail State Park Natural Area	364.10	PA
43	Burr Oak State Park	3,318.67	OH
44	Bushy Run Battlefield State Park	553.76	PA
45	Canaan Valley Resort State Park	162.81	WV
46	Carnifex Ferry State Park	298.84	WV
47	Carroll Co Veterans Park	8.30	OH
48	Carter Caves State Resort Park	667.40	KY
49	Cedar Creek State Park	2,009.70	WV
50	Cherry Springs State Park	394.06	PA
51	Chief Logan State Park	2,944.47	WV
52	Clear Creek State Park	1,196.16	PA
53	Cook Forest State Park	7,479.19	PA
54	Cove Lake State Ark	79.45	TN

Table I–6
Acreages of State Parks and Forests - Appalachian Basin

Map Key Number	Name	Total Acres	State
55	Crichton McCormick Park	48.29	PA
56	Crooked Creek State Park	12,182.13	PA
57	Cumberland Falls St Resort Park	1,346.56	KY
59	Cumberland Mountain State Park	1,465.16	TN
60	Dans Mountain State Park	506.65	MD
61	De Soto State Park	2,120.38	AL
62	Deep Creek State Park	90.71	MD
63	Denton Hill State Park	168.81	PA
64	Dillon State Park	2,572.29	OH
65	Eagle Creek St Nature Preserve	148.86	OH
66	Elk State Park	1,146.54	PA
67	Elliott State Park	389.68	PA
68	Fall Creek Falls State Park	15,065.07	TN
69	Flint Ridge State Memorial	446.23	OH
70	Forbes State Forest	3,954.73	PA
71	Forked Run State Park	847.50	OH
72	Franklin Marion State Forest	5,901.11	TN
73	Frozen Head State Park	8,352.94	TN
74	Gallitzin State Forest	20,125.28	PA
75	Grayson Lake State Park	1,723.40	KY
76	Grayson Lake State Park	1,867.29	KY
77	Greenbo Lake State Resort Park	3,700.56	KY
78	Grundy State Forest	216.64	TN
79	Guilford State Park	465.60	OH
80	Hawks Nest State Park	222.62	WV
81	Hillman State Park	7,064.00	PA
82	Hocking Hills State Park	2,889.09	OH
83	Holly River State Park	9,561.67	WV
84	Indian Mountain State Forest	435.56	TN
85	Indian Mountain State Park	434.50	TN
86	Jackson Lake State Park	406.73	OH
87	Jefferson Lake State Park	1,119.02	OH

Table I–6
Acreages of State Parks and Forests - Appalachian Basin

Map Key Number	Name	Total Acres	State
88	Jenny Wiley State Resort Park	1,711.03	KY
89	Kanawha State Forest	9,904.67	WV
90	Kettle Creek State Park	1,163.46	PA
91	Keystone State Park	1,197.88	PA
92	Kingdom Come State Park	967.40	KY
93	Kinzua Bridge State Park	318.27	PA
94	Kooser State Park	178.38	PA
95	Kumbrabow State Forest	3,855.73	WV
96	Lackawanna State Forest	313.70	PA
97	Lake Alma State Park	245.19	OH
98	Lake Barkcamp State Park	1,159.90	OH
99	Lake Guntersville State Park	1,134.26	AL
100	Lake Hope State Park	2,735.84	OH
101	Lake Lurleen State Park	1,448.89	AL
102	Lake Milton State Park	571.01	OH
103	Laurel Hill State Park	4,272.23	PA
104	Laurel Mountain State Park	494.79	PA
105	Laurel Ridge State Park	11,361.72	PA
106	Levi Jackson Wilderness State	693.01	KY
107	Linn Run State Park	558.30	PA
108	Little Beaver State Park	383.53	WV
109	Locust Lake State Park	716.78	PA
110	Lyman Run State Park	321.74	PA
111	Maurice Goddard State Park	1,546.49	PA
112	McConnells Mill	1,601.35	PA
113	Mohican State Park	127.59	OH
114	Mont Chateau State Park	285.51	WV
115	Moraine State Park	15,475.98	PA
116	Muskingum River State Park	22.54	OH
117	Nescopeck State Park	1,251.31	PA
118	North Bend State Park	1,295.24	WV
119	Oak Mountain State Park	1,655.09	AL

Table I–6
Acreages of State Parks and Forests - Appalachian Basin

Map Key Number	Name	Total Acres	State
120	Ohiopyle State Park	18,000.68	PA
121	Oil Creek State Park	685.71	PA
122	Parker Dam State Park	890.80	PA
123	Pickett State Park	84,610.54	TN
124	Pine Mountain State Resort Park	182.57	KY
125	Pinnacle Rock State Park	206.14	WV
126	Point State Park	34.82	PA
127	Portage Lakes State Park	1,585.58	OH
128	Potomac State Forest	2,438.56	MD
129	Prentice Cooper State Forest	1,367.94	TN
130	Pricketts Fort State Park	199.24	WV
131	Prince Gallitzin State Park	5,594.71	PA
132	Prouty Place State Park	103.08	PA
133	Quail Hollow State Park	44.97	OH
134	Raccoon Creek State Park	7,454.73	PA
135	Rickwood Caverns State Park	373.16	AL
136	Ryerson Station State Park	1,069.35	PA
137	Salt Fork State Park	21,031.79	OH
138	Savage River State Forest	1,163.13	MD
139	Scott State Forest	2,905.21	TN
140	Sinnemahoning State Park	696.73	PA
141	South Cumberland State Park	6,264.82	TN
142	State Game Land	1,117.57	PA
143	State Game Land NO 29	3,052.20	PA
144	State Game Lands	588.65	PA
145	State Game Lands NO 228	9,695.02	PA
146	State Game Lands NO 62	619.01	PA
147	Stonewall Jackson State Park	20,693.68	WV
148	Strouds Run State Park	2,590.24	OH
149	Swallow Falls State Park	3,634.78	MD
150	Tinkers Creek State Park	66.38	OH
151	Tomlinson Run State Park	1,337.18	WV

Table I–6
Acreages of State Parks and Forests - Appalachian Basin

Map Key Number	Name	Total Acres	State
152	Tuscarora State Park	728.92	PA
153	Twin Falls Resort State Park	3,751.20	WV
154	Tygart Lake State Park	10,900.18	WV
155	Valley Falls State Park	1,229.31	WV
156	Watters Smith State Park	550.44	WV
157	Weiser State Forest	12.71	PA
158	Wellston Wildlife Area	1,396.32	OH
159	West Branch State Park	8,333.89	OH
160	Wolf Run State Park	1,095.10	OH
161	Worlds End State Park	368.34	PA
162	Wyoming State Forest	3,057.90	PA
163	Yellow Creek State Forest	260.83	OH
164	Yellow Creek State Park	2,715.55	PA
	Total	**497,411.71**	

Coordinate system used: NAD 1983 UTM Zone 17N

Sources: ESRI, 2015

Table I–7
Miles of Wild and Scenic Rivers - Appalachian Basin

Name	Type	Total Miles	State
Allegheny Wild and Scenic River	National Wild and Scenic River USFS	6.85	PA
Clarion Wild and Scenic River	National Wild and Scenic River USFS	50.52	PA
Little Beaver Creek Wild and Scenic River	National Wild and Scenic River NPS	47.15	OH
Obed Wild and Scenic River	National Wild and Scenic River NPS	36.72	TN
Red Wild and Scenic River	National Wild and Scenic River USFS	11.34	KY
Sipsey Fork West Fork Wild and Scenic River	National Wild and Scenic River USFS	13.90	AL
Total		**166.47**	

Coordinate system used: NAD 1983 UTM Zone 17N

Sources: ESRI, 2015

Table I-8
2011 U.S. FWS Outdoor Recreation - Appalachian Basin

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
AL	683	$456,442	535	$913,387	1,114	$734,204
KY*	554	$807,293	347	$797,766	1,319	$773,221
MD	426	$535,232	88	$264,119	1,362	$483,421
OH	1342	$1,794,642	553	$752,996	3,197	$738,806
PA	1101	$485,490	775	$970,598	3,598	$1,270,888
TN	826	$1,137,104	375	$494,0005	1,955	$942,572
VA	833	$1,142,099	432	$877,038	2,509	$958,607
WV	376	$428,646	269	$409,219	850	$325,778
United States, Total	**33,112**	**$41,789,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

*KY crosses more than one coal region. This data is for the entire state.

[1] Participation in angling by both residents and non-residents in location where activity took place (2011)

[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)

[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)

Source: ESRI, 2015

Table I–9
Acreages of National Forests - Colorado Plateau

Map Key Number	Name	Acres	State
1	Apache-Sitgreaves National Forest	44,153.72	AZ
2	Ashley National Forest	214,822.01	UT
3	Carson National Forest	163,035.51	NM
4	Cibola National Forest	259,144.83	NM
5	Dixie National Forest	376,136.06	UT
6	Fishlake National Forest	194,691.94	UT
7	Grand Mesa, Uncompahgre and Gunnison National Forest	914,972.25	CO
8	Lincoln National Forest	27,758.05	NM
9	Manti-LaSal National Forest	710,814.77	UT
10	San Juan National Forest	485,451.11	CO
11	Santa Fe National Forest	137,897.64	NM
12	Uinta National Forest	99,510.96	UT
13	White River National Forest	23,2152.19	CO
	Total	**3,860,541.04**	

Coordinate system used: NAD 1983 UTM Zone 12N

Sources: ESRI, 2015

Table I–10
Acreages of National Parks - Colorado Plateau

Map Key Number	Name	Type	Total Acres	State
14	Aztec Ruins	National Monument	266.78	NM
15	Bryce Canyon	National Park	35,832.58	UT
16	Capitol Reef	National Park	241,234.29	UT
17	Cedar Breaks	National Monument	6,154.60	UT
18	Chaco Culture	National Historic Park	32,840.14	NM
19	Dinosaur	National Monument	203,031.38	UT, CO
20	Glen Canyon	National Recreation Area	1,238,621.99	AZ, UT
21	Hovenweep	National Monument	784.93	UT, CO
22	Mesa Verde	National Park	52,253.39	CO
23	Yucca House	National Monument	33.87	CO
	Total		**1,811,053.95**	

Coordinate system used: NAD 1983 UTM Zone 12N

Source: NPS, 2011 – Land Resources Division

Table I–11
Acreages of State Parks and Forests - Colorado Plateau

Map Key Number	Name	Total Acres	State
24	El Vado State Park	1,223.73	NM
25	Grand Staircase Escalante State Park	531.69	UT
26	Heron Lake State Park	101.09	NM
27	Mancos State Park	877.00	CO
28	Navajo Lake State Park	24,567.40	CO, NM
29	Paonia State Park	2,094.91	CO
30	Red Fleet State Park	1,157.79	UT
31	Rifle Gap State Park	560.84	CO
32	Scofield State Park	4,320.40	UT
33	Starvation State Park	7,223.13	UT
34	Steinaker State Park	42.87	UT
36	Utah Field House of Natural History State Park	34.55	UT
35	Vega State Park	3,083.09	CO
	Total	**45,818.49**	

Coordinate system used: NAD 1983 UTM Zone 12N

Sources: ESRI, 2015

Table I–12
2011 U.S. FWS Outdoor Recreation - Colorado Plateau

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
AZ	637	$755,478	269	$337,759	1,566	$935,880
CO*	767	$648,563	259	$460,914	1,782	$1,432,084
NM	278	$418,249	69	$139,264	566	$327,117
UT	414	$451,259	193	$449,141	717	$585,405
United States, total	**33,112**	**$41,789,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

*CO crosses more than one coal region. This data is for the entire state.

[1] Participation in angling by both residents and non-residents in location where activity took place (2011)

[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)

[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)

Source: ESRI, 2015

Table I–13
Acreages of National Forests - Gulf Coast

Map Key Number	Name	Acres	State
1	Angelina National Forest	301,200.25	TX
2	Bienville National Forest	38,7281.25	MS
3	Conecuh National Forest	173,855.47	AL
4	Davy Crockett National Forest	39,4074.22	TX
5	Delta National Forest	122,074.54	MS
6	Desoto National Forest	288,152.86	MS
7	Holly Springs National Forest	529,799.16	MS
8	Homochitto National Forest	248,146.73	MS
9	Kisatchie National Forest	931,912.79	LA
10	Mark Twain National Forest	6,791.12	MO
11	Ozark-St. Francis National Forest	29,023.00	AR
12	Sabine National Forest	447,231.55	TX
13	Sam Houston National Forest	500,871.84	TX
15	Tombigbee National Forest	54,819.88	MS
	Total	**4,415,234.66**	

Coordinate system used: NAD 1983 UTM Zone 15N

Sources: ESRI, 2015

Table I–14
Acreages of National Parks - Gulf Coast

Map Key Number	Name	Type	Acres	State
17	Arkansas Post	National Memorial	649.91	AR
18	Big Thicket	National Preserve	104,855.19	TX
21	Little Rock Central High School	National Historic Site	2.22	AR
22	Natchez	National Historical Park	85.50	MS
23	Natchez Trace Parkway and National Scenic Trail		46,320.02	MS-TN-AL
24	Poverty Point	National Monument	910.85	LA
25	San Antonio Missions	National Historic Park	390.77	TX
26	Vicksburg	National Military Park	1,747.68	MS
	Total		**154,962.14**	

Coordinate system used: NAD 1983 UTM Zone 15N

Source: NPS, 2011 – Land Resources Division

Table I–15
Acreages of State Parks and Forests - Gulf Coast

Map Key Number	Name	Total Acres	State
27	Alabama Creek Wildlife Management Area	15,043.65	TX
28	Arkabutla State Waterfowl Ref	739.51	MS
29	Atlanta State Park	1,194.01	TX
30	Bannister Wildlife Management Area	21,968.02	TX
31	Bastrop State Park	3,295.45	TX
32	Bentsen-Rio Grande Valley State Park	736.95	TX
33	Big Cypress Tree State Park	420.94	TN
34	Big Oak Tree State Park	1,051.48	MO
35	Bladon Springs State Park	364.71	AL
36	Blue Springs State Park	140.95	AL
37	Brackenridge Plantation Recreational Area	326.00	TX
38	Brushy Creek State Park	1,031.62	TX
39	Buescher State Park	1,629.88	TX
40	Caddo Lake State Park	583.16	TX
41	Cane Creek State Park	2,392.36	AR
42	Carver Point State Park	417.25	MS
43	Chattahoochee State Park	116.33	AL
44	Chemin-A-Haut State Park	432.09	LA
45	Chickasaw State Park	14,495.85	TN
46	Chicot State Park	4,582.17	LA
47	Choke Canyon State Park	1,421.06	TX
48	Choke Canyon State Park	999.70	TX
49	Clarkco State Park	818.70	MS
50	Claude D Kelley State Park	1,981.97	AL
51	Columbus-Belmont St Park	801.13	KY
52	Crowleys Ridge State Park	273.91	AR
53	Daingerfield State Park	610.12	TX
54	Fairchild State Forest	704.17	TX
55	Fairfield Lake State Park	1,702.92	TX
56	Falcon State Park	1,225.87	TX
57	Fannin State Park	10.79	TX

Table I–15
Acreages of State Parks and Forests - Gulf Coast

Map Key Number	Name	Total Acres	State
58	Fireman State Park	26.92	TX
59	Florala State Park	31.45	AL
60	Florewood River Plantation State Park	112.24	MS
61	Fort Boggy State Park	1,438.20	TX
62	Fort Defiance State Park	105.91	IL
63	Fort Massac State Park	2.55	IL
64	Fort Pillow State Park	694.74	TN
65	Frank Jackson State Park	1,713.83	AL
66	Geneva State Forest	9,758.84	AL
67	George Payne Cossar State Park	609.24	MS
68	Golden Memorial State Park	136.40	MS
69	Goliad State Park	278.57	TX
70	Holland Bottoms Wma	4,838.86	AR
71	Holloway Memorial State Park	82.52	AR
72	Holmes County State Park	496.82	MS
73	Hugh White State Park	590.11	MS
74	Huntsville State Park	2,010.49	TX
75	Interstate Park	85.92	AR
76	Jacksonport State Park	102.77	AR
77	Jim Hogg State Park	177.65	TX
78	Jimmie Davis State Park at Caney Lake	283.37	LA
79	John W Kyle State Park	489.54	MS
80	Kirby State Forest	602.08	TX
81	Lake Bistineau State Park	849.62	LA
82	Lake Bob Sandlin State Park	651.09	TX
83	Lake Bruin State Park	150.53	LA
84	Lake Casa Blanca State Park	952.76	TX
85	Lake Charles State Park	42.62	AR
86	Lake Chicot State Park	117.03	AR
87	Lake Claiborne State Park	751.50	LA
88	Lake D Arbonne State Park	706.61	LA
89	Lake Frierson State Park	770.42	AR

Table I–15
Acreages of State Parks and Forests - Gulf Coast

Map Key Number	Name	Total Acres	State
90	Lake Houston State Park	5,065.99	TX
91	Lake Houston State Park	2,545.42	TX
92	Lake Livingston State Park	628.12	TX
93	Lake Poinsett State Park	83.81	AR
94	Lake Somerville State Park	1,931.86	TX
95	Lake Somerville State Park	1,391.82	TX
96	Lake Texana State Park	876.07	TX
97	Lefleurs Bluff State Park	427.38	MS
98	Leroy Percy State Park	2,330.85	MS
99	Lipantitlan State Historic Site	10.70	TX
100	LK Corpus Christi State Park	374.29	TX
101	Logoly State Park	50.83	AR
102	Los Adaes State Historic Site	10.89	LA
103	Louisiana State Park Site 15	174.12	LA
104	Martin Creek Lake State Park	238.33	TX
105	Martin Dies Jr State Park	758.41	TX
106	Meeman-Shelby Forest State Park	11,976.60	TN
107	Mon Hill State Park	2.53	TX
108	Moro Bay State Park	119.49	AR
109	Nanih Waiya State Park	53.23	MS
110	Natchez State Park	3,651.42	MS
111	Old Davidsonville St Park	10.93	AR
112	Old Trace Park	36.20	MS
113	Palestine State Park	65.28	TX
114	Palmetto State Park	351.84	TX
115	Pearl River St Waterfowl Refuge	1,639.99	MS
116	Pearl River St Wildlife Ma	1,741.37	MS
117	Pinson Mounds Arch State Park	1,264.48	TN
118	Poison Springs State Park	18,753.65	AR
119	Purtis Creek State Park	1,565.06	TX
120	Rebel State Historic Site	195.90	LA
121	Reelfoot Lake State Park	81.82	TN

Table I–15
Acreages of State Parks and Forests - Gulf Coast

Map Key Number	Name	Total Acres	State
122	Roosevelt State Park	571.06	MS
123	Rusk-Palestine State Park	81.10	TX
124	South Toledo Bend State Park	4,010.84	LA
125	State Fish and Game Refuge	636.49	TN
126	Stephen F Austin State Park	726.69	TX
127	T O Fuller State Park	1,035.73	TN
128	Tejas Mission State Park	122.68	TX
129	Toltec Mounds State Park	129.27	AR
130	Towosahgy State Historic Site	63.95	MO
131	Tyler State Park	973.30	TX
132	Village Creek State Park	6,718.93	AR
133	W G Jones State Forest	1,706.14	TX
134	Wall Doxey State Park	865.09	MS
135	Washington-on-the-Brazos State Historic Site	183.96	TX
136	White Oak Lake State Park	215.37	AR
137	Winterville State Park	250.30	MS
138	Yockanookany Roadside Park	36.79	MS
	Total	**187,910.26**	

Table I-16
2011 U.S. FWS Outdoor Recreation - Gulf Coast Region

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
AL	683	$456,442	535	$913,387	1,114	$734,204
AR	555	$495,584	363	$1,018,793	852	$216,074
LA	825	$807,033	277	$564,385	1,010	$542,752
MS	165	$527,740	483	$914,889	781	$342,422
TN	826	$1,137,104	375	$494,005	1,955	$942,572
TX	2,246	$1,540,434	1,147	$1,835,098	4,376	$1,823,758
United States, total	**33,112**	**$41,788,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

[1] Participation in angling by both residents and non-residents in location where activity took place (2011)
[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)
[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)
Source: ESRI, 2015

Table I – 17
Acreages of National Forests Illinois Basin

Map Key Number	Name	Acres	State
1	Hoosier National Forest	221,580.54	IN
2	Shawnee National Forest	464,632.31	IL
	Total	**686,212.85**	

Coordinate system used: NAD 1983 UTM Zone 16N

Sources: ESRI, 2015

Table I – 18
Acreages of National Parks Illinois Basin

Map Key Number	Name	Type	Acres	State
3	George Rogers Clark	National Historical Park	26.17	IN
4	Jefferson National Expansion Memorial	National Memorial	85.46	MO
5	Lincoln Boyhood	National Memorial	180.81	IN
6	Lincoln Home	National Historic Site	12.03	IL
7	Mammoth Cave	National Park	52,003.24	KY
	Total		**52,307.71**	

Coordinate system used: NAD 1983 UTM Zone 16N

Source: NPS, 2011 – Land Resources Division

Table I–19
Acreages of State Parks and Forests - Illinois Basin

Map Key Number	Name	Total Acres	State
1	Angel Mounds State Memorial	394.36	IN
2	Argyle Lake State Park	1,054.84	IL
3	Beall Woods State Park	630.48	IL
4	Beaver Dam State Park	710.19	IL
5	Ben Hawes State Park	296.18	KY
6	Clinton Lake State Recreational Area	5,915.41	IL
7	Eagle Creek State Park	1,730.31	IL
8	Ferne Clyffe State Park	1,051.50	IL
9	Fox Ridge State Park	1,265.40	IL
10	Gebhard Woods State Park	34.85	IL
11	Giant City State Park	3,017.44	IL
12	Goose Lake Prairie State Park	1,807.95	IL
13	Harmonie State Park	3,907.37	IN
14	Hazlet State Park	1,896.53	IL
15	Hennepin Canal Parkway State Park	3,453.44	IL
16	Hidden Springs State Forest	1,121.13	IL
17	Illinois State Park	297.43	IL
18	John J Audubon State Park GC	115.36	KY
19	John James Audubon State Park	499.10	KY
20	Johnson Sauk Trail State Park	1,308.33	IL
21	Jubilee College State Park	3,376.58	IL
22	Kaskaskia River Wildlife Area	428.72	IL
23	Kickapoo State Park	3,296.21	IL
24	Lake Malone State Park	320.16	KY
25	Lake Murphysboro State Park	947.91	IL
26	Lake Waveland Park	2,507.52	IN
27	Lincoln Log Cabin State Historic Site	83.95	IL
28	Lincoln State Park	543.77	IN
29	Lincoln Trail State Memorial	222.51	IL
30	Lincoln Trail State Park	900.09	IL
31	Lincolns New Salem State Park	1,953.51	IL

Table I–19
Acreages of State Parks and Forests - Illinois Basin

32	Matthiessen State Park	1,793.90	IL
33	Moraine View State Park	1,650.56	IL
34	Pennyrile Forest State Park	1,980.69	KY
35	Pyramid State Park	2,620.07	IL
36	Railsplitter State Park	817.21	IL
37	Ramsey Lake State Park	1,789.03	IL
38	Red Hills State Park	971.68	IL
39	Richard Lieber State Park	3,565.05	IN
40	Sam Parr State Park	1,122.57	IL
41	Sangchris Lake State Park	1,751.10	IL
42	Shades State Park	2,763.20	IN
43	Shakamak State Park	1,413.20	IN
44	Siloam Springs State Park	2,705.61	IL
45	Sloughs Wildlife MGT Area	180.35	KY
46	South Shore State Park	415.69	IL
47	Spitler Woods State Natural Area	204.74	IL
48	Starved Rock State Park	1,261.81	IL
49	Stephen A Forbes State Park	2,468.66	IL
50	Turkey Run State Park	2,682.04	IN
51	Walnut Point State Park	468.81	IL
52	Wayne Fitzgerrell State Park	2,837.92	IL
53	Weinberg-King State Park	777.59	IL
54	Weldon Springs State Park	438.82	IL
55	William G Stratton State Park	92.35	IL
56	Wolf Creek State Park	1,655.44	IL
	Total	**83,516.64**	

Coordinate system used: NAD 1983 UTM Zone 16N
Sources: ESRI, 2015

Table I-20
2011 U.S. FWS Outdoor Recreation - Illinois Basin

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
IL	1,044	$972,729	512	$1,216,281	3,019	$1,306,258
IN	801	$671,840	392	$222,310	1,719	$751,343
KY*	554	$807,293	347	$797,766	1,319	$773,221
United States, total	**33,112**	**$41,788,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

*KY crosses more than one coal region. This data is for the entire state.
[1] Participation in angling by both residents and non-residents in location where activity took place (2011)
[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)
[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)
Source: ESRI, 2015

Table I–21
Acreages of National Forests - Northern Rocky Mountains and Great Plains

Map Key Number	Name	Acres	State
1	Arapaho and Roosevelt National Forest	155,894.01	CO
2	Ashley National Forest	68,411.61	WY
3	Beaverhead National Forest	30,743.03	MT
4	Bighorn National Forest	512.47	WY
7	Bridger-Teton National Forest	804,753.52	WY
9	Carson National Forest	32,931.35	NM
10	Cedar River National Grassland	661.19	ND
11	Custer National Forest	611,607.84	MT
12	Dakota Prairie Grasslands	216,8631.84	ND
13	Flathead National Forest	5,517.49	MT
14	Gallatin National Forest	43,365.05	MT
16	Helena National Forest	5,485.34	MT
17	Lewis And Clark National Forest	12,255.90	MT
18	Little Missouri National Forest	2,088,113.42	ND
19	Lolo National Forest	3,518.43	MT
20	Medicine Bow-Routt National Forest	411,708.62	WY, CO
21	Pawnee National Grassland	211,446.64	CO
22	Pike and San Isabel National Forest	25,588.49	CO
24	Shoshone National Forest	676.84	WY
25	Targhee National Forest	16,539.61	WY
26	Thunder Basin National Grassland	1,250,769.40	WY
27	Wasatch-Cache National Forest	76,691.66	WY, UT
28	White River National Forest	6,481.07	CO
	Total	**8,032,304.80**	

Coordinate system used: NAD 1983 UTM Zone 12N

Sources: ESRI, 2015

Table I–22
Acreages of National Parks - Northern Rocky Mountains and Great Plains

Map Key Number	Name	Type	Acres	State
29	Fort Union Trading Post	National Historic Site	720.60	MT
30	Glacier	National Park	1,012,834.31	MT
31	Grand Teton	National Park	272,751.28	WY
32	Knife River Indian Villages	National Historic Site	1,457.24	ND
34	Theodore Roosevelt	National Park	69,550.88	ND
35	Yellowstone	National Park	2,219,789.13	MT, WY
	Total		**3,577,103.44**	

Coordinate system used: NAD 1983 UTM Zone 12N
Source: NPS, 2011 – Land Resources Division

Table I–23
Acreages of State Parks and Forests - Northern Rocky Mountains and Great Plains

Map Key Number	Name	Total Acres	State
36	Ackley State Park	1,258.41	MT
37	Barr Lake State Park	725.24	CO
38	Bears Paw Battlefield State Park	4,216.33	MT
39	Boysen State Park	12,147.34	WY
40	Castlewood Canyon State Park	905.68	CO
41	Chatfield State Park	3,321.54	CO
42	Cherry Creek State Park	4,714.58	CO
43	Cross Ranch State Park	1,444.08	ND
44	Edness Kimball Wilkins State Park	217.38	WY
45	Fort Abraham Lincoln State Park	4,166.70	ND
46	Fort Abraham Lincoln State Park	1,909.57	ND
47	Fort Abraham Lincoln State Park	54.04	ND
48	Fort Abraham Lincoln State Park	5.74	ND
49	Fort Abraham Lincoln State Park	718.72	ND
51	Fort Abraham Lincoln State Park	1.56	ND
52	Fort Abraham Lincoln State Park	79.66	ND
53	Fort Clark Historic Site	112.14	ND
54	Fort Stevenson State Park	5,412.76	ND
55	Four Bears Park	204.25	ND
56	Giant Springs Heritage State Park	526.02	MT
57	Lake Metigoshie State Park	763.96	ND
58	Lake Sakakawea State Park	6,944.86	ND
59	Lathrop State Park	1,437.19	CO
60	Lewis and Clark State Park	469.09	ND
61	Little Missouri State Park	12,356.85	ND
62	Makoshika State Park	869.84	MT
63	Medicine Rocks State Park	455.83	MT
64	Molander Indian Village State Historic Site	13.61	ND
65	Pirogue Island State Park	238.90	MT
66	Ramah Reservoir State Wildlife Area	351.64	CO
67	Rosebud Battlefield State Park	2,463.31	MT

Table I–23
Acreages of State Parks and Forests - Northern Rocky Mountains and Great Plains

Map Key Number	Name	Total Acres	State
68	Seminoe State Park	19,049.52	WY
69	Sheep Creek Dam State Recreation Area	311.95	ND
70	Sluice Boxes State Park	87.03	MT
71	Steamboat Lake State Park	75.77	CO
72	Sully Creek State Park	442.25	ND
73	Sully Creek State Recreation Area	661.70	ND
74	Tongue River Reservoir State Park	7,875.69	MT
75	Trinidad State Park	3,821.08	CO
76	West Rosebud State Park	253.38	MT
	Total	**101,085.21**	

Coordinate system used: NAD 1983 UTM Zone 12N
Sources: ESRI, 2015

Table I–24
Miles of Wild and Scenic Rivers - Northern Rocky Mountains and Great Plains

Name	Type	Total Miles	State
Clarks Fork of the Yellowstone Wild and Scenic River	National Wild and Scenic River NPS	2.10	WY
Flathead Wild and Scenic River	National Wild and Scenic River NPS/USFS	9.63	MT
Missouri Wild and Scenic River	National Wild and Scenic River BLM	118.55	MT
Snake River Headwaters	N/A	109.58	WY
	Total	**239.87**	

Coordinate system used: NAD 1983 UTM Zone 12N
Sources: ESRI, 2015

Table I-25
2011 U.S. FWS Outdoor Recreation - Northern Rocky Mountains and Great Plains

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
CO*	767	$648,563	259	$460,914	1,782	$1,432,084
MT	267	$339,383	150	$627,298	402	$400,797
ND	1,394	$93,729	753	$129,114	3,227	$22,913
WY	303	$463,814	140	$288,736	518	$350,256
United States, total	**33,112**	**$41,788,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

*CO crosses more than one region. This data is for the entire state.
[1] Participation in angling by both residents and non-residents in location where activity took place (2011)
[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)
[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)
Source: ESRI, 2015

Table I–26
Acreages of National Forests - Northwest

Map Key Number	Name	Acres	State
1	Chugach National Forest	22,745.77	AK
2	Kenai National Wilderness Area	166,496.51	AK
3	Kenai National Wildlife Refuge	372,885.90	AK
	Total	**562,128.19**	**AK**

Coordinate system used: NAD 1983 UTM Zone 10N
Sources: ESRI, 2015

Table I–27
Acreages of National Parks - Northwest

Map Key Number	Name	Type	Acres	State
4	Aniakchak	National Preserve	458,124.00	AK
5	Denali	National Park	4,732,648.56	AK
6	Gates of the Arctic	Park and Wilderness	7,272,902.32	AK
7	Kobuk Valley	National Park	1,713,653.28	AK
8	Yukon-Charley Rivers	National Preserve	2,236,874.98	AK
	Total		**16,414,203.14**	

Coordinate system used: NAD 1983 UTM Zone 10N
Source: NPS, 2011 – Land Resources Division

Table I–28
Acreages of State Parks and Forests - Northwest

Map Key Number	Name	Total Acres	State
9	Denali State Park	1,605.31	AK
	Total	**1,605.31**	

Coordinate system used: NAD 1983 UTM Zone 10N

Sources: ESRI, 2015

Table I-29
2011 U.S. FWS Outdoor Recreation - Northwest

State	Anglers		Hunters		Wildlife-watching Participants	
	Total Participants[1] (1,000s)	Total Expenditures (1,000s)	Total Participants[2] (1,000s)	Total Expenditures (1,000s)	Total Participants[3] (1,000s)	Total Expenditures (1,000s)
AK	538	$639,356	125	$424,803	640	$2,058,355
United States, total	**33,112**	**$41,788,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

[1] Participation in angling by both residents and non-residents in location where activity took place (2011)

[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)

[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)

Source: ESRI, 2015

Table I–30
Acreages of National Forests - Western Interior

Map Key Number	Name	Acres	State
1	Caddo-LBJ Grasslands National Forest	84,131.36	TX
2	Mark Twain National Forest	35,401.02	MO
3	Ouachita National Forest	149,280.72	AR
4	Ozark-St. Francis National Forest	49,639.32	AR
	Total	**318,452.42**	

Coordinate system used: NAD 1983 UTM Zone 15N
Sources: ESRI, 2015

Table I–31
Acreages of National Parks - Western Interior

Map Key Number	Name	Type	Acres	State
5	Big Bend	National Park	775,273.38	TX
6	Brown v. Board of Education	National Historic Site	1.85	KS
7	Fort Scott	National Historic Site	16.69	KS
8	Fort Smith	National Historic Site	31.75	AR
9	Harry S. Truman	National Historic Site	10.49	MO
	Total		**775,334.16**	

Coordinate system used: NAD 1983 UTM Zone 15N
Source: NPS, 2011 – Land Resources Division

Table I–32
Acreages of State Parks and Forests - Western Interior

Map Key Number	Name	Acres	State
38	Knob Noster State Park	3,398.54	MO
39	Lake Dardanelle State Park	332.50	AR
40	Lake Dardanelle State Park	242.65	AR
41	Lake Heyburn State Park	623.85	OK
42	Lake Mineral Wells State Park	2,934.38	TX
43	Lake Murray State Park	2,341.29	OK
44	Lake Wister State Park	985.91	OK
45	Leavenworth County State Park	394.55	KS
46	Lester R Davis Memorial State Forest	81.95	MO
47	Lewis and Clark State Park	341.54	MO
48	Long Branch State Park	1,569.39	MO
49	Massacre Memorial St Park	48.54	KS
50	Miami County State Park	265.38	KS
51	Montgomery County State Park	388.74	KS
52	Mount Magazine State Park	3,332.51	AR
53	Nemaha County State Park	701.75	KS
54	Osage County State Park	504.79	KS
55	Osage State Park	1,279.77	OK
56	Perry State Park	3,026.40	KS
57	Pershing State Park	3,820.06	MO
58	Pershing State Park	488.87	MO
59	Pomona State Park	803.02	KS
60	Poosey State Forest	823.89	MO
61	Possum Kingdom State Park	1,831.82	TX
62	Pottawatomie County State Park Number One	184.00	KS
63	Prairie State Park	2,229.68	MO
64	Robbers Cave State Park	8,133.33	OK
65	Sequoyah State Park	51.02	OK
66	Shawnee County State Park	587.24	KS
67	Shelbina Lakeside Golf Course	63.78	MO
68	Sugar Creek State Forest	2,623.76	MO

Table I–32
Acreages of State Parks and Forests - Western Interior

Map Key Number	Name	Acres	State
69	The Eva Neely Davis Memorial Conservation Area	213.80	MO
70	Thousand Hills State Park	3,164.58	MO
71	Toronto State Park	2,208.47	KS
72	Wallace State Park	403.33	MO
73	Watkins Mill State Park	1,314.97	MO
74	Weston Bend State Park	563.49	MO
75	Will Rogers State Park	494.62	OK
76	Wilson County State Park	208.01	KS
77	Woodson County State Park	285.94	KS
	Total	**166,873.35**	

Coordinate system used: NAD 1983 UTM Zone 15N
Sources: ESRI, 2015

Table I–33
Miles of Wild and Scenic Rivers - Western Interior

Name	Type	Total Miles	State
Big Piney Creek Wild and Scenic River	National Wild and Scenic River USFS	0.78	AR
Mulberry Wild and Scenic River	National Wild and Scenic River USFS	3.39	AR
	Total	**4.17**	

Coordinate system used: NAD 1983 UTM Zone 15N
Sources: ESRI, 2015

Table I-34
2011 U.S. FWS Outdoor Recreation - Western Interior

State	Anglers Total Participants[1] (1,000s)	Anglers Total Expenditures (1,000s)	Hunters Total Participants[2] (1,000s)	Hunters Total Expenditures (1,000s)	Wildlife-watching Total Participants[3] (1,000s)	Wildlife-watching Total Expenditures (1,000s)
AR	555	$495,584	363	$1,018,793	852	$216,074
KS	400	$210,303	283	$401,452	792	$208,415
MO	1071	$657,024	576	$906,888	1,716	$940,818
OK	297	$730,503	244	$355,680	1,263	$474,662
United States, total	**33,112**	**$41,788,936**	**13,674**	**$33,702,017**	**71,776**	**$54,890,272**

[1] Participation in angling by both residents and non-residents in location where activity took place (2011)
[2] Participation in hunting by both residents and non-residents in location where activity took place (2011)
[3] Participation in Wildlife-Associated Recreation by both residents and non-residents (2011)
Source: ESRI, 2015

Appendix J
2005 Groundwater Usage in Coal-Producing Counties

J.1 APPALACHIAN BASIN

Table J-1 Coal-Producing Counties in Alabama, Groundwater Usage in 2005

COUNTY	Public Supply Groundwater Withdrawals Millions of Gallons per Day (MGD)	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
Bibb	4.16	0.13	7.14%	0.00	0.03	0.03	0.00	0.17	0.00	4.52	0.00
Cullman	0.50	0.21	3.21%	0.00	1.11	1.13	0.00	0.04	0.00	2.99	0.00
Fayette	0.05	0.42	40.69%	0.00	0.00	0.09	0.02	0.00	0.00	0.58	0.00
Franklin	1.05	0.33	21.11%	0.00	0.28	0.33	0.00	0.39	0.00	2.38	0.00
Jackson	0.64	0.91	25.58%	0.00	0.04	0.32	0.00	0.07	0.00	1.98	0.00
Jefferson	8.32	0.39	0.92%	0.40	0.09	0.03	0.02	1.93	0.00	11.18	0.00
Marion	0.64	0.92	32.13%	0.00	0.02	0.17	0.00	0.04	0.00	1.79	0.00
Shelby	14.12	0.52	3.51%	0.00	1.94	0.06	0.00	3.90	0.00	20.54	0.00
Tuscaloosa	0.80	0.84	5.90%	0.78	0.38	0.09	0.07	0.00	0.00	2.96	0.00
Walker	0.12	0.54	11.33%	0.00	0.23	0.13	0.02	0.10	0.00	1.14	0.00
Winston	0.00	0.44	35.22%	0.00	0.00	0.22	0.00	0.06	0.00	0.72	0.00
ALABAMA TOTALS	**30.40**	**5.65**		**1.18**	**4.12**	**2.60**	**0.13**	**6.70**	**0.00**	**50.78**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-2 Coal-Producing Counties in Kentucky, Groundwater Usage in 2005

COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
Bell	0.00	0.08	6.76%	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
Breathitt	0.00	0.47	59.35%	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00
Clay	0.00	0.48	42.94%	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.00
Elliott	0.18	0.16	54.80%	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00
Floyd	0.20	0.10	5.00%	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Harlan	0.30	0.42	32.05%	0.00	0.00	0.00	0.13	0.90	0.00	1.75	0.00
Jackson	0.00	0.02	4.21%	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.00
Johnson	0.00	0.41	35.05%	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00
Knott	0.36	0.71	86.07%	0.00	0.00	0.00	0.00	0.78	0.00	1.85	0.00
Knox	0.00	0.53	34.89%	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00
Laurel	0.00	0.13	5.00%	0.00	0.00	0.02	0.00	0.00	0.00	0.15	0.00
Lawrence	0.00	0.51	63.45%	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00
Leslie	0.00	0.28	51.80%	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00
Letcher	0.26	0.72	63.78%	0.00	0.26	0.00	0.00	0.00	0.00	1.24	0.00
Magoffin	0.00	0.11	17.13%	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Martin	0.00	0.19	32.53%	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00
Morgan	0.00	0.30	50.31%	0.00	0.00	0.01	0.00	0.00	0.00	0.31	0.00
Owsley	0.00	0.01	4.13%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Perry	0.00	0.37	30.43%	0.00	0.00	0.00	0.00	0.13	0.00	0.50	0.00
Pike	0.00	1.39	43.76%	0.00	0.00	0.00	0.00	0.58	0.00	1.97	0.00
Whitley	0.00	0.25	14.06%	0.00	0.00	0.00	0.00	0.29	0.00	0.54	0.00
KENTUCKY TOTALS	**1.30**	**7.64**		**0.00**	**0.26**	**0.04**	**0.13**	**2.68**	**0.00**	**12.05**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-3 Coal-Producing Counties in Ohio, Groundwater Usage in 2005

COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
Belmont	6.30	0.25	4.96%	0.00	0.00	0.06	0.00	0.00	3.09	9.70	0.00
Carroll	0.98	1.62	74.84%	0.08	0.00	0.08	0.00	0.00	0.00	2.76	0.00
Columbiana	2.92	3.36	41.20%	0.18	0.06	0.18	0.00	0.00	0.00	6.70	0.00
Coshocton	5.95	1.21	44.58%	6.90	0.39	0.13	0.00	0.33	1.25	16.16	0.00
Harrison	0.23	0.44	37.36%	0.00	0.00	0.05	0.00	0.00	0.00	0.72	0.00
Jackson	0.62	0.45	18.40%	0.00	0.00	0.02	0.00	0.00	0.00	1.09	0.00
Jefferson	3.11	0.60	11.49%	4.28	0.00	0.03	0.00	0.00	2.25	10.27	0.00
Lawrence	3.91	0.15	3.16%	1.16	0.00	0.02	0.00	0.00	0.00	5.24	0.00
Mahoning	0.19	0.58	3.12%	0.00	0.11	0.09	0.00	0.00	0.00	0.97	0.00
Monroe	1.27	0.16	14.38%	1.78	0.27	0.04	0.00	0.00	0.00	3.52	0.00
Muskingum	8.48	0.93	14.73%	1.64	0.00	0.06	0.00	0.29	0.00	11.40	0.00
Noble	0.00	0.26	24.70%	0.00	0.00	0.02	0.00	0.00	0.00	0.28	0.00
Perry	0.17	0.70	26.89%	0.00	0.00	0.03	0.00	0.00	0.00	0.90	0.00
Stark	29.78	6.72	24.01%	6.57	0.60	0.21	0.00	0.49	0.00	44.37	0.00
Tuscarawas	18.82	2.03	29.98%	7.38	0.34	0.22	0.00	0.00	0.00	28.79	0.00
Vinton	0.20	0.59	60.12%	0.00	0.00	0.01	0.00	0.00	0.00	0.80	0.00
OHIO TOTALS	**82.93**	**20.05**		**29.97**	**1.77**	**1.25**	**0.00**	**1.11**	**6.59**	**143.67**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-4 Coal-Producing Counties in Pennsylvania, Groundwater Usage in 2005

COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
Allegheny	0.45	0.00	0.00%	0.69	0.19	0.06	0.00	0.00	0.00	1.39	0.00
Armstrong	0.43	1.40	33.08%	0.06	0.18	0.34	0.00	0.00	0.00	2.41	0.00
Beaver	1.78	0.21	1.99%	4.57	0.08	0.22	0.00	0.00	0.00	6.86	0.00
Bedford	0.78	1.99	66.25%	0.42	0.03	1.19	0.00	0.00	0.00	4.41	0.00
Butler	1.25	4.73	43.28%	0.04	0.13	0.47	0.00	0.00	0.00	6.62	0.00
Cambria	1.97	0.57	6.46%	0.01	0.05	0.27	0.00	0.00	0.00	2.87	0.00
Cameron	0.00	0.11	33.71%	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Centre	16.83	1.53	18.16%	1.73	0.13	0.92	0.00	8.09	0.00	29.23	0.00
Clarion	0.34	1.11	45.62%	0.02	0.04	0.37	0.00	0.01	0.00	1.89	0.00
Clearfield	1.76	0.50	10.00%	0.00	0.03	0.18	0.00	0.00	0.00	2.47	0.00
Columbia	2.59	1.36	34.95%	1.09	0.17	0.38	0.00	0.01	0.00	5.60	0.00
Dauphin	3.13	2.46	16.11%	8.29	0.25	0.59	0.00	2.51	0.00	17.23	0.00
Elk	1.38	0.15	7.43%	0.00	0.02	0.06	0.00	0.00	0.00	1.61	0.00
Fayette	1.25	1.32	15.10%	0.00	0.04	0.44	0.00	0.39	0.39	3.83	0.00
Greene	0.00	0.61	25.59%	0.00	0.00	0.26	0.00	0.00	0.00	0.87	0.00
Huntingdon	0.83	1.18	42.76%	0.00	0.07	0.85	0.00	1.21	0.00	4.14	0.00
Indiana	0.40	2.21	41.45%	0.00	0.14	0.54	0.00	4.15	0.00	7.44	0.00
Jefferson	0.78	1.23	44.97%	0.01	0.01	0.25	2.23	0.00	0.00	4.51	0.00
Lackawanna	0.76	2.08	16.52%	0.03	0.08	0.11	0.00	0.05	0.00	3.11	0.00
Luzerne	3.87	2.77	14.77%	0.09	0.15	0.13	0.00	0.05	0.00	7.06	0.00
Lycoming	1.60	2.43	34.21%	1.16	0.15	0.70	0.10	0.30	0.00	6.44	0.00
Northumberland	0.20	0.66	11.86%	0.36	0.09	0.73	0.00	0.01	0.23	2.28	0.00
Schuykill	3.31	1.47	16.65%	0.56	0.19	0.49	0.15	18.73	2.56	27.46	0.00
Somerset	2.40	1.47	30.98%	0.00	0.08	1.40	0.00	0.54	0.00	5.89	0.00
Tioga	1.55	1.53	61.25%	0.51	0.03	1.10	0.00	0.01	0.00	4.73	0.00
Venango	0.77	0.96	28.61%	0.00	0.10	0.19	0.00	0.00	0.00	2.02	0.00
Washington	0.07	1.91	15.43%	0.00	0.15	0.70	0.00	0.00	0.00	2.83	0.00
Westmoreland	0.53	2.42	10.97%	0.04	0.19	0.59	0.18	0.05	0.00	4.00	0.00

COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
PENNSYLVANIA TOTALS	**51.01**	**40.37**		**19.68**	**2.77**	**13.53**	**2.66**	**36.11**	**3.18**	**169.31**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-5 Coal-Producing Counties in Tennessee, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
TN	Anderson	0.28	0.32	6.14%	0.00	0.05	0.00	0.00	0.09	0.00	0.74	0.00
	Campbell	0.63	0.31	10.72%	0.00	0.05	0.05	0.00	0.15	0.00	1.19	0.00
	Claiborne	0.21	0.55	24.52%	0.00	0.04	0.17	0.00	0.19	0.00	1.16	0.00
	Fentress	0.00	0.11	8.74%	0.00	0.01	0.11	0.00	0.07	0.00	0.30	0.00
TENNESSEE TOTALS		**1.12**	**1.29**		**0.00**	**0.15**	**0.33**	**0.00**	**0.50**	**0.00**	**3.39**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-6 Coal-Producing Counties in Virginia, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
VA	Buchanan	0.00	0.56	30.06%	0.00	0.00	0.00	0.00	0.07	0.00	0.63	0.00
	Dickenson	0.00	0.68	55.76%	0.00	0.00	0.00	0.00	0.02	0.00	0.70	0.00
	Lee	0.35	0.96	54.01%	0.00	0.42	0.03	0.00	0.23	0.00	1.99	0.00
	Russell	0.91	1.22	55.96%	0.01	0.08	0.08	0.00	0.00	0.00	2.30	0.00
	Tazewell	0.07	0.88	26.29%	0.00	0.07	0.06	0.00	0.02	0.00	1.10	0.00
VIRGINIA TOTALS		**1.33**	**4.30**		**0.01**	**0.57**	**0.17**	**0.00**	**0.34**	**0.00**	**6.72**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-7 Coal-Producing Counties in West Virginia, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
WV	Barbour	0.00	0.33	27.12%	0.00	0.00	0.01	0.00	0.02	0.00	0.35	0.01
	Boone	0.02	0.85	41.94%	0.01	0.00	0.00	0.00	0.57	0.00	1.43	0.02
	Brooke	1.84	0.15	7.70%	5.06	0.00	0.01	0.00	0.00	0.00	7.06	0.00
	Clay	0.06	0.49	60.22%	0.01	0.00	0.00	0.00	0.15	0.00	0.70	0.01
	Fayette	0.67	0.64	17.45%	0.05	0.00	0.00	0.00	0.04	0.00	1.39	0.01
	Greenbrier	2.00	1.01	36.78%	0.02	0.00	0.06	0.00	0.05	0.00	3.14	0.00
	Harrison	0.00	0.51	9.58%	0.07	0.00	0.01	0.00	0.08	0.00	0.64	0.03
	Kanawha	0.02	1.10	7.21%	1.22	0.00	0.00	0.00	0.54	0.00	2.84	0.04
	Lincoln	0.00	0.90	50.63%	0.00	0.00	0.00	0.00	0.04	0.00	0.92	0.02

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
	Logan	0.41	0.72	25.23%	0.06	0.00	0.00	0.00	0.44	0.00	1.60	0.03
	McDowell	3.11	0.65	33.51%	0.02	0.00	0.00	0.00	0.53	0.00	4.27	0.04
	Marion	0.06	0.24	5.32%	0.75	0.00	0.00	0.00	0.02	0.00	1.06	0.01
	Marshall	2.84	0.35	12.94%	5.72	0.00	0.02	0.00	0.12	0.00	9.05	0.00
	Mason	2.28	0.44	21.87%	1.29	0.00	0.06	0.00	0.00	0.20	4.27	0.00
	Mineral	0.11	0.60	27.94%	0.02	0.00	0.03	0.00	0.01	0.00	0.77	0.00
	Mingo	0.24	1.12	51.94%	0.06	0.00	0.00	0.00	0.32	0.00	1.71	0.03
	Monongalia	0.00	0.39	5.98%	3.96	0.00	0.01	0.00	0.24	0.00	4.59	0.01
	Nicholas	0.01	0.65	31.37%	0.09	0.00	0.00	0.00	0.25	0.00	1.00	0.00
	Preston	0.68	1.05	44.81%	0.12	0.00	0.05	0.00	0.05	0.00	1.95	0.00
	Raleigh	0.42	0.51	8.19%	0.81	0.00	0.00	0.00	0.11	0.00	1.84	0.01
	Randolph	0.21	0.72	32.03%	0.47	0.00	0.02	7.34	0.05	0.00	8.81	0.00
	Tucker	0.05	0.20	37.12%	0.17	0.00	0.00	0.00	0.03	0.00	0.45	0.00
	Upshur	0.00	0.57	30.23%	0.25	0.00	0.00	0.00	0.02	0.00	0.83	0.01
	Wayne	0.00	0.82	24.66%	0.15	0.00	0.00	0.00	0.25	0.00	1.21	0.01
	Webster	0.00	0.36	46.70%	0.03	0.00	0.00	0.00	0.12	0.00	0.51	0.00
	Wyoming	0.93	0.78	40.30%	0.14	0.00	0.00	0.00	0.43	0.00	2.23	0.05
WEST VIRGINIA TOTALS		**15.96**	**16.15**		**20.55**	**0.00**	**0.28**	**7.34**	**4.48**	**0.20**	**64.62**	**0.34**

Source: USGS, 2010b; Kenny et al., 2009

Table J-8 Coal-Producing Counties in Maryland, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
MD	Allegany	0.34	0.80	13.56%	0.12	0.01	0.02	0.01	0.31	0.00	1.61	0.00
	Garrett	1.10	1.72	71.98%	0.09	0.02	0.17	0.03	0.00	0.00	3.13	0.00
MARYLAND TOTALS		**1.44**	**2.52**		**0.21**	**0.03**	**0.19**	**0.04**	**0.31**	**0.00**	**4.74**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

J.2 COLORADO PLATEAU

Table J-9 Coal-Producing Counties in Arizona, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
AZ	Navajo	11.82	1.27	12.55	12.71	7.10	0.49	6.32	4.26	14.60	58.57	0.00
ARIZONA TOTALS		**11.82**	**1.27**		**12.71**	**7.10**	**0.49**	**6.32**	**4.26**	**14.60**	**58.57**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-10 Coal-Producing Counties in Colorado, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
CO	Delta	0.93	1.93	26.77%	0.00	0.01	0.17	0.00	0.39	0.00	3.43	0.00
	Garfield	1.35	1.15	17.59%	0.00	0.16	0.11	0.02	0.07	0.00	2.86	0.00
	Gunnison	1.83	0.03	2.71%	0.00	0.46	0.02	0.06	0.29	0.00	2.69	0.00
	La Plata	0.90	0.39	9.02%	0.00	1.10	0.06	0.00	0.33	0.00	2.48	0.30
	Montrose	0.07	0.36	5.37%	0.00	0.73	0.18	0.00	0.19	0.00	1.53	0.00
	Rio Blanco	0.60	0.35	23.96%	0.00	3.67	0.06	0.00	9.56	0.00	4.78	9.46
COLORADO TOTALS		**5.68**	**4.21**		**0.00**	**6.13**	**0.60**	**0.08**	**10.83**	**0.00**	**17.77**	**9.76**

Source: USGS, 2010b; Kenny et al., 2009

Table J-11 Coal-Producing Counties in New Mexico, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
NM	McKinley	3.79	2.85	56.69%	0.94	0.00	0.19	0.00	2.43	3.57	13.77	0.00
	San Juan	0.41	1.31	14.77%	0.29	0.00	0.14	0.00	0.00	0.00	2.15	0.00
NEW MEXICO TOTALS		**4.20**	**4.16**		**1.23**	**0.00**	**0.33**	**0.00**	**2.43**	**3.57**	**15.92**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-12 Coal-Producing Counties in Utah, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
UT	Carbon	4.51	0.05	1.08%	0.55	0.09	0.03	0.00	0.24	0.00	5.27	0.20
	Emery	0.42	0.08	0.39%	0.03	0.09	0.01	0.00	0.46	0.00	1.09	0.00
	Sevier	4.69	0.41	10.12%	0.08	11.61	0.42	4.79	0.01	0.00	22.01	0.00
UTAH TOTALS		**9.62**	**0.54**		**0.66**	**11.79**	**0.46**	**4.79**	**0.71**	**0.00**	**28.37**	**0.20**

Source: USGS, 2010b; Kenny et al., 2009

J.3 GULF COAST

Table J-13 Coal-Producing Counties in Louisiana, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
LA	De Soto	1.34	0.62	29.39%	0.10	0.02	0.18	0.03	2.33	0.00	3.53	1.09
	Red River	0.72	0.22	28.70%	0.00	0.73	0.05	0.00	0.16	0.00	1.75	0.13
LOUISIANA TOTALS		**2.06**	**0.84**		**0.10**	**0.75**	**0.23**	**0.03**	**2.49**	**0.00**	**5.28**	**1.22**

Source: USGS, 2010b; Kenny et al., 2009

Table J-14 Coal-Producing Counties in Mississippi, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
MS	Choctaw	0.75	0.17	17.30%	3.82	0.00	0.06	0.01	0.55	0.00	5.36	0.00
MISSISSIPPI TOTALS		**0.75**	**0.17**		**3.82**	**0.00**	**0.06**	**0.01**	**0.55**	**0.00**	**5.36**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-15 Coal-Producing Counties in Texas, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
TX	Atascosa	4.26	2.47	49.75%	0.01	21.05	1.22	0.01	0.67	5.76	34.88	0.57
	Freestone	2.14	0.53	24.61%	0.00	0.00	0.15	0.00	2.64	0.00	2.82	2.64
	Harrison	1.94	0.00	0.00%	0.11	0.11	0.08	0.00	1.10	0.00	2.24	1.10
	Hopkins	1.64	1.79	46.73%	0.00	0.00	2.98	0.00	0.85	0.00	6.47	0.79
	Lee	2.64	0.51	27.05%	0.01	0.52	0.47	0.01	0.23	0.00	4.16	0.23
	Leon	2.04	1.14	60.80%	0.47	0.27	0.09	0.00	0.59	0.00	4.01	0.59
	Panola	1.62	1.62	61.39%	0.00	0.00	2.28	0.00	3.83	0.00	5.90	3.45
	Robertson	2.58	0.88	47.04%	0.02	17.14	0.51	0.00	0.39	4.09	25.22	0.39
	Rusk	4.61	0.58	10.50%	0.01	0.08	0.32	0.00	10.02	0.00	5.76	9.86
	Titus	0.02	1.66	48.99%	0.09	0.00	0.36	0.00	2.96	0.00	2.13	2.96
TEXAS TOTALS		**23.49**	**11.18**		**0.72**	**39.17**	**8.46**	**0.02**	**23.28**	**9.85**	**93.59**	**22.58**

Source: USGS, 2010b; Kenny et al., 2009

J.4 ILLINOIS BASIN

Table J-16 Coal-Producing Counties in Illinois, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
IL	Gallatin	3.80	0.08	13.69%	0.00	12.91	0.07	0.16	0.71	0.00	17.46	0.27
	Jackson	0.06	0.17	3.23%	0.00	0.18	0.28	0.53	0.00	0.04	1.26	0.00
	Macoupin	0.00	0.89	20.18%	0.00	0.04	0.65	0.00	0.00	0.00	1.58	0.00
	Perry	0.04	0.48	23.60%	0.00	0.49	0.20	0.00	0.01	0.00	1.21	0.01
	Randolph	1.55	0.63	21.23%	0.00	0.14	0.34	0.00	0.00	0.00	2.66	0.00
	Saline	0.00	0.32	13.47%	0.00	0.66	0.17	0.00	1.26	0.00	2.06	0.35
	Sangamon	1.48	2.98	17.18%	0.00	1.00	0.36	0.00	0.00	0.00	5.82	0.00
	Vermilion	1.24	0.94	12.68%	2.70	0.05	0.19	0.00	0.15	0.00	5.27	0.00
	Wabash	1.85	0.21	18.46%	0.00	0.30	0.07	0.00	1.52	0.00	2.72	1.23
	White	1.20	0.19	13.77%	0.00	9.49	0.14	0.00	3.44	0.00	11.97	2.49
	Williamson	0.07	1.90	33.26%	0.00	0.00	0.16	0.01	0.03	0.00	2.14	0.03
ILLINOIS TOTALS		**11.29**	**8.79**		**2.70**	**25.26**	**2.63**	**0.70**	**7.12**	**0.04**	**54.15**	**4.38**

Source: USGS, 2010b; Kenny et al., 2009

Table J-17 Coal-Producing Counties in Indiana, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
IN	Daviess	2.94	0.64	27.50%	1.57	0.70	0.82	0.00	0.00	0.00	6.67	0.00
	Dubois	0.00	0.31	10.10%	0.00	0.00	0.87	0.00	0.00	0.00	1.18	0.00
	Gibson	1.84	0.41	16.20%	0.29	0.40	0.17	0.00	1.60	1.98	6.69	0.00
	Knox	4.94	0.50	17.20%	0.05	5.46	0.25	0.00	0.03	0.00	11.23	0.00
	Pike	1.17	0.15	15.30%	0.00	0.00	0.03	0.00	0.00	2.36	3.71	0.00
	Sullivan	1.63	0.31	18.70%	0.00	3.59	0.07	0.00	0.00	2.65	8.25	0.00
	Vigo	10.55	2.05	26.30%	2.99	1.04	0.07	0.00	0.43	1.93	19.06	0.00
	Warrick	3.29	0.35	8.20%	2.91	0.00	0.07	0.00	0.00	0.36	6.98	0.00
INDIANA TOTALS		**26.36**	**4.72**		**7.81**	**11.19**	**2.35**	**0.00**	**2.06**	**9.28**	**63.77**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-18 Coal-Producing Counties in Kentucky, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
KY	Christian	0.00	0.13	5.00%	0.00	0.02	0.04	0.00	0.00	0.00	0.19	0.00
	Daviess	14.10	0.33	7.16%	8.89	0.17	0.02	0.00	0.00	0.00	23.51	0.00
	Henderson	0.00	0.33	16.06%	0.00	0.04	0.01	0.00	0.00	0.00	0.38	0.00
	Hopkins	0.34	0.06	5.00%	0.00	0.00	0.03	0.00	2.03	0.00	2.46	0.00
	Muhlenberg	0.00	0.06	5.00%	0.00	0.00	0.03	0.00	0.00	0.00	0.09	0.00
	Ohio	0.60	0.06	5.86%	0.00	0.00	0.02	0.00	0.00	0.00	0.68	0.00
	Union	0.00	0.04	5.55%	0.00	0.02	0.01	0.00	0.00	0.00	0.07	0.00
	Webster	0.00	0.08	15.65%	0.00	0.00	0.04	0.00	0.06	0.00	0.18	0.00
KENTUCKY TOTALS		**15.04**	**1.09**		**8.89**	**0.25**	**0.20**	**0.00**	**2.09**	**0.00**	**27.56**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

J.5 NORTHERN ROCKY MOUNTAINS AND GREAT PLAINS

Table J-19 Coal-Producing Counties in Colorado, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
CO	Adams	12.24	0.02	0.07%	0.71	2.06	0.17	0.00	0.17	0.01	15.35	0.03
	Moffat	0.06	0.44	28.08%	0.00	9.38	0.20	0.00	0.65	0.00	10.24	0.49
	Routt	0.55	0.78	19.89%	0.00	5.41	0.07	0.02	0.45	0.00	7.28	0.00
COLORADO TOTALS		**12.85**	**1.24**		**0.71**	**16.85**	**0.44**	**0.02**	**1.27**	**0.01**	**32.87**	**0.52**

Source: USGS, 2010b; Kenny et al., 2009

Table J-20 Coal-Producing Counties in Montana, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
MT	Big Horn	0.27	0.52	51.02%	0.01	4.12	1.10	0.00	1.83	0.00	6.02	1.83
	Cascade	1.33	0.79	12.75%	0.01	1.68	0.24	0.82	0.01	0.00	4.87	0.01
	Judith Basin	0.11	0.08	46.31%	0.05	1.57	0.30	0.00	0.01	0.00	2.11	0.01
	Musselshell	0.62	0.18	51.30%	0.05	0.44	0.58	0.00	0.02	0.00	1.87	0.02
	Richland	1.09	0.27	38.32%	0.01	1.67	0.18	0.00	0.00	0.00	3.22	0.00
	Rosebud	0.71	0.09	12.29%	0.08	1.27	0.36	0.00	0.09	0.10	2.70	0.00

MONTANA TOTALS	**4.13**	**1.93**		**0.21**	**10.75**	**2.76**	**0.82**	**1.96**	**0.10**	**20.79**	**1.87**

Source: USGS, 2010b; Kenny et al., 2009

Table J-21 Coal-Producing Counties in North Dakota, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
ND	McLean	0.40	0.19	25.03%	0.00	1.08	0.30	0.00	0.13	0.00	2.10	0.00
	Mercer	0.76	0.12	16.79%	0.00	0.40	0.29	0.00	0.01	0.00	1.58	0.00
	Oliver	0.10	0.07	44.84%	0.26	0.60	0.28	0.00	0.00	0.00	1.31	0.00
NORTH DAKOTA TOTALS		**1.26**	**0.38**		**0.26**	**2.08**	**0.87**	**0.00**	**0.14**	**0.00**	**4.99**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-22 Coal-Producing Counties in Wyoming, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
WY	Campbell	3.66	0.01	0.49%	0.38	1.13	0.57	0.00	54.60	0.35	37.21	23.49
	Carbon	2.46	0.10	8.35%	0.10	1.22	0.23	0.74	3.11	0.00	4.85	3.11
	Converse	2.04	0.31	32.62%	0.06	2.77	0.24	0.00	4.67	0.00	8.41	1.68
	Lincoln	4.81	0.33	27.65%	0.23	3.20	0.10	0.00	0.75	0.00	9.10	0.32
	Sweetwater	0.14	0.00	0.00%	1.24	9.11	0.12	0.00	34.46	0.00	11.56	33.51
WYOMING TOTALS		**13.11**	**0.75**		**2.01**	**17.43**	**1.26**	**0.74**	**97.59**	**0.35**	**71.13**	**62.11**

Source: USGS, 2010b; Kenny et al., 2009

J.6 NORTHWEST

Table J-23 Coal-Producing Counties in Alaska, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
AK	Yukon-Koyukuk Division	0.18	0.02	18.21%	0.01	0.00	0.00	0.00	0.00	0.00	0.21	0.00
ALASKA TOTALS		**0.18**	**0.02**		**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.21**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

J.7 WESTERN INTERIOR

Table J-24 Coal-Producing Counties in Kansas, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
AR	Sebastian	0.2	0.51	4.81%	0.00	0.00	0.23	0.00	0.00	0.00	0.94	0.00
KANSAS TOTALS		**0.00**	**0.01**		**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-25 Coal-Producing Counties in Texas, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
KS	Bourbon	0.00	0.00	0.00%	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00
	Linn	0.00	0.01	2.10%	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
KANSAS TOTALS		**0.00**	**0.01**		**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-26 Coal-Producing Counties in Missouri, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
MO	Bates	0.00	0.04	3.24%	0.00	0.00	0.28	0.00	0.13	0.00	0.45	0.00
MISSOURI TOTALS		**0.00**	**0.04**		**0.00**	**0.00**	**0.28**	**0.00**	**0.13**	**0.00**	**0.45**	**0.00**

Source: USGS, 2010b; Kenny et al., 2009

Table J-27 Coal-Producing Counties in Oklahoma, Groundwater Usage in 2005

STATE	COUNTY	Public Supply Groundwater Withdrawals MGD	Domestic Groundwater Withdrawals MGD	Percent Domestic Groundwater Self Supplied	Industrial Groundwater Withdrawals MGD	Irrigation Groundwater Withdrawals MGD	Livestock Groundwater Withdrawals MGD	Aquaculture Groundwater Withdrawals MGD	Mining Groundwater Withdrawals MGD	Thermo electric Groundwater Withdrawals MGD	Total Fresh Groundwater Withdrawals MGD	Total Saline Groundwater Withdrawals MGD
OK	Craig	0.28	0.07	5.32%	0.00	0.00	0.23	0.00	0.01	0.00	0.58	0.01
	Haskell	0.00	0.45	43.67%	0.00	0.00	0.23	0.00	0.01	0.00	0.68	0.01
	Le Flore	0.16	0.54	12.87%	0.00	0.64	0.99	0.00	0.04	0.00	2.33	0.04
	Okmulgee	0.00	0.00	0.00%	0.00	0.00	0.09	0.00	0.81	0.00	0.09	0.81
	Rogers	0.00	0.47	6.93%	0.00	0.00	0.19	0.00	0.15	0.00	0.66	0.15
OKLAHOMA TOTALS		**0.44**	**1.53**		**0.00**	**0.64**	**1.73**	**0.00**	**1.02**	**0.00**	**4.34**	**1.02**

Source: USGS, 2010b; Kenny et al., 2009