Kayenta Mine Permit (AZ-0001D) Renewal

Environmental Assessment

August 2011

ENVIRONMENTAL ASSESSMENT

Kayenta Mine Permit Renewal
(Navajo County, Arizona)

U.S. Department of the Interior
Office of Surface Mining Reclamation and Enforcement
(Western Region)

August 2011

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ºF	degrees Fahrenheit
ADWR	Arizona Department of Water Resources
af	acre-feet
af/yr	acre-feet per year
AGFD	Arizona Game and Fish Department
AML	Abandoned Mine Land
APS	Arizona Public Service
ASU	Arizona State University
bgs	below ground surface
BIA	Bureau of Indian Affairs
BTCA	best technology currently available
Ca	calcium
CEQ	Council on Environmental Quality
cfs	cubic feet per second
CH_4	methane
CHIA	Cumulative Hydrologic Impact Analysis
CIAA	cumulative impacts analysis area
Cl	chloride
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
D aquifer	Dakota aquifer
dB	decibels
dBA	A-weighted decibels
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
GIS	geographic information system
gpd	gallons per day
gpm	gallons per minute
lux	lumens/m^2
m/s	meters per second
Mg	magnesium
mg/L	milligrams per liter
MMt	million metric tons
mph	miles per hour
MSHA	Mine Safety and Health Act
MSL	mean sea level

MSO	Mexican spotted-owl
N_2O	nitrous oxide
NO_x	nitrous oxides (general)
Na	sodium
N aquifer	Navajo aquifer
National Register	National Register of Historic Places
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NGS	Navajo Generating Station
NNEPA	Navajo Nation Environmental Policy Act
NNEPA	Navajo Nation Environmental Protection Agency
NNDFW	Navajo Nation Department of Fish and Wildlife
NNHP	Navajo Natural Heritage Program
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resource Conservation Service
NTUA	Navajo Tribal Utility Authority
O_3	ozone
OSHA	Occupational Safety and Health Administration
OSM	Office of Surface Mining Reclamation and Enforcement, Western Region
PAC	Protected Activity Center
pm	particulate matter
PWCC	Peabody Western Coal Company
SAR	Sodium Adsorption Rations
SMCRA	Surface Mining Control and Reclamation Act
SO_4	sulfate
TDS	total dissolved solids
tpy	tons per year
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
WACM	Western Alkaline Coal Mining

A. APPLICANT PROVIDED DESCRIPTION OF THE PROPOSED ACTION

The Office of Surface Mining Reclamation and Enforcement, Western Region (OSM) has received an application from Peabody Western Coal Company (PWCC) for the renewal of Permit AZ-0001D. This renewal application addresses mining operations during the period of July 6, 2010, through July 5, 2015, for the Kayenta Mine located in Navajo County, Arizona (Map A-1). This environmental assessment (EA) is being prepared in compliance with the National Environmental Policy Act (NEPA) to analyze and disclose the probable effects of renewing the permit that authorizes mining operations for the Kayenta Mine from July 2010 to July 2015. The Council on Environmental Quality (CEQ) regulations give OSM discretion under 40 CFR 1501.3(b) to prepare an environmental assessment on any action in order to assist the agency in planning and decision making.

This approval would authorize the continuation of ongoing mining operations in coal resource areas N-9, J-19, and J-21 from July 6, 2010 through July 5, 2015. Surface coal mining and reclamation activities are authorized in up to five-year incremental periods to provide an opportunity for OSM to review the mine's compliance with applicable terms and conditions of permits. Federal regulations in accordance with the Surface Mining Control and Reclamation Act (SMCRA) grant a right of successive renewal within the approved boundaries of an existing mining permit.[1] Based on 30 CFR 774.15(c)(1), OSM must approve a complete and accurate application for a permit renewal unless it finds, in writing that at least one of the following criteria exists:

(1) The terms and conditions of the existing permit are not being satisfactorily met;

(2) The present surface coal mining and reclamation operations are not in compliance with the environmental protection standards of the Act and the regulatory program;

(3) The requested renewal substantially jeopardizes the operator's continuing ability to comply with the Act and the regulatory program on existing permit areas;

(4) The operator has not provided evidence of having liability insurance or self-insurance as required in [30 CFR 800.60];

(5) The operator has not provided evidence that any performance bond required to be in effect for the operation will continue in full force and effect for the proposed period of renewal, as well as any additional bond the regulatory authority might require pursuant to subchapter J of [Title 30, Volume 3, Chapter VII of the Code of Federal Regulations]; or

(6) Additional revised or updated information required by the regulatory authority has not been provided by the applicant.

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[1] 30 CFR 773.19(d) & 30 CFR 774.15(a); 30 USC 1256(d)(1).

OSM has determined that PWCC has submitted a complete and accurate application for permit renewal. Consequently, OSM's jurisdiction to deny the renewal request is limited to the criteria listed above. Preliminary review by OSM has not identified that any of the six criteria has been met for denial, and therefore OSM does not have the authority to deny the permit renewal.

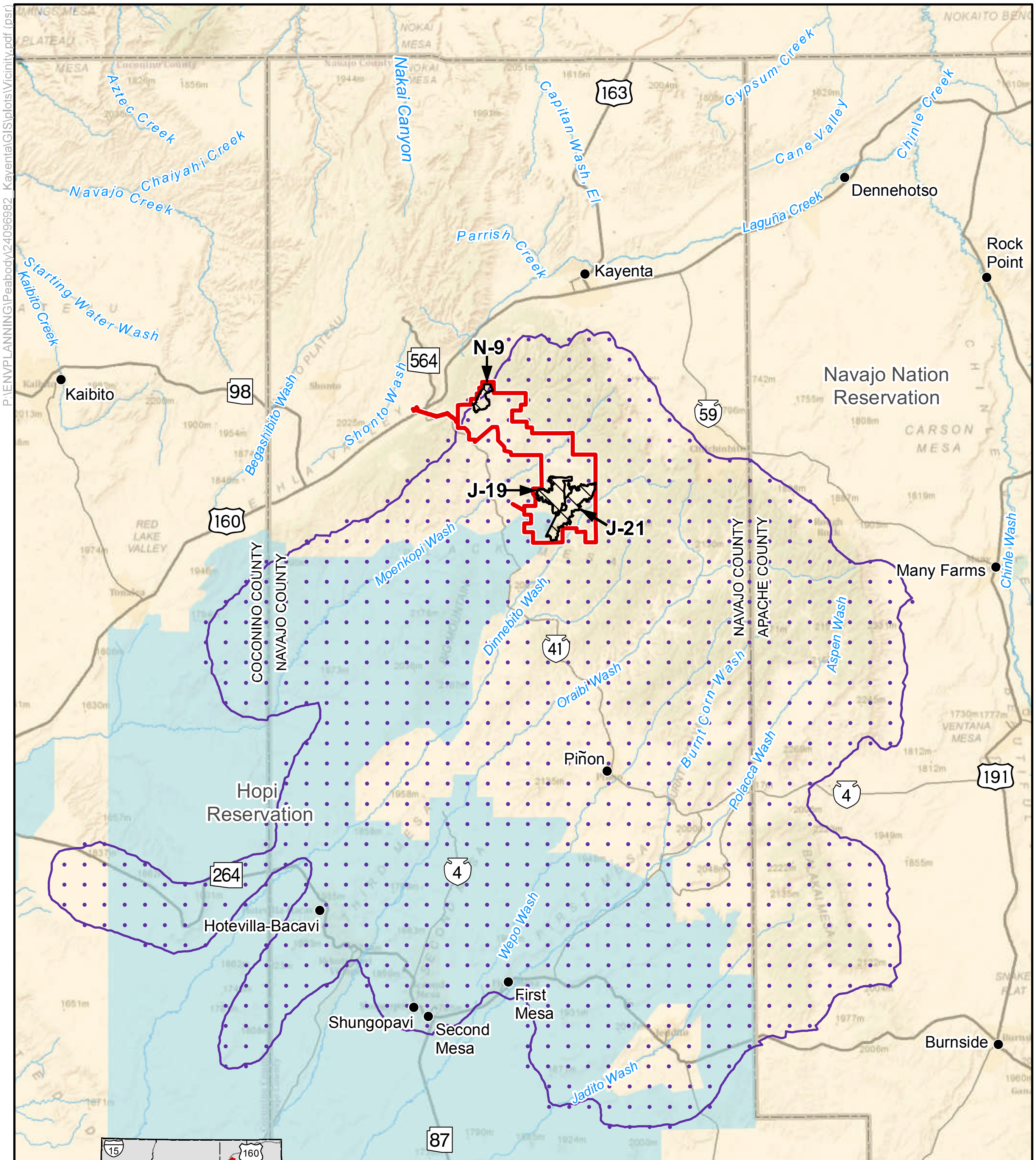
A.1 BACKGROUND INFORMATION

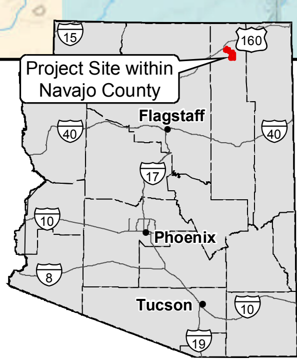
The Kayenta Mine permit area is located on about 44,073 acres of land leased within the boundaries of the Hopi and Navajo Indian Reservations in northern Arizona, near the town of Kayenta, in Navajo County (about 125 miles northeast of Flagstaff, Arizona) (Map A-1). The Kayenta Mine operation produces about 8.2 million tons of coal per year. The coal is delivered by electric railroad 83 miles northwest to the Navajo Generating Station, near Page, in northern Coconino County, Arizona.

PWCC holds leases with the Navajo Nation and Hopi Tribe to mine up to 670 million tons of coal from the Kayenta Mine permit area. Federal authority to mine the leased reserves is only granted for specific coal resource areas at five-year intervals according to a mining and reclamation plan approved by the agency.

PWCC and its predecessor Peabody Coal Company have been conducting mining and reclamation activities within the 44,073-acre permit boundary of the Kayenta Mine since 1973. In 1990, OSM approved a life-of-mine (LOM) mining plan and granted Permit AZ-0001C under the Permanent Indian Lands Program, supported by an Environmental Impact Statement (EIS) (OSM 1990). OSM has renewed Permit AZ-0001C every five years and converted the permit number to AZ-0001D in 1995. OSM approved two revisions of Permit AZ-0001D in 2004 and 2005 to add N-11 Extension and N-9 to the mine plan sequence along with other operational approvals. If approved, the renewed permit will be Permit AZ-0001E. Kayenta Mine Permit AZ-0001D remains the official permit designation for the authorization to operate the mine. Under permit AZ-0001D, PWCC has current approval to mine in coal resource areas N-9, J-19, and J-21 (Map A-2). Reclamation is actively conducted in previously mined areas where the minable coal reserves have been exhausted (see Map D-5).

PWCC timely submitted an application to OSM to renew permit AZ-0001D in February 2010. For the purpose of this mine permit renewal, PWCC proposes to continue mining operations in coal resource areas N-9, J-19, and J-21 from July 6, 2010 through July 5, 2015. The proposed permit renewal does not include any revisions to the mining and operations plan or the addition of any new mining areas. For the proposed five-year renewal period, coal-mining operations are assumed to continue at the recent historical pace and existing facilities will be used for ongoing operations. A number of existing facilities such as temporary and approved permanent sediment- and water-control facilities, topsoil stockpiles, and some of the water wells are located throughout the Kayenta mine permit area and used for ongoing mining operations. The mine facilities are described in more detail in Appendix A. The only new mine facilities that are proposed to be constructed as part of the mining in N-9, J-19, and J-21 under the proposed renewal are sediment ponds, roads, utilities, and topsoil stockpiles as new areas in these three areas are mined.





Legend

- Kayenta Mine Permit Area
- Coal Resource Area
- Black Mesa Coal Field
- Hopi Reservation
- Navajo Nation Reservation
- County Boundary
- City/Town
- Highway
- Road
- Wash or Ephemeral Stream

Source:
Base Map: ALRIS 1997 - 2008, ADOT 2009
Coal Resource: USGS National Atlas 2001
Streams: NHD 2008
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 4 8
Miles

Map A-1

Project Area

Kayenta Mine Permit Renewal EA

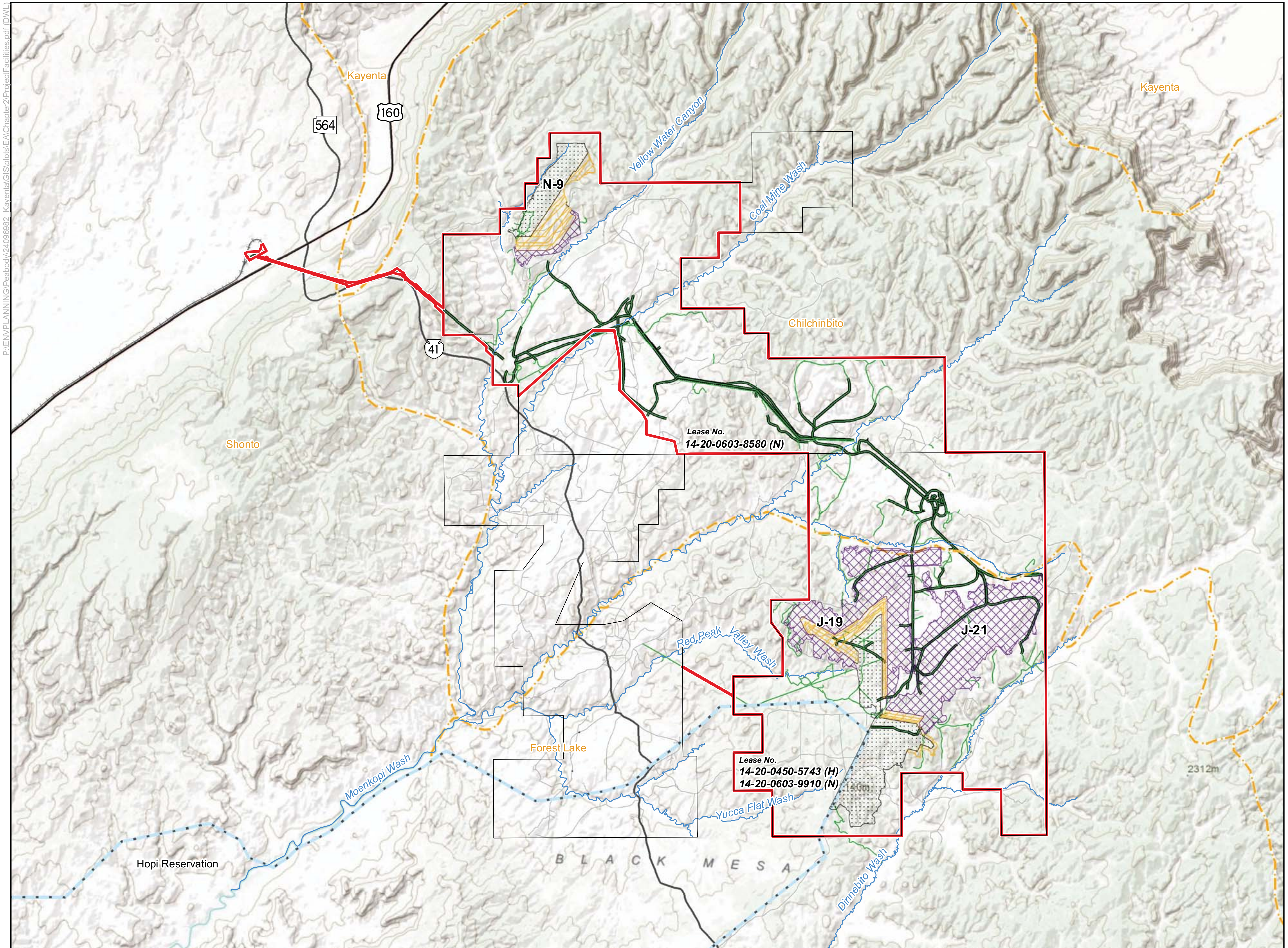
PWCC URS

Facilities necessary for the Kayenta mining operations are located within the PWCC lease area but some are located outside the boundaries of the Kayenta Mine permit area. These facilities include administrative offices and infrastructure; maintenance shops; warehouses; bath houses; empty silos and cap magazines; coal-processing facilities; equipment storage areas; water diversions and culverts; sheds; utilities; fuel-storage and tank farms; environmental monitoring sites; wells; and surface conveyor systems. The mine facilities outside the Kayenta Mine permit area have been separately authorized by OSM as part of the Initial Regulatory Program and are authorized for use in Kayenta mining operations in accordance with SMCRA regulations. This Environmental Assessment includes effects from the use of all mine facilities, within and outside the permit area; to the extent such facilities are necessary to the mining operations that would be authorized by the proposed action.

Table C-1 illustrates the acres of surface disturbance that has occurred in the three coal resource areas subject to the renewal through July 2010. As of July 2010, 20,851 acres within the Kayenta Mine permit area have been disturbed by mining activities. In addition, annual groundwater use for domestic and mine-related purposes from the Navajo aquifer (N aquifer) would average 1,236 acre-feet per year (af/yr), which is 70 percent less than used prior to 2006. Coal-mining techniques and mine reclamation are described in more detail in Appendix A.

B. PURPOSE AND NEED FOR THE PROPOSED ACTION

OSM is the regulatory authority for mining operations on Indian lands in Arizona. Pursuant to the Indian Lands Program (30 CFR VII, Subchapter E), OSM must make a decision whether to approve or disapprove renewal of the subject permit application (AZ-0001D) based only on the criteria listed at 30 CFR 774.15(c)(1) (see Section A above). Federal authority to mine these reserves can only be granted in up to five-year increments, although the permit holder has a statutory right to successive renewals as long as certain regulatory criteria are met. PWCC seeks to exercise its right to renewal so that it may continue extracting coal in accordance with its long-term mining plan. PWCC has applied for the renewal of Permit AZ-0001D in order to continue ongoing mining operations in coal resource areas N-9, J-19, and J-21 through July 6, 2015. PWCC holds leases with the Navajo Nation and Hopi Tribe to mine up to 670 million tons of coal from reserves within the Kayenta Mine permit area; PWCC and its predecessors have been mining these reserves at an annual rate of approximately 8.2 million tons per year since 1973 in accordance with an approved long-term mining plan.



Map A-2

Kayenta Mine Permit Area
PWCC Lease Area

Kayenta Mine Permit Renewal EA

Legend

- Kayenta Mine Permit Area
- PWCC Lease Area
- Permit Renewal Period Mine Area
- Coal Resource Previously Mined Area
- Future Mine Area
- Hopi Reservation
- Navajo Nation Reservation Chapter Boundary
- Wash or Ephemeral Stream
- Highway
- Rails

PWCC Mine Road

- Primary
- Ancillary
- PWCC Mine Road

Source:
Base Map: ADOT 2009, ESRI 2010
Project Data: PWCC 2006, 2010, 2011
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 0.5 1 2
Miles

PWCC URS

C. ALTERNATIVES CONSIDERED

This section describes the two alternatives evaluated in this EA for the Kayenta Mine under Permit AZ-0001D. The alternatives are presented in comparative form, with the differences between each alternative providing the decision maker with a clear basis for choice between the options. Factors considered in evaluating whether alternatives were technically feasible or economically practical, and whether these would meet the need for renewal of the AZ-0001D permit included: legal requirements; environmental issues and concerns; design and/or engineering feasibility. The two alternatives addressed in this EA are as follows:

- Alternative 1 – approval by OSM to renew permit AZ-0001D for coal resource areas N-9, J-19, and J-21 for not more than five years (2010-2015) and the facilities necessary for mining and reclamation operations.
- Alternative 2 (No Action) – disapproval by OSM to renew permit AZ-0001D for coal resource areas N-9, J-19, and J-21 for not more than five years (2010-2015) and the facilities necessary for mining; however required reclamation operations will continue.

Other alternatives that did not achieve the purpose of and need for the project or were not practicable for mining operations were eliminated from detailed study. These are described in Section C.3.

C.1 ALTERNATIVE 1: APPROVE THE RENEWAL OF PERMIT AZ-0001D

Under this alternative, the OSM Western Region Director would approve the renewal permit AZ-0001D which would authorize continued mining in coal resource areas N-9, J-19, and J-21 of the Kayenta Mine permit area. The permit area for Kayenta Mine is approximately 44,073 acres[2], and Table C-1 describes the three coal resource areas, including total acres of each area and their mining and reclamation status through July 2010. The eight standard permit conditions from 30 CFR subpart 773.17, standard permit terms and specifications from previous renewed permits, and one existing Special Condition pertaining to the monitoring plan for the Mexican spotted owl will be incorporated into the approved permit. Federal regulations in 30 CFR 774.15 grant the existing permit holder a right of successive renewal, and provide that OSM must approve the renewal application unless it finds one or more of six enumerated criteria are met.

Existing facilities to be used for mining operations under the proposed renewal are summarized in the following sections, while Appendix A provides more details of the facilities, mining operations, and reclamation activities. The mine facilities outside the Kayenta Mine permit area have been separately authorized by OSM as part of the Initial Regulatory Program and are authorized for use in Kayenta

[2] Due to differences in the level of detail between datasets, discrepancies in acreage calculations can occur. The acreage calculations presented in the EA are rounded to the nearest acre and are approximate projections used for comparison of alternatives and analytic purposes only; they do not reflect exact measurements of on-the-ground resources.

mining operations in accordance with SMCRA regulations. This Environmental Assessment includes effects from the use of all mine facilities, within and outside the permit area to the extent such facilities are necessary to the mining operations that will be authorized by the proposed action. Table C-1 provides the status of N-9, J-19, and J-21 coal resource areas through the permit period. As of July 2010, active mining and reclamation was on 8,013 acres in the three coal resource areas, and 4,222 acres have been reclaimed. The estimate for mining disturbance between 2010 and 2015 is 1,159 acres with 1,692 acres reclaimed in the three coal resource areas.

Table C-1 Coal Resource Areas and Mining Status[1]

Coal Resource Area	Total Acres[2]	July 2010 Mining and Reclamation Status	2010-2015 Estimated Disturbed and Reclamation Status	
N-9	1,891	Active mining and reclamation on 872 acres; 63 acres reclaimed; 1,019 acres to be mined and reclaimed in the future	2010	
			0 acres disturbed	0 acres reclaimed
			2011	
			45 acres disturbed	0 acres reclaimed
			2012	
			134 acres disturbed	3 acres reclaimed
			2013	
			126 acres disturbed	28 acres reclaimed
			2014	
			92 acres disturbed	165 acres reclaimed
			2015	
			91 acres disturbed	267 acres reclaimed
J-19	3,886	Active mining and reclamation on 3,385 acres;1,110 acres reclaimed; 502 acres to be mined and reclaimed in the future	2010	
			86 acres disturbed,	43 acres reclaimed
			2011	
			44 acres disturbed	104 acres reclaimed
			2012	
			50 acres disturbed	157 acres reclaimed
			2013	
			41 acres disturbed	207 acres reclaimed
			2014	
			49 acres disturbed	240 acres reclaimed
			2015	
			25 acres disturbed	168 acres reclaimed
J-21	5,314	Active mining and reclamation on 3,756 acres; 3,049 acres reclaimed; 1,558 acres to be mined and reclaimed in the future	2010	
			45 acres disturbed	40 acres reclaimed
			2011	
			86 acres disturbed	24 acres reclaimed
			2012	
			156 acres disturbed	9 acres reclaimed
			2013	
			36 acres disturbed,	46 acres reclaimed
			2014	
			53 acres disturbed,	96 acres reclaimed
			2015	
			0 acres disturbed	95 acres reclaimed

Coal Resource Area	Total Acres[2]	July 2010 Mining and Reclamation Status	2010-2015 Estimated Disturbed and Reclamation Status	
Totals	11,091 acres	8,013 acres active mining and reclamation 4,222 acres reclaimed	1,159 acres disturbed	1,692 acres reclaimed
		3,079 acres to be mined and reclaimed in the future		

SOURCE: Peabody Western Coal Company 2010a

NOTES: [1] In addition to the coal resource areas, additional areas are used for support facilities necessary for mine and reclamation operations.

[2] Over the next five years, reclamation from previously permitted mining would also occur at N-06 (475 acres), N-11 Extension (420 acres), J-16 (33 acres), and N-10 (66 acres).

C.1.1 Support Facilities

Support facilities used for the Kayenta Mine operations under this alternative include water supply wells, transportation facilities, office and equipment facilities, utilities, coal handling facilities, explosive storage facilities, environmental monitoring sites, water control facilities, and topsoil stockpiles.

C.1.1.1 Navajo Aquifer Water Supply Wells

Kayenta Mine operations currently use about 1,236 af/yr from the N aquifer, which would continue to be pumped for the mining authorized under Alternative 1. This water is used for ongoing mining and reclamation operations, principally dust suppression as required by Federal regulations, and to provide water to local residents. The projected amount of water use from the N aquifer during the five-year period is 1,236 af/yr from eight wells. PWCC’s existing leases with the tribes require N aquifer wells to be transferred to the tribes in operating condition for their use once PWCC successfully completes reclamation and relinquishes the leases unless the NDWR determines that the tribe does not need one or more of the wells. The PWCC leases and SMCRA permit specify the N aquifer wells monitoring and maintenance.

C.1.1.2 Roads

There are two types of transportation routes within the Kayenta Mine permit area: primary roads and ancillary roads. Primary and ancillary roads are designed, constructed, and maintained in accordance with regulations and performance standards set forth under 30 CFR 816.150 and 816.151. If necessary for future mine operations, regulatory approval will be obtained for mine-related roads crossing stream buffer zones prior to construction.

The primary roads on-site are used for mining operations such as heavy-duty vehicles to haul coal and other mine-support vehicles (including walking the draglines). Lighter-duty vehicles are used on ancillary roads to access environmental monitoring sites and remote mine facilities such as temporary or permanent water control facilities, water wells, and utility lines.

Existing primary roads will be used for Kayenta Mine operations in areas N-9, J-19, and J-21 through the permit period to transport coal to storage and processing sites within the PWCC lease area. Reclamation of the primary and ancillary roads will be completed as described in Appendix A.

C.1.1.3 Office and Equipment Facilities

Office and equipment facilities for the Kayenta Mine operations include mine buildings, offices, shops, bath houses, storage silos and cap magazines, coal storage and crushing areas, equipment storage areas, water diversions and culverts, sheds larger than 100 square feet constructed on permanent foundations, permanent and temporary fuel storage, and environmental monitoring sites.

C.1.1.4 Water Control Facilities

Sedimentation ponds, temporary and permanent impoundments, and Mine Safety and Health Administration sized impoundment structures are elements of the Kayenta Mine sediment and water control plan. Sediment ponds used to control runoff and sediment from disturbed areas will be constructed consistent with regulations and performance standards set forth under 30 CFR 816.46, 816.47, 816.56, and other applicable regulations. All surface drainage from most disturbed areas pass through either a temporary sedimentation pond or a siltation structure before leaving the Kayenta Mine permit area. Surface drainage from areas that are exempt from regulations (e.g., diversion ditches, roads or areas not disturbed by the operator) use sediment controls other than temporary sediment ponds. Temporary sediment ponds will be reclaimed when no longer needed to treat surface runoff from disturbed areas. As of 2010, 156 sedimentation structures exist within the areas leased by PWCC. Under this alternative, an additional 10 temporary sedimentation control ponds would be constructed during the five-year permit renewal period.

Water sources from pre-SMCRA impoundments, post-SMCRA impoundments, and existing or proposed sediment control ponds would be used to provide water for wildlife and livestock. Within the Kayenta Mine permit area, 19 permanent impoundment structures are available for post-mining wildlife and livestock use. Under this alternative, one additional impoundment would be constructed and proposed as permanent in the J-19 coal resource area, and 31 existing or proposed temporary sediment control structures would be converted to permanent impoundments including nine Mine Safety and Health Administration structures (see Map D-3) upon approval by OSM.

There are 11 existing impounding structures at the Kayenta Mine Complex that meet the size criteria set forth under 30 CFR 77.216(a). The primary purpose of these nine proposed permanent and two temporary structures, except for the Kayenta Mine freshwater pond, is to control sediment from disturbed areas. The purpose of the Kayenta Mine freshwater pond is to hold groundwater pumped from N aquifer wells for use during dust suppression activities.

C.1.2 Topsoil Stockpiles

Where prompt replacement of topsoil recovered in advance of mining disturbances is not feasible, topsoil will be stockpiled throughout the mine areas in accordance with regulations and performance standards set forth under 30 CFR 780.12(b)5 and 816.22(c) until needed for reclamation and revegetation activities. The dimensions, slopes, and volumes of topsoil stockpiles would vary depending upon the total salvage volumes, configuration of the stockpile location, and proximity to primary and ancillary roads within the Kayenta Mine permit area.

C.2 ALTERNATIVE 2: DISAPPROVE THE RENEWAL OF PERMIT AZ-0001D [NO ACTION]

Under this alternative, OSM would not approve the renewal of permit AZ-0001D for surface coal mining and reclamation in coal resource areas N-9, J-19, and J-21 as described above under Alternative 1, if one or more of the criteria enumerated in 30 CFR 774.15 exist. Due to the limited discretion under the statutory mandate for renewals, OSM cannot select this alternative unless a finding can be made that one or more of the six criteria in 30 CFR 774.15 is met. OSM's selection of Alternative 2, disapproval of the Kayenta Mine permit renewal would mean ongoing mining operations would cease after the renewal application was denied. Facility removal and reclamation activities would proceed within the three coal resource areas according to the provisions in the current Kayenta Mine closure plan and SMCRA regulations. Reclamation activities would continue in the surrounding areas throughout Kayenta Mine. Reclamation activities within the Kayenta Mine permit area would require approximately 500 af/yr from the water supply wells described in Alternative 1. The number of employees at the Kayenta Mine would be approximately 175 full time employees through 2012 and the coal royalties paid to the Navajo Nation and Hopi Tribe would cease. Water royalty payments to the tribes would continue at a reduced rate until reclamation was complete and the reclaimed lands are returned to the Tribes. The total estimated payments to the tribes is $1.2M to the Navajo Nation and $0.7M to the Hopi Tribe. Property taxes would continue to be paid to Navajo County, but at a reduced rate and sales taxes paid to the State of Arizona would cease.

C.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Federal agencies are required by NEPA to explore and objectively evaluate reasonably feasible alternatives that meet the project's purpose and need, and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). NEPA limits the range of reasonable alternatives to those that fall within the agency's statutory mandate and those that at least partially serve the agency's objective. During the development of this EA, several potential alternatives were considered by OSM. These alternatives were developed considering public comments received during review of the permit renewal application, but were eliminated because they do not meet the purpose and need or were not technically and economically practical and feasible (43 CFR 46.420(b)). NEPA does not require agencies to analyze the environmental consequences of alternatives that it has in good faith rejected as too remote, speculative, impractical, or ineffective. Descriptions of these alternatives and the reasons why they were eliminated from detailed study are provided in the following sections.

C.3.1 Renewal of Permit with Additional Special Conditions

In addition to the permit conditions described in Section C.1.1, OSM considered incorporating additional conditions to the permit renewal. OSM's authority for denying a request for renewal is limited under 30 CFR 774.15, and thus any conditions to the renewal must be warranted as necessary to ensure compliance with the six criteria listed at 30 CFR 774.15(c) (see Section A). OSM has determined that PWCC has submitted a complete application for renewal, and after agency review of the Permit Application Package (PAP) and consideration of prior public comments, OSM has not identified any additional conditions that would be warranted under the six statutory criteria. Moreover, based on the analysis of the environmental effects of the proposed action in this EA, OSM has not identified any conditions that would be necessary to reduce or eliminate any significant effects of the proposed action. The alternative was dismissed from further consideration because no conditions within OSM's statutory authority are warranted and such conditions would be ineffective in ensuring compliance with the statutory renewal criteria or reducing significant impacts.

C.3.2 Use of the Dakota Aquifer

PWCC evaluated the feasibility of using the Dakota aquifer (D aquifer) (GeoTrans, Inc. 2001), including whether 500 af/yr could be pumped from the D aquifer from five wells. The modeling results indicated pumping from five wells at 62 gallons per minute would result in well interference within 2 to 3 years and the wellfield cannot sustain 500 ac-ft/yr. In addition, the leases with the Tribes require PWCC to provide potable water to local residents. However, the quality of water from the D aquifer makes it unsuitable for potable uses due to elevated total dissolved solids (TDS) (Truini and Longsworth 2003). The use of water from the D aquifer would require the construction of a separate water delivery system to provide water for potable uses in accordance with the lease and for mining operations. Also, construction of the separate water system and use of the D aquifer will require a revision to the mining permit, which is beyond the statutory authority of OSM in considering a permit renewal application. Based on aspects of economic practicality the construction of a separate water system this alternative is not economically practical and fails to meet the OSM's purpose and need.

C.3.3 Alternative Mining Methods

OSM and PWCC evaluated using different methods to mine coal from areas N-9, J-19, and J-21. OSM and PWCC considered recovering coal reserves in the Kayenta Mine permit area by use of underground recovery methods. PWCC and OSM reviewed the technical feasibility and economic practicality aspects and determined that regional geology and anticipated surface cover within the project area would not facilitate this mining method. Three considerations preclude underground mining:

- The main coal seams in the Wepo formation are variable in thickness and tend to split into discontinuous seams (Nations, Swift and Haven 2000). Underground mining is not technically feasible in areas where coal resources are located with variable and discontinuous seams.

- Typically, underground mining operations occurring in areas with the coal resource in splitting seams requires operators to wash the coal if it is diluted with other materials such as partings and overburden. PWCC does not currently have a coal washing operation and has not proposed one for development as part of the permit renewal which results in this alternative not being economically feasible.

PWCC would have to refit existing or proposed operations to facilitate underground mining. PWCC would not be able to recover the same maximum economic recovery of coal reserves identified in the project area due to the nature of underground mining, where pillars would need to remain in place permanently. Furthermore, longwall mining is risky in shallow overburden situations due to the tendency to cave, crushing the support pillars surrounding the longwall panel. Collapse of overburden would create a very hazardous working situation for underground miners, and cause damage to, or even loss of, mining equipment. For these reasons, this alternative is not technically feasible or economically practical (43 CFR 46.420(b)).

D. AFFECTED ENVIRONMENT

This section identifies the affected environment and focuses on the existing resources and uses that could be affected by the alternatives described in Sections C.1 and C.2. This EA includes a comprehensive approach to describing the human environment, the natural and physical resources, and people's relationship to those resources. Study area boundaries were developed for each resource and are described in the respective resource sections. Study areas for each environmental resource are based on the predicted extent of direct and indirect impacts associated with the alternatives. Relevant current environmental conditions and human uses within the Kayenta Mine permit area have been identified and described using geographic information system (GIS) data, literature searches, electronic information and data searches, personal interviews, and detailed field surveys. The information presented in this section is derived from past studies and site-specific field data collected by or for PWCC.

The following resources are not analyzed further in this EA because they are not present within the study area (i.e., not directly affected) or would not be indirectly affected by continued mine operations: Wilderness, Wild and Scenic Rivers, and Wild Horses and Burros.

D.1 GENERAL SETTING

The 44,073 acre Kayenta Mine permit area, including coal resource areas N-9, J-19, and J-21, is located within the boundaries of the Hopi and Navajo Indian reservations near Kayenta in Navajo County, Arizona (see Map A-1 and Map A-2 and Appendix A, Section B for details on the mining operation). The Federal government holds these reservations in trust for the tribes. The PWCC lease area comprises approximately 24,858 acres of land where the surface and mineral interests are held exclusively by the Navajo Nation (Navajo Exclusive Lease Area, Lease 14-20-0603-8580), and approximately 40,000 acres of land are located in the Hopi and Navajo Joint Minerals Ownership Lease Area (Joint Lease Area, Leases 14-20-0603-9910 and 14-20-0450-5743).

The Kayenta Mine permit area is located within the Colorado Plateau physiographic province, which is a region of low relief, punctuated by erosional plateaus; steep-sided, river-cut canyons; and isolated volcanic landforms. To the west and southwest, the Colorado Plateau gives way to the Basin and Range province, characterized by lower elevations and steeper relief. The topography of the Colorado Plateau province in northern Arizona is the result of relatively gentle structural folding and contains coal-bearing formations on Black Mesa (see Figures D-1 and D-2). The Black Mesa Basin is a broad synformal geologic structure defined by major uplifts (e.g., Defiance uplift) and massive folds (e.g., Organ Rock Monocline). These large geologic structures control the regional attitudes of the rock formations and affect the types of landforms developed (Cooley 1969). The geographic feature known as Black Mesa sits high in elevation relative to the surrounding areas of Arizona (see Map A-1) (Arizona Geologic Survey 1979).

D.2 AFFECTED RESOURCES, INCLUDING SPECIAL AREAS OF CONSIDERATION

D.2.1 Cultural Resources

The cultural environment includes those aspects of the physical environment that relate to human culture and society, along with the social institutions that form and maintain communities and link them to their surroundings (King and Rafuse 1994). The Kayenta Mine permit renewal could affect two aspects of the cultural environment: (1) archaeological and historical resources, and (2) traditional cultural life ways and resources. These potential impacts were considered pursuant to Federal, Hopi Tribe, and Navajo Nation laws protecting cultural resources.

Section 106 of the National Historic Preservation Act requires Federal agencies to consider the effects of their undertakings on properties eligible for the National Register of Historic Places (National Register). To be considered for inclusion in the National Register, properties must be at least 50 years old (unless they have exceptional significance) and possess integrity of location, design, setting, feeling, materials, workmanship, and association. To be eligible, properties must meet one or more of the following criteria to demonstrate their significance in American history, architecture, archaeology, engineering, or culture:

Criterion A	Be associated with significant historical events or trends
Criterion B	Be associated with historically significant people
Criterion C	Have distinctive characteristics of style or type, or have artistic value, or represent a significant entity whose components may lack individual distinction.
Criterion D	Have yielded, or may be likely to yield, important information (36 CFR 60.4)

The area of potential effects (or region of influence) is the geographic area within which a project may affect resources. Traditional cultural resources can include places where ceremonies or rituals have been conducted; blessed locations such as hogans, houses, sweathouses, game corrals, springs, eagle collecting areas; trail shrines; places for gathering plants, minerals, and other materials for ceremonial and other traditional uses; places associated with traditional stories; rock art; marked and unmarked graves; and ancestral archaeological sites. The area of potential effects can vary for different types of potential impacts on the cultural environment. The impacts of the permit renewal would stem from ground disturbance related to continued mining operations within coal resource areas N-9 (1,019 acres), J-19 (502 acres), and J-21 (1,558 acres). Associated haul roads, coal-handing areas, conveyors, coal load out silo facilities, storage areas, shops, offices, and other structures and facilities would continue to be used as they have been, and such use is not expected to result in any additional effects on cultural resources. Ongoing mining in coal resource areas N-9, J-19, and J-21 will be limited to those areas if the permit is renewed. The ongoing mining in these three coal resource areas does not result in any potential for additional indirect impacts on cultural resources due to visual intrusions and increased noise outside those coal resource areas. Therefore, the area of potential effects for the permit renewal was defined as the coal resource areas N-9, J-19, and J -21 (a total of about 4.8 square miles).

From 1967 to 1986, the 20-year Black Mesa Archaeological Project conducted research to mitigate the impacts of mining coal within the PWCC mine lease area. The investigations recorded a total of 2,710 archaeological sites (1,671 pre-ceramic and Puebloan and 1,039 historic Navajo), excavated 215 of those sites, and archaeologically tested, mapped, and collected artifacts from 887 other sites (Powell et al. 2002). The Black Mesa Archaeological Project inventory includes 36 prehistoric sites and 20 historic Navajo sites within the area of potential effects defined for the permit renewal, including 12 sites (5 prehistoric and 7 historic) in the J-19 coal resource area, 22 sites (15 prehistoric and 7 historic) in the J-21 coal resource area, and 22 sites (16 prehistoric and 6 historic) in the N-9 coal resource area. The artifacts and project records of the Black Mesa Archaeological Project are curated at Southern Illinois University.

Through the Black Mesa Archaeological Project, OSM completed Section 106 requirements for the entire Kayenta Mine permit area. Therefore, the proposed permit renewal does not require additional Section 106 consultations to address the effects of coal mining on recorded properties eligible for the National Register. However, OSM continues to consider cultural resources pursuant to other laws through standard conditions and terms attached to mining permit renewals issued for continuing coal mining operations pursuant to the National Historic Preservation Act and other laws. Those terms were initially incorporated into the Mining Permit AZ-0001C issued on July 6, 1990 and were subsequently incorporated into Mining Permit AZ-0001D that was renewed on July 6, 2005 and would be incorporated into the permit renewal, if approved. Pursuant to those terms, PWCC continues to:

- Report the discovery of any previously unrecorded cultural resources to OSM and to suspend work near discoveries until OSM determines appropriate disposition
- Take into account any sacred and ceremonial sites brought to the attention of PWCC by local residents, clans, or tribal government representatives of the Hopi Tribe and Navajo Nation
- Identify and respectfully treat any human remains associated with archaeological sites pursuant to the 1990 Native American Graves Protection and Repatriation Act

Since the permit conditions were initially stipulated in 1990, PWCC has made three cultural resource discoveries in the J-19 and J-21 coal resource areas—two inadvertent discoveries of human bones, and one discovery of three possible historic gravesites. Those discoveries were treated in accordance with the permit terms which would continue to be effective under a renewed mining permit.

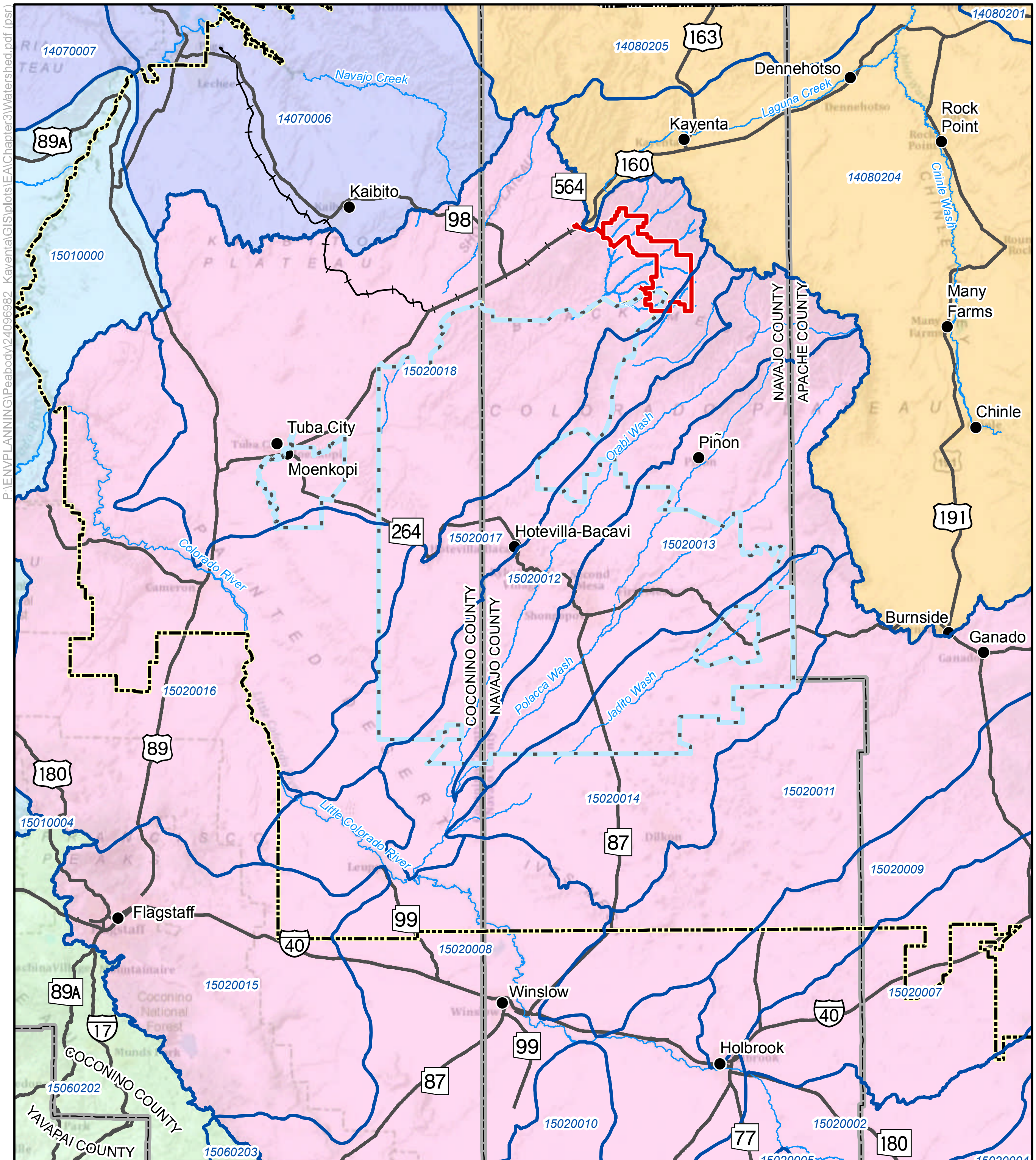
Traditional Hopis and Navajos consider all of Black Mesa (known as *Nayavuwaltsa* to the Hopi and *Dzilijiin* to the Navajo) to be a significant traditional cultural resource due to its role in traditional stories and ceremonial and clan traditions. Other mountains in the region, such as the San Francisco Peaks, also are considered sacred. Although Hopis and Navajos living anywhere might regard continued mining as an impact on their cultural traditions, the traditional life ways of the four Navajo households in the J-21 coal resource area could be most affected because they are required to move to accommodate the continued mining (SWCA Environmental Consultants 2005). No specific sacred or ceremonial sites have been identified in coal resource area J-19, but PWCC has been notified about five specific sacred and ceremonial sites within the N-9 coal resource area. Pursuant to permit AZ-0001D, PWCC previously considered those five sites and agreed to avoid mining at those locations (PWCC 2005b). Recently, PWCC has been notified of two additional potential sacred and ceremonial sites within the J-21 coal resource area, and is continuing to investigate and consider those sites in accordance with the approved permit.

Although the Black Mesa Archaeological Project excavated many burials, only a representative sample of the archaeological sites were excavated and additional burials could be present at unexcavated sites. In response to the permit terms, PWCC established and continues to implement an archaeological testing program at sites identified with potential for human remains. To date, PWCC has identified, documented, and reburied 74 burials found within 25 sites in accordance with the Native American Graves Protection and Repatriation Act, and the Navajo Nation policy for the Protection of Jishchaá: Gravesites, Human Remains, and Funerary Items before mining was initiated at those locations. Sixteen of those prehistoric burials were found at two archaeological sites within the J-19 coal resource area, and four prehistoric burials and one historic burial were found within the N-9 coal resource area. No additional archaeology sites with the potential for human remains have been identified within the areas that would be mined within the permit renewal period in coal resource areas J-21 and N-9. Two prehistoric archaeological sites within the part of coal resource area J-19 that may be mined within the permit renewal period have been identified as having potential for human remains.

D.2.2 Hydrology

Black Mesa, where the Kayenta Mine permit area is located, is a major geographic feature of the Colorado Plateau (see Map A-1). The Colorado Plateau is a region of low relief, punctuated by erosional plateaus; steep-sided, river-cut canyons; and isolated volcanic landforms. The area stands high in elevation relative to surrounding parts of Arizona. Drainage is controlled by the perennial Colorado River flowing from the northeast to the west, and by the Little Colorado River running from the south near the White Mountains to its junction with the Colorado River downstream from Page, Arizona. Major watersheds are shown on Map D-1.The Little Colorado River is intermittent and flows at certain times of the year from Holbrook, Arizona, to the Colorado River.

The study area for hydrologic resources in this EA underlies the Black Mesa and adjacent areas where the N aquifer discharges. Water resources on Black Mesa and in the vicinity have been studied and monitored for decades (e.g., McGavock et al. 1966; Macy 2010). PWCC has conducted extensive surface water and groundwater studies and monitoring in support of its permit applications and associated regulatory requirements (GeoTrans Inc. 2005; PWCC 2010a). These studies and monitoring include surface water quality, sedimentation and streamflow measurements, groundwater levels and quality, and groundwater modeling of the N and D aquifers. Discharges from sediment ponds, although infrequent, are also monitored in accordance with PWCC's NPDES Permit No. NN0022179. Details of the OSM-approved hydrologic monitoring conducted by PWCC at the Kayenta Complex are contained in Chapter 16, "Hydrologic Monitoring Program," in the AZ-0001D permit application package for the Kayenta mining



Legend

- Kayenta Mine Permit Area
- Sub-watershed Boundary and Hydrologic Unit Number
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad
- Wash or Ephemeral Stream

Watershed

- Upper Colorado River - Dirty Devil
- Little Colorado River
- Lower Colorado - Lake Mead
- Lower San Juan River
- Verde River

Source:
Base Map: ADOT 2009, PWCC 2010
Streams: NHD 2008
Watershed Data: Arizona Department of Water Resources 2004, 20
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

0 8 16
Miles

Map D-1
Major Watersheds

Kayenta Mine Permit Renewal EA

PWCC URS

operations. PWCC also collects samples from the water-distribution system to comply with the Navajo Nation's Safe Drinking Water Act requirements.

OSM prepared a Cumulative Hydrologic Impact Analysis (CHIA) to evaluate the potential for damage to the hydrologic balance outside the Kayenta Mine permit area (USDI 1989). The hydrologic balance is the relationship between the quality and quantity of water inflow to, and water outflow from, a hydrologic unit such as a drainage basin or aquifer. The 2008 updated CHIA (USDI 2008), which was approved by OSM in 2010 to update the Permit Application Package (AZ-0001-D-J-77), includes additional water resource information and determines potential mining-related hydrologic impact on the existing and foreseeable water uses (USDI 2008).

D.2.2.1 Surface Water

Surface water, including Moenkopi, Dinnebito, Oraibi, Wepo, Polacca, and Jeddito washes, drain Black Mesa to the southwest and join the Little Colorado River, as shown on Map D-2. Laguna Creek and Chinle Wash drain to the north and join the San Juan River. All of the washes draining Black Mesa are ephemeral with discontinuous and relatively short intermittent reaches. Springs also discharge into the washes and limited stream segments in the lower portions of these washes may be perennial due to groundwater discharge. Moenkopi Wash and Dinnebito Wash and their five main tributaries convey runoff and spring discharges from the PWCC lease area (see Map D-2). Segments of these washes, and tributaries including Moenkopi, Dinnebito, Wepo, Oraibi, Coal Mine, and Yellow Water Canyon washes and Laguna Creek are fed by springs (refer to Map D-2). None of the tributaries or washes in or near the mine permit area are a reliable source of water for irrigation, livestock, or potable use.

The washes within Black Mesa exhibit a parallel drainage pattern suggesting slope and structural control on drainage development. Within the PWCC lease area and in the upper reaches of the washes, channel gradients are higher and channel meandering is less compared with downstream reaches. Watersheds associated with upper reaches typically feature narrow valley profiles and deeply entrenched drainage channels with minimal meandering. In the lower reaches, channel gradients lessen, meandering is more pronounced, and valley bottoms and flood plains are wider. Drainage densities range from about 4 to 16 miles of stream channel per square mile. High densities such as these are common in semi-arid watersheds due to the sandier and less developed soils, higher basin elevation differences, lower vegetative cover, and the erosive power of flash flooding that typically occurs during high-intensity storm events (PWCC 2005b).

Surface flows within the Kayenta Mine permit area are highly variable and primarily consist of storm runoff. Typical of the area, runoff from storm events range from a few cubic feet per second (cfs) to more than 10,000 cfs, depending on the location, intensity, and duration of a storm. Intermittent reaches are the result of saturated rock units at the surface and the discharge of alluvial aquifers holding stormwater bank storage. This flow is referred to as base flow and is generally synonymous with the low flow of the stream. Not all stream reaches within the permit area have periods of base flow. Based on data collected in 1985 and in 2009, the base flow is generally low at stream sites located along the major washes and tributaries (PWCC 2010b, PWCC 2005b). Table D-1 shows that base flow varies from 0.09 to 1.12 cfs. Water quality standards established by the Navajo Nation EPA (Navajo Nation 2008) and Hopi Tribe (Hopi Tribe 2008) have been used to assess the historical and potential uses of various surface water sources in the vicinity of the Kayenta Mine. In addition, recommended livestock standards for both TDS (NAS 1972) and sulfate (Botz and Pederson 1976) have also been used (PWCC 2005b). Comparisons with water quality standards established by the Hopi Tribe are limited to sources within the boundary of the Hopi Reservation on PWCC's leasehold. Water quality standards associated with livestock drinking water and aquatic and wildlife habitat apply to surface waters that support livestock grazing and wildlife habitat, both of which are primary post-mining land uses at the Kayenta Mine. Comparisons of shallow groundwater quality are limited to livestock drinking water standards established by the Navajo Nation (2008) and Hopi Tribe (2008) where applicable. Comparisons of base flow water quality monitored in 2009 with livestock standards and aquatic and wildlife habitat standards established by the Navajo Nation (2008), and Hopi Tribe (2008) where applicable indicate most base flow meets these standards (PWCC 2010b).

Table D-1 Base Flow in Major Washes and Tributaries

Wash	Low Base Flow (cfs)	High Base Flow (cfs)
Lower Coal Mine Wash	0.13	1.12
Middle Coal Mine Wash	0.09	0.12
Middle Moenkopi Wash	0.12	0.30
Lower Red Peak Valley Wash	0.11	0.18

SOURCE: Peabody Western Coal Company 2010b

PWCC categorizes surface-water quality data based on sources of surface water monitored for permit requirements, including rainfall (stormwater). Stormwater generally has less contact time with salt-containing materials and TDS concentrations tend to decrease as runoff increases. Water quality analyses indicate a variety of water types, mostly calcium/magnesium sulfate and calcium/magnesium bicarbonate water. Mean concentrations of select chemical parameters in stormwater on streams with monitoring sites are shown in Table D-2. These chemical parameters are indicators of water quality. Comparisons of stormwater runoff water quality monitored in 2009 with livestock standards and aquatic and wildlife habitat standards established by the Navajo Nation (2008), and Hopi Tribe (2008) where applicable indicate 88 percent of the analytical results compared, met livestock standards. Comparisons of the same 2009 water quality data with acute aquatic and wildlife habitat standards indicate 86 percent of analytical results compared, met these standards (PWCC 2010b). Samples collected from stormwater runoff events that are not filtered and are analyzed for trace elements using the total or total recoverable methods often yield high values due to the high-suspended solids concentrations (PWCC 2008). Stormwater runoff typically carries very high concentrations of suspended solids, which are often greater than 10,000 milligrams per liter (mg/L) (PWCC 2005b).

Table D-2 Mean Concentrations of Chemical Parameters in Stormwater, Stream Monitoring Sites by Site Number (1986 to 2008)

Chemical Parameter	Streams with Monitoring Sites												
	Dinnebito Wash		Reed Valley Wash	Yellow Water Wash		Yazzie Wash	Coal Mine Wash			Red Peak Valley Wash		Moenkopi Wash	
	Site Numbers												
	34	78	37[1]	50	15	157	16	18[2]	25	14	155	35	26
pH	8.0	8.0	8.0	8.0	8.0	8.1	8.1	8.0	8.0	8.2	8.3	8.1	8.1
Total Dissolved Solids (TDS)	1,179	1,462	1,485	755	686	229	471	1,335	1,503	271	324	292	924
Alkalinity (Alk)	98	87	121	86	85	112	80	123	130	95	94	68	100
Sulfate (SO_4)	671	919	694	437	398	112	242	809	917	106	135	118	525
Calcium (Ca)	160	194	162	125	127	48	87	165	165	46	44	52	128
Magnesium (Mg)	62	95	105	44	34	8	19	80	92	12	12	11	53
Sodium (Na)	64	96	100	19	16	4	13	104	135	15	33	5	68
Chloride (Cl)	15	22	213	17	10	3	8	27	21	10	11	4	40

SOURCE: Peabody Western Coal Company 2005b

NOTES: 1 Excludes chemical data for two samples that were influenced by magnesium chloride spills upgradient of this monitoring site.

2 Includes chemical data from subsites FLUM18 and CG18.

Sediment control structures (or impoundments) are earthen embankments constructed across ephemeral drainages from materials excavated locally using standard engineering and construction methods. These impoundments (or ponds) are necessary to reduce sediment transport from disturbed areas prior to discharge into receiving streams. In 2010, 156 sediment impoundments provided treatment of disturbed area runoff from mined areas within the PWCC lease area. Ten additional sediment impoundments are planned for construction during the permit period, and 51 sediment impoundments would remain permanently after mining and reclamation (Map D-3).

Comparisons of water quality monitored between 1986 and 2008, and in 2009 at proposed permanent impoundments located within or adjacent to reclaimed areas with livestock-watering standards and aquatic and wildlife habitat standards established by the Navajo Nation (2008), and Hopi Tribe (2008) where applicable indicate more than 95 percent of the analytical results compared met the livestock standards, and more than 98 percent of the analytical results compared met the aquatic and wildlife habitat standards (PWCC 2005a, PWCC 2010b). The quality of water in these impoundments is similar to the water quality of stormwater collected from natural drainages, however TDS, sulfate (SO4), calcium (Ca), magnesium (Mg), sodium (Na), and chloride (Cl) concentrations are typically lower in the impoundments than natural drainages (see Table D-3). Based on the water quality of permanent impoundments located in reclaimed areas, runoff from reclaimed areas that contribute to the impoundments has similar water quality composition (PWCC 2005b). Permanent impoundments must meet performance standards outlined in 30 CFR 816.49(b), and meet applicable State, Federal and Tribal water quality standards. The quality of impounded water must be suitable on a permanent basis to support livestock grazing and wildlife habitat at final bond release.

Table D-3 Mean Concentrations of Chemical Parameters, Permanent Impoundments by Site Number (1986 to 2008)

Chemical Parameter	Permanent Impoundment Site Numbers													
	116	124	118a	N1-RA	122[1]	123[1]	112[1]	113[1]	119[1]	N7-D	N2-RA	N2-RB	N2-RC	N8-RA
pH	8.2	7.8	8.6	9.5	8.0	7.5	7.8	7.9	7.9	8.1	8.6	8.1	8.6	8.0
Total Dissolved Solids (TDS)	459	205	144	440	143	177	281	603	165	939	9509	566	227	133
Alkalinity (Alk)	84	100	105	142	96	102	109	205	116	74	261	113	97	56
Sulfate (SO_4)	225	68	16	197	15	21	98	252	25	595	6557	297	79	34
Calcium (Ca)	63	44	24	35	25	26	24	46	29	155	359	108	44	26
Magnesium (Mg)	25	13	11	24	9	9	12	21	12	56	432	34	12	4
Sodium (Na)	29	4	5	70	4	7	44	117	9	41	1934	12	6	2
Chloride (Cl)	10	3	5	7	5	6	4	8	2	20	45	7	4	4

SOURCE: Peabody Western Coal Company 2005b
NOTES: [1] Pre-law area ponds.

Seepage through the embankment of impoundments or surrounding geology (e.g., thin coal seams) can react with naturally occurring constituents in the embankment materials or the more permeable geologic formations in the vicinity. These reactions can result in elevated concentrations of water-quality parameters such as pH, nitrate, aluminum, selenium, iron, and other trace elements in the seep water. On occasion, water quality samples collected from seeps below impoundments have exceeded water-quality standards for these parameters within the permit area.

Since mining began, over 220 sediment impoundments have been built, and seeps have been observed at 33 of these impoundments since 1972. At some sediment ponds, impounded water persists in large enough amounts and for sufficient durations to seep through the bottom of the embankment or more permeable underlying geologic formations. The seeps range in size from damp areas less than 1/10th acre at the embankment toe to areas with persistent water flow at rates up to several gallons per minute (gpm). The USEPA required PWCC to conduct a comprehensive study of seeps below NPDES ponds in 1995. This study concluded that constituent concentrations in seep water greater than applicable water quality standards are attributable to natural processes, and/or the geologic material within the study area (Brogan-Johnson 1996). PWCC developed a Seepage Management Plan (PWCC 2005a) to manage seeps below NPDES-permitted sediment-control structures. The plan was approved by USEPA and subsequently incorporated in the Mine's NPDES permit.

During 2009, 12 of the 25 NPDES impoundments had seeps with sufficient water for water quality sampling. The water quality samples were measured in the field for electrical conductivity, pH, temperature, and salinity and analyzed in the laboratory for cadmium, nitrate/nitrite, selenium, aluminum and copper. The analytical results were compared to standards established for livestock drinking water and aquatic and wildlife habitat set by the Navajo Nation (2008), and Hopi Tribe (2008) where applicable (PWCC 2010c). The comparisons indicated that five of the 12 seeps sampled had one or more constituent concentrations greater than the standards. Table D-4 summarizes the seep water quality parameters and results that were higher than the corresponding water quality standards during the 2009 seep monitoring program.

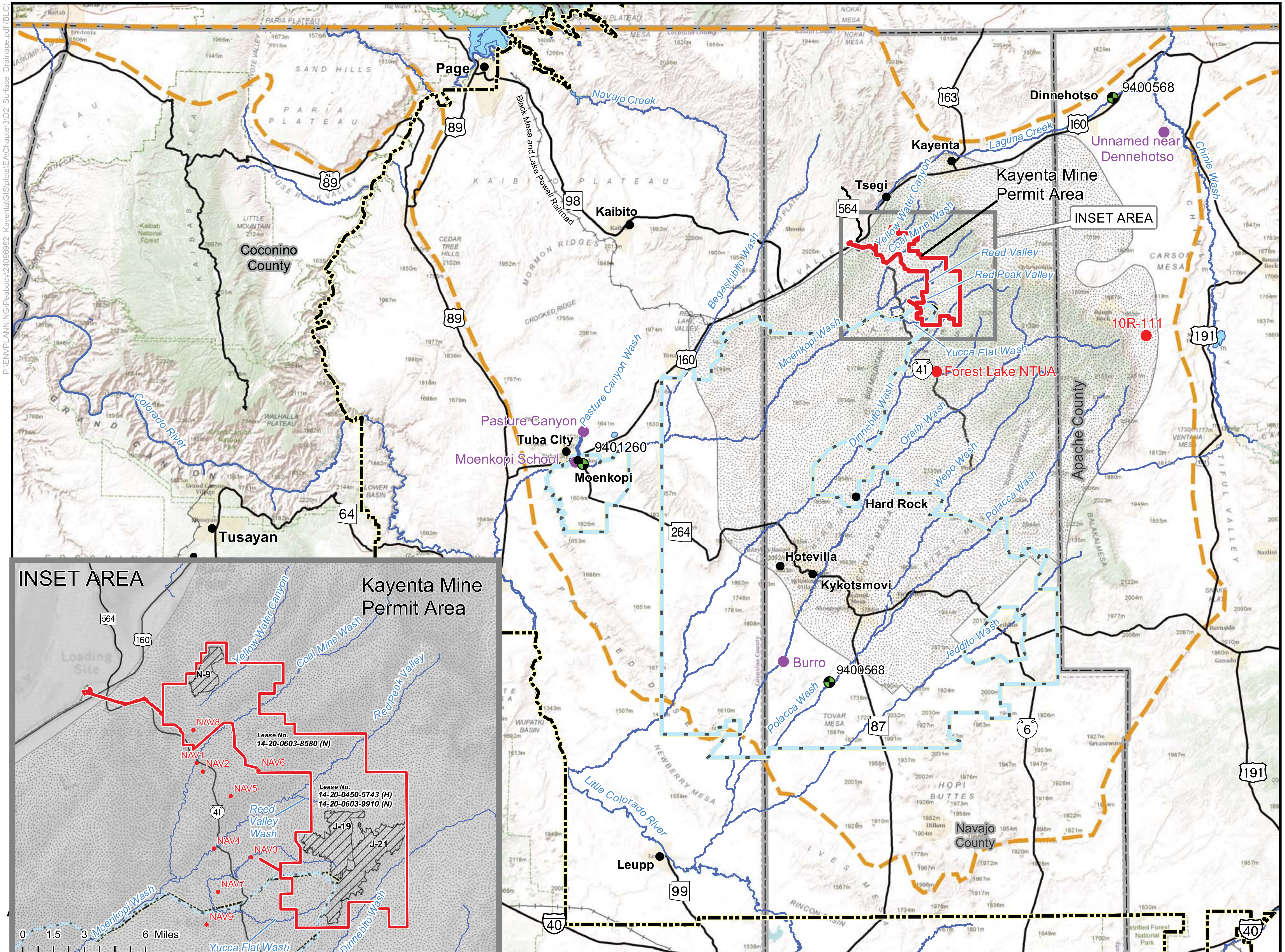
Table D-4 2009 Seep-Water Samples not Meeting Water Quality Standards

Seep Monitoring Site	Water-Quality Parameter(s)	Water Quality Standard	Result
BM-A1-SP1	Total recoverable cadmium	A&WHbt[1] – Acute[2]	8.0 μg/l
BM-A1-SP2	Nitrate/Nitrite Total recoverable selenium	LW[3] (132 mg/L) A&WHbt[1] (33 μg/l)	260 mg/L 36 μg/l
J3-E-S2	Total aluminum	A&WHbt[1] – 0.75 mg/l	2.18 mg/l
J7-JR-S1	Total recoverable copper	A&WHbt[1] – Acute[2]	60 μg/l
N6-F-S1	Total aluminum Field pH	A&WHbt[1] – 0.75 mg/l LW[3] (6.5 to 9.0 S.U.)	172 mg/l 3.62 to 4.12 S.U.

SOURCE: Peabody Western Coal Company 2010c
NOTES: [1]Aquatic and Wildlife Habitat; [2]Hardness based; [3]Livestock Watering
pH = measure of acidity or alkalinity of a solution, S.U. = standard units,
mg/L = milligrams per liter, μg/l = micrograms per liter

The cadmium value measured at BM-A1-SP1 was qualified as being between the method detection limit and the practical quantitation limit, and is therefore not considered to be a statistically valid analytical result. Local geologic materials may have contributed to the cadmium detection, or the lab result may be anomalous. Sheep and other livestock waste in the vicinity likely influence nitrate levels at BM-A1-SP2, and the selenium value (36 µg/l) was only slightly higher than the standard (33 µg/l). The aluminum value measured at J3-E-S2 was the first value that exceeded the standard, and is the only exceedance at the two seeps monitored below Pond J3-E since monitoring began, and may be anomalous. The copper value measured at J7-JR-S1 was qualified as being between the method detection limit and the practical quantification limit, and is therefore not considered to be a statistically valid analytical result. Local geologic materials may have contributed to the copper detection, or the lab result may be anomalous. Finally, the aluminum value that exceeded the standard at Seep N6-F-S1 and the low pH measurements are similar to historical measurements at this site. Reclamation in the fall of 2009 removed the sediment control structure at Pond N6-F, which removed Seep N6-F-S1 permanently. At the remaining eight NPDES sediment ponds, seeps met all standards established for livestock drinking water and aquatic and wildlife habitat established by the Navajo Nation (2008), and Hopi Tribe (2008) where applicable (PWCC 2010c).

Flow rates of the seeps monitored in 2009 were within the historical range of seep flows (ranging from pooled water [no flow] to 9.5 gpm). During 2009, there were fewer NPDES ponds exhibiting poor seep-water quality than in prior years. The constituent results that exceeded water-quality standards were comparable to historical ranges.



Map D-2

Location of Surface Drainages on Black Mesa and Key N Aquifer Features

Kayenta Mine Permit Renewal EA

Legend

- Kayenta Mine Permit Area
- Coal Resource Area

Surface Drainage Feature

- Wash or Ephemeral Stream
- Well
- Spring
- Stream Gage

Aquifer

- N Aquifer
- Confined Area of N-Aquifer (Southeast edge is limit of the model)

General Feature

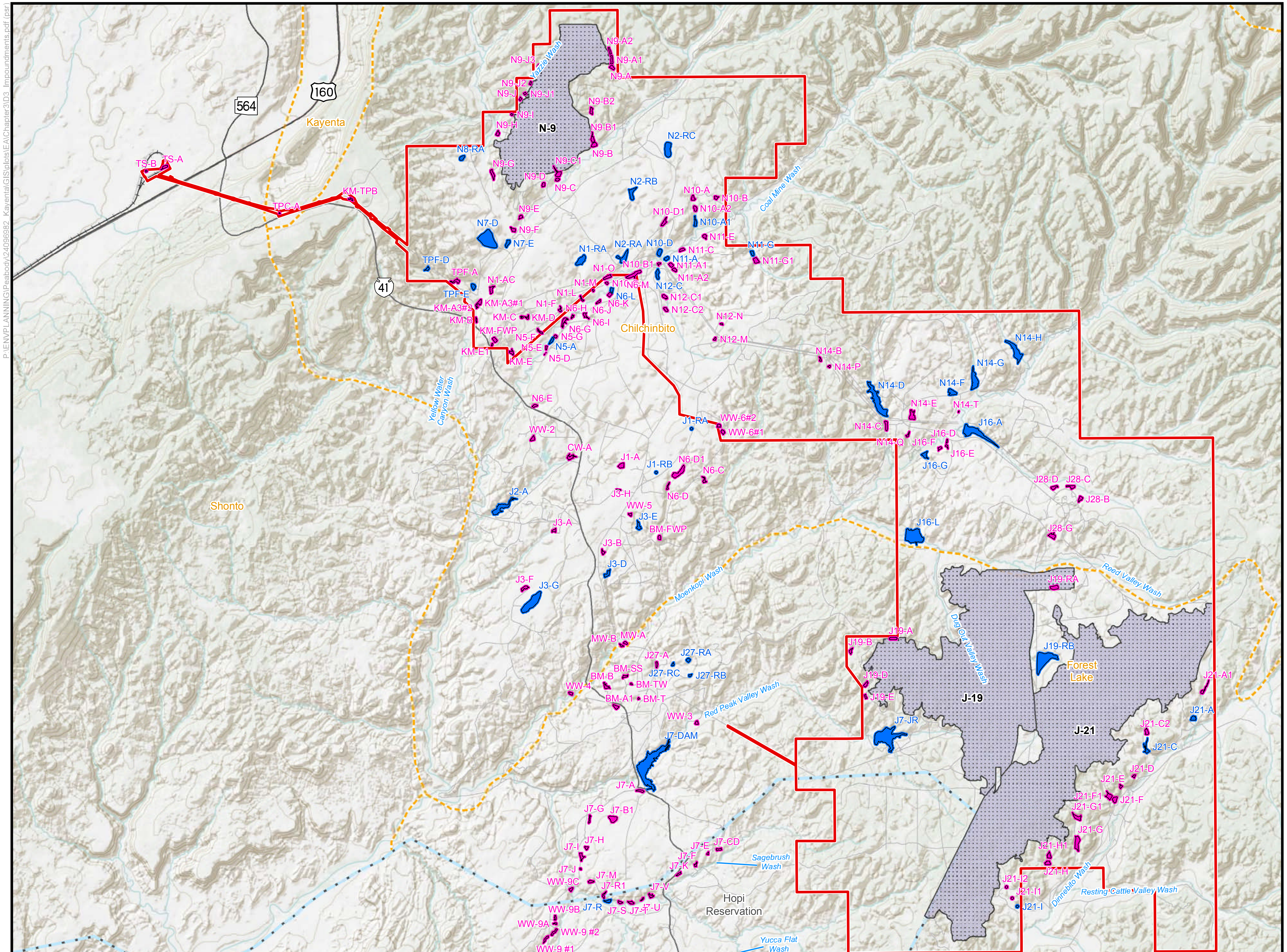
- Hopi Reservation Boundary
- Navajo Nation Reservation Boundary
- County Boundary
- Lake
- Interstate/U.S. Highway/State Route
- Railroad

Source:
Base Map: USGS 2005, PWCC 2010
Stream: USGS Water Resources 2006
Political Boundary: Bureau of Reclamation 2005
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 5 10 20
Miles

PWCC URS



Map D-3

Temporary and Permanent Impoundments

Kayenta Mine Permit Renewal EA

Legend

Kayenta Mine Permit Area

Coal Resource Area

Impoundment

Permanent

Temporary

General Feature

Hopi Reservation Boundary

Navajo Nation Reservation Chapter Boundary

Railroad

Highway

PWCC Mine Road

Source:
Base Map: ADOT 2009, PWCC 2011
Impoundments: PWCC 2010
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 0.5 1 2
Miles

PWCC URS

D.2.2.2 Groundwater

Within Black Mesa, groundwater in the region can be found in the alluvium, Mesa Verde Group, D, N, and C regional aquifer systems. The groundwater sources within each of these aquifer systems have varying water quality, and water-yielding capacity. Figure D-1 identifies the significant water-bearing units in the study area. Significant water-bearing formations and associated local and regional aquifers include the following, in descending stratigraphic order:

- The alluvial aquifer, composed of gravel, sand, and silt, is associated with stream channels that occur within the Black Mesa area (PWCC 2005b). This local aquifer system varies greatly in size, extent, and degree of saturation depending on the nature of the stream channels.
- Water-bearing formations of the Mesa Verde Group aquifer, specifically the Wepo Formation containing siltstone, mudstone, sandstone, and coal beds. There are no developed Wepo Formation water-use locations on the leasehold (GeoTrans Inc. 2005). The Wepo aquifer is discontinuous across the leasehold and does not constitute a regional aquifer.
- The D aquifer, which includes the Dakota Sandstone, portions of the Morrison Formation, and the Cow Springs Sandstone (Arizona Department of Water Resources [ADWR] 1989); the overlying Mancos Shale confines the D aquifer.
- The N aquifer includes the Navajo Sandstone, the Kayenta Formation, and the Lukachukai member of the Wingate Sandstone; the overlying Carmel Formation confines the N aquifer.
- The C aquifer includes the Kaibab Formation, the Coconino Sandstone, and the upper part of the Supai Group; beneath Black Mesa, the overlying Moenkopi and Chinle Formations confine the C aquifer.

The D, N, and C regional aquifers extend over large areas and are controlled by the regional northern dip of the rocks and the basin structure beneath Black Mesa (see Figure D-2). The relationships among these water-bearing units and the Kayenta Mine permit area are shown on Figure D-1 and Figure D-2. The extent of the regional aquifers is shown on Map D-4. Although the C aquifer is exposed at the surface south of the Little Colorado River it is buried beneath more than 5,000 feet of sedimentary rock beneath the Kayenta Mine permit area.

The N aquifer is a sandstone aquifer with a hydraulic conductivity (0.2 to 1.3 feet per day) that is confined beneath Black Mesa, and unconfined around the periphery of the basin where rocks of the N aquifer are exposed. Discharge from the N aquifer occurs where the aquifer is unconfined and near the boundary between the confined and unconfined portions. Examples include areas along Moenkopi Wash downstream of its confluence with Begashibito Wash, and the washes near the Hopi communities near Dinnebito, Oraibi, Wepo, Polacca, and Jeddito washes. Discharge also occurs where the Navajo sandstone is incised near recharge areas such as Tsegi Canyon northwest of Kayenta, and at Pasture Canyon near Tuba City and Moenkopi (see Map D-4). Navajo Creek is separated from the N aquifer underlying Black

Mesa, which isolates Navajo Creek from any pumping effects in the aquifer beneath Black Mesa (see Map D-2 and Figure D-2).

The alluvial-aquifer system represents alluvium (stream deposits) and colluvium (original rocks and debris) that occur within and along principal washes in the study area. These washes include Dinnebito, Reed Valley, lower Coal Mine, and lower Moenkopi. The saturated portions of these washes in the mine leasehold range from 900 to 40,000 square feet in area (Peabody 2005b). Transmissivity values are reported to range from 325 gallons per day per foot (gpd/ft) upwards to 63,800 gpd/ft (Peabody 2005b). The alluvial aquifer is recharged from infiltration of surface-water runoff, and from the intersection of the alluvial channels with saturated portions of the Mesa Verde Group, including the Toreva and Wepo Formations.

Alluvial-aquifer water quality is highly variable and dependent upon the water quality and quantity of the contributing source. The TDS concentrations range from 628 mg/L (Coal Mine Wash) to 62,000 mg/L (Moenkopi Wash) and nitrate concentrations (a concern for livestock) are in the alluvium, ranging up to a maximum of 540 mg/L in some samples. Water quality in alluvial wells upgradient of all mining activities (i.e., groundwater flow before reaching the mine area) has a median TDS concentration ranging from 540 mg/L (Coal Mine Wash) to 4,276 mg/L (Dinnebito Wash). Sulfate concentrations in upgradient background alluvial-monitoring wells have a median concentration ranging from 220 mg/L (Coal Mine Wash) to 2,774 mg/L (Dinnebito Wash). Of the 32 wells sampled in 2005, 5 wells potentially were suitable for livestock use (PWCC 2005b). In 2009, 29 of 30 alluvial wells within the Kayenta Mine permit area sampled were considered suitable for livestock use based on water quality standards established by the Navajo Nation (2008) and Hopi Tribe (2008) where applicable. Of note, more parameters were analyzed and compared against standards in 2009 than in 2005 (PWCC 2010a).). A difference in precipitation amounts from year to year is the likely cause of variable alluvial water quality.

The Mesa Verde Group, including the Wepo Formation, yields small amounts of water to wells and springs on Black Mesa. This group is a source of water for springs located on the Hopi Reservation and is of local significance as a shallow source of water supply. The relatively impermeable Mancos Shale (see Figure D-1) separates the Wepo Formation aquifer from the underlying D aquifer. Water levels in the Wepo Formation aquifer range from 0 (i.e., seep or spring) to 212 feet below ground surface (bgs) across the Kayenta Mine permit area (GeoTrans Inc. 2005). Groundwater within the Wepo aquifer occurs under both confined and unconfined conditions. The aquifer is not present continuously across the permit area. Recharge occurs in the unconfined formation and exposed surface areas of broken and burned coal-clinker material. Groundwater flow is generally southwest across the PWCC lease area. Unless the more permeable parts of the Wepo Formation (likely to be sandstones) are widespread and continuous, groundwater inflow into the mine pits is likely to be limited in volume and duration.

Groundwater modeling of both the Wepo and alluvial aquifers was performed to estimate groundwater flow to open mine pits at the Kayenta Mine (GeoTrans Inc. 2005). Simulated maximum inflow from the Wepo Formation into Pit N-14 were estimated to be about 23 gpm. The computer-predicted impact on Wepo aquifer water levels was as much as 65 feet. However, actual observations of both pit-water inflow and water-level change in Wepo wells suggests that groundwater modeling overestimated both these values (GeoTrans Inc. 2005). The actual volume of Wepo Formation inflow was too low to measure reliably.

Groundwater from the Wepo aquifer is highly variable in chemical quality. Water from sandstone units generally contains calcium bicarbonate while water from coal units contains calcium/magnesium sulfate, and water from shale units contains sodium/potassium sulfate. Comparisons of water quality collected at Wepo aquifer wells with livestock drinking water standards as applicable established by the Navajo Nation (2008) and Hopi Tribe (2008) indicate that most Wepo wells remain suitable for use as a livestock drinking water source (PWCC 2010b).

To date, two Wepo windmill wells have been removed by mining, and one additional windmill well is identified for future removal. PWCC has committed to replacing all three windmill wells once reclamation is complete and a grazing unit is established at the relocated sites and prior to final bond release or termination of jurisdiction. PWCC has installed two water stands that provide free potable (N aquifer) water to the public on a 24-hour, 7-day-a-week basis.

Springs emanating from the Mesa Verde Group within the PWCC lease area have been monitored for several years. Ten spring sites were monitored during 2009. Flow rates at these springs were low ranging from zero (pooled water) to 7.9 gpm, consistent with historical flow measurements. TDS concentrations range from 1,350 mg/L to 13,500 mg/L. Comparison of spring water quality data collected in 2009 with Navajo Nation (2008) and Hopi Tribe (2008) as applicable, and recommended standards for TDS and sulfate livestock standards indicate that five of the springs are suitable for livestock use, and the other five springs are either marginally suitable or unsuitable for livestock use (PWCC 2010b). Comparison of 2009 spring water quality data with aquatic and wildlife habitat standards established by the Navajo Nation (2008), and Hopi Tribe (2008) as applicable, indicate four of the ten springs are suitable for aquatic and wildlife habitat, and the remaining six are either marginally suitable or unsuitable for aquatic and wildlife habitat (PWCC 2010b).

D.2.2.3 Water Supply

N and D Aquifers

The N aquifer is the major source of potable water for municipal use and the current source of water supply for the Kayenta coal mining operation. The average thickness of the aquifer is approximately 400 feet (Eychaner 1983). Regionally, groundwater in the N aquifer flows to the south and west or north and west, but is locally influenced by pumping at the mine and communities.

Most of the N aquifer is confined in the center of the basin. Recharge generally occurs in the north-central part of the N aquifer, northwest of Kayenta, where aquifer formations are exposed at the land surface and precipitation is relatively high. Recharge occurs primarily from precipitation falling on outcrops of the Navajo sandstone, and estimated recharge rates range between 2,500 to 3,500 af/yr (for the outcrop area north of Black Mesa) to 20,248 af/yr with a median recharge rate of 13,000 af/yr (Brown and Eychaner

1998, Eychaner 1983, GeoTrans 1987, Lopes and Hoffman 1997, and Zhu 2000). As recharge is largely limited to the margins, water levels in the N aquifer throughout most of the basin do not respond to short-term changes in recharge. However, water levels in the recharge areas can respond to precipitation events.

The USGS has monitored N aquifer water levels since 1972 and currently uses a groundwater-monitoring network of 34 wells to track annual water-level changes. Six non-pumping observation wells evaluate the regional hydrologic condition of the N aquifer. The largest measured regional drawdown since 1965 is associated with observation well BM-6 with a water-level decline of 155 feet by 2004 (USGS 1985-2005). The USGS groundwater monitoring also indicated that although drawdown has occurred in the N aquifer, measured water levels have not dropped below the top of the N aquifer within the confined basin (see Map D-2). The saturated thickness of the confined portion of the N aquifer is unchanged at the monitored locations because water levels remain above the top of the aquifer.

The PWCC well field is located in the confined area of the N aquifer, which is shown on Map D-2. PWCC's usage of groundwater from the N aquifer for Kayenta mining operations since December 2005 has averaged about 1,240 af/yr. At the end of 2005, pumping by PWCC was greatly reduced because use of the coal-slurry pipeline was discontinued, and water levels in the confined N aquifer began to recover (i.e., rise). The greatest recovery has been at BM-6, which is the USGS observation well that had experienced the greatest historical drawdown.

Considered to be of good to excellent quality, groundwater from the N aquifer is suitable for most uses. Generally, the groundwater contains less than 500 mg/L of TDS and rarely exceeds 1,000 mg/L TDS. Fluoride concentrations are generally less than the 4 mg/L maximum contaminant level (MCL) for drinking water.

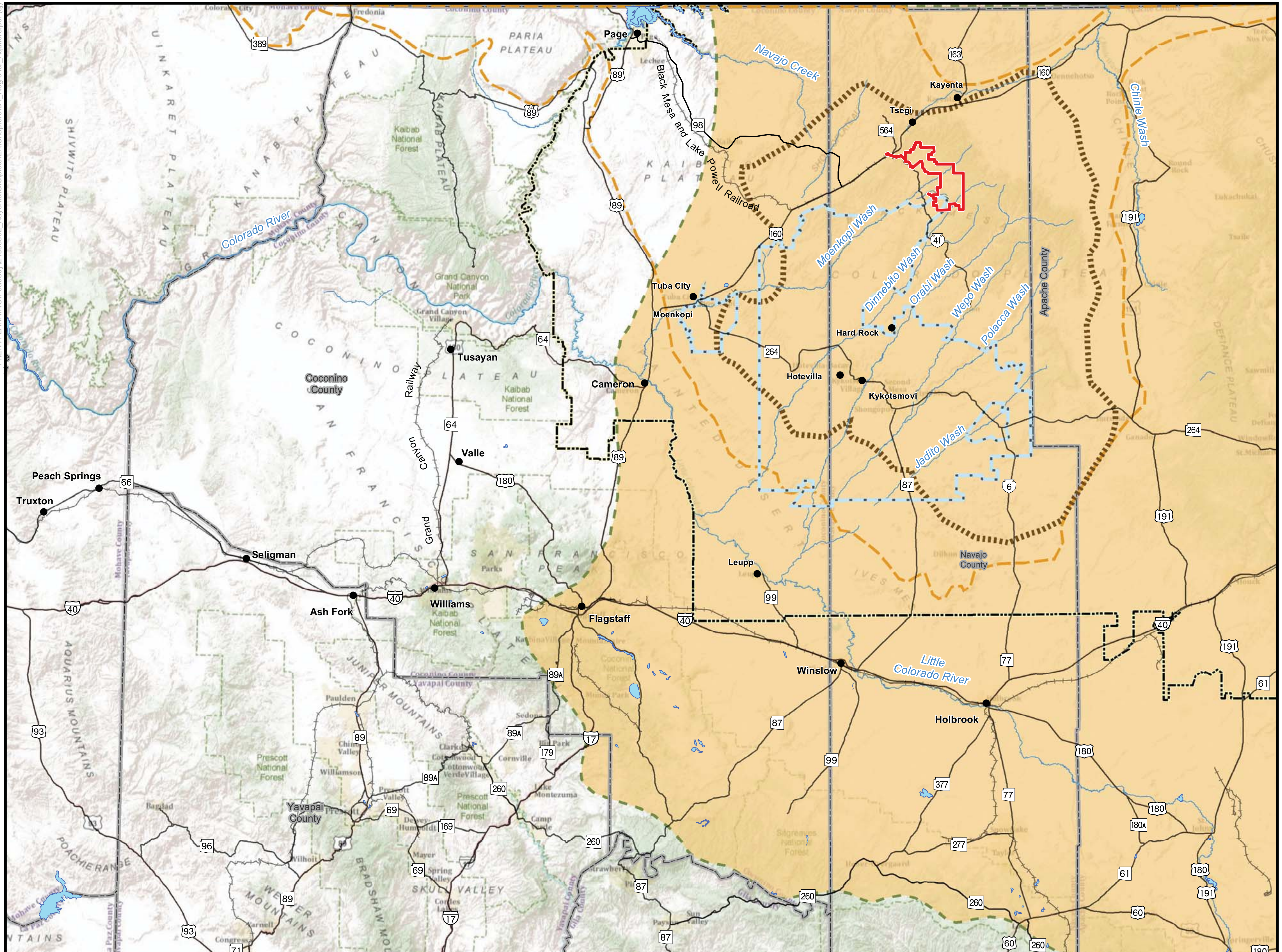
There is little or no leakage of groundwater from the N aquifer into the underlying C aquifer because approximately 1,000 feet of relatively impermeable Chinle and Moenkopi Formations occur between the two aquifer systems (ADWR 1989).

The D aquifer overlies and is separated from the N aquifer by the relatively impermeable Carmel Formation. The D aquifer provides limited water supply to the mine and local communities. The potential for leakage from the D aquifer because of groundwater pumping in the N aquifer is less in the area where the N aquifer is confined by the Carmel Formation than in areas where the Carmel Formation is thin or sandy (refer to Figure D-2). The thickness and lithology of the Carmel Formation are factors influencing groundwater leakage between the two aquifers. Areas where the Carmel Formation is less than 120 feet thick coincide with areas where water from the overlying D aquifer has over thousands of years mixed with underlying N aquifer water (Truini, Macy and Porter 2005).

Map D-4

Extent of Regional Aquifers

Kayenta Mine Permit Renewal EA



Legend

- Kayenta Mine Permit Area

Aquifer

- C Aquifer (Saturated)
- D Aquifer
- N Aquifer

General Feature

- Hopi Reservation Boundary
- Navajo Nation Reservation Boundary
- State Boundary
- County Boundary
- Lake
- Interstate/U.S. Highway/State Route
- Railroad
- Wash or Ephemeral Stream

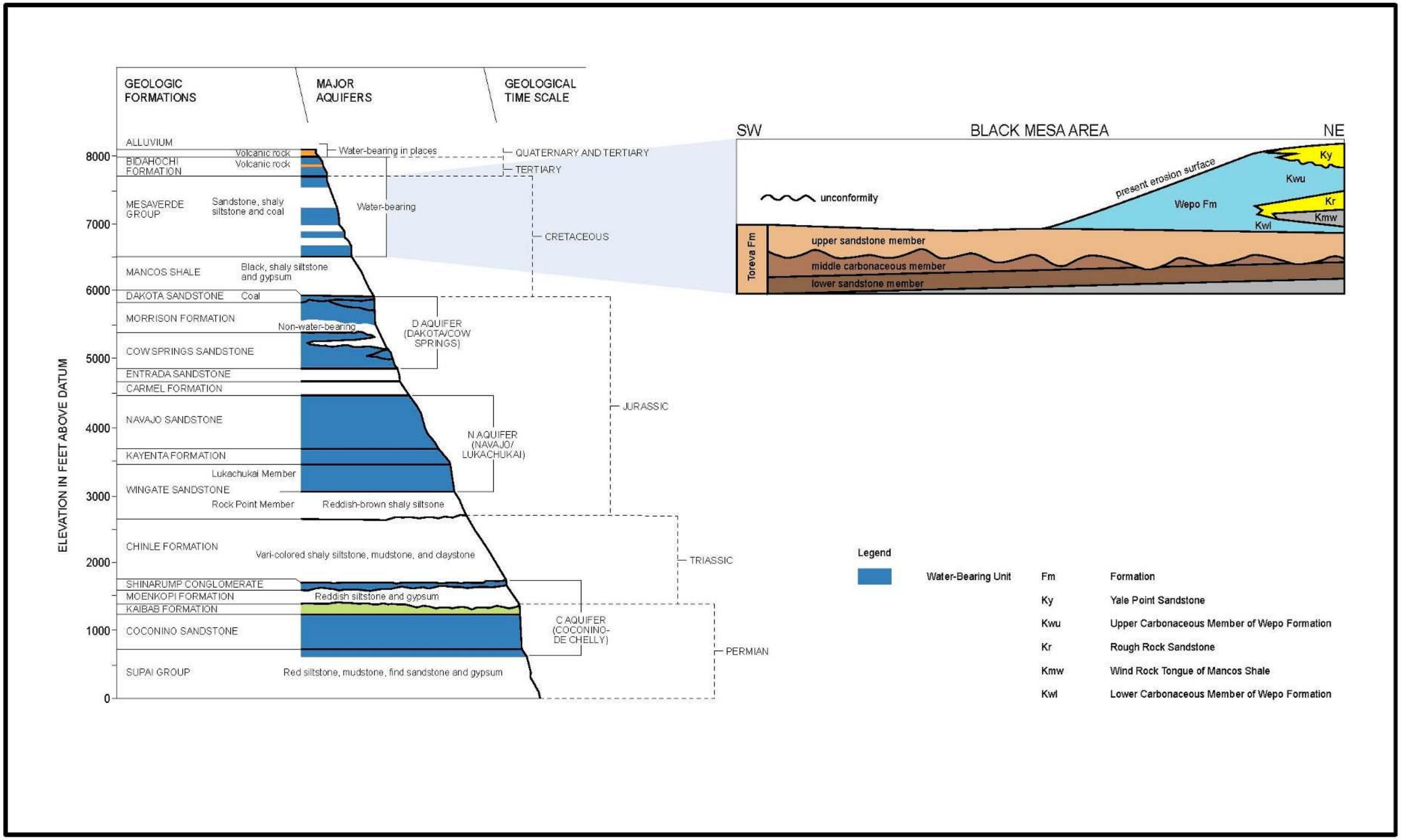
Source:
Base Map: Peabody Energy 2006
Stream: NHD 2008
C Aquifer: Bureau of Reclamation 2005
Aquifer: URS Corporation 2005, 2006
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 10 20 40
Miles

PWCC

URS



SOURCE: Modified from ADWR, 1989; Nations et. al., 2000

Figure D-1 Stratigraphic Column of Black Mesa Area

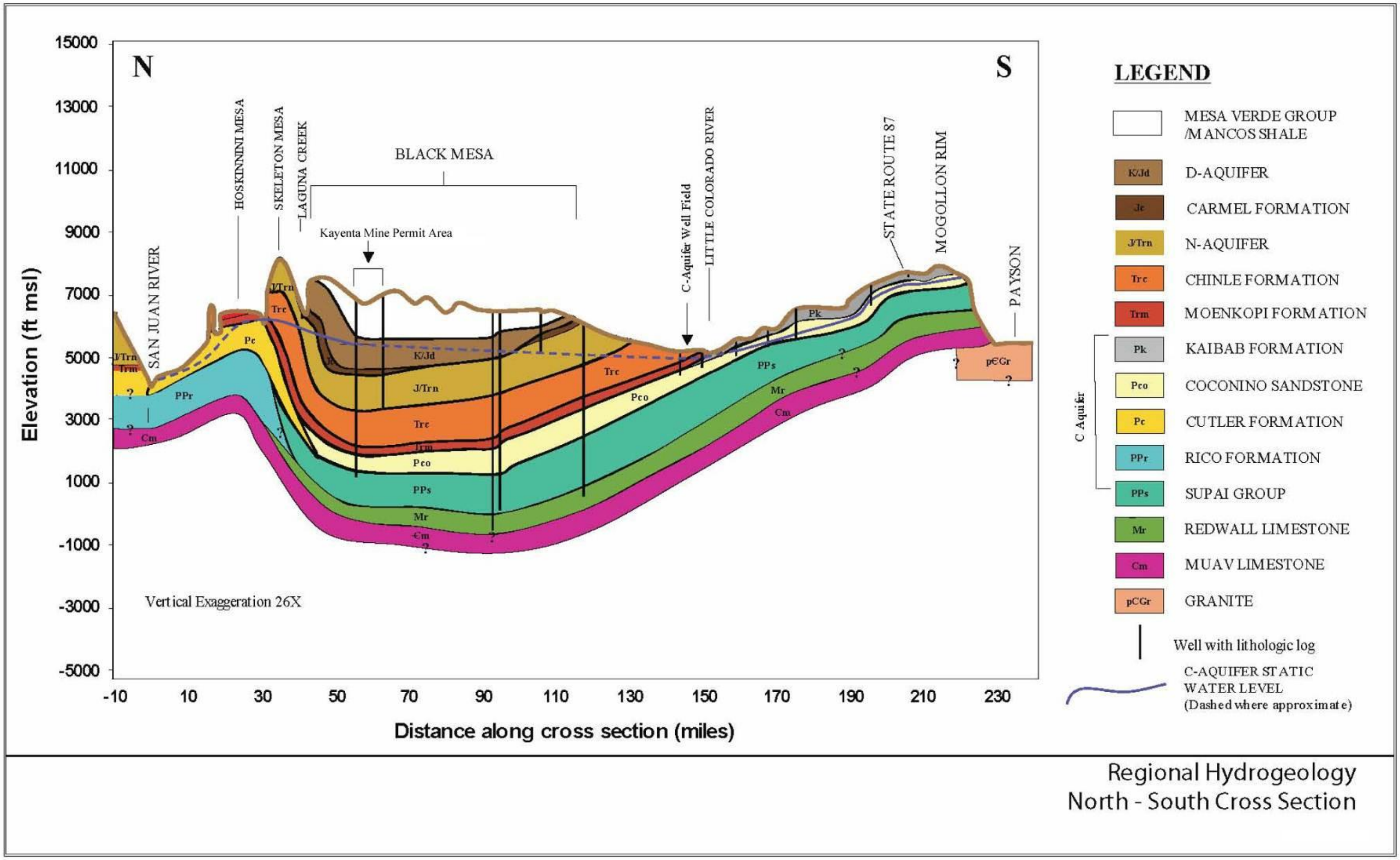


Figure D-2 Regional Hydrogeology

The D aquifer includes the Dakota Sandstone, the water-bearing portions of the Morrison Formation, and the Cow Springs Sandstone (see Figure D-1). Recharge generally occurs from precipitation along the eastern boundary of the D aquifer (see Map D-4). Groundwater flows south, west, and north and discharges as springs on the eastern and northern edges of the aquifer and into the alluvium of Polacca, Oraibi, and Dinnebito Washes along the southwest aquifer boundary, and Moenkopi Wash to the west. This discharge is consumed (i.e., transpired) by plants or lost to evaporation and is generally not seen as surface flow. The estimated saturated thickness of the D aquifer is roughly 500 feet; however, this also may include some variably saturated units within the Dakota and Morrison Formations.

Groundwater quality in the D aquifer is marginal to unsuitable for domestic use, although it may be acceptable for other uses. TDS concentrations range from 190 to 4,410 mg/L, generally exceeding the recommended limit of 500 mg/L for drinking water. Fluoride concentrations range from 0.2 to 9.0 mg/L and often exceed the MCL concentration of 4 mg/L. Water quality improves slightly in the southern portion of the D aquifer (ADWR 1989).

Infrastructure

PWCC Well Field

The N aquifer currently supplies the water for the mining operations in the Kayenta Mine permit area and the local communities. Used primarily for mining operations, the PWCC well field consists of eight wells that are located on the PWCC lease area (refer to Map D-2). The depth of these wells ranges from 3,417 feet to 3,733 feet bgs. Static (non-pumping) water levels in 2005 ranged from 945 to 1,374 feet bgs. These static well levels have recovered (risen and range from 932 to 1,264 feet bgs) due to the reduction in mine-related pumping over the past five years (2006-2010; PWCC 2010b). The reduction in pumping primarily occurred when use of the coal-slurry pipeline was discontinued in 2005.

Community Well Fields

The Bureau of Indian Affairs (BIA), Navajo Tribal Utility Authority (NTUA), and Hopi Tribe operate about 70 N aquifer wells combined into 28 well systems that supply water to several communities on Black Mesa. The closest communities to the PWCC well field are Forest Lake, Kitsillie, Chilchinbito, and Kayenta. The largest water users are Tuba City, Kayenta, and Shonto (Truini, Macy and Porter 2005). Well depths range from 475 feet bgs in the unconfined N aquifer near Tuba City to 2,600 feet bgs near Forest Lakes and Kitsillie in the confined N aquifer. Depth to water in 2009 ranged from 29 feet bgs (Tuba City) to 1,332 feet bgs (Kitsillie) (USGS 2010).

Water Withdrawal

The N aquifer currently supplies the majority of the water for the mining operations at the Kayenta Mine permit area. It also is used extensively by the Navajo Nation and Hopi Tribe as a public drinking supply. Total withdrawals from the N aquifer increased from about 70 to 8,000 af/yr from 1965 to 2002, with the major increase due to industrial pumping at the eight wells used for mining operations and the previously used coal-slurry pipeline. About 270 windmills produce about 65 af/yr of N aquifer water, primarily for watering livestock. In 2003, 5,800 af of water were withdrawn from the confined N aquifer, of which 4,450 af were attributed to operations at the Black Mesa and Kayenta Mines (USGS 1985-2005). The communities use the remaining water withdrawn. When use of the coal-slurry pipeline was discontinued in December 2005, PWCC's pumping declined. PWCC pumped approximately 1,171 af of water in 2010, a 3,279 af reduction in annual water use compared to 2003.

Groundwater pumping has occurred historically in the D aquifer. PWCC withdraws a minor amount of water from the D aquifer through its production wells, which are screened in both the N aquifer and D aquifer. Community pumping of the confined D aquifer accounts for an annual withdrawal of approximately 100 af.

D.2.3 Vegetation

The Kayenta Mine permit area and Black Mesa are located within the Great Basin conifer woodland biotic province and the Colorado Plateau physiographic province (AGFD 2006; Brown 1994; Reichenbacher et al. 1998). Detailed vegetation data, including baseline vegetation sampling of the coal-resource areas, were collected between 1979 and 1983, and supplemental baseline sampling has been performed at various times thereafter (BIOME 2003 and ESCO Associates 2000a, 2000b, 2003, 2010). The study area for vegetation includes the area that overlays the Black Mesa coal field (see Map A-1 for the extent of the coal field). This area contains canyons, mesas, and plains with precipitation ranging from 5 to 30 inches per year. Most precipitation falls as snow during the winter season. Elevation, temperature extremes, landforms, and local precipitation patterns influence the development of the various plant communities within the study area (AGFD 2006). Table D-5 provides the acres of the vegetation communities and land cover types within the study area. These acres were estimated based on GIS calculations derived from the Southwest ReGAP landcover data (USGS National Gap Analysis Program 2004) and Brown et al. (2007).The Kayenta Mine permit area and nearby vicinity include five plant communities: mixed-conifer, piñon/juniper woodland, sagebrush shrubland, saltbush and greasewood shrubland, and tamarisk dominated riparian and disturbed areas (Map D-5). A reclaimed plant community occurs where previously mined areas have been backfilled, graded, topsoil added to the surface, and revegetated.

Table D-5 Vegetation Communities and Landcover in the Study Area

Vegetation Community	Acres	Percent
Riparian[1]	20	<1
Water	130	<1
Mixed Conifer	12,500	1
Disturbed[2]	19,500	1
Sparse Vegetation[3]	144,200	8
Saltbush and Greasewood Shrubland	258,500	14
Sagebrush Shrubland	464,700	25
Piñon-juniper Woodland	950,400	51
Total	1,849,950	100

SOURCE: USGS SWReGAP 2004
NOTES: [1] Includes riparian areas dominated by tamarisk
[2] Includes developed areas, agricultural areas and previously mined or quarried reclaimed areas
[3] Includes cliff and canyon areas, sand dunes and other areas where vegetation cover is low.

Mixed Conifer. The mixed conifer vegetation community is mostly evergreen needle-leafed forest with patches of broadleaf deciduous trees. Tree cover varies from 50 percent to 80 percent cover, with the cover by understory shrubs decreasing relative to increasing shade from the tree canopy. Within the study area, mixed conifer vegetation occupies approximately 12,500 acres (1 percent of the total acres). Mixed conifer vegetation occurs north and east of but not within the Kayenta Mine permit area.

Common tree species include Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*), with lesser numbers of white fir (*Abies concolor*), spruce (*Picea* spp.), and aspen (*Populus tremuloides*). Important understory trees and shrubs in mature stands include Gambel's oak (*Quercus gambelii*), New Mexico locust (*Robinia neomexicana*), Rocky Mountain maple (*Acer glabrum*), Bigtooth maple (*A. grandidentatum*), and Saskatoon serviceberry (*Amelanchier alnifolia*).

Piñon-juniper Woodland. Within the Kayenta Mine permit area, piñon-juniper woodland is the most common plant community and occupies approximately two-thirds of the undisturbed land in the Kayenta Mine permit area(Map D-5) and about 51 percent of the land in the larger study area (Table D-5). Piñon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) are the common over-story tree species. Common under-story shrubs include big sagebrush (*Artemisia tridentata*), four-wing saltbush (*Atriplex canescens*), Mexican cliffrose (*Cowania mexicana*), Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), and rubber rabbitbrush (E*ricameria nauseosa*) (Brown 1994). Grasses and forbs provide a small amount of cover, with the most common of these being bottlebrush squirreltail (*Sitanion hystrix*), Indian ricegrass (*Oryzopsis hymenoides*), and muttongrass (*Poa fendleriana*) (Brown 1994).

Total vegetation cover is low, often less than 22 percent. Some piñon-juniper stands appear to have very little understory vegetation, while others have a lesser presence of shrubs (Jacobs 2008). Piñon-juniper woodland has extensive areas of bare soil, rock, and litter below trees (Brown 1994). This vegetation community occurs at an elevation range of 6,300 feet (1,920 m) to over 7,200 feet (2,195 m) in the mine area.

Sagebrush Shrubland. Sagebrush shrubland is the second most common vegetation type in the Kayenta Mine permit area, covering close to a third of the undisturbed land (Map D-5) and about 25 percent of the land area in the larger study area (Table D-5). This community occurs on deeper soils that develop in flatter areas and in valley bottoms. Total vegetation cover is often less than 20 percent with low rock cover and sparse understory vegetation (Brown 1994). Sagebrush shrubland usually occurs up to 7,000 feet (2,134 m) in elevation on Black Mesa. Above that elevation, it often is interspersed with piñon-juniper woodland. Within the study area, sagebrush shrubland occupies approximately 464,700 acres (21 percent of the total acres).

Sagebrush shrubland is dominated by big sagebrush and blue grama (*Bouteloua gracilis*) (Brown 1994). Other common shrub species include four-wing saltbush, Douglas rabbitbrush, Greene's rabbitbrush (*Chrysothamnus greenei*), and rubber rabbitbrush (Brown 1994). Blue grama and galleta (*Hilaria jamesii*) are the common warm-season grasses in this plant community. Cool-season grasses are less common and include big squirreltail (*Sitanion jubatum*), bottlebrush squirreltail, needle and thread (*Stipa comata*), Indian ricegrass, and western wheatgrass (*Agropyron smithii*).

Saltbush and Greasewood Shrublands. Saltbush and greasewood shrublands are two additional upland shrub communities that occupy relatively small, linear areas along washes in the study area and Kayenta Mine permit area (Map D-5). These shrublands grow on the margins of terraces associated with the higher order drainages. The terraces typically lie 5 to 20 feet (1.5 to 6 m) above a wash channel where saline-alluvial soil has accumulated. Four-wing saltbush dominates the saltbush community, and greasewood (*Sarcobatus vermiculatus*) dominates the greasewood community (Brown 1994). Annual forbs and grasses form sparse to dense understories (Brown 1994). Within the study area, saltbush and greasewood shrubland occupy approximately 258,506 acres (14 percent of the total acres).

Disturbed Lands. Within the study area, the disturbed landcover occupies approximately 19,500 acres, including the 11,670 acres of reclaimed land within the Kayenta Mine permit area (see Map D-5). Vegetation cover in reclaimed lands is usually higher than in native vegetation types and other disturbed lands, averaging 23 percent (BIOME 2003 and ESCO Associates 2000a, 2000b, 2003). Rock cover is low, but litter cover is high (BIOME 2003 and ESCO Associates 2000a, 2000b, 2003).

Native and introduced grasses and native shrubs dominate reclaimed lands in the Kayenta Mine permit area. Cool-season native grass species include western wheatgrass, thickspike wheatgrass (*Agropyron dasystachyum*), Indian ricegrass, needle and thread, big squirreltail, and bottlebrush squirreltail; and common warm-season native grass species include blue grama, galleta, and alkali sacaton (*Sporobolus airoides*). The most abundant introduced perennial grass species is Russian wildrye (*Elymus junceus*). Crested wheatgrass (*Agropyron desertorum*) and intermediate wheatgrass (*Agropyron intermedium*) also are present. Four-wing saltbush is the dominant shrub species, but several other species are common. Fourwing saltbush is long-lived, spreads primarily by seed dispersal, and could slowly spread into reclamation areas from adjoining plant communities (USDA 2011). Several weedy annuals occur primarily in newer reclamation areas; these include kochia (*Kochia scoparia*), Russian thistle (*Salsola iberica*), and cheatgrass (*Bromus tectorum*).

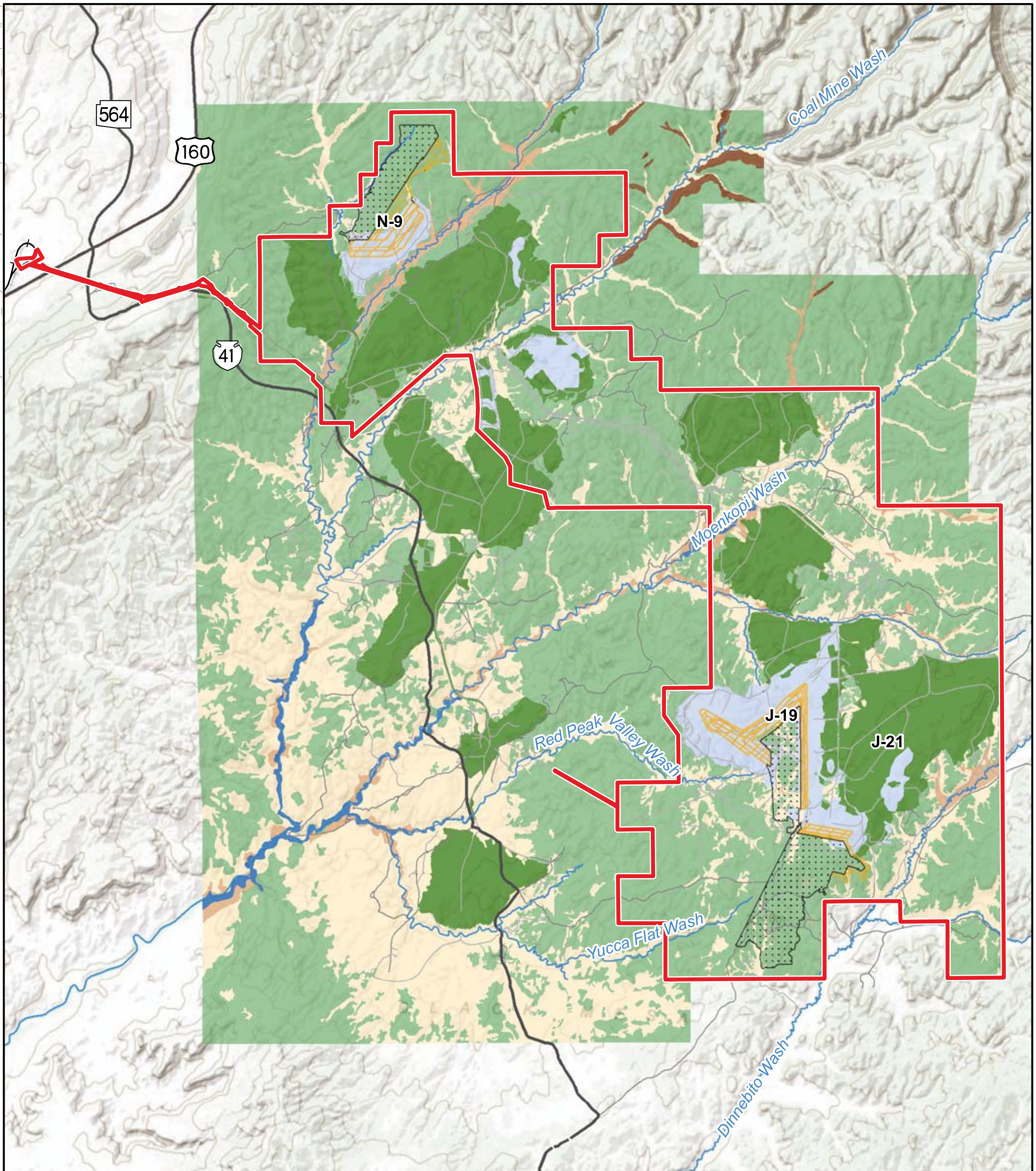
Riparian Vegetation and Aquatic Plants. Riparian vegetation occurs along major drainage ways, forming linear bands of vegetation within the study area. These form patches that are typically between 10 feet and 20 feet (3 meters and 6 meters) wide and from a few yards (meters) to more than 0.5 mile (800 meters) long. This vegetation occurs on the bottoms of the washes and typically occupies the depositional side of a channel. In the study area, surface water in riparian areas usually is ephemeral but short reaches of intermittent streams are sometimes present.

Tamarisk (*Tamarix* sp.) dominates in riparian vegetation within the Study Area. Small amounts of greasewood and four-wing saltbush associate with tamarisk in drier areas. Coyote willow (*Salix exigua*) occurs with tamarisk in wetter areas. Herbaceous understory vegetation is limited and is often composed of cheatgrass, European alkali grass (*Puccinellia distans*), stickseed (*Lappula occidentalis*), and desert seepweed (*Suaeda torreyana*). The largest areas of riparian vegetation occur in Yellow Water Canyon, Moenkopi Wash, and Dinnebito Wash south of the Kayenta Mine permit area (Map D-5). Riparian vegetation occupies only about 20 acres in the study area.

In the Kayenta Mine permit area, aquatic plants are limited to some impoundments, which include freshwater ponds, sediment ponds, and internally draining ponds in reclaimed areas. Some of the larger impoundments have emergent wetland plants along the margin, including tamarisk, coyote willow, bulrush (*Scirpus acutus*) and cattail (*Typha latifolia*). Submergent aquatic plants include common poolmat (*Zanichellia palustris*), pondweeds (*Potamogeton filiformis* and *P. pectinata*), and holly-leafed water nymph (*Najas marina*). The only non-microscopic alga that is found in most ponds is a type of green algae (*Chara sp*.).

D.2.3.1 Noxious Weeds and Invasive Plant Species

A number of noxious weed or invasive plant species are known or expected to occur in the Kayenta Mine permit area. Potential noxious weeds include common purslane (*Portulaca oleracea*), diffuse knapweed (*Centaurea diffusa*), field bindweed (*Convolvulus arvensis*), puncture vine (*Tribulus terrestris*), Russian knapweed (*Acroptilon repens*), and Scotch thistle (*Onopordum acanthium*). Common purslane and bull thistle are reported from the mine permit area (BIOME 2003). Weedy invasives occurring or potentially occurring in the Kayenta Mine permit area include tamarisk, bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), kochia, Russian thistle, and cheatgrass (California Information Node 2010; ESCO Associates 2003; USGS 2004). At the Kayenta mine, these species, with the exception of tamarisk, are ubiquitous, early successional weedy species found in newly reclaimed and disturbed areas that diminish as perennial vegetation develops and out-competes these species. The vegetation management program monitors and treats annual weeds (see Appendix A). The other areas with noxious weeds and invasive plants are mostly found along U.S. Highway 160 and Indian Route 41 and could potentially spread into the Kayenta Mine permit area (California Information Node 2010; USGS 2007).



Legend

- Kayenta Mine Permit Area
- Permit Renewal Period Mine Area
- Future Mine Area
- Highway
- PWCC Mine Road
- Railroad
- Wash or Ephemeral Stream

Vegetation Type

- Mixed Conifer
- Piñon-Juniper Woodland
- Sagebrush Shrubland
- Saltbush and Greasewood Shrubland
- Tamarisk Riparian Shrubland
- Reclaimed Lands
- Disturbed

Source:
Base Map: ADOT 2009, PWCC 2010
Streams: NHD 2008
Vegetation: PWCC 2011
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 1 2
Miles

Map D-5

Vegetation Communities

Kayenta Mine Permit Renewal EA

PWCC URS

D.2.3.2 Special Status Plant Species

Special status plant species considered for analysis included federally listed species under the Endangered Species Act, endangered species listed by the Navajo Nation, and plants listed under the Arizona Native Plant Laws. The analysis of threatened, endangered, and special status species included review of U.S. Fish and Wildlife Service (USFWS) county lists (USFWS 2010), the Navajo Nation endangered species list (Navajo Nation Department of Fish and Wildlife [NNDFW] 2008), Navajo Natural Heritage Program (NNHP) endangered species accounts (2008), Arizona Natural Heritage Program lists (Arizona Game and Fish Department [AGFD] 2010), and evaluation of habitats and ranges of the species. Special status plants and animals considered for analysis are presented in Appendix C.

There are no federally listed, proposed, or candidate plant species known or expected to occur within the Kayenta Mine permit area. No plants listed as endangered by the Navajo Nation occur in the Kayenta Mine permit area. Traditional Navajo and Hopi collect numerous species of plants for food, materials for making craft items, and for use in rituals and ceremonies. No populations of highly restricted plant species used for traditional purposes have been identified within the permit area.

Navajo Sedge. The Navajo sedge (Carex specuicola) is a perennial plant found in springs and seeps associated with hanging gardens, on vertical sandstone cliffs and alcoves comprised of Navajo sandstone (NNHP 2008). The species is confined to higher elevations that generally support Great Basin conifer forests and woodlands (NNHP 2008). The Navajo sedge was federally listed as threatened with critical habitat in 1985.

Navajo sedge has limited distribution in the region surrounding the Kayenta Mine permit area. The species does not occur, nor does any potential habitat exist, within the Kayenta Mine permit area. The only known populations potentially affected by the proposed action include the Tsegi Canyon population, about 12 miles north of the N-9 coal resource area, and the population where Moenkopi Wash and Ho No Geh Canyon overlap the unconfined portion of the N aquifer.

Alcove bog-orchid. The alcove bog-orchid (Platanthera zothecina) also is a perennial plant found in the same types of habitats as the Navajo sedge (NNHP 2008). The Navajo Nation lists the alcove bog orchid as a Group 3 (G3) endangered species (NNHP 2008). Group 3 designates a species or subspecies whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future. The alcove bog-orchid sedge has limited distribution in the region surrounding the Kayenta Mine permit area. The species does not occur, nor does any potential habitat exist, within the Kayenta Mine permit area. The closest population is approximately 12 miles north of the Kayenta Mine permit area in Tsegi Canyon and is associated with seeps and springs originating from the unconfined portion of the N aquifer.

D.2.4 Fish and Wildlife

The study area for fish and wildlife includes Black Mesa and the Kayenta Mine permit area containing the four vegetation communities described in Section D.2.3. This area of northern Black Mesa is approximately 2 million acres (Brown et al. 2007, LaRue 1994).

D.2.4.1 Fish and Wildlife Resources

Wildlife populations on Black Mesa and within the Kayenta Mine permit area reflect the diversity of available vegetation and landscape habitat features. Landscape features such as washes, rock formations, the hillside slope and aspect, alcoves and cave entrances, and ponds produce a variety of habitats and in turn, influence the natural and reclaimed land communities that contribute to the available habitats. Combined, these features and the vegetation communities support a diverse mix of wildlife in the area by providing a complex of micro and macro habitats for which species are adapted to or dependent on. Piñon-juniper habitat predominates in the Kayenta Mine permit area (>50 percent), with the remaining somewhat evenly split between sagebrush shrubland and reclaimed lands.

Wildlife baseline studies were conducted in 1979 through 1983 (PWCC 1992) and updated in 2003 (BIOME 2003). Annual wildlife monitoring is conducted in the Kayenta Mine permit area and supports baseline studies, documents wildlife population characteristics, and monitors for special status species.

Twenty-six mammal species were recorded in the PWCC lease area, which encompasses the Kayenta Mine permit area, during the 1979 to 1983 and 2003 wildlife studies. Two additional mammal species were observed during monitoring in 2008 (EMI 2009). Big game species, while present are not abundant. A 1979-1980 census for game species recorded two observations of mule deer (*Odocoileus hemionus*), both north of the PWCC lease area. In 2003, ten mule deer and numerous pellet groups of mule deer and elk (*Cervus elaphus*) were observed during biological surveys for birds and threatened and endangered species (BIOME 2003). More recent monitoring has documented the presence of elk, mule deer, white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), and coyote (*Canis latrans*) within the Kayenta Mine permit area (EMI 2009, EMI 2010). Increased elk presence has coincided with the increased reclaimed land vegetation.

Sagebrush shrublands and piñon-juniper woodlands support the largest variety of mammal species. Deer mice (*Peromyscus maniculatus*) are one of the most common species observed in the Kayenta Mine permit area, both in native and reclaimed lands. Also common are ground squirrels (*Ammospermophilus spp.*). Piñon-juniper woodland supports piñon-mice (*Peromyscus truei*), brush mice (*Peromyscus boylii*), Ord’s kangaroo rat (*Dipodomys ordii*), Stephen’s woodrat (*Neotoma stephensi*), and Colorado chipmunk (*Tamias quadrivittatus*). Gunnison’s prairie dogs (*Cynomys gunnisoni*) occur in low statured, sparse cover shrubland habitats adjacent to the Kayenta Mine permit area. Black-tailed jackrabbits (*Lepus californicus*) and desert cottontails (*Sylvilagus audubonii*) occur in all habitats within the Kayenta Mine permit area, as do coyotes, red foxes, and gray foxes.

Bat studies were conducted in 1999 in reclaimed lands and piñon-juniper within and adjacent to the Kayenta Mine permit area (SWCA Environmental Consultants 2000). Nine bat species were identified including the big brown bat (*Eptesicus fuscus*), long-legged myotis (*Myotis volans*), silver haired bat (*Lasionyctris noctivagans*), pallid bat (*Antrozous pallidas*), fringed myotis (*Myotis thysanodes*), Mexican free-tailed bat (*Tadarida brasiliensis*), big free-tailed bat (*Nyctinomops macrotis*), canyon bat (*Parastrellus hesperus*), and an unknown myotis species. Only the first six species were found in the piñon-juniper habitat, but all nine species were found in the reclaimed lands.

Bird surveys have recorded 235 bird species in the PWCC lease area, more than half of which are known to or potentially nest in the area (LaRue 1994). The highest number of birds and the greatest diversity of species have been observed in summer, partly due to fledged offspring and species that are breeding residents only (LaRue 1994 and BIOME 2003). Ongoing monitoring continues to document these trends (EMI 2009).

Raptor studies in the 1980s recorded a total of 22 raptor species with nine of those likely to nest in the Kayenta Mine permit area. Red-tailed hawks (*Buteo jamaicensis*) were the most abundant raptor species; Cooper's hawks (*Accipiter cooperii*) and sharp-shinned hawks (*Accipiter striatus*) were relatively common in coniferous woodland habitats. Later raptor surveys in 2003 recorded American kestrel (*Falco sparverius*) and Cooper's hawk. A historic red-tailed hawk nest remained inactive in 2003 (BIOME 2003). Two active red-tailed hawk nests were documented in the Kayenta Mine permit area in 2009 (EMI 2010). Other less common species that may breed include northern goshawk (*Accipiter gentilis*), prairie falcon (*Falco mexicanus*), western screech owl (*Otus kennicottii*), great horned owl (*Bubo virginianus*), northern pygmy owl (*Glaucidium gnoma*), and long-eared owl (*Asio otus*). Comprehensive raptor studies have been conducted on and adjacent to the Kayenta Mine permit area for red-tailed hawk, peregrine falcon (*Falco peregrinus*), and Mexican spotted owl (*Strix occidentalis lucida*). The results have been documented and reported to OSM.

A high diversity of migratory waterfowl and shorebirds utilize many of the larger impoundment ponds in the Kayenta Mine permit area. Mallards (*Anas platyrhynchos*) are likely the only nesting species, though redheads (*Aythya americana*), ruddy ducks (*Oxyura jamaicensis*), and American coots (*Fulica americana*) also may nest in the vicinity (Corman and Wise-Gervais 2005). Many other species may utilize the ponds during migration such as the eared grebe (*Podiceps nigricollis*), great blue heron (*Ardea herodias*), blue-winged teal (*Anas discors*), green-winged teal (*Anas crecca*), cinnamon teal (*Anas cyanoptera*), northern shoveler (*Anas clypeata*), gadwall (*Anas strepera*), American wigeon (*Anas americana*), and lesser scaup (*Aythya affinis*) (Corman and Wise-Gervais 2005). Killdeer (*Charadrius vociferous*) is the only shorebird that may nest in the Kayenta Mine permit area (Corman and Wise-Gervais 2005). All of these species have been observed in baseline studies and annual wildlife monitoring for the Kayenta Mine permit area.

Reptile and amphibian species observed during baseline studies from 1979 to 1983 and during the 2003 field reconnaissance include whiptail lizard (*Aspidoscelis* spp.), collared lizard (*Crotaphytus collaris*), sagebrush lizard (*Sceloporus graciosus*), fence lizard (*Sceloporus undulatus*), short-horned lizard

(*Phyrnosoma douglassi),* side-blotched lizard (*Uta stansburiana*), gopher snake (*Pituophis melanoleucus)*, western rattlesnake (*Crotalus viridis*), western spadefoot toad (*Scaphiopus hammondi*), Woodhouse's toad (*Bufo woodhousei)*, and red-spotted toad (*B. graciosus*) (BIOME 2003 and PWCC 1992).

D.2.4.2 Special Status Animal Species

Special status species considered for analysis included federally listed species under the Endangered Species Act, endangered species listed by the Navajo Nation, and wildlife species of concern tracked by AGFD. The analysis of special status species included reviews of USFWS county lists (USFWS 2010), the Navajo Nation endangered species list (NNDFW 2008), Navajo Nation Natural Heritage Program Endangered Species Accounts (NNHP 2008), Arizona Natural Heritage Program lists (AGFD 2010), and evaluation of habitats and ranges of the species. As described in the following species and habitat descriptions, there are no federally listed, proposed, or candidate animal species known or expected to occur within the PWCC mine lease area due to the lack of suitable habitats.

California Condor. The California condor (*Gymnogyps californianus*) is federally listed as an endangered species, and the reintroduced population in Arizona is managed as a threatened species outside the reintroduction area. It is listed as a Group 4 endangered species by the Navajo Nation (Group 4: lacks information to list as Group 2 or Group 3 endangered species, but the NNDFW has reason to consider listing).

The California condor is a species that utilizes canyon country and mountainous habitats for nesting and roosting, and can forage widely in a variety of habitats around these areas (NNHP 2008). The reintroduced population in Arizona has been expanding its foraging range to the north and northeast of its release site near the Grand Canyon and has not utilized areas south of the Grand Canyon since around 2000 (URS personal communication April 2010). This may represent a natural pattern related to the scarcity of carrion from big game. It is unlikely that California condors will utilize the Kayenta Mine permit area as a foraging site, but livestock and big game in the area could provide a limited carrion source.

Mexican Spotted-Owl. The Mexican spotted-owl (MSO) (*Strix occidentalis lucida*) is federally listed as a threatened species. It also is listed as a G3 endangered species by the Navajo Nation. MSOs occupy a variety of habitats for breeding and foraging. Breeding habitat includes dense old-growth mixed conifer forests along steep slopes and ravines (AGFD 2005). Within this habitat, the trees are dense, and form a closed canopy with a high basal area. The ground often is littered with numerous downed logs and snags. The large trees provide suitable nest cavities; whereas, the numerous smaller trees in combination with large trees provide roosting and foraging habitat (AGFD 2005).

The MSO is a year-round resident of the northeastern part of Black Mesa (BIOME 2003). As part of the Kayenta Mine permit, PWCC conducts ongoing monitoring surveys for the species whenever mining activities will occur within two miles of potential habitat for the owl pursuant to OSM and NNDFW requirements. Initial surveys were conducted between 1982 and 2000 and upon discovery of the species by PWCC, subsequent intensive surveys were conducted between 1994 and 2000 as required in the Kayenta Mine permit. Suspension of the annual surveys occurred in conjunction with completion of mining in the northern part of the Kayenta Mine permit area within the buffer zone. Consistent with OSM and NNDFW requirements and using USFWS survey protocols, monitoring for MSOs resumed in spring 2011 in advance of mining in the N-9 coal resource area because mining will soon advance into the established 2-mile sensitivity area. As per the OSM permit requirements, PWCC contracts professional biologists that are certified in USFWS monitoring protocols to conduct monitoring in the areas within a 2-mile radius north and east of the N-9 coal resource area.

The results of the annual surveys indicated that nesting occurs in mixed-conifer habitats, and active protected activity centers (PACs) are within the two-mile buffer around the northeastern portion of the Kayenta Mine permit area (BIOME 2003). Survey results have shown that the closest MSO detections to actively mined areas have been within two miles northeast of the Kayenta Mine area in upper Yellow Water Canyon, the side canyons of Coal Mine Wash, and upper Moenkopi Wash (BIOME 2003). No records or habitat of MSOs occur elsewhere in the vicinity of the Kayenta Mine permit area.

There have been no previous data to suggest that MSOs use the reclaimed mine areas or adjacent undisturbed piñon-juniper woodlands in the Kayenta Mine permit area. Development of the N-9 mining area will be within about 2 to 4 miles of known PACs in Yellow Water Canyon.

Southwestern Willow Flycatcher. The southwestern willow flycatcher (*Empidonax traillii extimus*) is federally listed as an endangered species and is listed by the Navajo Nation as a Group 2 endangered species. Group 2 designates a species or subspecies whose prospects of survival or recruitment are in jeopardy.

The southwestern willow flycatcher is a Neotropical migrant that nests in the United States, typically from April to August (NNHP 2008). It utilizes dense stands of riparian vegetation that have a layered canopy and are next to or are flooded by perennial sources of water (NNHP 2008). The primary vegetation can either be native blocks of cottonwood and willow or non-native stands of tamarisk or Russian olive (*Elaeagnus angustifolia*) that are taller than 3 meters (10 feet) (NNHP 2008).

Willow flycatchers have been documented on Black Mesa during migration, but the subspecies has not been definitely identified (BIOME 2003). Potential migration habitat is present in the Kayenta Mine permit area where larger blocks of tamarisk occur in Yellow Water Canyon Wash, Moenkopi Wash, and Dinnebito Wash (BIOME 2003). No critical habitat occurs within or adjacent to the Kayenta Mine permit area.

Black-Footed Ferret. The black-footed ferret (*Mustela nigripes*) is listed as an endangered species and was considered extinct in the wild after the last known population was removed from the wild in 1987 near Meeteetse, Wyoming. It has since been reintroduced to numerous sites in the western United States, Canada, and Mexico following a successful captive breeding program. Two release sites are in Arizona—

one north of Williams and one near Seligman. These are categorized as non-essential experimental populations. It is listed as a G2 species by the Navajo Nation.

Black-footed ferrets are highly specialized predators that depend on prairie dogs for food and shelter. More than 90 percent of the ferrets' diet is made up of prairie dogs. Ferrets live in prairie dog towns, nest in prairie dog burrows, and usually forage in the tunnel complexes of prairie dogs. Although Gunnison's prairie dogs occur near the Kayenta Mine permit area, the colonies remain too small to support a population of black-footed ferrets (BIOME 2003).

Prairie dog colonies within and adjacent to the Kayenta Mine permit area are censused and reported on annually. There has been no indication of the presence of black-footed ferrets, and habitat conditions remain unsuitable for ferrets within this area (EMI 2010).

Sora. The sora (*Porzana carolina*) is listed as a G4 endangered species by the Navajo Nation. It also receives protection under the Migratory Bird Treaty Act. The sora inhabits a variety of natural and man-made wetland habitats (Corman and Wise-Gervais 2005). Suitable habitat has dense emergent vegetation, and shallows are needed for adequate foraging (Corman and Wise-Gervais 2005).

The closest breeding site to the Kayenta Mine permit area is about 70 miles southwest near Tuba City (Corman and Wise-Gervais 2005). However, potential habitat exists at impoundments within the Kayenta Mine permit area. LaRue (1994) described the location of seven records of soras at various impoundments within the PWCC lease area. These likely are limited as stop-over habitat during migration (LaRue 1994).

Bald Eagle. The bald eagle (*Haliaeetus leucocephalus*) is listed by the Navajo Nation as a G2 species. It has been de-listed as a federally threatened species but remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. In Arizona, bald eagles typically nest in riparian areas with mature trees, particularly large mature cottonwoods that are adjacent to large bodies of water (major rivers, lakes, or reservoirs) with abundant prey (large fish and waterfowl) (NNHP 2008). Winter roost sites occur in the same type of large mature trees, but can include mature pine forests as well as riparian river bottoms, or canyon rims (NNHP 2008). Winter roost areas are typically used by a congregation of bald eagles and are usually within a few miles of a foraging site – a large lake or river with adequate prey (NNHP 2008).

The Kayenta Mine permit area lacks adequate breeding and winter roosting habitat because fish bearing ponds and impoundments are limited in the mine complex and offer a limited foraging resource (BIOME 2003). It is speculated that bald eagles also could forage on the occasional livestock or game carrion in the area (BIOME 2003). Bald eagles have been observed infrequently as early winter transients near the Kayenta Mine permit area. Individuals have been seen at temporary perch sites located in Coal Mine Wash, Moenkopi Wash, lower Yellow Water Canyon Wash, and in the vicinity of the J7-R and N1-RA permanent impoundments (see Map D-3) (BIOME 2003).

Golden Eagle. The golden eagle (*Aquila chrysaetos*) is listed as a G3 endangered species by the Navajo Nation. The species also receives protection under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The golden eagle typically inhabits mountainous terrain and canyon country where it nests on steep cliffs, typically more than 30 meters (98 feet) in height (NNHP 2008). Nesting cliffs are normally directly adjacent to foraging habitat that provides the primary prey of cottontails and jackrabbits (NNHP 2008). Perch sites can occur in tall trees or on structures that occur in habitat otherwise only suitable for foraging. The species has been documented from the north end of Black Mesa at Lolomai Point and Kayenta Point, and golden eagles occasionally utilize the Kayenta Mine permit area for foraging (EMI 2010). The most recent record was on April 12, 2009 of an individual seen following a northern harrier (*Circus cyaneus*) along the main drainage in the J-16 coal resource area (EMI 2010).

Ferruginous Hawk. The ferruginous hawk (*Buteo regalis*) is listed as a G3 species by the Navajo Nation. It also receives protection under the Migratory Bird Treaty Act. The ferruginous hawk is an open-country inhabitant in western North America. The species occurs in grasslands, sagebrush scrub, saltbush-greasewood shrubland, and the periphery of piñon-juniper and other western forests (Bechard and Schmutz 1995). The ferruginous hawk usually avoids dense montane forests, aspen parkland, and habitats recently altered by agricultural cultivation (Bechard and Schmutz 1995). It typically forages on rabbits (*Lepus* spp.), ground squirrels (*Spermophilus* spp.), and prairie dogs (*Cynomys* sp.) (Bechard and Schmutz 1995). It nests on a variety of elevated sites and structures in the landscape that are typically less than 30 meters (98 feet) above the ground.

The ferruginous hawk is an occasional visitor to the Kayenta Mine permit area (BIOME 2003). Potential foraging habitat occurs in and adjacent to revegetated areas and in prairie dog colonies in this area.

Northern Goshawk. The northern goshawk (*Accipter gentilis*) is listed as a G4 endangered species by the Navajo Nation. It also receives protection under the Migratory Bird Treaty Act. The northern goshawk inhabits a variety of mature forest types in North America (Kennedy 2003). In the West, it typically nests in mature ponderosa or mixed-conifer forests with high canopy closure and moderately steep slopes (Kennedy 2003). Adjacent foraging habitat has a similar structure but may require a less dense understory (Kennedy 2003). Wintering and post-fledgling habitats are more variable, less dependent on tree density, and more dependent on the availability of prey (Kennedy 2003).

The northern goshawk has been documented at several sites on the northeastern end of Black Mesa (BIOME 2003). One nesting record has been reported from this area, but the northern goshawk seems to be more common on Black Mesa during the winter months (BIOME 2003). The nearest sighting of a northern goshawk to the Kayenta Mine permit area has been a possible breeding female located about 2 miles north of the site (BIOME 2003). Potential habitat for the species occurs in the N-9 mining area (BIOME 2003).

Peregrine Falcon. The peregrine falcon (*Falco peregrinus*) is listed as a G4 endangered species by the Navajo Nation. The species also receives protection under the Migratory Bird Treaty Act. The peregrine falcon nests in a variety of habitats, with steep cliffs typically more than 45 meters (148 feet) tall (NNHP

2008). Suitable habitat requires an abundance of prey (birds of various species) near nest and roost sites (NNHP 2008). These areas typically occur along wetlands, riparian forests, and other forest habitats.

Peregrine falcons have been documented from the northeastern part of Black Mesa (BIOME 2003). Suitable breeding habitat occurs along the mesa escarpment and many of the taller, steeper canyons (BIOME 2003). Peregrine falcons occasionally forage in the Kayenta Mine permit area, and the species could be expected in the N-9 mining area and other places with piñon-juniper woodlands (BIOME 2003).

Northern Saw-Whet Owl. The northern saw-whet owl (*Aeoglius acadicus*) is listed as a G4 endangered species by the Navajo Nation. The species also receives protection under the Migratory Bird Treaty Act. The northern saw-whet owl typically utilizes relatively open ponderosa pine, Douglas-fir, or mixed conifer forests for foraging and nesting activities (NNHP 2008). The species also may occur in old-growth riparian woodlands (NNHP 2008). It nests in tree cavities in these habitats (NNHP 2008).

The species has been documented from the northeastern part of Black Mesa, but its breeding status there is unconfirmed (BIOME 2003). Suitable habitat for the species is absent from within the Kayenta Mine permit area (BIOME 2003).

Northern Pygmy Owl. The northern pygmy owl (*Glaucidium gnoma*) is listed as a G4 endangered species by the Navajo Nation. The species also receives protection under the Migratory Bird Treaty Act. The northern pygmy owl nests in tree cavities and uses habitats often near forest openings (e.g., meadows, lakes and ponds) (NNHP 2008). The species occurs in a variety of montane forest habitats, and possibly wooded canyons that include coniferous forest (spruce, fir, and ponderosa pine), mixed conifer-hardwood with oak and aspen, hardwood bottomlands, and occasionally aspen stands (NNHP 2008).

The northern pygmy owl has been documented on the northern part of Black Mesa (BIOME 2003). It occurs in Coal Mine Wash and Yellow Water Canyon outside of a two-mile buffer zone adjacent to the Kayenta Mine permit area (BIOME 2003). No suitable habitat occurs within the Kayenta Mine permit lease area.

Flammulated Owl. The flammulated owl (*Otus flammeolus*) is listed as a G4 endangered species by the Navajo Nation. The species also receives protection under the Migratory Bird Treaty Act. The flammulated owl nests in tree cavities in open conifer (usually ponderosa pine) or aspen forests, often with brushy understory of dense saplings or oak shrubs and clearings (NNHP 2008). It usually prefers to use old-growth stands with dense cover and large-diameter trees as roosting habitat (NNHP 2008).

The flammulated owl has been documented on the northeastern part of Black Mesa (BIOME 2003). It occurs in Yellow Water Canyon outside of a two-mile buffer zone adjacent to the PWCC lease area (BIOME 2003). No suitable habitat occurs within the Kayenta Mine permit area.

Burrowing Owl. The burrowing owl (*Athene cunicularia*) is listed as a G4 endangered species by the Navajo Nation. It also receives protection under the Migratory Bird Treaty Act. The burrowing owl inhabits flat, open areas with short-grass grasslands, sparse desert scrub, agricultural lands, and other areas with human disturbance (NNHP 2008). The species relies on areas with prairie dogs and other digging mammals in order to provide burrows for nesting (NNHP 2008). Suitable habitat also includes perch sites with unobstructed views (NNHP 2008). This species occurs both east and south of Black Mesa, and potential habitat occurs in prairie-dog towns in reclamation areas in the Kayenta Mine permit area. LaRue (1994) stated that potential habitat could be used by transient burrowing owls during migration.

Navajo Mountain Vole. The Navajo mountain vole (*Microtus mogollonensis*) is listed as a G4 endangered species by the Navajo Nation. It has no further designations. The Navajo mountain vole typically inhabits dry grassy vegetation in conifer forests and forest openings (BIOME 2003). The species also inhabits patches of sagebrush, greasewood, desert-olive (*Forestiera neomexicana*), and tamarisk with a heavy cover of grasses (NNHP 2008). The species has been documented in the Kayenta Mine permit area in places with rocky substrates, in continuous stands of sagebrush, near permanent impoundments on mine reclamation, and along drainage bottoms (BIOME 2003). Its abundance varies from rare to common and can vary with the annual precipitation and habitat (BIOME 2003).

Townsend's Big-eared Bat. Townsend's big-eared bat (*Corynorhinus townsendii*) is listed as a G4 endangered species by the Navajo Nation. It has no further designations. Townsend's big eared bat forages in a variety of habitats that include coniferous forests, piñon-juniper woodlands, deciduous riparian woodlands, and desert scrub habitats (NNHP 2008). It roosts, hibernates, and raises its young in caves, mine tunnels, and man-made structures (NNHP 2008). Townsend's big-eared bat has not been documented in the Kayenta Mine permit area, but suitable foraging habitat occurs in the mine complex, and suitable foraging and roost habitat occurs in the surrounding habitats on Black Mesa (BIOME 2003).

D.2.5 Soil Resources

Soil resources are the result of soil-forming processes on materials deposited or accumulated by geological processes. The development of diagnostic soil features are influenced over time by climate, parent material, biological activity and topography (Natural Resource Conservation Service [NRCS] 2009). The study area for soil resources is the Kayenta Mine permit area (see Map A-2). The Kayenta Mine permit area falls within the Colorado Plateau, as described in Section D.1. The soils on the plateaus, mesas, hillsides, and fan terraces of the Colorado Plateau range from a few inches to more than 5 feet deep and generally are well drained. Soils in many portions of the Colorado Plateau are subject to high wind and water erosion due to sparse vegetation cover, steep slopes, and soil type (AGFD 2006).

Soils within the coal resource areas N-9, J-19, and J-21 are derived from the Cretaceous Mesaverde Group, a series of sedimentary sandstones, siltstones, and mudstones (Figure D-1). In 1979, 1983, 1985, 2000, and 2003 SMCRA required that private contractors conduct site-specific soil surveys in the Kayenta Mine permit area and surrounding areas, to provide detailed soil taxonomy and determine thickness of suitable topsoil, subsoil, and unconsolidated material for reclamation use. The surveys identified 14 soils in and surrounding the area. These soils were predominantly very fine- to fine-grained sandy loams with minor smectitic clayey soils. The smectite clays, also referred to as "swelling clays," can undergo as much as a 30 percent volume change due to wetting and drying. Soils in the area are characterized generally as well drained with moderate shrink-swell potential (with the exception of the smectitic clayey soils) and as slightly susceptible to wind erosion.

Topsoil is essential for reestablishing native vegetation and forage on reclaimed surface mines. Subsoil and weathered rock overburden beneath the topsoil supply additional nutrients and moisture for plant growth. The removal and replacement of all topsoil is required by SMCRA unless it is demonstrated that selected subsoil, weathered overburden, or spoil is better suited for growing plants. Topsoil is removed as a separate layer before mining and is either spread directly on nearby regraded areas or, if necessary, temporarily stockpiled. Topsoil is spread to the appropriate depths for the approved post-mining land use.

By definition, topsoil means the A and E soil horizon layers of the four master soil horizons (30 CFR 701.5). The soils of the Kayenta Mine permit area have A horizons that range in thickness between 0 to 1 inch and 0 to 4 inches, depending on the soil. The topsoil is of insufficient quantity to salvage as a separate layer and must be salvaged together with suitable subsoil and suitable unconsolidated material below the subsoil to provide an average two feet thick topsoil mixture suitable for reclamation. Overall, a four foot thick suitable root zone is created per SMCRA requirements and the reclamation plan using a combination of this topsoil mixture underlain with suitable spoil. When a more rocky topsoil material is needed to support the reclamation plan, PWCC salvages the suitable residual soils unless their depth makes salvage impractical. The soil surveys assessed residual soils' suitability for restoration based on seven conditions: selenium concentration, sodic zones, pH, saline strata, texture, rock fragment percentage, and acid-forming spoils.

Soils developed in the Kayenta Mine permit area have the potential for higher than normal selenium concentrations. Native vegetation that bioaccumulates selenium on these soils can create a level of toxicity in the forage high enough to affect cattle.

PWCC's geobotanical studies demonstrated that selenium-accumulating plant populations are locally common. The selenium accumulators occurred on the shallow soils associated with wooded ridges and disturbed areas, and were absent from the broad sagebrush valleys and wash terraces where the deeper soils occur. Overburden material, which could be used to provide soil in reclamation areas, also was evaluated for selenium. Initial results indicated the probability of suspect concentrations of plant-available selenium occurring in regraded spoils. Based upon the results of selenium analysis in plants and soils at a representative cross section of sites where accumulator plants were found, the soils in which they were growing are not seleniferous. No selenium poisoning of livestock has been reported in or surrounding the Kayenta Mine permit area. Selenium supplements are often added to salt blocks used by the local ranchers.

Analysis of selenium levels of regraded spoil in comparison to selenium blood levels in cattle grazing on reclaimed areas indicate that the selenium levels present in the regraded spoil do not pose a threat to livestock and in fact are at or slightly below levels desired for cattle.

Sodium adsorption ratios (SAR) greater than 18 or 22, depending on soil texture, are indicative of elevated sodium in soil.

Overburden materials having elevated SAR also may have unsuitable pH values: either alkaline pH values greater than 8.8, or acidic pH values less than 5.5. However, acidic soils may not be a significant issue because of excess alkalinity measured in many core samples. Acidic or acid-forming spoils are not anticipated in most areas.

Negative acid-base account potential values indicate a potential for acid-forming zones that make spoil unsuitable for use as replacement soil in reclamation areas. Negative acid-base accounting has been detected at unsuitable levels in about 10 percent of the total samples of spoil collected and analyzed.

D.2.5.1 Prime Farmland Determination

The soils that occur are predominantly in the Natural Resource Conservation Service (NRCS) land capability Classes VI and VII. Soils in Classes VI and VII have severe to very severe limitations that make them unsuitable for cultivation and limit or restrict their use largely to pasture, range, woodland, or wildlife habitat. Soils in these groupings are used primarily for livestock grazing. The land in the study area has received a negative determination as prime or unique farmland from the NRCS (NRCS 2005).

D.2.6 Recreation

The Kayenta Mine is located atop the Black Mesa, a major geographic feature of the Colorado Plateau, where geological and archaeological features provide opportunities for recreation and tourism. The study area for recreation is Black Mesa, and within the study area, all areas are closed to non-tribal members without a permit or authorization. The Moenkopi Wash area southwest of the study area also may be a prominent location for game hunting, commercial trapping, bird watching, and photography. Hiking may occur to a limited extent north of the study area near the rim of Black Mesa.

There are no developed recreation resources within the Kayenta Mine permit area and no specific data are available on the use of the study area for recreation. Residents report that the area is sparsely used for sightseeing (OSM 1990). Possible recreational activities may include hiking and game and bird hunting; however, the area north of the Kayenta Mine permit area is closed to all big game hunting (PWCC 2005b).

D.2.7 Air Quality

Under the Clean Air Act, national ambient air quality standards (NAAQS) establish the maximum allowable levels of certain pollutants in the ambient air in order to protect public health and welfare. Those “criteria pollutants” consist of particulate matter (PM), sulfur oxides (SO_x), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and lead (Pb). However, because emissions from surface coal mining are predominantly particulate matter, current and projected ambient levels of PM are the primary focus of this analysis.

Ambient concentrations of particulate matter are currently expressed both in terms of PM_{10}, i.e., particles that are 10 microns or less in size, and in terms of $PM_{2.5}$, i.e., particles that are 2.5 microns or less in size. The particulate matter emissions from surface coal mining activities are predominantly PM_{10} (which includes all $PM_{2.5}$), and this analysis focuses upon current and projected ambient concentrations of PM_{10}.

Sources of PM_{10} emissions from surface coal mining include blasting, overburden removal, coal extraction, coal preparation/handling/storage and fugitive road dust from haul trucks. The vast majority of such emissions are fugitive in nature. Tailpipe emissions from vehicles and mining equipment include particulate matter and also CO, SO_2, NO_x, and volatile organic compounds (VOC).

Existing ambient concentrations of a pollutant are most accurately characterized by actual measurements, as opposed to the alternative of predicting ambient concentrations with dispersion models. This principle is particularly true for characterizing ambient levels of PM_{10} that are due primarily to fugitive PM_{10} emissions from coal mining activities. When the ambient concentration of a pollutant is lower than its maximum allowable level, i.e., the standard, that pollutant's concentration is said to be in "attainment." In determining the attainment status of a given criteria pollutant in a particular geographic area, EPA policy focuses on evaluation of the most recent three years of ambient monitoring data that are considered to be representative of concentrations in that area.

In keeping with a requirement under SMCRA, Peabody has operated a network of PM_{10} ambient air monitors at the Kayenta Mine permit area for just under two decades (see Map D-6). The purpose of the monitoring program is to facilitate assessment of the effectiveness of existing fugitive dust control measures at the Kayenta Mine permit area in order to ensure continued satisfaction of the NAAQS for PM_{10}. In consultation with OSM, the Navajo Nation EPA (NNEPA) and the U.S. EPA, the network configuration has been modified on several occasions either to add additional monitors and/or to relocate existing monitors. Revisions to the monitoring network design represent continuing attempts to accurately characterize ambient PM_{10} impacts caused by some of the larger mining sources of fugitive PM_{10} emissions while distinguishing those impacts from ambient PM_{10} concentrations resulting from on- or off-site non-mining activities and/or uncontrollable meteorological events.

Currently, the Kayenta Mine permit area monitoring network includes twelve PM_{10} samplers, four meteorological monitoring stations and numerous precipitation gauges (Map D-6). PWCC generally operates its PM_{10} monitoring network in accordance with applicable EPA requirements, including a quality assurance program, although the network is designed primarily for the purpose of providing data OSM can use to evaluate the effectiveness of the fugitive dust control plan. Quarterly monitoring reports are submitted to OSM and NNEPA. In the event that a PM_{10} concentration is measured that exceeds the level of the PM_{10} standard, PWCC submits an assessment of the probable cause of that exceedance to OSM. PWCC's monitoring sites were very reliable in the three-year period from 2007 to 2009, collecting more than 98 percent of the required samples. For purposes of this EA, the results of the air quality monitoring conducted at the mine are conservatively assumed to be representative of the larger region assessed to determine the impacts of the Kayenta Mine within and surrounding the permit area, including proximate Class I areas designated by USEPA and locations considered sensitive by the tribes (see Section E.1.7).

Short-term (24-hour) Ambient Air Concentrations

Table D-6 shows the highest and second highest PM_{10} concentrations at each sampler for the three-year period. There were a total of twelve sample results that exceeded the PM_{10} 24-hour standard of 150 µg/m^3 applicable during the three-year period. These twelve elevated measurements account for 0.6 percent of 2,143 valid measurements taken during this period. The exceedances occurred on only six separate days. The dates of the exceedances are indicated in the footnotes to the table.

Table D-6 Kayenta Mine Permit Area PM_{10} 24-Hour Ambient Air Concentrations, 2007-2009 (in µg/m^3)

Monitor Site	2007		2008		2009	
	First High	Second High	First High	Second High	First High	Second High
1	84.6	29.9	106.0	70.3	161.7[c]	102.2
2R	112.7	56.7	116.5	76.8	355.6[c]	218.1[d]
3R	104.3	49.0	140.8	92.4	186.4[e]	174.9[f]
4R	101.8	100.0	65.5	52.7	86.7	81.5
5R	105.0	102.1	93.4	69.1	125.9	86.0
6R	83.5	35.0	81.9	44.7	166.7[c]	101.2
7R	220.9[a]	41.0	112.5	89.1	195.8[c]	115.2
8R	126.0	54.2	143.6	129.0	142.7	95.9
12	72.7	38.6	263.2[b]	119.1	129.9	128.6
200	83.3	44.8	90.2	46.2	105.1	89.0
201	97.7	57.9	107.8	72.9	193.9[c]	104.9
202	62.7	32.3	70.9	65.6	208.9[c]	78.6

NOTES: [a] April 14, 2007: Cause was regional dust storm.
[b] October 27, 2008: Cause was temperature inversion with calm wind and negligible precipitation.
[c] October 4, 2009: Cause was regional dust storm.
[d] April 25, 2009: Cause was regional dust storm.
[e] December 27, 2009: Cause was temperature inversion with calm wind.
[f] June 30, 2009: Cause was temperature inversion with calm wind and negligible precipitation.

When an exceedance of the ambient PM_{10} standard has been measured at one of the samplers, PWCC follows up with a report to OSM. That report documents related on-site sampling and meteorological data for the day of interest as well as that day's operations with respect to both mining activities and fugitive dust control actions. The footnotes to Table D-6 summarize PWCC's assessment of each reported exceedance of the 24-hour PM_{10} NAAQS.

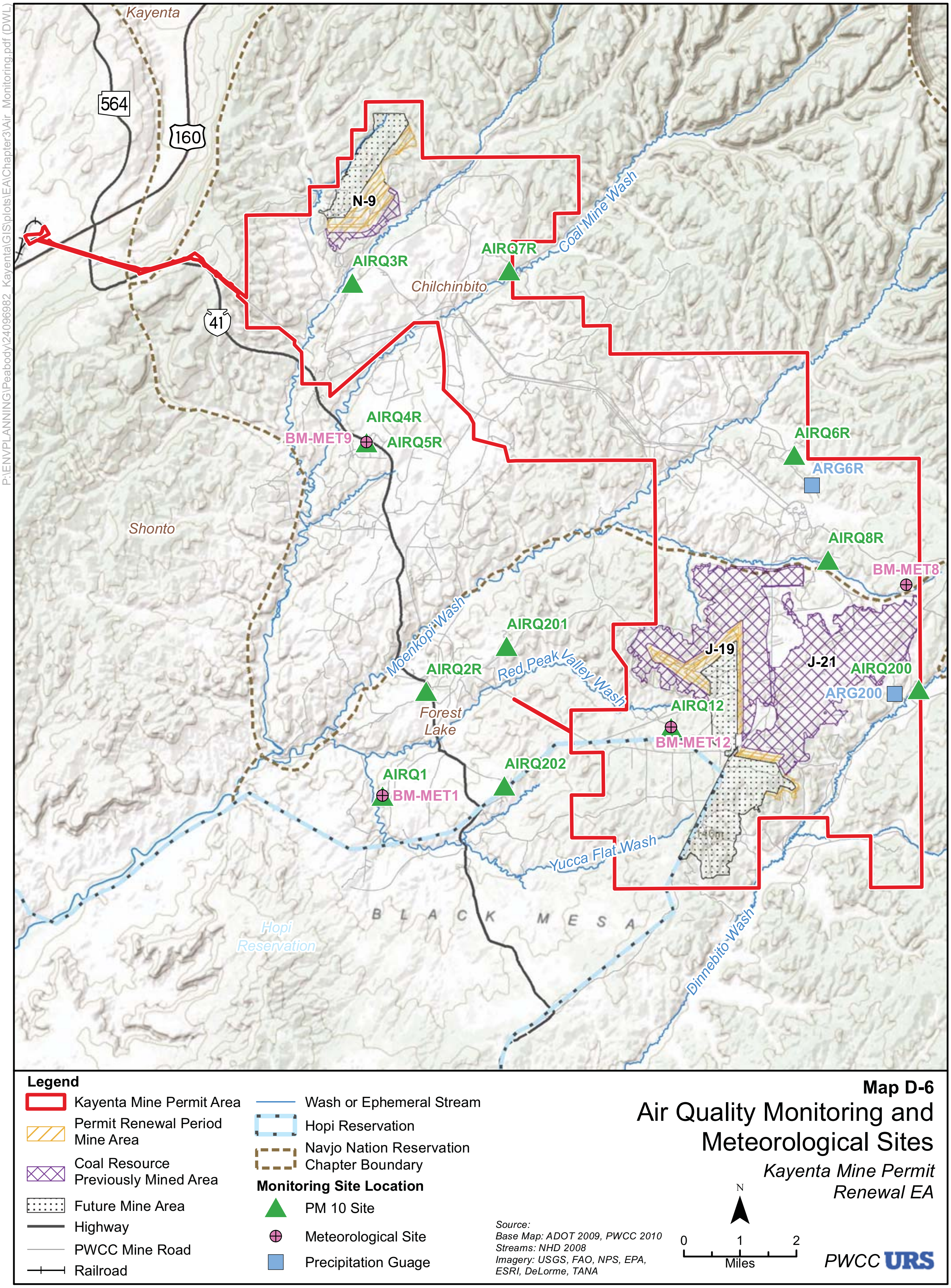
A thorough examination of the related on-site meteorological data and documentation of on-going mining activities during the six days of exceedances shown above reveals that the exceedances were likely caused by non-mining activities and climatic conditions leading to off-site generation of wind-blown particulates. Given the dry, arid conditions which prevail throughout the area for long periods of time, wind erosion can generate significant amounts of fugitive PM_{10} emissions. Despite the fact that PWCC operates its fugitive dust control plan to suppress mining-generated emissions of PM_{10} throughout the Kayenta Mine permit area, climatic conditions may frequently be ripe for the transport of off-site fugitive PM_{10} emissions into the permit area where their resultant impacts are monitored.

In summary, recorded short-term (24-hour) concentrations of PM_{10} have exceeded the NAAQS on only six days in the past three years. Evaluations of sampler, meteorological and operating data from the mine indicates that Peabody's mining activities have seldom been the cause of these exceedances of the short-term ambient PM_{10} NAAQS. Instead, long-term dryness, high winds, PM from off-site sources, and the generation of fugitive road dust by non-mining activities near the mine are recognized as significant contributors to or causes of the recorded exceedances.

Additionally, the atmospheric deposition of mercury (Hg) and selenium (Se) was identified as a specific concern relative to the use and handling of coal in the Four Corners region of New Mexico. Mercury and selenium have been recognized as chemicals of potential ecological concern that may cause adverse effects in certain invertebrates, fish, bird and mammal populations by exposure through cycling and bioaccumulation. In northern Arizona, ENVIRON International Corporation conducted a screening analysis of the impact of mercury and selenium emitted from the Salt River Project's Navajo Generating Station on local aquatic life (ENVIRON 2011). (See Appendix E for a summary of the ENVIRON report).

Reported evidence from laboratory and field studies indicates that methylmercury can lead to direct mortality in some fish at high tissue concentrations and suggests that mercury and selenium can cause toxicity and reproductive failure at lower concentrations. Exposure to these chemicals occurs throughout the food web in a complex chemical and biological cycle, including the deposition and transportation of the chemicals to a waterbody, organic and inorganic uptake, plant absorption, exposure to aquatic and sediment dwelling invertebrates, and consumption by fish and wildlife populations throughout the food chain.

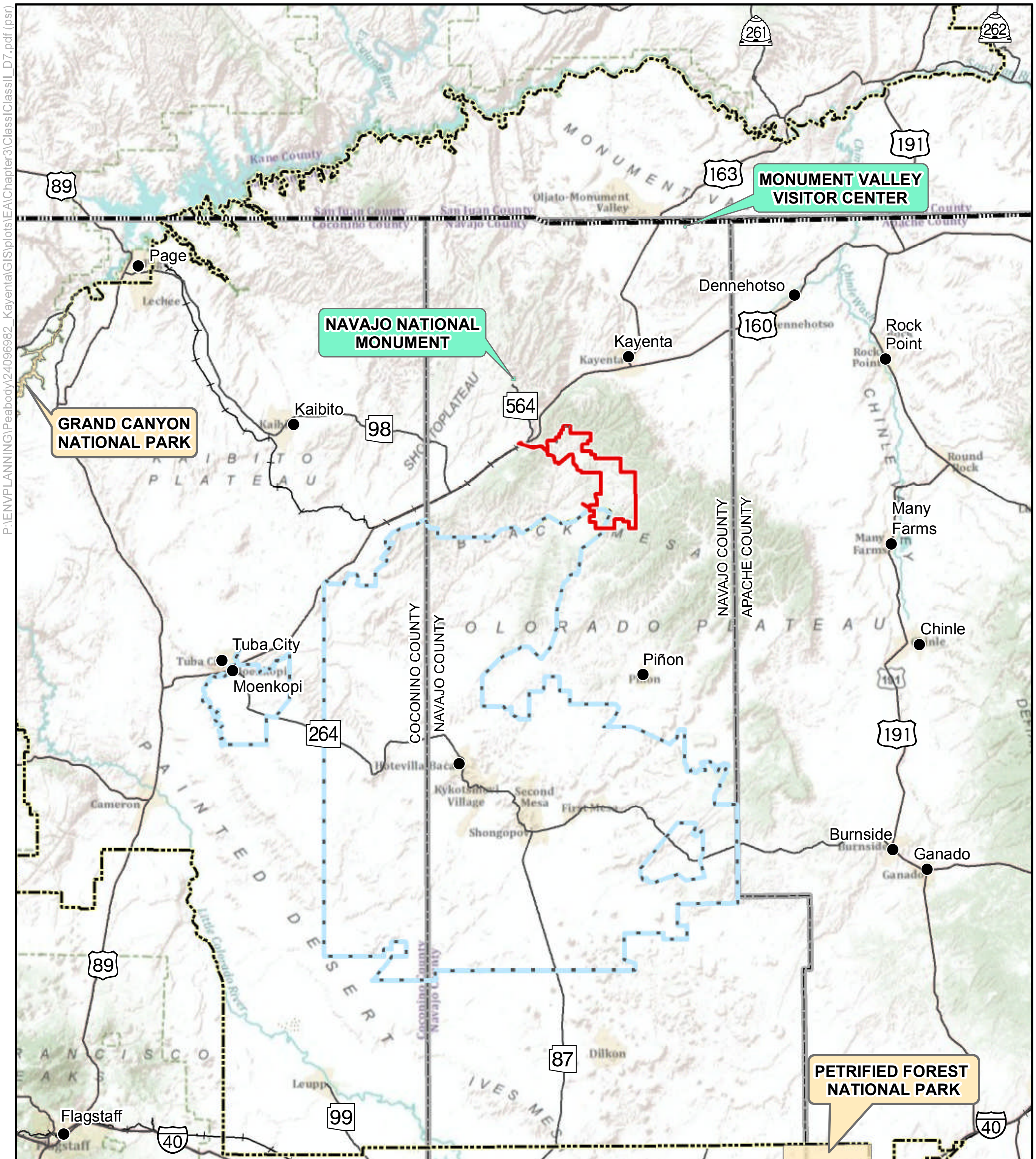
Mercury occurs naturally in the environment as several different chemical compounds. Most mercury in the atmosphere (95–97 percent) is present in a neutral, elemental state, Hg0. In water, sediments, and soils, most mercury is found in the oxidized, divalent state, Hg2+ (ENVIRON 2011). A small fraction of



Map D-6

Air Quality Monitoring and Meteorological Sites

Kayenta Mine Permit Renewal EA



Legend

- Kayenta Mine Permit Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- Federal Class I Area
- Sensitive Class II Area

Map D-7

Class I and Sensitive Class II Areas

Kayenta Mine Permit Renewal EA

Source:
Base Map: ADOT 2009, PWCC 2010, ESRI 2010
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 8 16
Miles

PWCC URS

this pool of divalent mercury is transformed by microbes into methylmercury ($CH3Hg2+$ [abbreviated MeHg]) (ENVIRON 2011). Methylmercury is retained in fish tissue and is the only form of Hg that biomagnifies in aquatic food webs (ENVIRON 2011). Selenium in sediments is particularly important to long-term habitat quality because mechanisms present in most aquatic systems effectively mobilize such selenium into food chains and thereby cause long-term dietary exposure of fish and wildlife (ENVIRON 2011).

Appendix E discusses the process of measuring or estimating the magnitude, frequency, and duration of receptor exposure to mercury and selenium; the assessment of the potential for these chemicals to cause adverse effects; and the risk characterization to evaluate the likelihood, severity, and spatial distribution of predicted or observed effects. The effects assessment in the report evaluates the potential for mercury and selenium to cause adverse effects in certain receptors and estimates the relationship between the extent of exposure and severity of effects. The effects assessment utilizes several metrics and ecological screening benchmarks, including literature-derived concentrations or doses, USEPA's Criterion Continuous Concentration, sediment concentrations from the National Atmospheric and Oceanic Administration (NOAA), and literature-derived critical body residues.

D.2.8 Noise and Vibration

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level, commonly expressed as a logarithm in units called decibels (dB). Vibration consists of rapidly fluctuating motions that can be described in terms of displacement, velocity, or acceleration.

The study area for noise and vibration are the noise-sensitive receptors including residences within the Kayenta Mine permit area and up to three miles from the permit renewal areas. The three-mile distance was selected based on attenuation of a 100 dBA noise source to approximately 50 dBA. A sound level of 50 dBA is generally considered to be quiet (Table D-7). Based on information from previous noise studies (see Table D-8) the loudest single mining and excavation equipment noise source is the rock drill at 95 dBA (Federal Transit Authority [FTA] 2006). Sensitive receptors in the study area including the Kayenta Mine permit area are residences clustered near the intersection of U.S. Highway 160 and Navajo Route 41, and along Moenkopi and Dinnebito washes.

The ambient conditions encountered in the study area consist of an assortment of sounds at varying frequencies (FTA 2006). Sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level. A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the average threshold of human hearing. The A-rated scale is logarithmic, that is, a sound that is 10 decibels louder is perceived by people as twice as loud (FTA 2006). Table D-7 lists measured values of common noise sources to provide context.

Table D-7 Sound Levels of Typical Noise Sources and Noise Environments

Noise Source or Environment	A-Weighted Sound Level (decibels)	Subjective Evaluation
Shotgun blast in close range Jackhammer in close range	130	Deafening
Commercial jet take-off (200 feet away)	120	
Motorcycle (25 feet) Propeller plane fly-over (1,000 feet) Diesel truck, 40 miles per hour (50 feet)	90	Very Loud
Passenger car, 65 miles per hour (25 feet) Vacuum cleaner (3 feet)	70	Loud
Normal conversation (5 feet)	60	Moderate
Average office	50	Quiet
Average residence without radio playing	30	Faint
Soft whisper (5 feet)	20	
Normal breathing (0 feet) Rustle of leaves in the wind	10	Very faint
Normal breathing (5 feet)	5	
Average threshold of human hearing	0	

SOURCES: Housing and Urban Development 1991, and United States Environmental Protection Agency 1971

The existing noise environment near the coal resource areas is dominated by noise associated with mining operations, including coal processing, blasting, and hauling. No noise measurements or detailed field reconnaissance were conducted to measure existing noise sources or noise levels in sensitive areas for this EA. Precise data on existing noise sources (type, number, locations, and operating times) were not generally available at the time of this study. Therefore, noise levels expected by sensitive receptors within and adjacent to the Kayenta Mine permit area were estimated from typical mining equipment noise levels, as listed in Table D-8. The noise levels presented in Table D-8 offer reasonable expected sound decibels consistent with mining activities.

Based on the noise sources described in Table D-8, existing sound levels at 50 feet from equipment are likely to range from 50 dBA to 95 dBA for typical daytime noise levels, depending on the level of intensity of mining activities, and less depending upon distance from the noise source. For comparison, 40 dBA is relatively quiet and can be equated to the noise level of a residence at night, while 60 dBA is comparable to a normal conversation and is considered a comfortable noise level. Noise from a point source, such as mining equipment decreases approximately 6 dB per doubling of the distance to a sensitive noise receptor. For example, a source that emits 85 dBA at 50 feet decreases to 79 dBA at 100 feet (OSHA 1999).

Table D-8 Source Noise Used for Estimating Existing Noise Levels[1]

Noise Source		Source-to-Receiver Distance (feet)	Noise Exposure Estimates[1] (decibels)	Source-to-Receiver Distance (feet)	Noise Exposure Estimates[1] (decibels)
Mining and excavation related noise sources	Bucket loader	50	89	200	65
	Haul trucks (100 tons)	50	88	200	64
	Ore trucks (tractor-trailer)	50	88	200	64
	Water truck	50	91	200	67
	Front end loader	50	80	300	70
	Fork lift	50	73	200	49
	Dozer	50	92	300	77
	Rock drill	50	95	300	79
	Dragline crane	50	88	300	73
	Scraper	50	92	300	77
	Pumps	50	71	200	47
	Generators	50	83	200	59
	Compressors	50	86	200	62
Traffic-related noise sources	Roadways[2]	50	70	200	60
	Electric railroad[3]	50	70	240	60

SOURCES: Mining sources – Minor, Michael & Associates 2000, Transportation sources – FTA 2006

NOTES: 1 All noise exposure estimates are based upon typical highway or vehicle operation. Railroad noise levels are described in day-night average sound level; all others are in equivalent noise level daytime.

2 Roads with traffic at 55 miles per hour, but without trucks.

3 Typical for Black Mesa and Lake Powell electric-railroad operations.

Surface blasting is conducted an average of twice daily during weekdays, from sunrise to sunset and is conducted at least 0.5 mile from any residence or occupied dwelling. Warning and all-clear signals audible for at least 0.5 mile are sounded before and after blasting. Except for emergencies, blasting occurs according to a schedule that is published annually in a newspaper with general circulation in the mining area. Additionally, blasting schedules are delivered to all individuals living within the Kayenta Mine permit area and within 0.5 mile outside the permit area.

Low-frequency vibrations are normally felt rather than heard. Existing sources of vibrations within the study area may occur as heavy equipment or trucks travel through Kayenta mining areas or from blasting. Blasting is used as part of the mining operations to fragment material for excavation and transport. Energy liberated from the blast is converted into vibrations as either ground motion or air overpressure (air blast). Ground motion is the principal vibration that could result from blasting, though air blast may be more noticeable because of the accompanying noise effects. Like other noises, air blast is measured in decibels; however, the overpressure is normally at low frequencies, an air blast may be felt more than heard. Ground motion is a wave motion spreading outwards from the blast, like ripples spreading outwards after a stone is dropped into water. This ground motion is measured as peak particle velocity and is used as an indicator of possible blast damage.

In support of mining activities carried out at the Kayenta Mine permit area and compliance with the Blasting Guidance Manual, PWCC issues monthly blasting reports to OSM that contain seismographic data, including all ground-motion and air-overpressure records. Monitoring levels for ground movement and air overpressure from the mining operation have not exceeded established OSM limits.

Flyrock is rock that is ejected into the air or along the ground from a blast. Flyrock is controlled by the blasting design and by limiting access near the blast. The Federal regulation in 30 CFR 816.67(c) prohibits flyrock from being cast more than one-half the distance to the nearest dwelling, beyond the area of control [required under 30 CFR 816.66(c)], or beyond the permit boundary.

D.2.9 Landforms and Topography

The project study area is Black Mesa which is a geographic feature located within the Colorado Plateau physiographic province. The Colorado Plateau is defined by an abrupt change in elevation, coincident with uplifted and gently folded sedimentary layers internal to the plateau, and steep-sided valleys that incise the plateau's perimeter. The Colorado Plateau province is higher in elevation than surrounding provinces, with elevations generally between 5,000 and 7,000 feet above mean sea level (MSL). Elevations within the project study area generally range from 6,500 to 7,000 feet above MSL.

The topography of the Kayenta Mine permit area is characterized by gently rolling hills on a relatively flat mesa. Through 2009, approximately 20,756 acres have been disturbed in the Kayenta Mine permit area and 11,670 acres have been graded, topsoiled, and seeded per the approved reclamation plan. Restoration of mining sites to the approximate original contour is required by SMCRA. Mined areas are backfilled and graded to approximate the original topographic relief. The approximate original contour restoration is designed to reestablish the drainage patterns to blend in with the surrounding undisturbed areas. Restored areas generally have smoother contours with less topographic relief than the original topography, and no pronounced landforms (e.g., no cliffs, steep buttes, or narrow canyons).

D.2.10 Geology and Mineral Resources

The study area for geology and mineral resources is the Black Mesa coal field (see Map A-1 for the extent of the coal field). The Colorado Plateau physiographic province is characterized by relatively flat-lying and laterally continuous Paleozoic and Mesozoic sedimentary formations. Coal resource areas N-9, J-19, and J-21 fall within Black Mesa, which contains coal-bearing rocks deposited within the basin that supply the Kayenta Mine operation (Figure D-2).

Black Mesa is a broad upward fold in rock layers trending northwest to southeast. It is bounded by uplifts on the eastern, southeastern, western and northern sides and folds define the southwestern and northeastern sides. These folds have very gentle dips even though they extend for miles. The folds along the north and northwest dip down to the southeast and create a hydrologic barrier within the N aquifer.

Faulting is less extensive than folding in the study area. Normal faulting associated with fold axes is the most common type found. None of these faults are considered significantly active, and there is no indication that any recent volcanism ever extended to Black Mesa. Several recorded earthquakes have measured between 5 and 6 magnitude on the Richter scale.

D.2.10.1 Geologic Environment

Geologic formations are illustrated in Figure D-1 and Figure D-2. Relatively level sedimentary rocks dominate the geology of the Kayenta Mine permit area with minor structural deformation by local folding and faulting. The rock units of Black Mesa are primarily undeformed and oriented in roughly horizontal beds. The Oljeto Syncline is a prominent fold that cuts north-south across the area, and lesser folds, such as the Maloney Syncline, are roughly parallel to it. Most faults are oriented east-west and are displaced less than 40 feet. The coal seams that are mined at the Kayenta Mine are contained within the Wepo Formation. The Yale Point Sandstone is a medium- to coarse-grained quartz sandstone. It is interbedded with the underlying Wepo Formation and can exceed 200 feet of thickness in the outcrop on the northeastern edge of Black Mesa.

D.2.10.2 Mineral Resources

The 90,000-square-mile Colorado Plateau, is rich in coal, uranium, and oil shale, all of which produce energy. Past mining activity in this area included uranium, gravel, and coal mines (NEMO 2010). Black Mesa, which includes the Kayenta Mine permit area, has proven coal reserves that have been mined for use by local communities as well as commercial enterprises. Mining in coal resource areas N-9, J-19, and J-21 is within the economically viable coal reserves of the Wepo Formation. In 2010, more than 7.7 million tons of coal were extracted by the Kayenta Mine operation. Through 2009, 259 million tons of coal had been mined at Kayenta Mine and 153 million tons at the neighboring Black Mesa Mine. The USGS' inferred total coal resource in the Wepo Formation exceeds 4.8 billion tons (Nations, Swift and Haven 2000).

Coal from the Black Mesa area has been analyzed for rare earths and germanium, but only trace amounts (less than 0.01 percent) are present. Such trace concentrations are currently not recoverable economically. Only secondary uranium mineralization occurs in the Toreva Formation on Black Mesa (Bureau of Indian Affairs [BIA] 1987). Minor quantities of the mineral material scoria are present. Scoria is used for road maintenance and in reclamation activities.

D.2.10.3 Paleontological Resources

Paleontological resources (fossils) are the remains, imprints, and traces of once-living organisms preserved in rock layers. Fossils can be bones and teeth, shells, leaf impressions, footprints, or burrows. Fossils are nonrenewable resources with scientific, educational, commercial, and recreational values. The Cretaceous coal-bearing strata in Black Mesa contain abundant plant and animal fossils and have high potential for yielding fossils. The fossils contained in these rocks are common throughout the Kayenta Mine permit area. Field surveys in N-9, J-19, and J-21 coal resource areas will be conducted to document any important fossils, and PWCC will recover important fossils that are discovered during mining operations.

D.2.11 Climate

The Colorado Plateau region in northeastern Arizona has a semiarid climate, characterized by wide variations in diurnal and annual temperature. This region defines the study area for purposes of the discussion of climate. Black Mesa receives much of its precipitation during the summer months, when afternoon showers form due to moist air from the Gulf of Mexico moving over the area. Rainfall as high as 1.26 inch for 1 hour and 2.35 inches for 24 hours have been recorded. Most snowfall on Black Mesa is light and evaporates within a few days. Topographic features and changes in altitude influence the total amount of precipitation received at various locations on Black Mesa.

Due to the elevation (ranging from 6,000 to 8,200 feet above MSL), Black Mesa has mild summers and cold winter temperatures. The average annual temperature is about 50 degrees Fahrenheit (ºF). Summer temperatures generally range from the mid-50s to the low 80s. Temperatures over 100ºF are rare.

Within the PWCC mine lease area an extensive climatological monitoring program has been operating since the early 1980s (Map D-6). Temperature, wind speed, and precipitation data recorded at site BM-MET9 from January 2005 through December 2009 are summarized by season in Table D-9. This meteorological data describes the recent climate variables important to atmospheric transport and dispersion across the Kayenta Mine permit area.

Table D-9 Seasonal Meteorological Conditions at the Kayenta Mine Permit Area (2005-2009)

Parameter	Winter	Spring	Summer	Fall	Annual Average
Average daily mean temperature (ºF)	30.8	48.6	70.0	51.1	50.6
Maximum daily temperature (ºF)	59.4	84.9	94.5	82.2	92.1
Minimum daily temperature (ºF)	-3.4	7.8	35.8	8.0	2.9
Average wind speed (miles per hour)	6.6	8.3	7.0	7.3	7.3
Hourly maximum wind speed (miles per hour)	34.5	38.0	32.0	36.5	35.6
Precipitation (liquid inches)	2.36	1.70	2.28	1.72	8.05

NOTE: ºF = degrees Fahrenheit

The dominant wind directions recorded from January 2005 through December 2009 are from the north and north-northeast. The other primary wind directions are from the south through southwest. The direction associated with the highest hourly average wind speed was southwest at 10.5 miles per hour (mph) (4.7 meters per second [m/s]) while the lowest average wind speeds occur under east-northeasterly and southeasterly winds at 4.7 mph (2.1 m/s). The overall average wind speed for the period at this site was 7.3 mph (3.3 m/s). A wind rose for the five-year period is provided in Figure D-3.

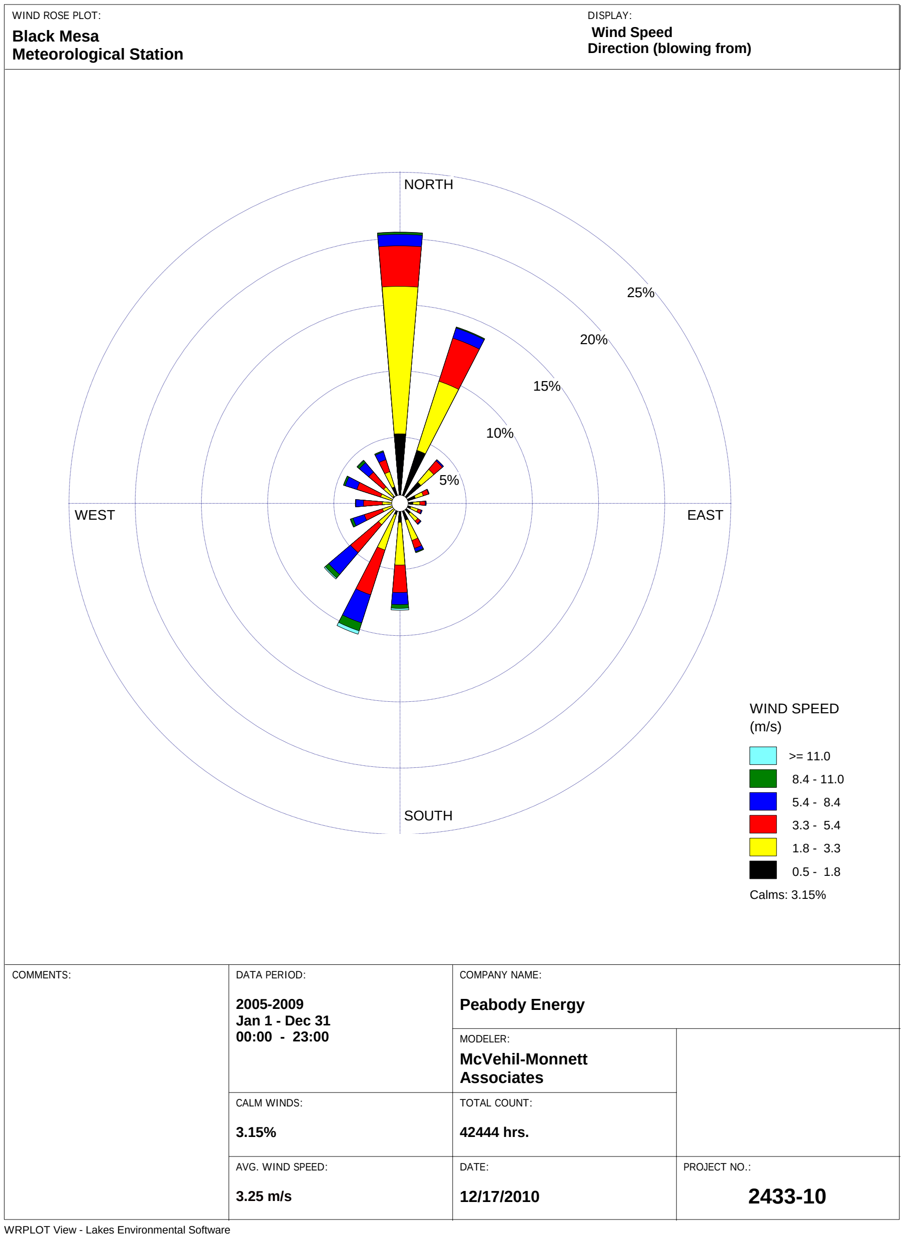


Figure D-3 Site BM-MET9 Wind Rose

D.2.11.1 Climate Change

Based on recent reports, there is concern about changes that may occur in the global climate. The U.S. Environmental Protection Agency (EPA) recently found that human greenhouse gas (GHG) emissions cause or contribute to air pollution that may reasonably be anticipated to endanger the public health or welfare (EPA 2009a).This section discusses the issues relevant to global climate change and summarizes the scientific uncertainties that make predictions about foreseeable changes in weather, localized effects and attribution to individual sources indeterminate and unreliable. Ultimately, under any scenario about whether and how climate might be changing, greenhouse gas emissions from the proposed action are too small to allow calculation of any measurable change on global climate.

Reports of observed temperature measurements over the last 150 years indicate the occurrence of periods of global temperature increases, such as the period from 1910 to 1945 and a period from 1977 to 1998 (U.S. EPA 2009b, National Oceanic and Atmospheric Administration 2010).[3]

Between 1998 and 2010, there has been a twelve-year period of less or no warming (NOAA 2010, Easterling and Wehner, 2009, EPA 2009c). Uncertainty exists over whether the temperature increases during the last several decades of the 20th century have been unprecedented over the past 1,000 to 2,000 years (EPA 2009b, National Research Council 2006).

Relying on the work of the International Panel on Climate Change, EPA concluded that the warming that occurred during the 20th century is evidence that GHG emissions affect global climate change (EPA 2009a, Intergovernmental Panel on Climate Change 2007). EPA, however, also emphasized the uncertainties involved in attempting to attribute specific amounts of warming to human GHG emissions EPA (2009b).[4]

Additional research is being conducted to better understand current scientific views on mechanisms with the potential to affect climate change. For example, recent scientific studies are raising new questions about the physics of GHG emission pathways and how water vapor variations in the lower stratosphere play a role in the variability of global temperature trends (Soloman et al. 2010).

With regard to the warming potential of greenhouse gases, water vapor is the most abundant greenhouse gas (Congressional Budget Office [CBO] 2003). Several other trace gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and several fluorine- and chlorine-containing gases, also have been identified as potential greenhouse gases. Scientists have attempted to compare the global warming potential of each of these compounds.[5] Because of this potential variability, these compounds are expressed in this EA in terms of CO_2 equivalent (CO_2e).

Most greenhouse gases have both natural and anthropogenic sources (EPA 2011a). For example, natural sources of carbon dioxide are more than 20 times greater than sources due to human activity.[6] The

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[3] These data rely upon a combination of land-based meteorological measurements, water temperature recordings from ships at sea prior to 1982 and satellite measurements of the troposphere since 1982, which may introduce error into the trends. Also, the long-term instrumental record is incomplete and the data include systematic problems due to sampling errors and variability concerns (Hegerl et al. 2001, Kalnay and Cai 2003).

[4] A number of scientists also stress that insufficiencies in our understanding of key aspects of the climate system, such as the role of water vapor and clouds (Spencer and Braswell 2010), limitations in climate model performance (Fildes and Kourentzes 2011), and uncertainties in future emissions pathways (Intergovernmental Panel on Climate Change 2007), make specific forecasts unreliable (see also: Spencer et al. 2007, Pielke et al. 2007, McKitrick and Michaels 2007).

[5] Atmospheric greenhouse gases (except water vapor) are adjusted for heat retention characteristics, relative to CO2.

[6] http://www.newworldencyclopedia.org/entry/Greenhouse_gas#cite_ref-13 (citing United Nations Environmental Programme, at http://www.grida.no/publications/vg/climate/).

primary natural processes that release CO_2 into the atmosphere (sources) and that remove CO_2 from the atmosphere (sinks) are (EPA 2011a):

- Animal and plant respiration, by which oxygen and nutrients are converted into CO_2 and energy;
- Plant photosynthesis, by which CO_2 is removed from the atmosphere and stored as carbon in plant biomass;
- Ocean-atmosphere exchange, in which the oceans absorb and release CO_2 at the sea surface; and,
- Volcanic eruptions, which release carbon from rocks deep in the Earth's crust.

With regard to anthropogenic GHG emissions, EPA reports that global CO_2 emissions from fossil fuel use (including power generation, transportation, and all other human uses of fossil fuel) account for 56.6% of the anthropogenic sources (EPA 2011b. Deforestation and the decay of biomass account for the second largest source (17.3%) of anthropogenic greenhouse gases (EPA 2011b). The Food and Agriculture Organization of the United Nations estimates the percentage of greenhouse gases released into the atmosphere each year from deforestation to be much higher in the range of 25 to 30 percent of all anthropogenic sources (Food and Agriculture Organization of the United Nations [FAO] 2006).

Substantially greater uncertainty exists when trying to disaggregate, or spatially downscale, the global models into regional or local predictions, even among those who believe some climate change is likely (Bureau of Reclamation 2011). Although it warns about the uncertainties from spatial downscaling, the Bureau of Reclamation has attempted to forecast future changes in climate and hydrology in the Colorado River Basin.

The Bureau of Reclamation's findings apply to an area approximately 250,000 square miles with varying terrain and habitat; therefore, the general predictions cannot be extrapolated to the Kayenta Mine Permit Area. However, according to Reclamation's climate modeling, the Colorado River Basin overall could face the following:

- On average, the Colorado River Basin temperature is projected to increase by 5-6 degrees Fahrenheit during the 21st century, with slightly larger increases projected in the upper Colorado Basin.
- Precipitation is projected to increase by 2.1 percent in the upper basin while declining by 1.6 percent in the lower basin by 2050.
- Mean annual runoff is projected to decrease by 8.5 percent by 2050.
- Warmer conditions are projected to transition snowfall to rainfall, producing more December-March runoff and less April-July runoff.

- Warmer conditions might result in increased stress on fisheries, shifts in species geographic ranges, increased water demands for instream ecosystems and thermoelectric power production, increased power demands for municipal uses – including cooling – and increased likelihood of invasive species infestations.

The U.S. Department of the Interior Task Force on Climate Change warns that "[t]here are large uncertainties in the projections of how fast these changes are occurring, what the full extent of the changes will be, and how our ecosystems will be permanently altered" (Department of the Interior 2008a).

Most sources acknowledge that current climate models are not able to predict with sufficient precision the localized climate impacts resulting from global climate changes, particularly in an area as small as the Kayenta Mine, nor can they accurately and reliably identify global impacts caused by individual projects. Based on a review of data from USGS, the Department of the Interior concluded that "[g]iven the nature of the complex and independent processes active in the atmosphere and the ocean acting on [greenhouse gases], the causal link simply cannot be made between emissions from a proposed action and specific effects on a listed species or its critical habitat. [A]ny observed climate change effect on a member of a particular listed species or its critical habitat cannot be attributed to the emissions from any particular source" (U.S. Department of the Interior, Office of the Solicitor 2008).

In the United States, the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* reports U.S. anthropogenic sources of CO_2 by use category to the United Nations (EPA 2011c). According to the most recent U.S. inventory, the main fossil-fuel CO_2 emission-source categories include electric-power generation (41 percent of total anthropogenic CO_2 emissions), transportation (33 percent), other industrial uses (14 percent), and residential and commercial uses (10 percent) (EPA 2011c).

The *Final Arizona Greenhouse Gas Inventory and Reference Case Projections for 1990-2020*, taking into account all human emission sources within the state, reports that Arizonans emit about 14 tons of CO_2e per capita, 36 percent less than the national average (Arizona Department of Environmental Quality 2006 [p. D-7]). The Arizona GHG inventory specifically addressed methane emissions from coal mining in the state, with Kayenta Mine accounting for most of the coal production. According to the inventory, these emissions are less than 0.1 million metric tons (MMt) CO_2e and have remained relatively constant from 1990 to 2002 (Arizona Department of Environmental Quality 2006). The inventory also anticipated that coal production and resulting methane emission would remain at 2002 levels through 2020. By comparison, total GHG emissions from all industrial processes in the state were projected to grow from 1.9 MMt CO_2e in 1990 to more than 9.0 MMt CO_2e in 2020 (Arizona Department of Environmental Quality 2006).

Net CO_2e emissions from all anthropogenic emission sources in Arizona was estimated to be approximately 80 MMt in 2000 and projected to be more than 100 MMt by 2010 (Arizona Department of Environmental Quality 2006).

Globally, CO_2 emissions in 2008 from all human sources were estimated to be 29,000 MMt (International Energy Agency 2010). PWCC estimated its GHG emissions from all emission sources at Kayenta Mine to be 163,000 metric tons total CO2e (PWCC 2011a).

D.2.12 Land Use

The study area for land use is Black Mesa. Land uses within and adjacent to the Kayenta Mine permit area include mineral exploration and development, dispersed residential uses, livestock grazing, and traditional uses (such as hunting, gathering, and ceremonial (Map D-8). PWCC's Kayenta Mine operation, including transportation and support facilities, is the only industry currently within or adjacent to the Kayenta Mine permit area (PWCC 2005b).

There is little commercial development on or within 5 miles of the Kayenta Mine permit area. A gas station and convenience store are located north of the mine at the intersection of U.S. Highway 160 and Navajo Route 41. The closest commercial area with food and lodging is in Tsegi on U.S. Highway 160 about six miles north of the study area. The next closest commercial area is Kayenta, approximately 15 miles northeast of the study area.

There are 83 Navajo households within the Kayenta Mine permit area, four of which are located in the J-21 coal resource area. Regulations require a minimum distance between mining activities and residential properties. Residences consist of individual family dwellings or extended family camps with several dwellings. PWCC, in cooperation with the Navajo Nation and according to approved procedures, relocates households to an agreed location, as needed, to accommodate surface coal mining activities. Relocated residents are compensated for the replacement of all structures, including homes, corrals, and sheds, and for lost grazing acreage if the resident can establish a customary use area claim (PWCC 2005b; OSM 1990). PWCC, through its relocation program would attempt to relocate residents within their customary use areas (i.e., where ranching activities take place or where sociocultural ties exist). Long-term residents would be able to return to their original home sites after reclamation is completed and the land is returned to tribal control after 20 to 25 years.

Historically, individual land ownership by Native American tribes did not exist. This perspective persists today within the Navajo and Hopi tribes, in that they consider themselves caretakers of the land and its resources. Land, a part of the universe, belongs to all, and all are entitled to the fruits of nature. Users' rights are protected and specified in various traditions, but there is no such thing as land "ownership".

Livestock grazing is a traditional and predominant land use on Black Mesa. Grazing in the Kayenta Mine permit area and vicinity occurs throughout the year and includes all classes of livestock. There are three range management districts, two Navajo and one Hopi, that overlap with the Kayenta Mine permit area. A small percentage of the permitted sheep units for the districts are grazed within the Kayenta Mine permit area. Residents may graze sheep, cattle and/or horses under a livestock grazing permit. Range condition on all native grazing lands is generally low due to heavy year-round livestock grazing. Extensive vegetation monitoring of reclaimed areas in 2009 (ESCO 2010) continues to document that as areas are reclaimed to meet post-mining land uses, the reclaimed areas contain the best developed grazing lands.

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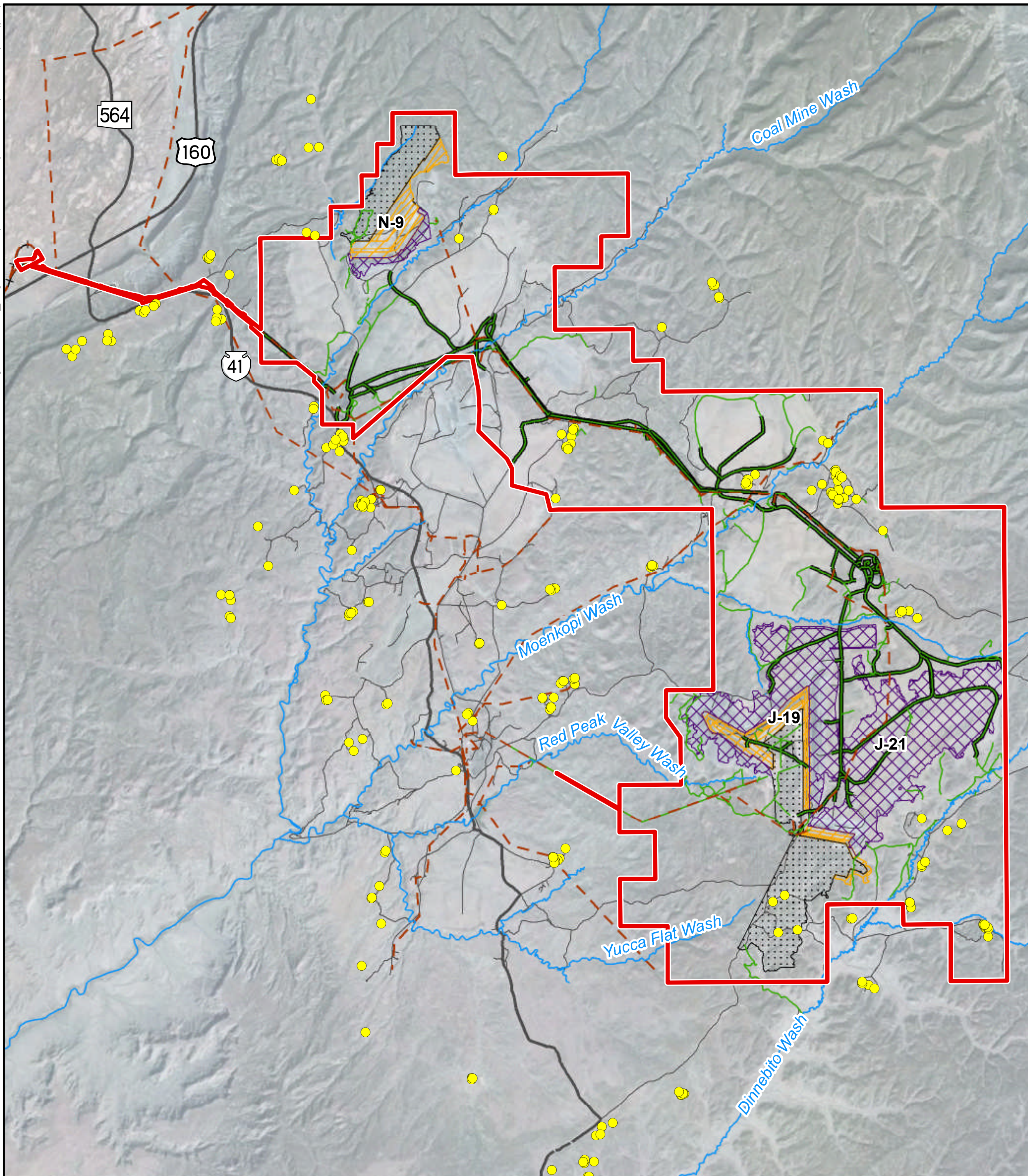

Legend

- Kayenta Mine Permit Area
- Permit Renewal Period Mine Area
- Coal Resource Previously Mined Area
- Future Mine Area
- Occupied Structure
- Highway
- Road
- Railroad
- Wash or Ephemeral Stream

PWCC Mine Road

- Primary
- Ancillary
- Powerline

Source:
Base Map: ADOT 2009, PWCC 2010
Streams: NHD 2008
Aerial Image: Bing

N

0 1 2
Miles

Map D-8

Land Use and Roads

Kayenta Mine Permit Renewal EA

PWCC URS

Traditional family gardens associated with residences occur within the Kayenta Mine permit area. These small fields are used or have been used for the production of adapted crops, particularly corn for domestic use. The size of individual plots averages approximately 4.5 acres (OSM 1990).

Numerous plant species have cultural significance to the Hopi and Navajo people on Black Mesa. Plants are used for construction, heating, medicine, ceremonies, and food. Hundreds of culturally important plants to the Hopi and Navajo have been documented by a number of authors (Rainey and Adams 2004), and one of the missions of the Navajo Nation Natural Heritage Program is to document cultural information on plants and animals important to the Navajo. Unknown quantities of piñon pine, Utah juniper, and one-seed juniper trees are harvested for firewood, fence posts, and construction materials (OSM 1990). No specific collection areas have been identified in the Kayenta Mine permit area, and many of the species are widely distributed within their habitats, including the Kayenta Mine permit area. Culturally important plants also are present in reclaimed areas where cultural plant sites have been established and where natural recolonization has occurred.

Coal from Kayenta Mine is provided to the Navajo and Hopi people on Black Mesa for home heating. Other natural resources that may be used for traditional purposes include minerals or clay deposits and sources of surface water or shallow groundwater.

The presence of wildlife habitat and associated species encourages recreational activities, such as hunting, and provides a means of supplementing the dietary needs of the residents. Hunting is regulated by the Navajo and Hopi tribal governments.

D.2.13 Social and Economic Conditions

In accordance with the NEPA, the analysis of social and economic conditions addresses the relationships between the proposed project and the communities it may affect. The following characterization of current social and economic conditions describes demographics, employment, income, fiscal and budgetary information, and community facilities in the region that could potentially be affected by the Kayenta Mine operations during the permit period.

The social and economic conditions study area includes areas that could be affected economically and socially by the proposed project due to their proximity to project facilities. For the regional analysis, data were collected for Navajo, Coconino, and Apache Counties, the Hopi and Navajo Reservations, and local villages and chapters of government on the Hopi and Navajo Reservations. Data also were collected for the State of Arizona, to use for comparison purposes.

The Kayenta Mine permit area is located entirely within Navajo County, Arizona and is located within a portion of the Hopi Reservation and the Navajo chapters of Chilchinbito, Forest Lake, Kayenta, and Shonto. A village is the Hopi unit of local government; a chapter is the Navajo unit of local government. Generally, 2000 census data are provided for tribal areas and chapters. The U.S. Census Bureau defines portions of some chapters or other areas densely populated unincorporated communities as census-designated places. Certain information in Census 2000, such as the unemployment rate, is shown for census-designated places. Tribal and county-level data used in this analysis overlap in places where these geographic units overlap. A summary of the proportion of each county's population in each of the two reservations, as well as living off-reservation, is shown in Appendix F, Table F-1, which indicates the extent to which this data may be duplicative.

Regional Overview of Demographics and Economics

Table D-10 presents an overview of demographic characteristics for the Hopi Reservation, Navajo Nation, Apache, Coconino, and Navajo Counties, and the State of Arizona. Arizona was one of the fastest growing states in the nation in the 1990s. Rapid growth continued between 2000 and 2004 at the State, county, and tribal levels.

Table D-10 Key Population Characteristics – Regional

	Counties			Tribal Areas		
	Apache	Coconino	Navajo	Hopi Reservation [1]	Navajo Nation	State of Arizona
Total Population						
Census 1990	61,591	96,591	77,658	7,360	148,451	3,665,228
Census 2000	69,423	116,320	97,470	6,946	180,462	5,130,632
Census 2010[2]	N/A	N/A	N/A	N/A	N/A	6,392,017
Percent Change, 1990-2000	12.7	20.4	25.5	-5.6	21.6	
Percent Change, 2000-2010	N/A	N/A	N/A	N/A	N/A	24.6
Median age, 2000	27	29.6	30.2	29.1	24.0	34.2
Median age, 2010						35.9
Dependency ratio, 2000 [3]	67.1	44.2	64.6	68.9	69.7	54.9
Dependency ratio, 2010 [3]						53.9
Persons per household, 2000	3.41	2.80	3.17	3.49	3.77	2.64
Persons per household, 2010[2]						2.63

SOURCE: U.S. Census Bureau 1990, 2000, 2010; Hopi Tribe 2001, Navajo Nation 2005

NOTES: [1] Surveys completed for the Hopi Strategic Land Use and Development Plan indicated a year 2000 population of 10,571, rather than the 6,946 reported in Census 2000.

[2] Detailed 2010 census data is currently only available at the state level and 2000 Census data was used as the best available data. State of Arizona numbers reflect calculations from 2000 to 2010 and all calculations for other entities are based upon comparisons of 1990 and 2000 data.

[3] The dependency ratio is the proportion of dependents in relation to a working-age adult.

According to the 2000 U.S. Census, the median age of the population in the region is similar to that of the State of Arizona. However, the Hopi Reservation, Navajo Nation, Apache, Coconino, and Navajo County have lower median ages than relative to the State of Arizona. The region also has a larger number of persons per household in comparison to the State of Arizona (see Table D-10).

The dependency ratio is a statistic that compares the size of the economically dependent population age groups to the size of the working-age population expressed as a percentage. The dependency ratio is the sum of the under 15 and over 65 population divided by the population aged 15 through 64. Areas with dependency ratios over 60 tend to have a proportionately small number of employed persons supporting the remainder of the residents. While the State of Arizona and Coconino County have dependency ratios less than 60, the remaining areas of the region have dependency ratios over 60, and both tribes' dependency ratios are higher than any of the counties in the study area. The dependency ratio reported in the 2010 U.S. Census for the State of Arizona is similar to that reported in the 2000 U.S. Census for the State of Arizona. At this time, no data is available for the dependency ratio at the County and Tribal level.

Recently, unemployment rates in the study area generally have been higher than those for Arizona as a whole (Appendix F, Table F-2). In 2004, while Arizona's statewide unemployment rate was 4.8 percent, Coconino County had a rate slightly higher than the state (6.1 percent). Navajo County, which contains the Kayenta Mine operations, had a rate of 10.6 percent, and Apache County had a rate of 13.3 percent.

In 2004, the unemployment rates of the Hopi Reservation (18.2 percent) and the Navajo Nation (20.6 percent, Arizona portion) were highest in Arizona, according to the Arizona Department of Economic Security. Arizona Department of Economic Security data consider neither the unemployed whose unemployment benefits have run out nor those who are a part of the informal economy. The informal reservation economy focuses on non-business-related social, traditional, and avocational activity and reflects the production of traditional goods required to reciprocate in clan and family social obligations. A 1999 survey for the Hopi Strategic Land Use and Development Plan documented an unemployment rate of about 64 percent for the reservation. The Navajo Nation Department of Economic Development conducted surveys that indicated an unemployment rate of about 47.6 percent for 2003 (SWCA Environmental Consultants 2005).

Employment status data for the years 2005-2009 is available for the Hopi Reservation and Navajo Nation from the U.S. Census Bureau, 2005-2009 American Community Survey. During that time period, unemployment rates for the Hopi Reservation and Navajo Nation (Arizona, New Mexico, and Utah) dropped to 12.4 percent and 14.3 percent, respectively. Employment data for the State of Arizona from 2005 through 2009 were only available from the U.S. Bureau of Labor Statistics website (www.bls.gov). The trend from 2003 through 2007 showed a decrease in the unemployment rate percentage at a state level. The percentages for the region from 2003 through 2004 correlated with the state level decrease. However, from 2007 through 2009, the trend in unemployment rate percentages showed a significant increase. The data for years 2005 through 2009 are not available at a regional level; however, based on data at the state level, it can be assumed that a similar increase in the unemployment rate percentage occurred at a regional level.

The distribution of employment by industry sector in the study area appears in Table D-11. In the year 2000, the services and information sector dominated employment to a similar extent in Apache, Coconino, and Navajo County, the Hopi Reservation and Navajo Nation, and the State of Arizona. Retail and wholesale trade and manufacturing were the next largest sectors of Arizona's employment, although they were generally smaller proportions of total employment on the reservations. Mining employs a much higher proportion of workers on the Navajo Nation than statewide. Public administration employs a higher proportion of workers on both reservations than statewide.

Table D-11 Regional Employment, Percent Share by Industry Sector, 2000

Area	Total Employment	Industry as Percent (%) of Total Employment								
		Agriculture, Forestry, Fishing, and Hunting	Mining	Construction	Manufacturing	Retail and Wholesale Trade	Transportation, Ware-housing, and Utilities	Services and Information	FIRE and Rental/Leasing	Public Administration
Counties										
Apache	16,469	1.9	1.2	10.9	2.6	9.1	7.2	51.7	2.8	12.6
Coconino	55,510	1.3	0.4	7.7	5.2	14.8	5.4	54.5	3.9	6.8
Navajo	29575	2.3	1.4	11.1	5.4	14.7	7.0	45.1	3.8	9.2
Tribal Areas										
Hopi Reservation	1,869	0.3	0.7	10.5	5.5	8.6	1.4	45.2	1.8	26.0
Navajo Nation (Arizona portion)	21,907	1.0	2.7	12.9	3.3	8.4	6.0	52.7	2.2	10.8
State of Arizona	2,233,004	1.0	0.5	8.7	10.2	15.6	5.0	45.8	7.9	5.4

SOURCE: U.S. Census Bureau 2000

NOTE: FIRE = Finance, Insurance, and Real Estate

Kayenta Mine

The Kayenta Mine permit area is within the jurisdiction of the Hopi Reservation and Navajo Nation, and is located entirely within Navajo County. The area of influence for social and economic conditions is defined as the areas where the socioeconomic effects of Kayenta Mine mining operations are most keenly felt. The population in this area includes the residents of the Hopi Reservation and 14 Navajo chapters. The Coconino County communities of Page and Flagstaff also are included because these provide some mine-support services, trade activities, and some mine-related employment. There are 83 occupied structures within the Kayenta Mine permit area, including four households located in the J-21 coal resource area.

Population in the Study Area

Population in the study area has generally grown over the past 20 years. The Navajo Nation population has grown from 148,451 in 1990 to 155,214 in 2000 (Appendix F, Table F-3). There were 40,933 households documented in the Navajo Nation in 2000. On the Hopi reservation, population decreased from 7,360 in 1990 to 6,815 in 2000. The Hopi reservation reports 1,938 households. Population growth has increased from 1990 to 2000 in both of these agencies. The Chinle agency increased from 5,221 people in 1990 to 6,212 in 2000, and there were 1,589 households reported in 2000. The Western agency population has also grown, increasing from 23,787 people in 1990 to 28,434 in 2000. There were 7,143 households reported among the members of the Western agency in 2000. Specific population data can be found in Appendix F, Table F-3.

The two largest communities within the study area are Kayenta Township (within Kayenta Chapter) and Tuba City (a census-designated place within Tuba City Chapter), both designated by the Navajo Nation as "primary growth centers" for economic development. Kayenta Township is the closest urban community to the Kayenta Mine operation; the township is the only government structured as a municipality on the Navajo Reservation, with taxing authority and a sales tax of 5 percent.

The Navajo Nation and the BIA each distribute a variety of services through the agency system, and residents tend to identify with their agency. The Western Navajo Agency and the Chinle Agency are two of five administrative jurisdictions of the BIA, providing services to the Navajo Indian people within the central and western region of the Navajo Nation. These services include natural resource, real estate, transportation, and safety programs. Tuba City is the headquarters of the Western Navajo Agency, and Chinle is the headquarters of the Chinle Agency. While most of the chapters in the local area of influence belong to the Western Navajo Agency, a few belong to the Chinle Agency.

Unemployment

Unemployment is a persistent problem in communities within the study area, particularly on the reservations. The overall unemployment rates for the Hopi Reservation and Navajo Nation appear in Appendix F, Table F-2 as reported by the Arizona Department of Economic Security and the tribes. The rates are significantly higher than the unemployment rates for the State of Arizona and for Apache, Coconino, and Navajo County. The Kayenta and Tuba City areas of the reservation have unemployment rates that are lower than those in the other parts of the reservation. Of the two areas, the Kayenta area's 2004 unemployment rate was lowest, at 9.6 percent, less than half the overall Navajo Nation rate.

Employment and Income

The major employment sectors on the Hopi Reservation, according to the 2000 Census, appear on Table D-11. Information from the Hopi Tribe (Hopi Office of Community Planning and Economic Development 2001) indicates that manufacturing employment is at 40 percent of the labor force, compared with the Census' figure of 5.5 percent. The difference is partly explained by some differences in the definition of employment. The Hopi Tribe count as manufacturing employees, people who produce crafts—some for market and some for ceremonial purposes and exchange within extended families. The Hopi Tribe's information indicates that services employ 37 percent of the labor force. The Hopi definition includes all jobs that the Census defines as public administration, plus a small number of the jobs that the Census defines as service jobs, so the figures from the Hopi Tribe and Census 2000 are consistent. The most numerous public administration jobs are with the Hopi tribal government, schools, and the Indian Health Services.

The five largest employers on the Navajo Nation in 2002 were government entities: the Navajo Nation, the State of Arizona (including school districts), the Indian Health Services, the BIA's Office of Indian Education Program, and the State of New Mexico (SWCA Environmental Consultants 2005). That ranking of largest employers was consistent, in general, with Census 2000 figures, which indicated that public administration and the services and information sectors accounted for over 60 percent of employment on the Arizona portion of the Navajo Reservation. Private industries, including mining, manufacturing, agriculture, and tourism are a few in comparison. After the five government entities listed above, PWCC is the sixth largest employer.

According to the 2000 Census, the median family income for residents of the Hopi Tribe and Navajo Nation were $23,496 and $23,209, respectively; these data were below the median family income for residents in the Kayenta census-designated place ($32,500), Navajo County ($32,409), and the State of Arizona ($46,723).

The mining sector provides many jobs in the local area of influence. The Kayenta Mine currently employees 422 people, the majority of whom reside in the local area; only 13 people live in an area outside of Arizona. Of the 409 miners residing in Arizona, 369 live on the Hopi Reservation or Navajo Nation. In 2010, employees of the Kayenta Mine are expected to earn $51.5 million through payroll and fringe benefits. Table D-12 shows the estimated Kayenta employees and payroll and benefits for the years through 2015.

Table D-12 PWCC Employment Data

Year	Kayenta Mine Employees [1]	Kayenta Mine Payroll ($ million) [1, 2]	Kayenta Mine Benefits ($ million) [1]	Total Payroll and Benefits ($ million) [1]
Actuals				
2009	426	31.6	14.1	46.2
Projected				
2010	422	31.0	20.5	51.5
2015	432	29.6	20.6	50.2
SOURCE: URS personal communication, December 2010				

NOTES: [1] Totals include both hourly and salaried employees.
[2] Above dollars are not escalated; to escalate salaries a 2.5% annual increase is used.

Mining's share of local employment is higher than its share of regional employment. While mining employed more than 5 percent of workers in the local communities in the year 2000, mining employed less than 3 percent of workers in the Arizona portion of the Navajo Reservation. In Chilchinbito and Kayenta, the employment in the mining sector is second to the services and information sector (Appendix F, Table F-4).

Mine employees support many young and elderly persons. The ratio of the dependent aged population to the working age population is higher overall for the Tribal Areas than the ratios for Apache, Coconino, and Navajo Counties and these are significantly higher than the ratio for the State of Arizona (Table D-10).

Residents of the area around the Kayenta Mine permit area generally enjoy greater prosperity than residents of the Hopi and Navajo Reservations. Incomes are highest for mining workers and for those employed in tourism or government. Typically, wages are low in other sectors, and those seeking work exceed the number of jobs available.

A 2004 study of the area including the communities of Kayenta, Chilchinbito, and Oljato identified the mining operations as the driving force behind the local economy (Arizona State University [ASU] Center for Business Research 2004). Jobs that exist due to a mine worker's household spending, or the spending of a business that supplies the mines, represent indirect jobs attributable to current mining operations. Similarly, income and spending that support the increase in household spending and supplier spending attributable to the mining operation represent indirect economic impacts.

Fiscal Conditions

PWCC pays property and sales taxes, and makes special payments to federal agencies, the Navajo Nation, and Hopi Tribe. The following sections describe these payments and include the entity receiving the payments.

Property Valuation and Taxation

PWCC pays property and sales taxes to the State of Arizona (Appendix F, Table F-5). Property taxes are based on the assessed value, not the current market value. In addition, cities and counties, schools, water districts, community colleges, and bond issues all affect the amount paid in property taxes. The tax rate of each property is the sum of the state, county, municipal, school, and special district rates. The property taxes for the mines are paid to Navajo County. It is estimated that about 85 percent of the property tax paid by PWCC is distributed back to Kayenta Unified School District. State sales tax is paid on coal sales, outside services, and materials and supplies. The revenue from the State sales tax is retained by the State and distributed through a number of funds based upon the approved State budget. Various State services are provided to residents within the area of influence, most notably through distributions back to local school districts. PWCC compensates local area residents for acreage removed from customary grazing areas as a result of the mining activities. On average, these payments amount to about $487,000 distributed on an annual basis to those residents whose grazing area has been reduced due to mining and reclamation activities (see Appendix F, Table F-5).

Federal Payments

OSM is responsible for collecting fees related to the SMCRA, which provides for the restoration of land mined and abandoned or left inadequately restored before August 3, 1977. Under this program, production fees (based on a per/ton basis) are collected from coal producers at all active coal mining operations. The fees are deposited in the Abandoned Mine Land (AML) Reclamation Fund, which is used to pay the reclamation costs of abandoned mine land projects. The Hopi Tribe and Navajo Nation receive grants on an annual basis awarded under Title IV of SMCRA to fund reclamation of eligible mines (SWCA Environmental Consultants 2005). A variety of projects have been funded by these grants for reclamation work on tribal or Indian lands, including abandoned coal and uranium mine reclamation and assorted community development projects. Another Federal tax paid by PWCC is the Black Lung Excise Tax, the proceeds of which are provided to the United Mine Workers of America Combined Benefit Fund.

Since 2001, annual payments have been made by PWCC under the AML Reclamation Fund, as well as the amounts paid through the Black Lung Excise Tax for 2001 through 2009 (Appendix F, Table F-6). The 2010 estimated payments for both the AML Reclamation Fund was $2.5 million and the Black Lung Excise Tax was $4.3 million.

Payments to Tribes

The coal produced from the mining operations also is subject to three coal-mining leases approved by the Hopi Tribe, Navajo Nation, and Secretary of the Interior. The lease agreements provide for payment of royalties and bonuses to the tribes. The royalty rates were adjusted in 1987 and were again adjusted for the Hopi lease in 1997. Since 1987, the total coal royalties paid to the tribes is $797.4 million; $235.3 million to the Hopi and $562.1 million to the Navajo. The yearly average of coal royalties paid to the tribes by PWCC is $34.7 million; $10.2 million to the Hopi and $24.4 million to the Navajo. Table F-7 in Appendix F includes historical and current revenues to the tribes for royalties and bonuses related to coal extraction.

The lease agreements with the tribes provide for royalty payments for use of the N aquifer water. The fees paid are based on the amount of water withdrawn from the aquifer. Table F-8 (Appendix F) summarizes the historical and current annual payments for water-use royalties to both tribes. Since 1987, the total water use fees paid to the tribes is $73 million; $36.5 million to the Hopi and $36.5 million to the Navajo. The yearly average of water use fees paid to the Hopi and Navajo by PWCC is $3.2 million; $1.6 million to each Tribe. The years 2005 to 2009 show an overall reduction of $0.5 million in the yearly average paid to each Tribe. It is estimated that in 2010, $543,300 would be paid to both the Hopi Tribe and Navajo Nation for water use fees associated with Kayenta Mine operations.

In some recent years, mining operations have been the single largest source of revenue in the Hopi and Navajo Nation tribal budgets. Funds received by the tribes are distributed broadly to a number of tribal agencies, Hopi villages, and Navajo chapters. Historically, coal revenues fund the bulk of the Hopi Government’s annual operating budget and have funded the majority of more than 500 jobs provided by the Hopi Tribe. According to the Navajo Nation Division of Economic Development’s *2009-2010 Comprehensive Economic Development Strategy – The Navajo Nation* report, of the fiscal year 2009 Navajo Nation General Fund budget of $150.5 million, total mining revenues contributed $54.9 million, or 36.5 percent (Navajo Nation 2009). According to March 2010 written comments made by the Hopi Tribe in response to the Environmental Protection Agency’s Advanced Notice of Proposed Rulemaking Regarding Best Available Retrofit Technology for Nitrogen Oxide Emissions at the Navajo Generating

Station Docket Number EPA-R09-OAR-2009-0598, "[t]he Hopi Tribe derives almost all of its revenues directly or indirectly from coal mining activities. In 2009, the Hopi Tribe's coal-based revenues were $14 million, representing approximately 88 percent of the Tribe's annual governmental budget."

Electric

The Navajo Tribal Utility Authority (NTUA) is an enterprise of the Navajo Nation, providing electric, natural gas, water, wastewater treatment, and solar energy to residents and businesses of the Navajo Nation and limited areas of service to the Hopi Reservation. The NTUA purchases electrical power from off the Navajo Nation reservation and transmits that power to homes across northeastern Arizona, northwestern New Mexico, and southeastern Utah. Arizona Public Service provides electrical service to part of the study area, particularly on the Hopi Reservation. There is no service provided to the mine by Arizona Public Service.

There are two 69 kilovolt feeder lines servicing the mines; NTUA has an agreement with PWCC by which PWCC operates the substation to serve the mine. As Kayenta Mine is a major user of power provided by NTUA, payments for electric service represent approximately 16 percent of NTUA's electric revenue and about 10 percent of the total revenue for the NTUA for the years 1987 through 2004 (see Appendix F, Table F-10). The data for total electric revenue and total revenue are not available from the NTUA for the years 2005 to 2010. The average payment for electric service at the Kayenta Mine between 2005-2010 is approximately $8.01 million dollars per year. A summary of these payments can be found in Appendix F, Table F-10.

Education

The educational institutions at the kindergarten through high-school levels in the local area comprise four categories of schools: Arizona unified school districts, BIA schools, BIA contract schools (funded by BIA but managed by the tribes), and Arizona charter schools (see Table D-13).

Table D-13 Schools (Grades K-12) in the Local Area

Name of District or School	Category	Grade Levels
Kayenta Unified District	Arizona Unified District	K-12
Tuba City School District	Arizona Unified District	K-12
Piñon Unified District	Arizona Unified District	K-12
Shonto Preparatory School	BIA contract and Arizona charter	K-12
Kayenta Community School	BIA	K-8
Chilchinbito Community School	BIA contract	K-8
Greyhills Academy (Tuba City)	BIA contract	9-12
Moenkopi Day School	BIA	K-8
Dennehotso Boarding School	BIA	K-8
Kaibito Boarding School	BIA	K-8
Tonalea Day School	BIA	K-8
Tuba City Boarding School	BIA	K-8
Rough Rock Community School	BIA contract	K-12

SOURCES: Arizona Department of Education 2005, SWCA Environmental Consultants 2005
NOTES: K = kindergarten; K-12 = kindergarten through the twelfth grade

Arizona schools' five-year graduation rate in 2003 averaged 73 percent, compared to rates ranging from 51 percent to 87 percent for the schools in the local area near the Kayenta Mine permit area for which the rate was available (Arizona Department of Education 2005). In 2008, the statewide four-year graduation rate was 75 percent, compared to 60 percent for those students who classified themselves as Native American; the percentage for Native Americans is up from 55 percent in 2007 (Arizona Department of Education State Report Card 2008-2009, 2010 www.ade.state.az.us).

Tuba City, Kayenta, and Moenkopi have a higher proportion of high-school graduates among residents aged 25 and over than the overall rates for the Hopi (67 percent) or Navajo (57 percent). The State of Arizona's rate of high-school graduates is 80.9 percent. The greater percentage of college graduates reside in Tuba City and Kayenta than overall Navajo Nation's 8 percent college graduates rate. The other local communities have lower educational attainment among adults than is the case for the Hopi Tribe or Navajo Nation overall. PWCC contributes about $0.4 million annually to Hopi Tribe and Navajo Nation scholarship funds. Through 2010, PWCC has contributed about $8.1 million to these scholarship funds.

D.2.14 Environmental Justice

In accordance with Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, it is the responsibility of Federal agencies to identify and address "disproportionately high and adverse human health or environmental effects of its activities on minority populations and low-income populations." The general purposes of the Executive Order are to (1) focus attention of Federal agencies on the human health and environmental conditions in minority and low-income communities with the goal of achieving environmental health; (2) foster nondiscrimination in Federal programs that substantially affect human health or environment; and (3) give minority communities and low-income communities greater opportunities for public participation in, and access to public information on, matters relating to human health and the environment.

An environmental justice population can be defined by one of two criteria: (1) the number of minority and/or low-income persons within a defined area exceeds 50 percent of the population, or (2) the number of minority and/or low-income persons within a defined area exceeds the number of minority and low income persons in a larger community of which it is a part (e.g., State, county, or other division) (Council on Environmental Quality [CEQ] 1997). The study area for Environmental Justice includes the Hopi Reservation and two Navajo Nation chapters (Chilchinbeto and Forest Lake).

The most recent available census data (Census 2000) on race and ethnicity were used to identify minority populations that might be disproportionately larger than the general population. The Hopi and Navajo reservations are predominantly American Indian (93.4 percent and 95.6 percent, respectively). The study area overlaps two Navajo Nation Chapters, Chilchinbeto and Forest Lake, which are about 98 percent American Indian. The Moenkopi Administrative Area in the Hopi Reservation is about 96 percent American Indian (Table D-14 and Table D-15). The percentage of American Indian residents in Navajo County (47 percent), as well as in the Navajo Nation Chapters and Moenkopi Village, significantly exceed the proportion of American Indians in the overall Arizona population (5 percent), but is similar to the proportion of American Indians within the Navajo Nation and Hopi Reservation (refer to Table D-15).

The economies of minority and low-income communities often are less resilient than economies of other communities because these populations generally are dependent upon their surrounding environment (e.g., subsistence living), more susceptible to pollution and environmental degradation (e.g., reduced access to health care), and often less mobile or transient than other populations (e.g., unable to relocate to avoid potential impacts). Census data also were used to identify low-income populations, using thresholds for poverty as defined by the CEQ guidance. On average, low-income populations of the Navajo and Hopi reservations exceed low-income populations in the surrounding county and in the state of Arizona. Navajo and Hopi reservations have disproportionately high low-income populations with 42.1 percent and 41.0 percent below the poverty line, respectively, compared to 13 percent for Arizona overall. Navajo County, at 29.5 percent, also exceeds the statewide proportion of persons below the poverty level (Table D-16). Poverty data from the Census 2000 also were analyzed for both Navajo Chapters and the Moenkopi Administrative Area of the Hopi Reservation that overlap the study area. Both the Chilchinbeto (47.3 percent) and Forest Lake (62.3 percent) chapters have a significantly higher percentage of individuals below the poverty level than the statewide average. While the percentage of individuals below the poverty line on the Hopi Reservation is 41.0 percent, exceeding the statewide percentage, the percentage of individuals below the poverty line living in the Moenkopi Administrative Area appears as zero (Census 2000).

Table D-14 Race and Ethnicity – Regional Level[1,2]

	Arizona (2000 U.S. Census)	**Arizona** (2010 U.S. Census)	**Navajo County**	**Navajo Reservation**	**Hopi Reservation**
Total population	5,130,632	6,392,017	97,470	155,214	6,815
Race (alone)					
White	3,274,258	3,695,647	41,196	3,566	240
Percent of total population	*63.8*	*57.8*	*42.3*	*2.3*	*3.5*
Black or African American	149,941	239,101	794	122	14
Percent of total population	*2.9*	*3.7*	*0.8*	*0.08*	*0.2*
American Indian and Alaska Native	233,370	257,426	45,846	148,423	6,365
Percent of total population	*4.5*	*4.0*	*47.0*	*95.6*	*93.4*
Asian	89,315	170,509	315	100	4
Percent of total population	*1.7*	*2.7*	*0.3*	*0.06*	*0.06*
Native Hawaiian/Other Pacific Islander	5,639	10,959	39	28	1
Percent of total population	*0.1*	*0.2*	*0.04*	*0.02*	*0.01*
Some other race	6,120	8,595	29	7	2
Percent of total population	*0.1*	*0.1*	*0.03*	*0.005*	*0.03*
Two or More Races	76,372	114,631	1,240	1,054	58
Percent of total population	*1.5*	*1.8*	*1.3*	*0.7*	*0.9*
Ethnicity					
Hispanic or Latino origin	1,295,617	1,895,149	8,011	1,914	131
Percent of total population	*25.3*	*29.6*	*8.2*	*1.2*	*1.9*

SOURCE: U.S. Census Bureau 2000, SF1, P4; 2010, DP-1 (Demographic Profile Data)

NOTES: [1] Includes population on Hopi Reservation and off-reservation land in Arizona.

[2] Includes population on Navajo Reservation and off-reservation land in Arizona, New Mexico, and Utah.

Table D-15 Race and Ethnicity – Relevant Navajo Chapters and Hopi District

	Navajo Chapters		Hopi
	Chilchinbeto	**Forest Lake**	**Moenkopi District**
Total population	1,325	573	901
White	13	1	13
Percent of total population	*1.0*	*0.2*	*1.4*
Black or African American	0	0	0
Percent of total population	*0*	*0*	*0*
American Indian or Alaska Native	1,296	566	869
Percent of total population	*97.8*	*98.8*	*96.4*
Asian	0	0	0
Percent of total population	*0*	*0*	*0*
Native Hawaiian/Other Pacific Islander	0	0	0
Percent of total population	*0*	*0*	*0*
Other	0	0	0
Percent of total population	*0*	*0*	*0*
Two or more races	0	2	12
Percent of total population	*0*	*0.3*	*1.3*
Hispanic or Latino origin	16	4	7
Percent of total population	*1.2*	*0.7*	*0.8*

SOURCE: U.S. Census Bureau 2000, SF1, P4

Table D-16 Regional Income Characteristics

				Navajo Chapters		Hopi	
	Arizona	**Navajo County**	**Navajo Reservation**	**Chilchinbeto Chapter**	**Forest Lake Chapter**	**Hopi Reservation**	**Moenkopi**
Total population	5,021,238	95,084	154,496	1,367	424	6,595	15
Per capita income	$20,275	$11,609	$7,486	$5,745	$3,638	$8,637	$11,800
Median Family Income	$46,723	$32,409	$23,209	$26,029	$9,479	$23,496	$41,250
Persons below poverty level	698,669	28,054	65,001	647	264	2,702	0
Percentage of persons below poverty level	13.1	29.5	42.1	47.3	62.3	41.0	0

SOURCE: U.S. Census Bureau 2000, SF3, P77; SF3, P82; SF3, P87

OSM's responsibilities for administering the Indian lands program, Federal program, and Federal lands program established under SMCRA and the implementing regulations for these programs specifically address public notification and participation, and availability of documents to the general public. As part of the public outreach with environmental justice populations in the study area and as part of the permit renewal application, announcements were published in the Navajo-Hopi Observer and the Navajo Times once a week in March and April of 2010. These announcements provided information to residents on the permit renewal application and the request for public comments. During the comment period that ended June 4, 2010, two requests were made for informal public conferences to be held in accordance with 30 CFR 773.6 (c).

Informal public hearings were held on May 26, 2010 in the town of Second Mesa and on May 27, 2010 in the town of Kayenta. These informal public hearings on PWCC's application to renew the permit provided residents with information related to the project and meeting attendees were provided the opportunity to voice their questions and concerns related to the permit renewal. Information provided during the meeting was a description of the Kayenta Mine permit area, which coal resources areas were proposed for renewal, and the regulatory criteria associated with the renewal application. The residents were notified by public announcements in local newspapers and by radio stations. Approximately 26 people provided comments during the informal hearings (OSM 2010a and OSM 2010b).

In addition to this public outreach regarding the Kayenta Mine permit renewal, the Black Mesa Review Board, whose mission is to advocate for the best interest of the local families within the leased area of Peabody Western Coal Company (PWCC), has also been informed of the PWCC permit renewal application. PWCC collaborates with the Black Mesa Review Board to address local issues and provides technical assistance, data and field research (Black Mesa Review Board 2011).

D.2.15 Indian Trust Assets

The United States has a responsibility to protect and maintain rights reserved by or granted to American Indian tribes by treaty, statutes, and executive orders. This responsibility requires Federal agencies to take actions necessary to protect Indian trust assets. The Secretary of the Interior's Order Number 3215, dated April 28, 2000, addresses "Principles for the Discharge of the Secretary's Trust Responsibility." That Secretarial Order cited the American Indian Trust Fund Management Reform Act of 1994 (Public Law 103-412, 108 Statute 4239) as the most comprehensive and informative legislative statement of Secretarial duties in regard to the trust responsibility of the United States. A key section of that law indicates that the Secretary's proper discharge of the trust responsibilities of the United States shall include, but are not limited to, appropriately managing the natural resources located within the boundaries of Indian reservations and trust lands (25 U.S. Code 162a(d), cited in Babbitt 2000).

D.2.15.1 Indian Trust Assets Definition and Characteristics

The Federal Government defines Indian trust assets as legal interests in assets that are held in trust or restricted status for federally recognized American Indian tribes or individual American Indians. Based on Department Manual 303, Indian Trust Assets [are] lands, natural resources, money, or other assets held by the federal government in trust or that are restricted against alienation for Indian tribes and individual Indians (USDI 2000). Examples of Indian trust assets include minerals, water rights, lands, hunting and gathering rights, other natural resources, or money. Examples of property interests, other than exclusive ownership, are leases or rights of use. Indian trust assets can be real property, physical assets, or intangible property rights. Indian trust assets do not include things in which a tribe has no legal interest. For example, off-reservation sacred sites in which a tribe has no legal property interest generally are not considered Indian trust assets. Important characteristics of the trust relationship between American Indian tribes and the United States include the following:

- A trust has three components—the trustee, the beneficiary, and the trust asset(s). In the case of Indian trust assets, title to Indian trust assets is held by the United States (trustee) for the benefit of a tribe or individual American Indian.
- Legal interest means there is a property interest for which a legal remedy may be obtained.
- Indian trust assets cannot be sold, leased, or otherwise alienated without the United States' approval. While most Indian trust assets are located on Indian reservations, they also can be located off reservation.

Indian Trust Assets are property interests held in trust by the United States for the benefit of Indian tribes or individuals, Indian reservations, rancherias, and public domain allotments. The Indian Trust Assets for the Navajo Nation and Hopi Tribe within the study area are minerals, water rights, lands, hunting and gathering rights, and other natural resources.

D.2.15.2 Indian Trust Assets within the Affected Environment

Minerals

The primary statutes governing the leasing of Indian coal assets for the benefit of an Indian tribe or nation are the Indian Mineral Leasing Act of 1938 and the Indian Mineral Development Act of 1982. An American Indian Coal Lease is obtained by direct negotiation with Indian tribal authorities, but is subject to approval and administration by the United States Department of the Interior (USDI). The authority by which coal reserves that are Indian trust assets are leased is described in 25 U.S. Code 396a and concerns leases of unallotted lands for mining purposes. It states the following:

> On or after May 11, 1938, unallotted lands within any Indian reservation or lands owned by any tribe, group, or band of Indians under Federal jurisdiction, except those specifically excepted from the provisions of Sections 396a and 396g of this title, may, with the approval of the Secretary of the Interior, be leased for mining purposes, by authority of the tribal council or other authorized spokesmen for such Indians, for terms not to exceed ten years and as long thereafter as minerals are produced in paying quantities.

The coal resource areas (N-9, J-19, and J-21) are located on leased land within the boundaries of the Navajo Nation near Kayenta in Navajo County. All of the coal produced from these areas is an Indian trust asset and is produced subject to one of three coal-mining leases, which designates land rental rates, royalty rates for the coal, other fees, and additional terms. One lease covers the 24,858 acres of the northern portion of the Kayenta and Black Mesa mining operations, where the Navajo Nation holds both surface and mineral land ownership. In 1964, that lease No. 14-20-0603-8580, was approved by the Navajo Nation Tribal Council, executed by the Navajo Nation, and approved by the Secretary of the Interior. Coal resource area N-9 is within this area.

The other two leases, approved by the Hopi Tribe and Navajo Nation in 1966, cover the southern portion of the mining operations, where the tribes have joint and equal interests in the minerals that underlie the former Joint Use Area. Lease No. 14-20-0603-9910 was approved by the Navajo Nation Tribal Council, executed by the Navajo Nation, and approved by the Secretary of the Interior. Lease No. 14-20-0450-5743 was executed by the Hopi Tribe and approved by the BIA. The surface of the southern portion of the leasehold has been partitioned. Approximately 33,863 acres are in Navajo Nation ownership, while 6,137 surface acres are in Hopi Tribe ownership (PWCC 2002). Coal resource areas J-19 and J-21 are within the area owned by the Navajo Nation.

Land

Infrastructure for the existing coal resource areas N-9, J-19, and J-21, within the Kayenta Mine permit area, occupies land that is an Indian tribal asset. PWCC holds leases, rights-of-way, and easements for the associated facilities such as haul roads, coal-handing areas, conveyors, the Black Mesa and Lake Powell Railroad loading site, storage areas, shops, offices, and other structures and facilities.

Water

Rights to the surface water and groundwater associated with the Navajo Nation and Hopi Tribe are Indian trust assets of the tribes. The Little Colorado River watershed comprises all of the existing project components. The Navajo Nation claims water as an Indian Trust asset as a party to the Little Colorado River water rights litigation entitled, "In re: The General Adjudication of all Right to use water in the Little Colorado River System and Source (Nos. 6417-033-9055 and 6417-033-9066, Consolidated)." A settlement agreement has been proposed. The Navajo Nation Tribal Council approved the proposed settlement agreement and it was signed by the Navajo Nation President in November, 2010. Agreement among other parties to the case remains pending. The proposed agreement will not be final until all parties have agreed. Water from the N aquifer would be used in mining operations, principally dust suppression as required by Federal regulations, and to provide water to local residents. PWCC's existing leases with the tribes require N aquifer wells to be transferred to the tribes in operating condition for their use once PWCC successfully completes reclamation and relinquishes the leases.

Hunting and Gathering and Other Natural Resources

The tribes have rights to continue hunting, gathering, grazing, and their traditional uses on the reservations. Ongoing activities of hunting and gathering, grazing, and traditional uses are described in Section D.2.12 of this EA.

D.2.16 Visual Resources

Visual resources are the natural and man-made features that give an area its visual character. The study area for visual resources was defined as 5 miles beyond the edge of the permit renewal area, which is limited to the mining areas of N-9, J-19, and J-21. The 5 miles represent a middleground to background viewing threshold as defined by the Bureau of Land Management's Visual Resource Management system (USDI Bureau of Land Management 1984). Visual conditions are described in terms of landscape character, viewer sensitivity, and visibility. The Kayenta Mine permit area is on Navajo Nation and Hopi Tribe land; neither tribe classifies lands for scenic resources nor are areas specifically designated for the protection of visual resources.

The study area landscape is characterized using physiographic provinces, or geomorphic regions that are broadscale subdivisions based on terrain texture, rock type, and geologic structure and history. The study area is contained within the Navajo Section of the Colorado Plateau physiographic province, which exhibits several unique landscape settings and viewing conditions. The Colorado Plateau's major distinguishing features are landforms cut by wind and water erosion from the largely horizontal strata and the relatively high elevations of this province (Fenneman 1931).

Scenic integrity indicates the degree of intactness and wholeness of the landscape character (U.S. Department of Agriculture, Forest Service 1995). Human alterations can sometimes raise, maintain, or lower scenic integrity. In general, the landscapes are vast and expansive, permitting extensive views of undisturbed landscapes with rolling piñon-juniper woodlands and rock outcroppings. Often, these same views contain evidence of existing man-made structures or existing coal mining activity. Areas with existing disturbance include active coal mine operations, reclaimed areas with a grassland-shrubland vegetation community, agricultural and rural housing along the Moenkopi and Dinnebito washes, grazing or livestock facilities, transmission lines, and airstrips.

The extent to which new development contrasts with the existing scenic integrity is one of the factors used to analyze potential impacts to visual resources. Visual resource elements consist of form, line, color, texture, and motion. The current PWCC mining areas and associated facilities are notable visual features that contrast with the surrounding natural and reclaimed landscapes. Changes in form and line range from the gently rolling rounded hills to the horizontal and parallel ridges and troughs. Changes in color range from the dark, olive, and silver greens of the piñon-juniper woodland and sagebrush shrubland, and the reds, tans, and grays of the soil to the blacks and dark grays of the exposed overburden ridges. Changes in texture range from the scattered-medium to course patterns of vegetation to the random to linear relatively fine-textured overburden ridges.

Viewer sensitivity is defined by the type of viewer and circumstance of their activity in a landscape. Residents in a residential neighborhood or natural setting who have continuous potential views of the mining area are considered highly sensitive. Residents surrounded by an agricultural area are considered moderately sensitive. Routine travelers along major roads who have transitory and directed views are considered to be moderately sensitive. Daily mine employees are considered to have low sensitivity. Within the 5 mile radius of the study area, the occupied structures are usually in clusters of approximately two to 30 structures (see Map D-8). The major roads include U.S. 160 and Arizona Route 564. Navajo Route 41 is used by the local residents and mine employees. It is reported that this area is sparsely used for sightseeing (OSM 1990). Visibility of the mining operations depends upon distance, topography, and screening by vegetation and structures.

Once mining operations end, the disturbed areas are reclaimed to meet pre-mine conditions as per the permit. Reclamation includes re-grading the land to its approximate original contours, replacing topsoil, and replanting vegetation according to the approved post-mining land uses of livestock grazing, wildlife habitat, and cultural plant use (see Appendix A, Section D). Compared to the natural landscape, reclaimed land in the Kayenta Mine permit area consists of large patches of darker colored soil/rock and various ages of vegetation. The topography is less steep and coarser patterned. The lack of trees in most of the reclaimed areas could widen and extend views. However, as the vegetation matures, reclaimed areas blend into surrounding landscapes and appears to be undisturbed.

D.2.17 Transportation

The transportation study area is the Kayenta Mine permit area roads, Navajo Route 41, State Highway 98, and US Highway 160, that are used to support mine related vehicle traffic. Regionally the transportation network provides access to neighboring communities and the surrounding project area. U.S. Highway 160 lies north of the project boundary and extends from the southwest to the northeast as shown on Map A-1. State Route 98 is located west of the project, extending northwest from U.S. Highway 160 toward Page, Arizona. Navajo Route 41 is also located west of the Kayenta Mine permit area, extending south from U.S. Highway 160 to the town of Piñon.

Primary roads within the mine area are used by major haul vehicles and general access vehicles. Ancillary roads support the primary road system. The Kayenta Mine operation uses approximately 194 miles of primary and ancillary mine roads. Primary and ancillary roads are located, designed, constructed, used, maintained, and reclaimed in accordance with Federal regulations and performance standards. PWCC has constructed or upgraded both primary and ancillary roads within the Kayenta mining area. The primary roads include coal-haul and mine-vehicle roads a minimum of 50 feet wide, and coal-haul, mine-vehicle, and dragline deadheading roads approximately 150 feet wide (OSM 1990). To gain access to mine facilities in remote sites, on-highway vehicles most frequently use ancillary roads. There are two types of ancillary roads: two-lane roads a minimum of 24 feet wide, and single-lane roads with a minimum width of a bulldozer blade or a motor-grader blade. The single-lane roads usually follow the natural topography and were established by area residents prior to mining activities (OSM 1990).

Unless these have been approved by the regulatory authority as a part of the post-mining land use plan, all roads used or built by PWCC on or after December 16, 1977 are to be reclaimed. There are about 57 miles of primary roads and 109 miles of ancillary roads that willd be totally reclaimed, and 28 miles of primary haulage roads that will be narrowed as permanent roads for public use. Due to the extent of PWCC's mining activities, very few of the primary haulage roads are reclaimed until mining activities are completed. However, roads in the immediate vicinity of pits and ramps, which are created in the spoil, are reclaimed as the general reclamation activities progress within a specific coal resource area.

D.2.18 Health and Safety

The affected environment for public health and safety includes the mine operations and individuals who could be exposed to dust, noise, heat stress, and chemicals from the Kayenta Mine operations in coal resource areas N-9, J-19, and J-21. Many activities conducted during mining operations carry inherent health and safety risks. Typical risks encountered include exposure to dust, noise, heat stress, and chemicals, as well as the opportunity for accidents due to working directly with or in proximity to large equipment. Procedures used during operation and maintenance activities associated with the project, such as blasting or construction, also pose health and safety risks. However, the establishment of appropriate policies and procedures, and the monitoring of those procedures to verify that they are properly observed, helps to reduce the risk involved. The Federal Mine Safety and Health Act of 1977 regulate health and safety associated with the Kayenta Mine operations. During Kayenta Mine operation, permits will be required along with safety inspections to minimize the frequency of accidents and maximize worker safety.

D.2.18.1 Safety Practices and Procedures

Safety practices at the Kayenta Mine and all associated facilities were determined by review of the policies and procedures established by the Mine Safety and Health Act of 1977 (MSHA). MSHA implemented regulation 30 CFR 1-199 and outlined the policy and procedures for safety at mining operations. In addition to complying with the regulations of MSHA, the Kayenta Mine operation is consistent with all Federal, State, and Tribal regulations related to mining operations.

D.2.18.2 Contaminants and Solid Waste

All mining operations are required to be in compliance with regulations promulgated under the Resource Conservation and Recovery Act, Federal Water Pollution Control Act (Clean Water Act), Safe Drinking Water Act, Toxic Substances Control Act, Mine Safety and Health Act, Department of Transportation, and the Federal Clean Air Act. In addition, the Kayenta mining operations comply with all attendant federal and tribal rules and regulations relating to hazardous material reporting, transportation, management, and disposal. Wastes produced by current mining activities at the Kayenta Mine are handled according to the procedures, as described in the approved mine permit (PWCC 2005b). The procedures and requirements for handling hazardous and solid wastes comply with NNEPA and USEPA-approved waste disposal plans. Potential sources of hazardous or solid waste would include spilled, leaked, or dumped hazardous substances, petroleum products, and/or solid waste associated with mine operation or maintenance activities. No hazardous or solid wastes are known to be present on the proposed development area at this time.

A contractor removes non-hazardous waste for disposal in a regulated landfill, which is similar to the disposal of domestic or municipal solid waste from the mine site. At the Kayenta Mine, hazardous materials and materials that could be classified as hazardous include greases, solvents, paints, flammable liquids, and other combustible materials determined to be hazardous by the USEPA under the Resource Conservation and Recovery Act. These types of wastes are recycled where practicable or disposed of by licensed contractors at an off-site USEPA-permitted hazardous waste facility.

Several products are recycled at the mining operation area, including scrap metal, tires, batteries, computer equipment, fluorescent lamps (4-foot and 8-foot lengths), high-pressure sodium light bulbs, and mercury-vapor light bulbs. Per waste stream analysis, used oil, parts washer fluid, spent solvent, grease, and antifreeze are recycled. Ranging from monthly to annually, materials are removed from the Kayenta Mine by contractors on an as-needed basis.

D.2.18.3 Hazards

The main hazards associated with mining and the use of explosives are the handling of explosives by workers and the proximity to the blast site. Blasting operations at the Kayenta Mine are conducted according to Federal law, applicable regulations, and the approved permit application. Under OSM's permitting requirements, a resident or owner of a dwelling or structure within 0.5 mile of any part of the permit area may request that a pre-blasting survey be conducted on their dwelling or structure. Upon receipt of this request, Peabody conducts the survey by analyzing the conditions of the dwelling or structure prior to blasting activities and documenting any pre-blasting damage and other physical factors that could be affected by the blasting. A written report is prepared and a signed copy provided to the regulatory authority and the person requesting the survey (OSM 1983).

According to the regulations, no blasting is conducted within 0.5 mile of an occupied dwelling. Therefore, residents in or nearby the blasting area are evacuated prior to proceeding with any blasting actions. Residents are notified well in advance of the blasting schedule, and notices are posted in public locations. Federal law and regulations both allow mining to within 300 feet of such a structure. The permit requirements are more stringent than the typical Federal limits. Blasts are monitored for air blast and ground vibration by five seismographs located throughout the Kayenta Mine permit area. The OSM reviews Kayenta Mine's blasting records monthly during field inspections and quarterly through reports submitted by PWCC and their blasting contractor.

Along Navajo Route 41, PWCC assists with maintenance of the road surface and slopes and coordinates maintenance with the Navajo Nation Department of Transportation for repaving, seal coating the road or through their own roadway maintenance contract to maintain roadway shoulders and drainage. To ensure public safety along the mine roads, public traffic is excluded from active mine areas by security gates. All roads are signed and maintained by grading and dust suppression, and school buses and deliveries are escorted by PWCC security vehicles.

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E. ENVIRONMENTAL IMPACTS OF THE PROPOSED ALTERNATIVES

This section provides a description of the effects on the environment that could be caused by the agency's action under Alternative 1 or Alternative 2 (described in Sections C.1 and C.2, respectively). An action can have direct or indirect effects, and it can incrementally contribute to cumulative effects. Direct and indirect effects of the alternatives are presented in Section E.1 below. Cumulative effects are addressed in Section E.2.

Direct effects are effects that "are caused by the [proposed] action and occur at the same time and place." (40 Code of Federal Register [CFR] 1508.8(a)). Indirect effects are effects that "are caused by the [proposed] action and are later in time or farther removed in distance, but are still reasonably foreseeable." (40 CFR 1508.8(b)). For example, indirect effects could 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. However, NEPA does not require an agency to engage in speculation regarding the cause of effects or the results of an action. Moreover, where an agency has no jurisdiction to prevent or reduce certain environmental effects, such effects are not a direct effect or an indirect effect of the proposed action for purposes of NEPA because the proposed action is not the legal cause of the effect.

Therefore, effects attributed to the alternative proposals in this Environmental Assessment, whether directly, indirectly or cumulatively, are those effects reasonably predicted to be caused by OSM's permit renewal. In deciding whether to renew or deny renewal of the Kayenta Mine permit, OSM's authority to consider environmental factors is constrained by SMCRA and its implementing regulations. Under SMCRA, once a mining permit is granted, the coal mine operator has a right to successive renewal within the approved mine permit boundaries. OSM may deny the permittee's application for renewal only if one of six specific criteria is present (See Section A, Description of the Proposed Action). One of OSM's approval criteria requires the surface coal mining and reclamation operations to be in compliance with SMCRA's environmental protection standards; however, the standards exclusively concern the surface coal mining operation and govern the conduct of the mining operation itself. Unless OSM finds that the mining operator is in violation of the standards, or another one of the statutory criteria is present, OSM must renew the permit.

Consistent with SMCRA's focus and OSM's authority, this section addresses the environmental effects of the alternatives, including direct, indirect and cumulative effects, but does not address the effects of the transportation and use of coal mined at Kayenta Mine. Neither SMCRA nor its implementing regulations permit OSM to consider the effects of coal transportation or the use of coal on the environment, or impose measures to remedy those effects, in deciding whether to renew or deny renewal of the Kayenta permit. OSM only has regulatory jurisdiction over coal mining and reclamation operations and has no legal authority to prevent the effects of the transportation and use of coal mined at Kayenta. OSM's action is not the legal cause of those effects, and those effects are beyond the scope of analysis in this EA.

CEQ regulations implementing NEPA require agencies evaluating effects on the human environment to identify incomplete or unavailable information, if that information is essential to a reasoned choice among alternatives (43 CFR 1502.22). For the analysis in this EA, site-specific data are used to the extent possible but may not be entirely available; however, these data are not essential for a reasoned choice among alternatives. The best available information was used to develop this EA. Considerable effort has been made to acquire data from both PWCC and other sources such as NNDFW. However, detailed data were unavailable for all resources, because inventories have not been conducted or are not complete. For these resources, estimates were made regarding the number, type, and significance of these resources based on previous surveys and existing knowledge. Data unavailable for this analysis is recreation visitation based on actual use and economic expenditure data associated with such use.

E.1 RESOURCE VALUES

Resource specialists considered the following impact levels in qualitative and quantitative terms. The environmental consequences of each impact topic are defined on the basis of type of effect, duration, context, and intensity. Type refers to an effect that either can improve or degrade the resource and the terms major, moderate, minor, or negligible describe the anticipated magnitude, or importance, of impacts, including those on the human environment. Because definitions of magnitude vary by resource topic, separate intensity definitions are provided for each impact topic. Table E-1 provides definitions of impact thresholds for resources. The table does not describe impact thresholds for those resources where no impacts are anticipated. Impacts on resources are described in terms of duration. Impacts are described as either permanent, long-term effects that persist beyond mine operations or reclamation, or short-term, those effects that persist during mine operation and reclamation activities and until the time the reclamation bond is released.

Impacts also vary in terms of significance. The basis for conclusions regarding significance are the criteria set forth by the Council on Environmental Quality (40 CFR 1508.27) and the professional judgment of the specialists doing the analyses. The thresholds and logic for the intensity of impacts and significance are presented for each resource accordingly in Table E-1. Impact significance may range from negligible to major (Table E-1), and impacts can be significant during mining but may be reduced to insignificant following completion of reclamation. The level of detail in the environmental impacts analysis corresponds to the context and intensity of the impacts anticipated for each resource.

Table E-1 Intensity of Impacts for Resources Analyzed in Detail

Impact Topic	Negligible	Minor	Moderate	Major
Cultural Resources	Properties listed in or eligible for the National Register will not be directly or indirectly affected. For purposes of Section 106, the determination will be no effect.	Properties listed in or eligible for the National Register might be directly or indirectly affected but the effects are unlikely to be adverse, that is, they will not diminish the location, design, setting, materials, workmanship, feeling, or association that qualify a property for the National Register. For purposes of Section 106, the determination will be no effect or no adverse effect.	Properties listed in or eligible for the National Register can be directly or indirectly affected in a manner that will diminish the integrity of a property's location, design, setting, materials, workmanship, feeling, or association that qualify the property for the National Register. For the purposes of Section 106, the determination will be adverse effect, but there is good potential that the effect can be adequately mitigated by treatment developed in consultation with parties participating in the Section 106 review of the Project.	Properties listed in or eligible for the National Register can be directly or indirectly affected in a manner that will diminish the integrity of a property's location, design, setting, materials, workmanship, feeling, or association that qualify the property for the National Register. For the purposes of Section 106, the determination will be adverse effect, and consulting parties are unlikely to concur that treatment can be implemented to adequately mitigate those impacts.

Impact Topic	Negligible	Minor	Moderate	Major
Hydrology	Impacts will be considered negligible if there was 1 to 10 percent increase in pumping costs. Impacts will be considered negligible if the saturated thickness of an aquifer was reduced 20 percent or less. Impacts will be considered negligible if groundwater discharge was reduced 10 percent or less. Impacts will be considered negligible if water quality changes are within the range of background levels and do not change the present or potential use within the permit area. Impacts will be considered negligible if changes in sediment loads or yields are less than or equal to the range of background levels within the permit area. Impacts will be considered negligible if the watershed area controlled by impoundments is less than 10 percent of the total drainage area.	Impacts will be considered minor if there was 11 to 25 percent increase in pumping costs. Impacts will be considered minor if the saturated thickness of an aquifer was reduced by 21 to 30 percent. Impacts will be considered minor if there was an 11 to 20 percent reduction in groundwater discharge. Impacts will be considered minor if water quality changes occasionally exceed the range of background levels and do not change the present or potential use within the permit area. Impacts will be considered minor if changes in sediment loads or yields occasionally exceed the range of background levels within the permit area. Impacts will be considered minor if the watershed area controlled by impoundments is between 10 and 30 percent of the total drainage area.	Impacts will be considered moderate if there was 26 to 50 percent increase in pumping costs. Impacts will be considered moderate if the saturated thickness of an aquifer was reduced by 31 to 50 percent. Impacts will be considered moderate if there was a 21 to 30 percent reduction in groundwater discharge. Impacts will be considered moderate if water quality changes consistently exceed the range of background levels and do not change the present or potential use within the permit area. Impacts will be considered moderate if changes in sediment loads or yields are consistently greater than the range of background levels within the permit area. Impacts will be considered moderate if the watershed area controlled by impoundments is between 30 and 50 percent of the total drainage area.	Impacts will be considered major if there was a greater than 50 percent increase in pumping costs. Impacts will be considered major if there was a greater than 50 percent reduction in the saturated thickness of an aquifer. Impacts will be considered major if there was a 31 percent or greater reduction in groundwater discharge. Impacts will be considered major if water quality changes consistently exceed the range of background levels and change the present or potential use outside of the permit area. Impacts will be considered major if changes in sediment loads or yields are consistently greater than the range of background levels and extend a measurable distance outside of the permit area. Impacts will be considered major if the watershed area controlled by impoundments is greater than 50 percent of the total drainage area.

Impact Topic	Negligible	Minor	Moderate	Major
Vegetation	There will be no measurable or perceptible changes in plant community structure or composition.	Direct effects on vegetation community structure and composition will be limited to areas disturbed by mining activities. There will be no changes in plant community structure or composition elsewhere in the permit area.	Direct effects on vegetation community structure and composition will be limited to areas disturbed by mining activities. There can be changes in plant community structure or composition elsewhere in the permit area.	Direct effects on vegetation community structure and composition will be limited to areas disturbed by mining activities. There will be changes in plant community structure or composition elsewhere in the permit area.
Wildlife	Wildlife species will not be affected or the effects on wildlife species will not have perceptible changes to the population.	The effects on wildlife species will be detectable and short-term. The effects will be limited to local changes to the population.	The effects to wildlife species will be detectable and long-term. The effects will be limited to local changes to the population.	The effects to wildlife species will be detectable and long-term. The effects can result in regional changes to the population.
Special Status Species **(Federal and Navajo Nation listed species)**	No federally listed or Navajo Nation listed species will be affected. A negligible effect will equate with a "no effect" determination from the U.S. Fish and Wildlife Service and Navajo Nation.	The effects on an individual or population of federally listed or Navajo Nation listed species or its critical habitat will be detectable and short-term. Minor effect will equate with a "may affect" determination from the U.S. Fish and Wildlife Service and Navajo Nation. The determination will be accompanied by a statement of "not likely to adversely affect" the species.	The effects on an individual or population of a federally listed or Navajo Nation listed species, or its critical habitat will be detectable and long-term. Moderate effect will equate with a "may affect" determination from the U.S. Fish and Wildlife Service and Navajo Nation. The determination will be accompanied by a statement of "may affect, but not likely to adversely affect" the species.	The effects on an individual or population of a federally listed or Navajo Nation listed species, or its critical habitat will result in a loss of species presence or habitat and long-term. Major effect will equate with a U.S. Fish and Wildlife Service and Navajo Nation determination of "is likely to adversely affect" the species or its critical habitat.
Soils	Soils will not be affected by erosion. The effects on soil productivity or fertility will be below levels of detection with no long-term effects.	The effects on soil productivity or fertility from gullies and sheet erosion will be detectable and short-term but will not result in sediment loss exceeding background levels within the permit area.	The effects on soil productivity or fertility from gullies and sheet erosion will be detectable and long-term but will not result in sediment loss exceeding background levels within the permit area.	The effects on soil productivity or fertility from gullies and sheet erosion will be detectable and long-term and will result in sediment loss exceeding background levels beyond the permit area.

Impact Topic	Negligible	Minor	Moderate	Major
Recreation	Recreation activities will not be affected or changes in use and/or experience will be below or at the level of detection by the recreation user.	Changes in recreation activities and/or experience will be detectable and short-term. The recreation user experience will change, but location of the recreation activity will not change within the permit area.	Changes in recreation activities and/or experience will be detectable and long-term. The recreation user experience and location of the recreation activity will change within the permit area.	Changes in recreation activities and/or experience will be detectable and long-term. The recreation user experience and location of the recreation activity will change outside of the permit area.
Air Quality	The maximum for each pollutant is 60% to 70% of the national ambient air quality standards	The maximum for each pollutant is 71% to 80% of the national ambient air quality standards.	The maximum for each pollutant 81% to 90% of the national ambient air quality standards.	The maximum for each pollutant is greater than 90% of the national ambient air quality standards.
Noise and Vibration	Noise levels (dBA) will not be detectable (3 dBA increase) from current levels.	Noise levels (dBA) will be detectable from current levels but will not exceed 35 dBA at residences at night or exceed 55 dBA other than from temporary sources during daytime hours.	Noise levels (dBA) will increase more than 3 dBA but will not exceed 35 dBA at residences at night or exceed 55 dBA other than from temporary sources during daytime hours.	Noise levels (dBA) will increase more than 3 dBA and will exceed 35 dBA at residences at night or 55 dBA during daytime hours.
Landforms and Topography	Changes to topography will not be detectable.	Changes in slope, elevation or the landform complexity will be detectable and long-term, but will resemble the approximate original contour of undisturbed landforms within the permit area.	Changes in slope, elevation or the landform complexity will be detectable and long-term within the permit area but will satisfy postmine land use requirements.	Changes in slope, elevation or the landform complexity will be detectable and long-term, will not resemble the topography of surrounding undisturbed landforms within the permit area, and will not meet postmine land use requirements.
Geology and Mineral Resources	Changes will not result in a loss of scientific and educational values for geologic and paleontological resources or potential mineral resource development.	Changes will result in a loss of geologic and paleontological resources or potential mineral resource development, but will not result in the loss of unique geologic and paleontological resources or economic benefits from mineral resources.	Changes will result in a loss of geologic and paleontological resources or potential mineral resource development, but mitigation will reduce loss of unique geologic and paleontological resources or economic benefits from mineral resources.	Changes will result in a loss of geologic and paleontological resources or potential mineral resource development and mitigation will not reduce loss of unique geologic and paleontological resources or economic benefits from mineral resources.

Impact Topic	Negligible	Minor	Moderate	Major
Land Use	There will be no changes to existing or future land use or change in planned projects. For livestock grazing, there will be no change in the number of livestock raised within the permit area.	There will be short-term changes to existing land uses within coal resource areas but there will not be any adjustment or change to planned projects. For livestock grazing, changes in the number of livestock raised within the permit area can be discernable from changes caused by economics or seasonal vegetation factors. Changes in livestock numbers will not be discernable at the Navajo Chapter or Hopi Tribe level.	There will be long-term changes to existing land uses within the permit area but there will not be any adjustment or change to planned projects. For livestock grazing, changes in the number of livestock raised within the permit area will be discernable from changes caused by economics or seasonal vegetation factors, but changes in livestock numbers will not be discernable at the Navajo Chapter or Hopi Tribe level.	There will be long-term changes to existing land uses within the permit area and there will be adjustment or changes to planned projects. For livestock grazing, changes in the number of livestock raised within the permit area will be discernable from changes caused by economics or seasonal vegetation factors and changes in livestock numbers will be discernable at the Navajo Chapter or Hopi Tribe level.
Socioeconomic environment	The effects on the socioeconomic environment will not be distinguishable from changes that were occurring from other social and economic activities within the surrounding counties, communities, and tribal areas.	The effects will be a less than 1 percent change in population, employment, dependency ratio, or housing and a less than 5 percent change in household income.	The effects will be a 1 to 3 percent change in population, employment, dependency ratio, or housing and a 5 to 10 percent change in household income.	The effects will be a more than 3 percent change in population, employment, dependency ratio, or housing and a more than 10 percent change in household income.
Visual Resources	The change to the visual appearance of the site will not be noticeable.	The change to the visual appearance of the site will generally be noticeable but subtle. It will usually be subordinate, but will be noticed by viewers without being pointed out.	The change to the visual appearance of the site will be distracting. It will be visually co-dominant; the change will compete for attention of viewers and will be equally conspicuous with other features.	The change to the visual appearance of the site will be dominant, distracting, and will demand attention. The change to the landscape is the focus of attention and will become the primary focus of the viewer.

Impact Topic	Negligible	Minor	Moderate	Major
Human health and safety	Human health and safety will not be affected, or the effects will not be measurable or perceptible using standard scientific tests.	The effect will be detectable and temporary, but will not be measurable or perceptible using standard scientific tests.	The effects will be detectable and short-term, and will be measurable or perceptible using standard scientific tests.	The effects will be detectable and long-term, and will be measurable or perceptible using standard scientific tests

Although present in the project area solid or hazardous materials and waste is not affected by the alternatives because no chemicals subject to Superfund Amendments and Reauthorization Act (SARA) Title III in amounts greater than 10,000 pounds would be used in the mine operations or at the associated facilities. No hazardous substances above threshold planning quantities, as defined by 40 CFR 355, will be used for mine operations or at the associated facilities. Trash receptacles are in place and would remain on site for the full duration of the project. PWCC and contractors responsible for the storage and handling of solid or hazardous materials and wastes, including diesel fuel, are required to meet applicable federal, state, and local regulations. Therefore, this impact topic was dismissed from further analysis.

E.1.1 Cultural Resources

Examples of the types of adverse effects on cultural resources that might occur at the Kayenta Mine include the following:

- Physical destruction, damage, or alteration of all or part of a cultural resource
- Removal of a cultural resource from its historic location
- Change of a cultural resource's use or setting that contributes to its historic significance
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of a cultural resource's significant historic features [see 36 CFR 800.5(a)(2)]

E.1.1.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

PWCC estimates that 1,159 acres (1.8 square miles) within the three coal resource areas (488 acres in N-9, 295 acres in J-19, and 376 acres in J-21) would be disturbed by mining activities during the 5-year permit renewal period (refer to Table C-1). That ground disturbance could disturb or destroy some of the 36 prehistoric archaeological sites and 20 historic Navajo sites recorded in those areas. Two archaeological sites in coal resource area J-19 have been identified as having potential human burials and if burials are present, they could be disturbed by coal mining during the permit renewal period. Two possible sacred and ceremonial sites recently identified within the J-21 coal resource area, as well as others that might be identified during the permit renewal period, also could be disturbed. To mitigate the identified adverse effects of coal mining, PWCC sponsored the 20-year Black Mesa Archaeological Project between 1967 and 1986 to recover and preserve information and artifacts to mitigate the impacts of coal mining on archaeological and historical sites within the Black Mesa and Kayenta mines.

Therefore, the anticipated impacts on archeological sites in coal resource areas N-9, J-19, and J-21 have already been identified and mitigated, and no additional studies to recover information and artifacts are proposed.

Since 1990, PWCC has considered and mitigated impacts on new discoveries of cultural resources, including traditional cultural resources, and removed and reburied human remains associated with unexcavated archeological and historical sites in accordance with standard conditions and terms that OSM has attached to the Mining Permit AZ-0001C and AZ-0001D issued pursuant to the Surface Mining Control and Reclamation Act of 1977 (SMCRA). If Alternative 1 is implemented, PWCC would continue to comply with those standard conditions and permit terms.

The permit terms require PWCC to report the discovery of any previously unrecorded cultural resources that might be made during the permit renewal period and to suspend work in the vicinity to protect discoveries until OSM determines appropriate disposition.

The permit terms also require PWCC to address the potential effects on sacred and ceremonial sites that might be identified during the 5-year permit renewal period. As per the permit terms, PWCC will address any human remains that might be disturbed in accordance with the Native American Graves Protection and Repatriation Act, and the Navajo Nation policy for the Protection of Jishchaá: Gravesites, Human Remains, and Funerary Items. If Alternative 1 is implemented, PWCC will sponsor testing at two known archaeological sites in coal resource area J-19 that have been identified as having potential for human burials. If human remains and associated funerary objects are found, they would be documented, removed, and reburied in accordance with the ongoing program that has been established to comply with the permit terms. No similar sites are known in the N-9 and J-21 coal resource areas.

As mining has continued, additional cultural resources have been occasionally discovered and additional discoveries could be made during the permit renewal period. By definition, it is not possible to predict unexpected discoveries, but PWCC's experience since 1990 suggests that continued coal mining through 2015 is unlikely to result in more than one or two additional unanticipated discoveries of archaeological, historical, or traditional cultural resources that could be affected by coal mining.

Although continued mining in the permit renewal area could have impacts on cultural resources, it is expected that continued implementation of the standard conditions and permit terms described in Section D.2.1 will satisfactorily mitigate any such impacts and impacts on cultural resources would be minor and would not be considered significant.

To accommodate continued mining in the J-21 coal resource area, four of the 83 occupied houses within the Kayenta Mine permit area would be relocated during the permit renewal period. Those relocations could affect any traditional aspects of the lifeways of those residents, such as use of ceremonial hogans, use of prayer or offering locations, or collection of traditionally used plants minerals and other materials. The residents of the four occupied houses have not indicated that they have concerns about impacts on traditional cultural resources. If any such impacts are identified, they would be addressed in accordance with permit terms and the relocation compensation program will reduce the effects. During the past 2 years, PWCC has been coordinating with the four Navajo households that would be relocated during the permit renewal period to discuss relocation arrangements and a mutually acceptable relocation site has been identified within the customary use areas of those households in the southern part of the J-21 coal resource area that will not be mined. PWCC would conduct the relocations in accordance with established procedures that would compensate the households for replacement of all structures and any lost grazing acreage and work to reduce any impacts on any traditional cultural resources (refer to Section D.2.12 for more information about those procedures). Effects from these relocations on traditional uses would be minor and would not be considered significant.

E.1.1.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, mining operations in N-9, J-19, and J-21 would cease. Mining facilities would be removed and reclamation operations would begin at coal resource areas N-9, J-19, and J-21 in accordance with the provisions of the current Kayenta Mine Permit closure plan and SMCRA regulations. Facility removal and reclamation operations would occur in previously disturbed areas of N-9, J-19, and J-21, and no households would be relocated. No additional effects on cultural resources are anticipated under this alternative. No additional impacts to cultural resource would be expected from reclamation activities and the impacts on cultural resources would be negligible and would not be considered significant.

If Alternative 2 were implemented, no impacts on cultural resources are anticipated, but if any were identified during the course of facility removal and reclamation operations, mitigation measures would be implemented pursuant to standard and special permit conditions.

In summary, previously implemented mitigation measures implemented pursuant to standard conditions and terms of the permit will mitigate impacts on cultural resources, and the residual impacts are expected to be negligible and would not be considered significant.

E.1.1.3 Unavoidable Adverse Impacts

The studies to recover and preserve information and artifacts have been completed, the collected artifacts and project documentation are curated at Southern Illinois University, and ongoing programs are in place to mitigate impacts on unanticipated cultural resources that could be discovered in the future pursuant to standard conditions and terms of the permit. These programs include the removal and mitigation of human remains and funerary items in accordance with Navajo and Hopi tribal requirements, and evaluation and treatment, as warranted, of any new discoveries of cultural resources or recognition of sacred and ceremonial sites. Therefore, no unavoidable adverse impacts to cultural resources are anticipated.

E.1.2 Hydrology

Impacts on surface-water and groundwater quantity and quality can occur as a result of coal mining and other related surface activities. These activities have the potential to impact the flow and quality of surface water and the shallow groundwater system, and the deeper D and N aquifers. Impacts are measured by changes in water flows and water quality and are generally limited to an area within a few miles of the mining operations.

Impacts on surface water and groundwater due to pumping of the N aquifer for mining-related water supplies are the result of changes in the water levels in the aquifers. These changes can occur over relatively large areas, especially in the confined portions of the aquifer systems. Data and measurements used to assign degrees of impact are discussed in Appendix B.

E.1.2.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Impacts on Surface Water

Surface water was evaluated for potential impacts to flow and water quality that could occur from mining operations within the Kayenta Mine permit area. Changes in surface water quality were evaluated by considering impounded water quality, seep discharges to surface water and the potential for increased suspended sediment loads in runoff. Changes in surface water flow were evaluated by considering modifications to the contributing drainage basin, surface runoff characteristics and conveyance including sediment control and channel restoration. The restoration of channel geometry, morphology, or location resulting from the destruction and reconstruction of drainage channels and the use of sediment control structures to manage discharge of surface water from the mine areas would not alter surface flows into regional drainages beyond the short-term. These impacts would be minor and would not be considered significant.

The water quality of proposed permanent impoundments should reflect the quality of runoff from reclaimed areas and be comparable to stream runoff after reclamation activities have been completed and vegetation becomes established, which could take upwards of ten years. OSM requires PWCC to monitor water quality in proposed permanent impoundments in order to determine whether the impounded water is suitable on a permanent basis to support livestock grazing and wildlife habitat at final bond release (PWCC 2005b). If the data indicate a proposed permanent impoundment does not meet the performance standards at 30 CFR 816.49(b) including applicable Tribal water quality standards, OSM will require PWCC to reclaim the impoundment. Therefore, the impact of the permanent impoundments on surface water quality would be short-term and negligible, and would not be considered significant.

The release of constituents to surface water could occur by formation of seeps downstream of existing and/or new sediment ponds. If seeps form, some degradation of surface-water quality could occur locally, however, the impact on overall surface-water quality would be negligible, as the volume of seep water released into the ephemeral streams would be diluted by the stormwater runoff volume (PWCC 2005b). Any potential released seep water would also encounter alkaline soils, causing the pH in the water to rise and any metals present would tend to precipitate or be absorbed in the soils. At proposed sediment ponds, PWCC will use design and construction methods that minimize seep formation by identifying geochemically inert materials for constructing the embankments, compacting the embankments based on engineering design standards, and siting embankments at locations with low permeability geologic units to the extent practicable. The NPDES permit requires all discharges from NPDES outfalls, including those associated with the N-9, J-19, and J-21 mining areas, meet specific effluent limitations and applicable water quality standards for receiving streams. Therefore, discharges from new ponds would result in negligible impacts to surface water quality and would not be considered significant.

Sediment ponds are designed to treat the equivalent volume of runoff generated by a 10-year, 24-hour precipitation event. The capacity of ponds also includes an additional amount of volume for storing sediment. Ponds proposed for construction during the permit period that would serve as NPDES outfalls will be subject to the requirements of a modified Seepage Management Plan in the renewed NPDES permit. Of these ten proposed ponds, ponds N9-A, N9-J, and J21-I would be added to the list of outfalls in the NPDES permit. Future ponds where seeps develop will also be evaluated in accordance with the Seepage Management Plan. The minor short-term and localized impacts of the existing seeps associated with existing sediment ponds and seeps that could occur below new sediment structures on surface water quality would not be considered significant.

Erosion rates are typically high on areas disturbed by mining and could increase the amount of suspended sediment in stormwater runoff. The potential increase in suspended sediment load from the mined areas would be minimized using engineering controls such as sedimentation ponds and/or other sediment control structures. Design and operation of sedimentation ponds would result in lower sediment loads than are generated by the natural flow regimes of the various washes and channels within and adjacent to the PWCC lease area. Erosion of the sides and channel bottom of washes downstream of sediment ponds would be expected for a short distance as the wash adjusts to lower contributions of sediment from the upstream watershed. Sediment control structures are designed in anticipation of this behavior, and allow the water (using grade-control structures, gabion aprons, and bank stabilizers) to discharge with minimal erosion. In all cases, rates of erosion or deposition of sediment would reach a balance with natural rates in receiving streams over relatively short distances (i.e., several hundred yards), well before the washes exit the PWCC lease area. In addition, performance standards are monitored and corrected by PWCC as they are observed, confirmed by regular OSM and tribal inspection, and monitored by BIA to ensure compliance with lease terms and conditions. Therefore, the effects of erosion and sediment loads from control structures would be negligible, short-term and limited to short distances in receiving streams within the permit area. These impacts would not be considered significant.

The diversion and reconstruction of natural streamflow also would be designed to preserve geomorphic and fluvial stability and prevent uncontrolled erosion or sedimentation. Where this is not possible, engineered durable structures, such as rip-rap grade-control structures, would be designed and constructed in the channel to prevent uncontrolled erosion or sedimentation. Similar to the pond discharges, these channels and structures are regularly inspected and maintained by PWCC and reviewed by OSM and tribal inspectors.

PWCC would ensure, per the approved permit, that any effects of the mine’s drainage system on the natural stream patterns in the affected environment would be confined to the Kayenta Mine permit area. Reclaimed watersheds would be constructed using similar ranges of naturally occurring geomorphic features such as drainage density, hillslope lengths and slopes, and channel gradients. These constructed features would be similar to natural variability of the unmined watersheds within and adjacent to the PWCC lease area. The impact of the mine on the landform geometry, morphology, stream channel systems including drainage patterns and channel characteristics would be minor within the permit area and would not be considered significant.

The temporary diversion and impoundment of runoff water for sediment control could reduce stream flow volumes and peak flows downstream of the mined lands. Impounded water could be used on the mine site for dust control, livestock and wildlife use, or lost because of infiltration and evaporation and would not be released downstream. However, to maintain adequate storage volume in the sedimentation ponds, the impounded water is discharged when it meets permit effluent limitations.

Within the Kayenta Mine permit area, the use of sediment ponds results in some surface water being lost, either through infiltration into the subsurface, evaporation from the surface of the pond, or use by livestock and wildlife. This loss of potential surface flow represents a diminution of surface-water quantity a short distance below the Kayenta Mine permit area, relative to the reaches of the regional drainage system outside of this area. Decrease of runoff also occurs where existing streams in the permit area are diverted from their channels to allow surface-mine excavations and reclamation to proceed. As of 2010, approximately 0.6 percent of the Dinnebito drainage area and 2.6 percent of the Moenkopi drainage area were controlled by drainage control structures. The structures have the potential to impound 36.5 acre-feet of runoff, or about 1.2 percent of the total runoff in the entire Dinnebito basin (3,034 acre-feet). Drainage control structures in Moenkopi Wash, in 2010 have the potential to impound 532.8 acre-feet of runoff, or about 5.5 percent of the total runoff in the entire Moenkopi basin (9,727 acre-feet).

Estimates comparing the change in potential runoff controlled by ponds reflect the potential volumetric loss on downstream water quantities for the five-year mine plan. These estimates indicate there would be a net reduction of 655 acres within the Moenkopi drainage of area controlled by ponds and a net increase of 580 acres within the Dinnebito drainage of area controlled by ponds. The estimates within the Moenkopi drainage take into account plans to reclaim 29 ponds and construct 7 new ponds ((N9-A, N9-A1, N9-A2, N9-J, N9-J1, N9-J2, and N9-J3). The Dinnebito drainage estimates account for plans to reclaim three ponds and construct three new ponds (J21-I, J21-I1, and J21-I2). Overall, the changes during the term of the mine plan would be negligible, resulting in less than 1 percent increase in potential runoff loss in the Dinnebito basin, and less than a 1 percent decrease in potential runoff loss in the Moenkopi basin as of December 2014. Negligible effects would not be considered significant.

After mining, about 0.5 percent of the entire Dinnebito basin and 2.2 percent of the entire Moenkopi basin would be impounded permanently. The permanent impoundments are estimated to result in a diminution of flow at the lower end of Dinnebito and Moenkopi Washes of about 1 and 5 percent, respectively, of the average annual runoff (PWCC 2005b). The evaluation concluded that the volume of water retained or detained by the permanent impoundments is a small proportion of average annual runoff at the lower ends of Moenkopi Wash (4.7 percent) and Dinnebito Wash (1.0 percent) in the affected watersheds. Therefore, the effect of permanent impoundments left in the post-mining landscape would be negligible and long-term, and considered not to be significant.

The analysis described above assumes no transmission loss of flow between the PWCC lease area and the downstream USGS streamflow gage near the village of Moenkopi. Historic measurements indicate that loss through infiltration is very high in Moenkopi Wash, with rates of about 1 inch per hour (Peabody 2005b). Using a 644 acre-foot volume (equal to the total impounded volume for 1983 to 1984), the analysis indicated surface flow from the PWCC lease area could travel about 45 miles downstream before it was completely absorbed by the wash bed material. This is short of the 70 miles to the first location of surface water use downstream at the town of Moenkopi, where most irrigation operations are located. This estimate is supported by measurements from a storm event on July 27, 1998, where 206.7 acre-feet of water were gauged at the permit boundary of Moenkopi Wash, and only 14 acre-feet were measured at the USGS gage near Moenkopi from July 27 to 29, 1998.

Based on these observations and other comparisons of flow records (PWCC 2005b), it appears that about 50 percent of runoff events in excess of 1,000 cfs, and up to 100 percent of smaller runoff events can be lost naturally through infiltration in the wash. The change in streamflow, resulting from the added mine operations, would not be detectable approximately 70 miles downstream. The short-term effects of surface water diversions, impoundments and sediment ponds on surface water quantity would be minor within the Kayenta Mine permit area and negligible outside of the Kayenta permit area, and would not be considered to be significant.

Impacts on Groundwater

Groundwater was evaluated for potential impacts that could occur from mining operations within the three coal resource areas during the permit renewal period to dewater coal seams and shallow aquifers or other changes in the flow of shallow groundwater. Groundwater quality was evaluated for potential changes from infiltration of surface water, or spoils leaching and migrating into adjacent groundwater aquifers.

Review of Wepo water level contours developed from data collected between 1995 and 2003 indicated no groundwater inflows would be encountered during mining in the N-9 pit (PWCC 2005b). The groundwater level in Wepo well 52 declined approximately 7 feet following initiation of mining in N-9. Water has been reported in a small portion of the N-9 pit requiring periodic pumping of limited quantities from 2006 into 2010. In some areas, limited perched zones of groundwater in the Wepo formation may result in periodic groundwater inflows to relatively small portions of mine pits where analyses indicate no groundwater inflows will be encountered during mining as observed in the N-9 pit. TDS concentrations in Wepo well 52 declined from approximately 380 mg/L to about 310 mg/L after the water level declined. As mining continues toward the north and northwest in N-9, the elevation of the pit floor could rise above the groundwater level in the Wepo formation.

Limited perched zones of Wepo Formation groundwater could be encountered during the permit period as mining progresses in the southwestern area of the J-21 pit, but significant water has not been encountered in J-21 in the past. Comparison of the planned bottom of the pit and the estimated elevation of the Wepo groundwater suggests that the westernmost part of the pit is more likely to encounter water than the eastern part of the pit. The water encountered in J-21 is expected to be a small volume that is not measurable.

Mining of J-19 is not expected to encounter water, based on experience from earlier mining of this pit. Comparison of the estimated Wepo groundwater level with the planned elevation of the bottom of the J-19 pit suggests that the easternmost part of J-19 is the most likely to encounter groundwater. However, past mining in this pit in this area has not encountered water in sufficient quantities to require pumping.

In the event springs are mined out in any of the coal resource areas during the 5-year mine plan term, PWCC would be required to provide alternative water supplies to replace the lost water source. Upon completion of backfilling, regrading, topsoiling, and revegetation, the replaced spoil in areas that were previously saturated could resaturate and create a localized change in the potentiometric surface within the Wepo Formation adjacent to the reclaimed mine pit. Based on estimates of the pre-mining hydraulic properties of the Wepo Formation, porosities and hydraulic conductivities within the regraded spoils would be higher, and recharge capacities should be similar or somewhat greater than pre-mining capacities. However, this does not mean that water levels in the Wepo Formation would return to original levels. It is likely that there would be some minimal impact on local groundwater levels in the Wepo Formation and adjacent alluvial aquifers during mining. After reclamation is complete, the hydrologic balance within the shallow aquifers would approach a new equilibrium. Therefore, changes in Wepo water levels due to mine dewatering will be long-term but limited to the local vicinity of the mine pit, resulting in minor impacts on the use of the shallow groundwater system within the permit area and would not be considered significant.

Surface-water flow events recharge the alluvial aquifers associated with the stream channels. Reduced flows in washes could decrease the amount of recharge; however, the impoundment of runoff water and subsequent seepage of sediment pond water into the banks and substrate of the ponds locally enhance recharge. The primary effect is likely to be a local redistribution of where recharge occurs, and the length of time the effect would occur depending on whether sediment ponds are temporary or permanent. It is expected that any reduction in recharge would be immeasurable and there would be negligible impact on the quantity of recharge to the alluvial aquifers from mining activity.

Acid reactions in the spoil water could occur, but are unlikely to be widespread. There are sufficient carbonate minerals in the overburden materials to neutralize most acidic water that could be produced by the oxidation of sulfides. All but one of the overburden core samples taken on the PWCC lease area and Kayenta Mine permit area had excess neutralization potential (PWCC 2005b). These cores also indicate that there are no high concentrations of metals in the overburden. The alkalinity imparted by the dissolution of carbonate minerals slows the dissolution of sulfide minerals, preventing the release of metals. If acidic water is produced and encounters the alkaline overburden, the pH could rise and metals that are present would tend to precipitate in or absorb into the soils. This evaluation is supported by the analysis of groundwater in the Wepo and alluvial aquifer monitoring wells. Water from these wells is near neutral in pH, and concentrations of metals in groundwater at these wells generally do not exceed livestock watering standards (PWCC 2005b).

Although there are specific procedures to minimize and mitigate acid-forming materials, and the presence of carbonate minerals in the Wepo Formation overburden and interburden is sufficient to neutralize any acidic waters formed, some local pockets of acidic water could form. Areas where this occurs could result in the release of trace elements present in the sulfide minerals. These chemical reactions could result in some minor-to-moderate water-quality impacts on local wells, increasing TDS and trace element concentrations in groundwater to a level that decreases their usability. However, the impact of acidic drainage on groundwater quality likely will not be widespread and will be contained to the mine pit and adjacent area, and will not migrate outside the permit area. The potential effects from acid-forming materials on groundwater would be minor and would not be considered significant.

Similarly, spoil water also could discharge to the surface water as springs or seeps. Some degradation of surface-water quality could result, particularly near the springs. As noted above, discharges from springs with low pH water could be neutralized by the alkaline soils. Since streams are ephemeral and generally flow only after precipitation events, the much larger streamflows tend to dilute poor-quality spring or seep water discharges. Streamflow events are generally not suitable for use by livestock because of the high sediment load, high velocities and short durations, resulting in little potential for livestock to be exposed to poor-quality spoil water that could be released into the stream. The potential effects on the overall surface-water quality would be minor in volume of spring or seep water and would not be considered significant.

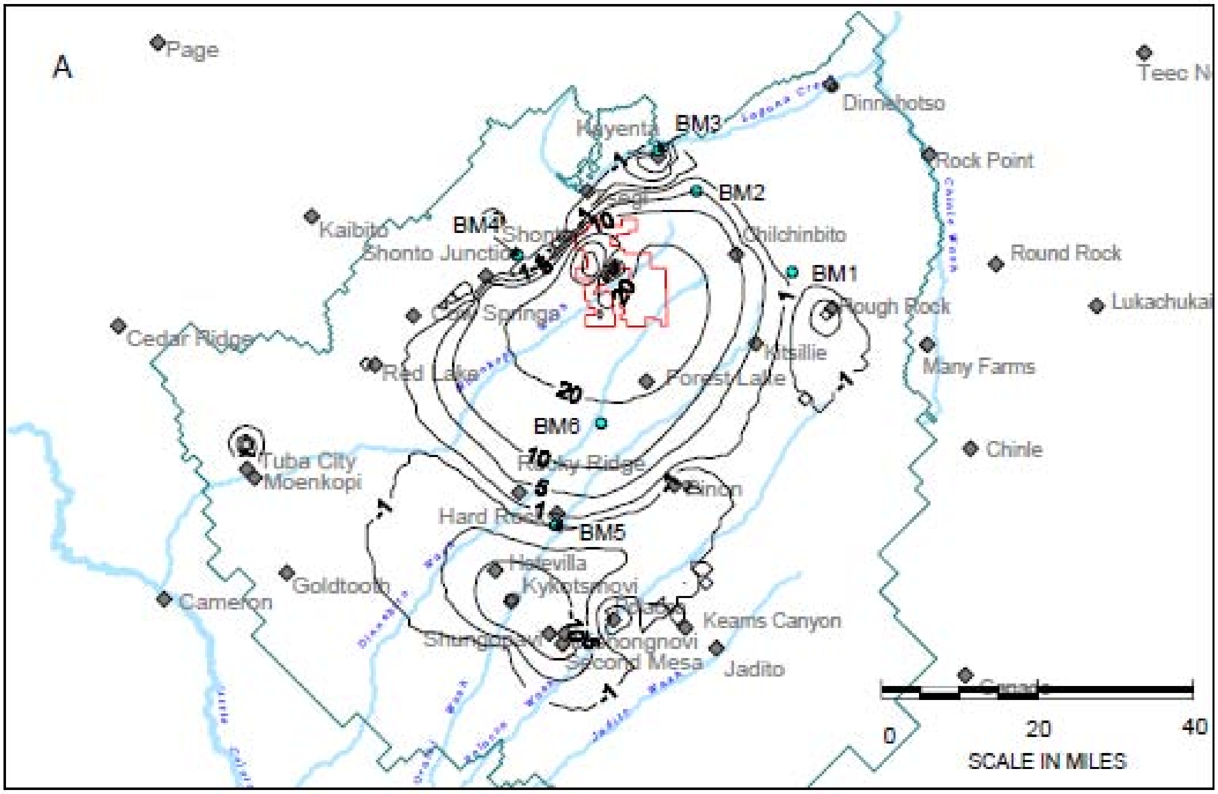
Surface-mining activities could degrade groundwater quality if surface water infiltrates into the subsurface. Controlled surface water would infiltrate to the shallow subsurface in impoundments, sediment ponds, or diversions potentially increasing the concentrations of some soluble ions (Ca, Mg, Na, SO_4, and bicarbonate) and TDS. The potential for formation of acidic seepage and trace-metal migration is minimal because of the high carbonate content of the soils. The magnitude of the impact on groundwater quality should be limited to the immediate pond and pit areas due to low transmissivity and groundwater gradients in the shallow aquifers (PWCC 2005b). The potential effects to groundwater within the Kayenta Mine permit area and the PWCC lease area would be minor and would not be considered significant.

Impacts on Water Supply

There is a potential for the local water supply to be affected by continued use of water from the D and N aquifers by the mine. The impact of groundwater withdrawal is commonly assessed by a measured or projected lowering of the water levels in the pumping wells and in wells located within and outside the cone of depression created by the pumping well(s). Effects from lowering the water level in the D and N aquifers were evaluated for potential increases in the cost of pumping, reduction in the saturated thickness or transmissivity in unconfined or confined aquifers, changes in stream baseflow or spring flow, and the flow of groundwater towards the well field.

Unconsolidated aquifer systems have the potential for subsidence due to compression of fine-grained layers during groundwater withdrawal. In addition, the removal of cavity filling material and dissolution of limestone in some limestone aquifers can foster sinkhole development. These effects are not a concern in this evaluation, because the primary water-bearing units of the D and N aquifers are not composed of unconsolidated sediments or limestone that would be subject to subsidence effects (Appendix B).

The potential impact of continued pumping at the mine site was evaluated by simulating future water level changes in the D and N aquifers within and adjacent to the permit area for the permit period through 2038. The detailed numerical model results are provided in Appendix B. The model predicts that groundwater levels would rise (i.e., recover) beneath the PWCC lease area during the permit period. Groundwater levels are recovering because less groundwater has been used by PWCC since the coal slurry pipeline was discontinued in 2005. In 2015, the simulated recovery in groundwater levels near the PWCC lease area is between 20 and 30 feet (see Figure E-1). The simulated recovery at some of the PWCC's production wells is greater. The simulated groundwater level recovery is relatively small near the boundary between confined and unconfined conditions in the N aquifer, as the total drawdown prior to 2005 was also small near this boundary. The greatest differences in groundwater levels occur near communities, where local pumping is predicted to cause continued drawdown. Continued groundwater drawdown by community pumping could be less than the values predicted by the model if future community water use is less than modeled. By 2025, groundwater level recovery is predicted to be more than 30 feet (relative to 2010 levels) within most of the central part of the basin. Groundwater level recovery would continue until 2038, and possibly beyond, in the central part of the basin where the groundwater levels could recover more than 50 feet relative to 2010 levels (see Figures B-9 and B-10 in Appendix B).



Note: This figure presents PWCC and community pumping.

Figure E-1 Simulated Changes in Water Levels between 2010 and 2015

Table B-4 in Appendix B shows the simulated groundwater drawdown in the N aquifer (relative to July 2010) for selected community wells in 2015, 2025, and 2038. In most of the wells, the simulated groundwater drawdown (with both community and PWCC pumping) increases with time. However, the change in water levels caused by PWCC's pumping is estimated to decrease with time. Local community pumping causes the simulated increases in drawdown. In all instances but one, water is predicted to remain above the top of the screened interval by hundreds of feet. At Rough Rock, the water level was only 40 feet above the top of the screen interval when first measured. The model predicted that PWCC's pumping would cause only 2 feet of drawdown in this well. Pumping by PWCC has caused drawdown in these wells, but has not threatened the ability of these wells to produce water. With the reduction in pumping that occurred at the end of 2005, the effects of PWCC's pumping have become smaller.

At most communities, groundwater drawdown that is attributable to PWCC pumping is predicted to decrease from the baseline value in 2010 (Appendix B, Table B-4). Additional groundwater drawdown is predicted for Kykotsmovi and Keams Canyon, where the increasing drawdown caused by community pumping is larger than the recovery from PWCC's reduced groundwater use since 2005. The largest drawdown increase is predicted to occur in Kykotsmovi, where the original depth to water was 220 feet. The predicted drawdown from PWCC's pumping would increase the lift and power costs about 1.3 percent at Kykotsmovi, resulting in negligible impact on pumping cost. The widespread recovery of water levels from earlier pumping would either reduce or slow the increase in pumping costs expected to be caused by increases in the effects of community pumping. The effects are regional in scale, and recovery would likely continue for several decades.

Some of the PWCC production wells pump from both the D and N aquifers, with about 3 percent of the water coming from the D aquifer (PWCC 2005b). The communities of Chilchinbito, Kitsillie, and Kykotsmovi, also use D aquifer water but are located far enough from the Kayenta Mine that drawdown due to PWCC pumping is about 1 foot or less. This level of drawdown would have no measurable impact on pumping cost for these communities.

D aquifer uses near the PWCC lease area could be adversely impacted if groundwater levels decline in the wells to a point where pumps must be lowered or the wells deepened to remain productive. The groundwater level in Windmill Well 4T-402 in the D aquifer would be affected most by pumping at NAV5. The model predicts that Windmill Well 4T-402 could experience drawdown of up to 5 feet, which is considered a negligible impact. The predicted drawdown would not require the well to be deepened or the pump to be lowered. SMCRA regulations at 30 CFR 816.41(h) specifically requires PWCC to replace water supplies that have been adversely impacted by mining. Compliance with these regulations resulted in PWCC's commitment to replace three windmill wells that have or would be removed by mining. Any other water supply that could be adversely impacted by mining during the five-year permit term would be replaced by PWCC.

With the anticipated use of the N aquifer, there are no significant predicted changes in the saturated thickness of the D and N aquifers as a result of continued PWCC's pumping. Pumping has been primarily occurring within the confined part of the N aquifer, and water levels are currently rising or are predicted to rise because of the reduction in PWCC's pumping. Near the boundary between the confined and unconfined areas of the aquifer, a small water-level drawdown in the unconfined aquifer is predicted north of the PWCC lease and Kayenta Mine permit areas near Kayenta and Shonto. The effects of mine-related pumping are minor compared to community pumping. Pumping by the communities in the unconfined parts of the aquifer would decrease the saturated thickness near those wells.

Monitoring data shows that PWCC pumping to date has not measurably reduced the monitored N aquifer spring flow. N aquifer spring discharge monitoring data is limited to records collected since the late 1980's at Moenkopi School Spring, Pasture Canyon, and Burro Spring. Discharge measurements measured at both Moenkopi School Spring and Pasture Canyon are strongly influenced by local community pumping stresses. Spring discharges at Burro Spring have been relatively persistent since monitoring began in 1989, and the persistence of flow and absence of a decreasing trend in discharge through 2009 (USGS 2010) indicate PWCC's pumping has not caused measurable discharge to this spring. However, modeling of N aquifer groundwater discharge suggests that as future non-mining-related groundwater pumping near some of these springs increases, flows from springs could be affected (GeoTrans 2006). Historical changes to N aquifer spring flows, which have not been monitored, are not known (Peabody 1999) and are not included in the model. However, the model does predict changes in groundwater discharge to the washes. The greatest predicted effect on groundwater discharge occurs along Begashibito Wash approximately 25 miles west of the Kayenta Mine permit area. This wash contains the closest area of seeps and springs to the Kayenta Mine permit area and could experience the greatest effect due to mine-related pumping (Appendix B, Table B-6).

Between 2010 and 2015, groundwater discharge to Begashibito Wash is predicted to decrease by 3.4 af/yr, or 0.005 cfs. This predicted decrease in discharge is 0.16 percent of the estimated 2010 discharge (without PWCC pumping) of 2,177 af/yr, and results in a negligible impact. The predicted reduction in discharge as a result of PWCC's pumping in 2025 is 10.5 af/yr (0.014 cfs or 0.49 percent), and in 2038 is 19.0 af/yr (0.026 cfs or 0.88 percent). These regional-scale and long-term changes in discharge are too small to be measured. The impacts of PWCC's pumping in other potential discharge areas are smaller. The maximum predicted impact in 2015 at other washes is 1.9 af/yr (0.05 percent of the 2010 discharge) at Moenkopi Wash, which would be minor and would not be considered a significant impact.

The potential for groundwater leakage from the D aquifer to the N aquifer through the Carmel Formation confining bed was evaluated by comparing present day with predicted sulfate concentrations in the N aquifer in 2038 (PWCC 2005b). Model results predicted that sulfate concentrations would increase in the N aquifer by as much as 0.07 percent (an increase from 30 mg/L to 30.022 mg/L) beneath the lease and permit areas by 2038 (PWCC 2005b). The negligible increase in sulfate concentration in the N aquifer by 2038, if it occurred, would be limited to the immediate area of the PWCC well field and would not change the drinking-water use designation of the N aquifer. The negligible regional scale, long-term impact, if any, would not be considered significant.

E.1.2.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Impacts on Surface Water

Under Alternative 2 surface water runoff controls (i.e., sedimentation ponds) existing as of 2010 would remain in place until reclamation activities are completed and vegetation becomes established. No additional ponds would be built, including several planned beyond the permit term that are proposed as permanent. Similar to Alternative 1, PWCC would remove 32 ponds but on a more accelerated schedule. During the 16-year reclamation period, PWCC would continue to operate under the terms and conditions of the NPDES permit, including compliance with the Seepage Management Plan and procedures to allow removal of all temporary ponds under Western Alkaline Coal Mining regulations. The impacts on local washes and channels from the sediment ponds or any existing seeps would be negligible to minor, and would not be considered significant. Existing impediments to natural drainage patterns would be reduced due to accelerated reclamation of all temporary sediment ponds within the Kayenta Mine permit area. Changes in streamflow after reclamation will be reduced as a result of reclaiming all temporary sediment ponds within the next three years. Fewer permanent sediment ponds would be left in the post-mining landscape, reducing the overall effects on surface water quantity or quality within the Kayenta Mine permit area, PWCC lease area, or within the entire basins of both Moenkopi and Dinnebito Washes. These changes to surface water quantity or quality would be negligible to minor, and would not be considered significant.

Impacts on Groundwater

Under Alternative 2 the permit renewal application would be rejected and coal removal and the associated groundwater impacts would not occur within the PWCC leasehold. Groundwater quantity and quality impacts to the shallow aquifers as a result of mining to date have been negligible. Since mining would cease in the N-9, J-19, and J-21 coal resource areas, and backfilling and grading would occur within the next several years, the potential for additional impacts on groundwater to occur would be further reduced. 30 CFR 780.21 requires PWCC to develop a hydrologic reclamation plan that will ensure the relevant requirements for protecting the hydrologic balance will be met. Chapter 19, Hydrologic Reclamation Plan in the Kayenta Mine permit application package (PAP) summarizes all methods and plans PWCC would use during mining and reclamation for the 5-year permit term, and through bond release to minimize disturbances to the hydrologic balance as required and specifically listed at 30 CFR 816.41 through 816.43. The PAP, including the hydrological reclamation plan, was previously approved by OSM and no revisions to the PAP are part of this renewal application. Pertinent aspects of these plans and methods are presented in Chapter 17, Protection of the Hydrologic Balance of the Kayenta Mine PAP. The potential impacts on groundwater would be negligible to minor, and could be less than described under Alternative 1 and would not be considered significant.

Impacts on Water Supply

Withdrawals from the N aquifer would be reduced from an average rate of 1,236 af/yr to about 500 af/yr to support reclamation activities for the next 13 years. The reduced pumping rate would allow recovery of water levels more quickly in the vicinity of the PWCC well field, and further reduce PWCC's contributions to drawdowns that would continue to occur as a result of community pumping. Reduced pumping from the N aquifer would also lessen the potential for causing considerable drawdown in the D aquifer. These predicted regional-scale reductions in stream baseflows, which are too small to be measured, would be even less. The potential for leakage from the D aquifer into the N aquifer has been judged to be negligible for the permit term, and would be even lower than those described under Alternative 1 as the pumping rate is reduced to 500 af/yr for a 13 year reclamation period.

E.1.2.3 Unavoidable Adverse Impacts

Past, present, and ongoing studies of ground and surface water characterize the hydrologic setting in the study area, and assess whether adverse impacts have or would occur. Potential adverse impacts from mining during the permit renewal period are mitigated in accordance with the requirements of SMCRA with continuing oversight by OSM. Mitigation analysis and commitments to protect the hydrologic balance are contained in the required Hydrologic Reclamation Plan. No unavoidable adverse impacts on hydrology have been identified.

E.1.3 Vegetation

This section describes the analysis of direct and indirect effects on the upland, riparian, and wetland[7] and aquatic vegetation communities, noxious weeds and invasive plant species, and special status plant species.

E.1.3.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Developing the N-9, J-19, and J-21 coal resource areas during the permit period will have the direct impact of removing 1,159 acres (approximately 0.1 percent or less) of the existing piñon/juniper woodland, saltbush and greasewood, and sagebrush shrubland vegetation types in the study area (Table E-2). However, reclamation will replace the areas mined during the permit renewal period with an all-purpose rangeland composed primarily of native species. The reclamation vegetation will be dominated by grasses and shrubs and scattered groupings of trees. Long-term, this will increase the amount of reclaimed (disturbed) vegetation in the study area by about 6 percent. No lands with mixed conifer or tamarisk riparian shrubland will be removed by coal mining activities during the permit renewal period (Table E-2). The conversion of existing vegetation communities to the reclaimed vegetation community is minor because the mined and reclaimed areas will affect less than one percent of the total available acres of plant communities in the study area. Also reclaimed sites would transition to a stable vegetation community, and the use of native species could provide additional seed sources of native populations of these species in adjacent areas (Peters et al. 2006, Schuman 2002).

Table E-2 Acres of Vegetation Communities Disturbed during the Permit Period (2010 to 2015)

Vegetation Community	Acres[1] in Coal Resource Area			Total Acres
	N-9	J-19	J-21	
Piñon-Juniper Woodland	464	172	316	952
Saltbush and Greasewood Shrublands	>1	1	1	3
Sagebrush Shrubland	23	122	59	204
Total				1,159

SOURCE: PWCC 2010 GIS data
NOTE: [1] Acres rounded to nearest whole acre

[7] The term wetland in this document describes vegetation and does not indicate jurisdictional status.

Existing plans for reclamation activities that mitigate mining related surface disturbance to vegetation resources include reclamation activities that consist of establishment of grasses, forbs and shrubs. Plant species used for revegetation will be mostly native, but some non-native grasses and forbs are used to aid in the post-mine land uses. On reclamation areas, 4 feet of soil and suitable plant growth media are replaced. These areas are seeded with approved seed mixtures that are stipulated to be free of noxious weeds. Seeded areas are mulched with native grass hay. Habitat islands for wildlife will be established in the reclamation areas in which small, periodic clusters of exposed rock are installed, and clusters of piñon, juniper, forbs, and shrubs are planted. Shrubs and woodland vegetation also will be established around ponds, drainage bottoms, and hill slopes. Reclaimed sites will continue to be monitored twice a year for 10 years to evaluate the adequacy of reclamation and the presence of weed species. Prescriptions for reseeding, grazing management, or weed control are made based on the results of statistical sampling or monitoring observations in reclaimed areas.

Cultural plant sites will be established on select sites within reclamation areas. These are developed in areas with a mesic aspect and on coarse-textured skeletal soils and rocky substrates similar to native areas supporting piñon-juniper woodland and historic cultural collection sites. These sites, combined with native shrubland and piñon-juniper planting areas, will comprise approximately 5 percent of reclaimed lands.

Disturbed and reclamation areas will have the indirect impact of being susceptible to invasion by noxious weeds and other invasive plant species. Livestock grazing and reclamation activities to regrade, spread topsoil, and reseed areas disturbed during the permit renewal mining activities could increase the potential for establishment of noxious weeds and invasive species in the short-term (Bryson and Carter 2004, Pyke 1999). Most of the weeds that are present in the Kayenta Mine permit area are annual weeds, which compete poorly with established reclamation vegetation. Additionally, PWCC maintains a twice per year vegetation monitoring and weed program for 10 years after reseeding areas. This program identifies the measures to control noxious weeds that could establish in the Kayenta Mine permit area. With ongoing reclamation and mitigation efforts, potential establishment of invasive plant species or noxious weeds will be temporary and highly localized. With the potential for weed establishment being temporary and localized, the impact would be minor and would not be considered significant.

Settling ponds, impoundments, and other erosion control measures would prevent sediments from moving to riparian vegetation stands within or downstream of the Dinnebito, Moenkopi Wash and Coal Mine Wash drainages. Impoundments developed in association with the N-9, J-19, and J-21 coal resource areas and reclamation sites could augment the small number of wetland areas present at impoundments in previously mined areas in the Kayenta Mine permit area. The impacts to riparian vegetation from the various water impoundments would be negligible and would not be considered significant.

Water withdrawals for mining activities are not likely to affect riparian vegetation in areas downstream as the amount of groundwater and surface water quantity and quality will not change during the permit period. Monitoring during of the N aquifer water withdrawal has not shown impacts on surface water or effects on riparian vegetation downstream of the Kayenta Mine permit area. Similarly, the results of modeling water withdrawal during the permit period indicate no effects from water withdrawal on surface water downstream of the Kayenta Mine permit area (see Section E.1.2 Hydrology for additional information). The impacts to riparian vegetation from water withdrawal for mining activities would be minor and would not be considered significant.

Special Status Plants

Navajo Sedge. With no potential habitat in the Kayenta mine permit area, the potential effects on the species from the proposed action would come from drawdown of the N aquifer due to pumping, which could potentially affect habitat by decreasing water flow in seeps and springs. The only known populations potentially affected by the proposed action include the Tsegi Canyon population, about 12 miles north of the N-9 coal resource area, and the population where Moenkopi Wash and Ho No Geh Canyon overlap the unconfined portion of the N aquifer. However, the Kayenta mining operation is not predicted to decrease flows in seeps and springs associated with the N aquifer, thus the impacts on the species would be negligible and would not be considered significant.

Alcove bog-orchid. With no potential habitat in the Kayenta mine permit area, the potential effects on the species from the proposed action would come from drawdown of the N aquifer due to pumping, which could potentially affect habitat by decreasing water flow in seeps and springs. The closest population is approximately 12 miles north of the Kayenta Mine permit area in Tsegi Canyon and is associated with seeps and springs originating from the unconfined portion of the N aquifer, which is unaffected by groundwater pumping from the Kayenta mining operations. The impacts on the species would be negligible and would not be considered significant.

E.1.3.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Not authorizing mining in the N-9, J-19, and J-21 coal resource areas will result in retaining 1,159 acres of existing vegetation (approximately 0.1 percent of the total available in the study area). Retaining the existing vegetation will remove the necessity of disturbing and converting these areas to an all-purpose rangeland. Under Alternative 2, the amount of reclaimed (disturbed) vegetation will not increase (see Table E-2). These areas will retain their existing vegetation community state and species composition (ESCO 2010). In comparison, the effects will be negligible under this alternative, which would not be considered significant.

Livestock grazing and vehicles used during reclamation activities of other previously mined areas will retain the possibility of introducing noxious weeds and invasive plant species into the Kayenta Mine permit area. Initiating reclamation for all areas disturbed by mining activity, roads and support facilities could increase the number of vehicles entering and exiting areas within the Kayenta Mine permit area. This could indirectly increase the potential for noxious weed and invasive species establishment in the short-term in comparison to Alternative 1. However, monitoring requirements will be the same as Alternative 1, and the long-term potential for noxious weed and invasive species establishment within the

Kayenta Mine permit area will not differ substantially from Alternative 1. In comparison, the effects would be minor under this alternative, which would not be considered significant.

Similar to Alternative 1, sediment control structures and impoundments will continue to prevent sediments originating in previously mined areas from reaching riparian vegetation downstream from the Kayenta Mine permit area under this alternative. Reclamation will restore natural drainage patterns, and the removal of temporary impoundments will result in a short-term change in vegetation species present in localized areas. Long-term, not authorizing mining will reduce the number of permanent ponds within the study area that could alter the vegetation species present in localized areas relative to Alternative 1. In comparison, the effects would be negligible under this alternative, which would not be considered significant.

Reducing the water withdrawal from the N aquifer to approximately 500 af/yr from 1,236 af/yr will be less than the potential effect described in Alternative 1. As the withdrawal of water from the N aquifer is considered to have a negligible effect on surface water under Alternative 1 (see Section E.1.2.2), the potential effects on vegetation communities would be negligible under this alternative, which would not be considered significant.

E.1.3.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts on vegetation communities will come from the local loss of 1,159 acres of piñon-juniper woodland, saltbush and greasewood shrubland, and sagebrush shrubland during the permit period (Table E-2). In mined areas, reclamation will establish a grass shrubland of mostly native species that is dominated with grasses and secondarily shrubs and some forbs. Long-term successional processes will return additional native species to the reclamation sites, but reclaimed sites will likely maintain a different potential vegetation in comparison to the original site conditions (West 1997). In a broader context, the mine-related disturbance during the permit period will affect only about 0.1 percent or less of the available sagebrush shrublands, piñon-juniper woodlands, and saltbush and greasewood shrublands in the study area. The conversion of existing vegetation including piñon-juniper woodland to a reclaimed vegetation community would be minor and would not be considered significant.

E.1.4 Fish and Wildlife

This section describes the analysis of effects on fish and wildlife resources. The analysis for fish and wildlife resources includes potential impacts of noise and light from the mining activities from the three coal resource areas.

E.1.4.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Developing N-9, J-19, and J-21 coal resource areas will have the direct impact of removing wildlife habitats in about 1,159 acres of upland vegetation communities (Table E-2). Habitats in the N-9, J-19, and J-21 coal resource areas are already disturbed by numerous interlacing roads and other human disturbances. Mining operations will principally result in the direct impact of displacing wildlife adapted to piñon-juniper woodland and secondarily to sagebrush shrubland habitats. Also, mining will have the direct impact of removing rock outcrops, bluffs, and talus and the indirect impact of replacing these at reclamation with a more uniform reconstructed minesoil and a more gentle and rolling topography. Piñon-mice, brush mice, Colorado chipmunks, Stephen's woodrats, gray foxes, western spotted-skunks (*Spilogale gracilis*), rock squirrels (*Spermophilus variegatus*), porcupine (*Erethizon dorsatum*), woodland adapted bats, sharp-shinned hawks, Cooper's hawks, great horned owls, piñon jay (*Gymnorhinus cyanocephalus*), gray flycatcher (*Empidonax wrightii*), juniper titmice (*Baeolophus ridgwayi*), mountain chickadees (*Poecile gambeli*), black-throated gray warblers (*Dendroica nigrescens*), collared lizards, and sagebrush lizards are some of the more common wildlife species that could be displaced by the loss of woodland and shrubland vegetation or complex, rocky habitats. The loss of wildlife habitats in the N-9, J-19, and J-21 coal resource areas will be minor in comparison to the larger context because the affected habitats for wildlife, regardless of the current quality, will total about 0.1 percent of the available wildlife habitat in shrublands and woodlands within the study area established for the vegetation analysis (see Table E-2) (Brown et al. 2007).

During reclamation, the mined-out N-9, J-19, and J-21 coal resource areas will be replaced primarily with native grasses, forbs, shrubs, and concentrated planting areas with some cultural plants and trees within the reclamation. The reclaimed areas will provide habitat for species adapted to habitat edges, early successional environments, and grassland habitats. Species that are highly adaptable could increase in abundance in reclaimed areas. These species include deer, elk, deer mice, Ord's kangaroo rats, Gunnison's prairie dogs, Navajo mountain vole, black-tailed jackrabbits, desert cottontails, red foxes, coyotes, some bats, eastern fence lizards, prairie falcons, and red-tailed hawks. In the long-term, the breeding potential for all raptors, except the bald eagle, could increase as trees develop in portions of the reclamation. Black Mesa does not have potential breeding habitat for bald eagles, and the reclaimed areas are unlikely to develop breeding habitat characteristics for this species.

Additional indirect impacts to wildlife—particularly to raptors, owls, and other bird species—could come from daily noise associated with mine activity. Noise from vehicles will be ongoing and localized around mining pits, mine facilities, and haul roads and could cause wildlife such as birds, deer, and elk to flush or alter normal behavior patterns within 50 to 100 feet of the source (Barber et al. 2010). Noise from blasting will be intermittent, but the region of influence for blasting at the mines will extend up to several miles from the source. Noise induced behavioral responses could occur (Barber et al. 2010) beyond the N-9, J-19, and J-21 coal resource areas but would be attenuated by distance, topography, and vegetation cover. Some birds and wildlife may flush or increase their alert responses (Barber et al. 2010) within the 2-mile buffer area around the coal resource areas. However, blasting activities have occurred on a regular schedule (twice daily on weekdays between sunrise and sunset) for decades, and some wildlife likely have become accustomed to the ambient noises from mining activities (PWCC 2001).

PWCC will continue to conduct annual wildlife monitoring and special studies within the Kayenta Mine permit area through final reclamation and bond release as part of its permitting stipulations from OSM. These include small mammal studies, passerine and migratory bird observations, raptor monitoring, MSO and wildlife surveys, prairie dog colony monitoring for black-footed ferrets, and special interest reconnaissance surveys for species listed by the Navajo Nation and USFWS. As part of reclamation, monitoring will continue to be conducted in revegetated areas and prescriptive measures will be applied to help encourage development of desired vegetation and discourage the establishment of noxious weeds or invasive species. The results of these long-term surveys will be submitted to OSM.

Vegetation reclamation plans will continue to include the establishment of all-purpose rangeland for grazing of livestock and big game species and many other wildlife species. The standard rangeland seed mix is comprised of grasses, forbs, and shrubs, which includes fifteen native plant species and six introduced plant species.

Key shrubland and woodland wildlife habitat areas will be established at cultural plant sites, concentrated shrub and tree planting sites and rock habitat features interspersed as patches within the broader reclamation areas. These patches include trees, forbs, and shrubs and an understory of native grasses that do not out-compete the woody species. These areas will be planted with seedlings, container-grown specimens and a light rate seed mix with cultural plant species. PWCC also will create rock piles about every 100 acres to provide some habitat for rock-dwelling species in reclamation areas.

Impacts from habitat loss and mining-related noise during the permit period would be minor on wildlife, within and surrounding N-9, J-19, and J-21 coal resource areas. Also, extensive areas of wildlife habitat will be unaffected by mining noises outside the Kayenta Mine permit area and the larger region. Minor impacts would not be considered significant.

Special Status Animal Species

This section describes the analysis of effects on special status species. The analysis for special status species includes potential impacts of noise and light from the mining activities from the three coal resource areas.

California Condor. There are no unique foraging opportunities (concentrations of large carrion) or distinctive roosting or nesting features (tall cliffs or canyons) within the vicinity of the N-9, J-19, and J-21 coal resource areas to attract condors to the area. As the California condor is highly unlikely to occur in the region and because roosting and foraging habitat is likely inadequate, the effects of mining will be negligible to individuals in the area during the permit period. Negligible impacts would not be considered significant.

Mexican Spotted-Owl. Coal mining in the Kayenta Mine permit area will not remove suitable habitat for the MSO. All suitable habitat and PACs for the species are located in canyons north of the boundary limits of Kayenta Mine permit area (refer to D-5). No suitable, occupied habitat occurs in the vicinity of the J-19 and J-21 coal resource areas, and no MSOs activity has been detected at any of the coal resource areas in the past (PWCC 2001). The closest stands of suitable habitat in mixed-conifer forest are about 11 miles to 12.5 miles north of the J-19 and J-21 coal resource areas. Mixed conifer habitat occurs north and east of the N-9 coal resource area at much closer distances that range between about 2.0 miles and 4.8

miles at the closest point. Although habitat for the spotted owl will not be removed, noise from mining activities and light coming from dragline lights during the night could influence occupied habitat.

Anthropogenic sources of noise could initiate various behavioral responses in MSOs, depending on the distance and source of the noise. Existing studies on noise indicate that the response of wildlife to noise disturbance is complex, being neither uniform nor consistent (Barber et al. 2010). Delaney et al. (1997) reviewed literature on the response of owls and other birds to noise and concluded the following: (1) raptors are more susceptible to disturbance-caused nest abandonment early in the nesting season, (2) birds generally flush in response to disturbance when distances to the source are less than approximately 200 feet (61 m) and when sound levels are in excess of 95 dBA, and (3) the tendency to flush from a nest declines with experience or habituation to the noise, although the alert response (i.e., head movements or agitated behavior) cannot be completely eliminated by habituation. The USFWS (2003) has established strict thresholds for noise exposure to spotted owls. The agency estimated the sound-only injury threshold for spotted owls at approximately 92 dBA at nest sites. Disturbance thresholds were estimated at 70 dBA and detectability thresholds were estimated at 44 dBA (USFWS 2003). The intervening topography beyond the N-9 coal resource area will attenuate the impacts from mining-related sources of noise and light.

The loudest noises from typical mining activities at the Kayenta Mine will come from rock drills and blasting (see Table D-8). Surface blasting is conducted an average of twice daily during weekdays, between sunrise and sunset. Other mining activities occur throughout the day and night all days of the week. OSM requires that air-blast levels be limited to a maximum of 134 dB (peak) at the source, and a typical rock drill creates is about 95 dB of noise measured at 50 feet from the source (Minor, Michael & Associates 2000).

Using the inverse square law ($I= P/4\pi r^2$), the estimate of mining-related noise in MSO habitat from rock drills at the N-9 coal resource area would measure about 48.5 dB in MSO habitat 2.0 miles away and 40.9 dB in MSO habitat 4.8 miles away (Davis and Patronis 2006). Blasting noise would measure about 33.5 dB at 2.0 miles and 25.9 dB at 4.8 miles. Rock drills, which are the loudest source of mining noise, operating in the J-19 coal resource area would register at about 34.5 dB in the closest MSO habitat, and rock drills operating in the J-21 coal resource area would register about 33.1 dB in the closest MSO habitat. Noise from mining operations will attenuate further where topography and weather further reduce the amount of noise reaching MSO habitat. The loudest mining noises detectable in MSO habitat could range from the levels of an average quiet residence at night (about 30 dB) to an average office environment (about 50 dB) (see Table D-7).

Rock drills and other heavy machinery operating above 90.5 dB in the N-9 coal resource area produce the only likely detectable sound in the closest MSO habitat about 2.0 miles away and could fall below detectable levels beyond about 3.4 miles. Mining-related noises coming from the N-9, J-19, or J-21 coal resource areas will not reach the disturbance or injury thresholds according to these USFWS standards. Also, noises from mining have been occurring on a regular schedule for decades, and MSOs likely have adapted to the ambient noises from mining activities (PWCC 2001).Therefore, it is unlikely that MSOs will be exposed to noises that could induce stress, alter behavior, or suppress breeding in the action area.

Studies of light pollution on the MSO do not exist. Light pollution can have substantial effects the annual rhythms of wildlife, which could affect the onset of reproductive behavior, the effectiveness of foraging activities, individual mating patterns, and other essential activities (Kempenaers et al. 2010). Observations of many rodent species indicate that individuals reduce activity or stay under canopy cover to reduce predation risks in response to higher ambient light (O'Farrell 1974, Vickery and Bider 1981, Getz 2009), but MSOs success at catching prey could increase under higher ambient light, as is suggested by observations of other owl species (Daly et al. 1992). However, the potential amount of light coming from the coal resource areas, described previously, is anticipated to be below levels that could affect the natural behaviors of MSOs or prey species.

During the permit renewal period, the dragline excavators work area is illuminated at night with lights mounted to the machinery and focused on the mining surface. Ecological light pollution from the draglines could disrupt the foraging behavior of MSO. Rather than shining directly into MSO habitat, mining lights will most likely produce a visible glare and skyglow outside of active mining areas. At the time of this analysis, no data were available regarding the specifications on lights used at the Kayenta Mine. Assuming that safety standards require illuminating the mining surface within the pit at a level similar to direct sunlight, the amount of light could be as high as 130,000 lux (lumens/m^2). Also, conservatively assuming that about half the light is reflected and half is absorbed by the surfaces within the mining pit, about 65,000 lux could be emitted from mining areas.

Using the inverse square law ($I= P/4\pi r^2$), the potential amount of mining-related light reaching the closest MSO habitat, which is 2.0 miles from N-9, could be approximately 0.006 lux and 0.001 lux in MSO habitat 4.8 miles away (Ryer 1998). Light coming from the J-19 coal resource area could result in about 0.00031 lux in the closest MSO habitat, and light from the J-21 coal resource area could result in about 0.00021 lux in the closest MSO habitat. Ambient light on a moonless night is about 0.002 lux, and mining operation lights could decrease to this ambient level at about 3.5 miles. Therefore, mining-related light could be obscured by the ambient level of light with the exception of that coming from the N-9 coal resource area. The topography will shade most of the MSO habitat from mining-sourced light, with only some of the canyon rims being within the line of sight of the mine. Also, the upper tree canopy likely will further block light and reduce the possible impact from mining lights.

Between 1994 and 2000, mining activity was closer to occupied habitat than the areas that will be mined during the permit renewal period and MSOs continued to inhabit and successfully reproduce during previous mining operations (PWCC 2001). The effects of noise and light during the permit period would be less than previous mining operations and MSOs are expected to continue to occupy habitats and successfully reproduce during the permit renewal period mining. During the permit renewal period, no MSO habitat will be removed, noise levels are anticipated to be below the FWS threshold, and indirect light levels would be similar to a moonlight night. The effects from mining during the permit renewal period will be minor on MSOs. Minor impacts would not be considered significant.

Southwestern Willow Flycatcher. Willow flycatchers have been observed infrequently during migration in a limited number of places in the Kayenta Mine permit area and in riparian areas farther away near the confluence of Moenkapi Wash and Dinnebito Wash (LaRue 1994). However, no suitable habitat occurs near the N-9, J-19, and J-21 coal resource areas, and no riparian habitat will be removed as part of the proposed action. Groundwater monitoring of the N aquifer has demonstrated that water withdrawal has not had significant impacts on riparian areas downstream of the Kayenta Mine permit area, which includes stopover habitat for migrating southwestern willow flycatchers (LaRue 1994). As habitat for the southwestern willow flycatcher is limited on Black Mesa, and the species' occurrence would be rare and transient in the Kayenta Mine permit area, and because southwestern willow flycatchers would not use the N-9, J-19, or J-21 coal resource areas, and habitat will not be removed as part of the proposed action; the effects of mining will be minor on the southwestern willow flycatcher in the area during the permit renewal period. Minor impacts would not be considered significant.

Black-Footed Ferret. Wildlife monitoring for prairie dogs in the Kayenta mine permit area has not identified any colonies in the N-9, J-19, or J-21 coal resource areas, and evidence of black-footed ferret use has not been observed during monitoring studies for the species elsewhere within the Kayenta mine area (EMI 2010). In addition, suitable habitats in prairie dog towns southwest of the Kayenta Mine permit area are too small to support a local population of black-footed ferrets. As habitat for black-footed ferrets is lacking, and because no ferrets occur in the PWCC lease area, there will be no impact to black-footed ferrets from mining activities during the permit renewal period.

Sora. Annual wildlife monitoring within the Kayenta Mine permit area has documented this species in a number of reclaimed areas (LaRue 1994). Additional wetland vegetation could develop at impoundments and other freshwater ponds constructed for mining within the N-9, J-19, and J-21 coal resource areas, which could have the direct impact of developing additional habitat resources for the species within the Kayenta Mine permit area during the permit period. This could increase potential habitat for the sora due to mining activities during the permit renewal period these effects would be minor and would not be considered significant.

Bald Eagle. Mining activities will remove piñon-juniper woodlands from the N-9, J-19, and J-21 coal resource areas, which could be used briefly as perch sites by individuals during migration. Transient eagles infrequently occur within the Kayenta Mine permit area (LaRue 1994), and potential roosting habitat in mixed-conifer forests occurs as close as about two miles north of the N-9 coal resource area. Potential roosting habitat could be influenced by blasting noise up to 2 miles distant. Blasting and other mining noises could arouse or flush individual eagles in the Kayenta Mine permit area or arouse individuals at roost sites; however, blasting noise would measure about 33.5 dB at 2.0 miles and 25.9 dB at 4.8 miles, which could be further attenuated by topography and vegetation (Mohamed 2010). Additionally, noise from mine operations and blasting is not predicted to change from 2010 levels and no increase in the severity of the potential impact is anticipated on bald eagles. The effects on bald eagles from noise would be minor because the sources of noise would be intermittent, single events, which are similar to noises that were occurring while the bald eagle was observed in the study area. Minor impacts would not be considered significant.

Golden Eagle. The golden eagle uses the Kayenta Mine permit area infrequently and occasionally forages near the N-9, J-19, and J-21 coal resource areas (EMI 2010). Blasting could arouse or flush individual eagles in the Kayenta Mine permit area or arouse individuals at perch sites; however, blasting noise will be attenuated by the square of the distance from the source and from obstructions such as topography and vegetation (Mohamed 2010). Additionally, noise from mine operations and blasting is not predicted to change from 2010 levels, and no increase in the severity of the potential impact is anticipated on golden eagles. The effects on golden eagles from noise would be minor because the sources of noise would be intermittent, single events, which are similar to noises that were occurring while golden eagles were observed using the Kayenta Mine permit area. Minor impacts would not be considered significant.

Ferruginous Hawk. Potential foraging habitat occurs in revegetated areas and in prairie dog colonies that could develop in these areas. The N-9, J-19, and J-21 coal resource areas could result in the indirect impact of providing additional foraging habitat after reclamation by creating areas with little tree canopy cover and greater foraging opportunities. However, blasting could arouse or flush individual ferruginous hawks that happen to use the Kayenta Mine permit during foraging; however, blasting noise will be attenuated by the square of the distance from the source and from obstructions such as topography and vegetation (Mohamed 2010). As noise from mine operations and blasting is not predicted to change from previous levels when ferruginous hawks were observed in the vicinity, and because reclamation could develop additional habitat for the ferruginous hawk; there would be no increase in the severity of the potential impacts anticipated on ferruginous hawks during the permit renewal period. The impacts to the ferruginous hawk will be minor and would not be significant during the permit renewal period.

Northern Goshawk. Potential foraging habitat for the species occurs in the N-9 mining area (BIOME 2003), which will be lost with development of this area. Piñon-juniper woodlands are infrequently utilized as post-fledgling foraging habitat by dispersing juveniles (Weins et al. 2006). Monitoring for northern goshawks is conducted annually as part of the advancing mine front surveys and will continue in advance of mining the N-9 coal resource area. To date, no northern goshawks have been detected in the 2-mile survey area around the northern part of the Kayenta Mine permit area. As the habitat removed for mine development likely is of limited quality for goshawks and because the species has not been recorded within or near the Kayenta Mine permit area, the effects of mining in the Kayenta Mine permit area on the northern goshawk will be minor and would not be significant during the permit period.

Peregrine Falcon. Peregrine falcons occasionally forage in the Kayenta Mine permit area, and individual falcons could occur periodically in the N-9 mining area and other places with piñon-juniper woodland (BIOME 2003). Development of the N-9 mining area will remove potential foraging habitat for the species in this coal resource area, but a utilitarian foraging habitat will be replaced by the reclamation and permanent impoundments, which could have greater abundance of prey for any peregrine falcons that forage in the Kayenta Mine permit area. Blasting could arouse or flush individuals in the Kayenta Mine permit area or arouse individuals during foraging; however, noise from mine operations and blasting is not predicted to change from 2010 levels, and no increase in the severity of this potential impact is anticipated on peregrine falcons. Potential effects on peregrine falcons will be minor because the removal of potential foraging habitat for the peregrine falcon is 0.1 percent or less in comparison to the total available habitat on Black Mesa and foraging opportunities could return after reclamation. In addition, noise would be associated with intermittent, single events, which are similar to likely noises that were occurring when peregrine falcons were previously observed in the Kayenta Mine permit area. The effects of mining in the Kayenta Mine permit area on the peregrine falcon will be minor and would not be significant during the permit renewal period.

Northern Saw-Whet Owl, Northern Pygmy Owl, and Flammulated Owl. These three species could inhabit mixed-conifer forests north and northeast of the N-9 coal resource area. Habitat could be indirectly impacted by noise from blasting and mining activities, and from light pollution coming from dragline lights at the N-9 coal resource area at night. The mining noises could arouse individual owls, the additional light could increase foraging efficiency but decrease prey availability, or both noise and light could affect behavior of individual owls (Barber et al. 2010, Kempenaers et al. 2010, O'Farrell 1974, Vickery and Bider 1981, Getz 2009). However noise and light will attenuate by the square of the distance from the source and from obstructions such as topography and vegetation (Mohamed 2010), and given the distance between the mining areas and the habitat of these owl species, it is not anticipated that noise or light would affect the biology of these species (see impact analysis for the Mexican spotted owl). Thus, impacts on the Northern saw-whet owl, northern pygmy owl, and flammulated owl would be minor, because the proposed action would likely not affect the behavior or ecology of these species during the permit renewal period. Minor impacts would not be considered significant.

Burrowing Owl. Development of the N-9, J-19, and J-21 coal resource areas will not impact potential habitat for the species. However, reclamation activities could increase the amount of habitat for Gunnison's prairie dog, which could create more potential habitat for burrowing owls. However, all prairie dog towns are outside of the Kayenta Mine permit area, and no burrowing owls have been seen on Black Mesa. Coal mining during the permit period would have no anticipated impacts to the burrowing owl, which would not be considered significant.

Navajo Mountain Vole. Development of the N-9, J-19, and J-21 coal resource areas could remove habitat for the species in piñon-juniper woodlands and big sagebrush shrublands during the permit period. Mining activities also could result in the death of some individuals. Reclamation vegetation and habitats planted in these areas would suitably replace the lost habitats. The results of previous studies by LaRue and SWCA Environmental Consultants have shown relatively large populations of Navajo mountain voles in reclaimed areas (PWCC 1992). As reclamation could add additional habitat and reduce the loss of habitat from mining of the N-9, J-19, and J-21 coal resource areas; the effects of mining during the permit period mining will be negligible on the Navajo mountain vole. Negligible impacts would not be significant.

Townsend's Big-eared Bat. Development of the N-9, J-19, and J-21 coal resource areas could remove foraging habitat for the species during the permit period, but reclamation vegetation in these areas may suitably replace the lost foraging opportunities. As reclamation may eventually add additional habitat, which would offset any loss of habitat from mining of the N-9, J-19, and J-21 coal resource areas, the effects of mining will be minor on Townsend's big-eared bat during the permit period. Minor effects would not be significant.

E.1.4.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [D [No Action]

If authorization is not provided to proceed with mining in the N-9, J-19, and J-21 coal resource areas, there will be no further loss of wildlife habitats in these areas. Blasting will cease and traffic associated with mine activities will decrease, which will reduce the potential for noise impacts in the Kayenta Mine permit area. Reclamation activities, and vegetation and wildlife monitoring will continue until bond release requirements are met. During this time, impacts to fish and wildlife in reclamation areas will be the same as those described in Alternative 1. Wildlife habitat around ponds will continue at a number of local temporary and permanent impoundments sites, even after reclamation is complete. These areas could continue to attract migrating waterfowl, raptors, and shorebirds and could provide localized habitat for resident wildlife species. The availability and influence of these artificial wetlands will decrease compared to Alternative 1 as no additional permanent or temporary ponds (sediment structures) will be constructed. As reclamation activities are completed, temporary ponds will be removed. This would result in a localized reduction in habitat for the sora, migrating waterfowl, and shorebirds within the Kayenta Mine permit area. However, wildlife habitat will still be available at the permanent ponds in the reclaimed areas. Impacts to wildlife overall will be negligible under this alternative. Negligible impacts would not be considered significant.

Under this alternative, impacts to special status animal species would be negligible. Localized noise from vehicles during reclamation of previously mined sites could affect peregrine falcons, ferruginous hawks, northern goshawks, golden eagles, and bald eagles that forage in reclamation sites around the previously mined coal resource areas, but negligible impacts would not be significant.

There will be no impacts to federally listed animal species under this alternative. Noise from blasting that could disrupt MSOs will cease. Groundwater withdrawals from the N aquifer will decrease to approximately 505 acre feet per year through final reclamation. This could help to improve the quality of potential southwestern willow flycatcher habitat in Moenkopi Wash that is downstream of the study area.

Under this alternative, potential habitat for the Navajo mountain vole and Gunnison's prairie dog would decrease with less land moving into reclamation and as woody vegetation begins to replace herbaceous vegetation in land currently under reclamation. About 1,159 acres of foraging habitat will not be available in the future for ferruginous hawks or for deer and elk potentially grazing in reclamation areas. A decrease in the number of available ponds in reclaimed areas could further decrease habitat qualities for deer and elk in the long-term. A loss of some sources of water would be a minor impact that will not eliminate any of the currently documented species from the local area. Minor effects on wildlife and special status species would not be considered significant.

E.1.4.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts on wildlife result from conversion of 952 acres of piñon-juniper woodland to a reclaimed vegetation community dominated by grasses and shrubs. In mined areas, reclamation will establish a grass shrubland of mostly native species that is dominated with grasses and secondarily with shrubs and some forbs. Long-term successional processes would return additional native species to the reclamation sites, but reclaimed sites would likely maintain a different potential vegetation in comparison to the original site conditions (West 1997). Converting areas of piñon-juniper woodlands to reclaimed vegetation could increase habitat mosaic and wildlife species in reclaimed areas. However, the types of wildlife species present in reclaimed areas would be different because the vegetation community structure and uniform slopes alter habitat complexity, favoring early successional or grassland species (Kasner and Slack 2002). Species adapted to woodlands and cliff and outcrop habitats may underutilize reclaimed sites compared to native ones (Ireland et al. 1994). Reproduction also may be lower or absent in reclaimed sites than in adjacent native ones, suggesting that reclaimed areas contain more non-breeding colonizers than in native habitats (LaRue 1994, Chamblin 2002). In a broader context, the mine-related disturbance during the permit period would affect only about 0.1 percent or less (Brown et al. 2007) of the sagebrush-shrubland, piñon-juniper woodland and saltbush and greasewood shrublands that are available for wildlife habitat on Black Mesa, which would constitute a minor impact that would not be considered significant.

E.1.5 Soil Resources

The analysis of potential effects on soil resources include the acres of soils disturbed by mining activities and the potential for soil loss, stability, and productivity.

E.1.5.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Surface-mining activities would blend and homogenize soil resources and the original soil profile would be lost permanently. Surface disturbance of soils and vegetation on approximately 1,159 acres through mining operations and haul road construction could increase short-term erosion and soil movement from the coal resource areas N-9, J-19, and J-21. Temporary or permanent impoundments also could decrease off-site sedimentation and soil movement in localized areas. Surface-mining activities and road or support facilities construction would directly affect soil structure from surface disturbance that blends soil layers resulting in long-term loss of the original soil profile. Indirectly this could reduce short-term soil productivity in these areas.

Slope reclamation operations generally include regrading, smoothing, and slope contouring to approximate the original topographic contours, considering the needs of minimizing erosion and supporting the post-mining land uses of livestock grazing and wildlife.

In coal resource areas, topsoil and suitable subsoil will be removed and replaced immediately for reclamation following backfilling and regrading or stockpiled for use after mining operations. Soil removed during mine operation activities and not used for reclamation would remain in stockpiles. OSM guidelines for reclamation programs and projects identify soil and slope conditions considered acceptable or suitable during reclamation, including soil pH and acid-forming spoils, sodic zones, toxic substance occurrence in soil, percent and length of slope, and slope stability. Reclamation activities will reduce the loss of soil to erosion. The soil loss on restored land would be approximately 3 to 9 tons/acre/yr after 10 years, which is less than the 7 to 22 tons/acre/yr that can be expected on undisturbed slopes.

By salvaging topsoil and suitable subsoil from areas to be disturbed prior to mining, PWCC estimates approximately 2.1 feet of soil material is available to uniformly cover all reclaimed areas. The Minesoil Reconstruction Plan proposes to salvage the topsoil (as defined in 30 CFR Part 701.5i) together with suitable subsoil and underlying unconsolidated material to provide a topsoil mixture suitable for reclamation. Salvaged material is either redistributed immediately or stockpiled for use as topsoil on future regraded areas. Topsoil stockpiles are protected from wind and water erosion by seeding the stockpiles and placing berms around the perimeter of the stockpile.

In the short-term, soil erosional stability would be maintained by an effective and permanent vegetative cover established during reclamation. Although the reclaimed (postmining) land cannot be restored to pre-mining productive use immediately due to the long timeframe required for plant establishment in the arid climate, soil productivity would be maximized by reclamation procedures that create a suitable 4-foot-deep plant root zone over the entire reclaimed area and establishing a diverse and permanent vegetation cover. Soil reconstruction and revegetation would be undertaken to restore the land to productive use and, in the long-term, soil productivity should exceed premining capability (PWCC 2002). Through incorporation of reclamation and mitigation measures within coal mining areas N-9, J-19, and J-21, soil productivity and stability for post-mining activities would improve. Appendix A Section D provides a summary of the procedures PWCC will follow including adherence to approved soil mitigation plans, use of sedimentation control structures, and revegetation practices. PWCC's mitigation reduces soil loss, improves soil suitability, and increases soil productivity on reclaimed areas compared to native sites (PWCC 2002). Effects on soil productivity, erosion, and soil stability after reclamation for post-mine land uses (livestock grazing and wildlife) would be minor and would not be considered significant.

E.1.5.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Soil resources would remain in their existing condition in the undisturbed areas of N-9, J-19, and J-21. Similar to Alternative 1, reclamation activities would restore the existing disturbed 8,013 acres (see Table C-1), improving soil productivity within these areas. Soil not used in reclamation will remain in stockpiles on a stable site protected from wind and water erosion. Soil resources would remain in their natural condition in the undisturbed areas, which could result in an increase in soil loss from erosion (PWCC 2002). The loss of soils from the 1,159 acres of disturbed lands is less than 1 percent of the soils in the study area. Effects on soil productivity, erosion, and soil stability after reclamation is completed would be minor and would not be considered significant.

E.1.5.3 Unavoidable Adverse Impacts

Surface mining would permanently remove existing soils and their horizons from 1,159 acres within coal resource areas N-9, J-19, and J-21. Reclamation will create a more uniform soil mix that would be more productive for the various post-mining activities; however, the loss of the original soil profile would result in an unavoidable adverse impact on soil resources. Reclamation willreduce the effects on soil productivity, erosion and soil stability and the unavoidable, adverse impacts on soil would be minor and would not be considered significant.

E.1.6 Recreation

This section evaluates the potential for the alternative to change recreation opportunities. The analysis assumed recreation use within the study area is dispersed, and limited to tribal members or the members of the public with a tribal recreation permit.

E.1.6.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Based on existing data, recreation activities within the permit renewal area are not measurable, and there are no developed recreation sites within the Kayenta Mine permit area. The permit renewal period mining could shift where dispersed recreation activities such as wildlife watching occur. In addition, surface disturbance on 1,159 acres within the three coal resource areas during the permit renewal period would make these areas unavailable for recreation use (refer to Table C-1). The impacts resulting from surface disturbance and mining operations would be short-term and reclamation will restore these areas by regrading slopes and reseeding. As required in the AZ-0001D permit, the disturbed areas would be reclaimed as specified in the approved mining and reclamation plan, but until reclamation is completed and vegetation established, these areas would not be available for recreational activities. If all dispersed recreation use avoided the Kayenta Mine permit area, approximately 2 percent of the study area would be unavailable for recreation use. Long-term disturbed areas would be available for dispersed recreation use by tribal members or the members of the public with a permit to recreate on tribal land after vegetation is established and reclamation completed. As mined areas are reclaimed and available for recreation use, the impacts on recreation from the permit renewal mining would be negligible to minor and would not be considered significant.

E.1.6.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

PWCC would not disturb an additional 1,159 acres within the three coal resource areas, mining operations would cease, and facility removal and reclamation operations would begin as specified in the approved mining and reclamation plan. Similar to Alternative 1, once the vegetation is restored, the land would be available for dispersed recreational use by tribal members or the members of the public with a permit to recreate on tribal land. The cessation of mining activities would reduce the amount of mining-related traffic in the coal resource areas, which could improve the recreational quality of the area, but because no specific data are available on the use of the area for recreation, it would be speculative to conclude that recreational opportunities would improve under Alternative 2. As recreation activities within the permit renewal area are not measurable and reclamation would restore vegetation, regardless of which alternative were implemented. Impacts on recreation under Alternative 2 are also considered negligible because once the area is reclaimed to meet pre-mine conditions, the lands would be available for dispersed tribal recreation use. Impacts on recreation would be negligible and would not be considered significant.

E.1.6.3 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts associated with recreation.

E.1.7 Air Quality

The assessment of air-quality impacts is based on an emissions inventory of predominant criteria pollutant emissions from the Kayenta Mine operations and modeled predictions of ambient air quality impacts by those emissions.

The analysis in this EA is based on metrics from the EPA's program for the prevention of significant deterioration (PSD) of air quality, which defines when an emissions increase that results from a change at a stationary source is "significant" and when the ambient impact from an emissions increase is "significant." PM_{10} emissions increases of 15 tons per year or more are considered "significant." Similarly, an increase in $PM_{2.5}$ emissions of 10 tons per year or more or an increase in NO_x emissions of 40 tons per year or more also are considered "significant."[8]

Under EPA's PSD program, EPA prescribes "significant impact levels" or "SILs" for PM_{10}, $PM_{2.5}$, NO_x and other criteria pollutants. The SIL is the level of ambient impact from an emission increase that is deemed significant enough to warrant a complete source impact analysis. That analysis involves modeling the emissions from that source along with emissions from other nearby existing sources to determine whether their cumulative impact will either threaten or exceed a national ambient air quality standard (NAAQS).

E.1.7.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, the air quality impacts would be similar to those from the 2010 Kayenta mining operations, as there are no proposed changes to the current mining methods or coal production rates. Mining activities at surface coal mines are not fixed at a single location from year-to-year, as they move with the progressions of the pits, roads, backfill, and reclamation areas. Fugitive dust from natural wind erosion of disturbed areas and stockpiles, and emissions from reclamation activities and truck haulage would continue until reclamation activities are completed. The current fugitive dust control plan for the Kayenta Mine operations uses emission control practices and low-emission equipment to ensure that emissions from the mining operations do not result in ambient concentrations in excess of the applicable NAAQS (see Appendix D). A comprehensive meteorological and ambient PM_{10} monitoring program at the Kayenta Mine is used to document the effectiveness of those dust control practices. Should monitoring data of fugitive dust impacts indicate that ambient particulate standards are being threatened by fugitive dust from mining operations, PWCC would adjust the nature, extent and frequency of fugitive dust control measures in order to maintain compliance with the applicable NAAQS. The number and types of emission sources would not change. There would not be additional sources of fugitive dust from

[8] 40 CFR 52.21(b)(23).

Kayenta Mine, but the relative locations of emission sources such as topsoil removal areas, haul roads, and active pit areas would change.

The annual emissions from mining activities will vary slightly due to changes in the quantities of overburden, disturbed acreages, and haul distances (see Appendix D, Table D-1). The locations of the preparation plants will remain fixed, and their maximum emissions will remain at or near the 2010 levels. Table E-3 summarizes the predicted emissions of PM_{10}, $PM_{2.5}$, and NO_x from the coal preparation facilities and mining activities.

Table E-3 Pollutant Emission Summary (tons/yr) from Coal Preparation Facilities and Mining Activities

Pollutant	Source	Tons/Year Estimate[1]		
		2010	2012	2018
PM_{10}	Coal Preparation Facilities			
	J-28	39.04	38.98	38.94
	N-11 Extension	12.46	12.63	12.75
	N-8	65.08	65.17	65.23
	Mining Activities	1,121.79	1,119.66	1,017.73
$PM_{2.5}$	Coal Preparation Facilities			
	J-28	7.44	7.39	7.35
	N-11 Extension	2.27	2.41	2.52
	N-8	10.22	10.3	10.36
	Mining Activities	155.56	155.37	140.91
NO_x	Coal Preparation Facilities			
	J-28	4.17	4.17	4.17
	N-11 Extension	2.08	2.08	2.08
	N-8	10.33	10.33	10.33
	Mining Activities	360.70	347.43	322.93

SOURCE: Appendix D, Tables D-2 and D-3
NOTE: [1] The year 2018 was evaluated because that year results in the greatest reasonably foreseeable air polluting emission levels during the permit renewal period.

For the Coal Preparation Facilities, the emissions of PM_{10}, $PM_{2.5,}$ or NO_x either remain at 2010 levels or slightly increase during the permit period. For the Mining Activities, the emissions of PM_{10}, $PM_{2.5,}$ or NO_x either remain at 2010 levels or decrease during the permit period. Any emissions increase from the Kayenta Mine operations would be minor and would not be considered "significant" for these pollutants during the permit period.

Emissions of PM_{10}, $PM_{2.5}$ and NO_x from the Kayenta Mine operations were each modeled to assess the levels of the Mine's overall ambient air impacts. Table E-4 shows that less than "significant" impacts of PM_{10} and $PM_{2.5}$ (> 5 µg/m^3 for the 24-hour averaging time) are predicted at Navajo National Monument and Monument Valley, the nearest culturally important locations. The modeling analyses confirm that significant impacts of NO_2 would also not occur at the Navajo National Monument or Monument Valley.

The significant impact areas associated with those criteria pollutant emissions from the Kayenta Mine operations do not extend to any Class I areas (see Appendix D, Figures D-1 through D-12).

Table E-4 PM_{10} and $PM_{2.5}$ from the Kayenta Mine Operations on Local Sensitive Receptors

Receptor	24-Hour Impact (μg/m³)[1]								
	2010		Above SIL?	2012		Above SIL?	2018		Above SIL?
	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$	
Navajo National Monument	0.86	0.12	No	1.03	0.14	No	1.04	0.15	No
Monument Valley Visitor Center	4.38	0.61	No	3.82	0.54	No	4.14	0.59	No

NOTE [1] The year 2012 is the worst case year in the permit renewal term, but 2018 was included in the analysis because it is the estimated worst case year for determining maximum impacts.

Table E-5 compares the modeled maximum impacts of the Mine's emissions of PM_{10}, $PM_{2.5}$ and NO_x relative to the NAAQS for those criteria pollutants. Modeling results predict the maximum concentrations of PM_{10} and $PM_{2.5}$, (24-hour NAAQS) occurred during 2010. The modeling results also indicate the predicted annual maximum annual NAAQS concentrations of $PM_{2.5}$, and NO_2 occur during 2012, the year of worst-case emissions for these NAAQS. These predicted concentrations are all below the annual and short-term NAAQS standards.

Table E-5 Maximum Criteria Air Pollutant Concentrations and Applicable Standards

Pollutant	Averaging Period	Year	Concentration (μg/m³)	Concentration with Background (μg/m³)	National Ambient Air Quality Standard (μg/m³)	Percent of National Ambient Air Quality Standard
PM_{10}	24 hour	2010	110.58	124.18	150	83
		2012	97.88	111.48	150	74
$PM_{2.5}$	24 hour	2010	15.31	22.31	35	64
		2012	13.27	20.27	35	60
	Annual	2010	3.46	10.46	15	70
		2012	4.37	11.37	15	76
NO_2	Annual	2010	5.29	7.39	100	7
		2012	9.34	11.44	100	11

SOURCE: Peabody Western Coal Company 2011

As shown in Tables E-5 through E-7, concentrations of other criteria pollutants in the region remain well below applicable NAAQS. Given that emissions of these pollutants and their precursors from the proposed action are minor, the proposed action will not pose a threat to ongoing compliance with these national health and welfare standards and would not be significant.

Additionally, an analysis was conducted of the long-range atmospheric deposition of mercury and selenium contained in particulate matter emissions from operations at Kayenta Mine. As discussed in section D.12.4 of Appendix D, AERMOD dispersion modeling was performed to predict the atmospheric deposition of particulate mercury and selenium from coal and overburden operations for seven different drainage basins at Lake Powell and the Colorado River. As shown in Table D-11 in Appendix D, annual deposition rates for selenium are on the order of a few nanograms per square meter per year, and rates for particulate-phase mercury yet a hundred times less than for selenium across all seven drainage areas. Compared to ecological benchmarks identified by ENVIRON International, these rates of deposition from Kayenta Mine are below ecological screening levels and do not pose a significant risk to aquatic receptors (see Appendix E). Impacts would be negligible and would not be considered significant.

E.1.7.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2, the projected emissions of NO_x, PM10, and PM2.5 emissions discussed above for the Kayenta Mine operations would be less, as reclamation activities would not require the same activities for mining coal as described in Appendix D, Table D-3. Under Alternative 2, the effects of fugitive dust from natural wind erosion of disturbed areas and stockpiles, emissions from reclamation activities (scrapers and dozers on spoil) and truck haulage would continue the same as under Alternative 1, until reclamation activities are completed. With the level of emissions-producing activities being less than those described under Alternative 1, the corresponding impacts on air quality would less than those described under Alternative 1, which would be negligible and would not be considered significant.

E.1.8 Noise and Vibration

Noise and vibration impacts are evaluated based on the extent the alternative could exceed Federal noise regulations or by the potential increase in noise from existing conditions. The Noise Control Act of 1972 indicates that a 24-hour equivalent level of less than 70 dBA prevents hearing loss and that a level below 55 dBA, in general, does not constitute an adverse impact. 30 CFR 816.67 regulates the control of adverse effects resulting from blasting activity in terms of noise and vibration resources.

E.1.8.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Sensitive noise receptors, including residents who live near mine roads and within range of warning signals for blasting during mining operations at coal resource areas N-9, J-19, and J-21 would continue to experience noise from mining activities. The number of warning and all-clear signals produced at blasting sites by an audible-speaker warning device of 100 watts or greater—audible at 0.5 mile—also would remain at 2010 levels as overall coal production per year is not anticipated to increase. There is additional natural topographic screening between mining operations and sensitive noise receptors, which could reduce noise for sensitive receptors. In addition to the distance of the sensitive noise receptors from the permit period mine areas, mining activities occur below grade, the walls of the pit and spoil piles could absorb and attenuate some of the noise from mining activities. The noise reduction measures associated with activities at mining sites will include maintenance of equipment exhaust systems and engine sound controls to manufactures' specifications and limiting blasting to daylight hours. Additionally, measures to reduce noise generated from construction activities when the activities are within 0.5 mile of a noise-sensitive receptor will be implemented in accordance with the Kayenta Mine PAP. Such measures could include the use of temporary sound-baffle walls.

Vibration impacts were determined by using the Blasting Guidance Manual, which was developed by OSM to prevent injury and damage to public and private property outside the mine permit area. OSM requires that airblast levels be limited to a maximum of 134 dB (peak). Ground vibrations cannot exceed

Table E-6 Regional Ozone Monitoring Summary

Monitor Location	State	Monitor ID	Distance from Monitor to Kayenta Mine (km)	Maximum 1-Hour Concentration (ppm)									
				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mesa Verde NP	CO	080830101	183.0	0.077	0.080	0.088	0.080	0.088	0.094	0.077	0.075	0.081	0.087
Petrified Forest NP	AZ	040170119	188.0	--	0.070	0.084	0.088	0.101	0.093	0.080	0.082	0.073	0.080
Grand Canyon NP	AZ	040058001	104.0	0.074	0.087	0.082	0.082	0.093	0.081	0.080	0.078	0.072	0.080
USBR Shiprock Substation	NM	350451005	172.0	0.087	0.087	0.091	0.080	0.088	0.093	0.086	0.082	0.069	0.080
Canyonlands NP	UT	490370101	226.0	0.072	0.078	0.079	0.080	0.081	0.076	0.082	0.080	0.078	0.081
Zion NP	UT	490530130	262.0	--	--	--	0.083	0.128	0.086	0.083	0.088	0.080	0.078
Glen Canyon	AZ			--	--	--	--	--	--	--	--	--	--
S. Ute Tribe - Ignacio	CO	080677001	253.0	0.068	0.069	0.075	0.077	--	--	0.077	0.078	0.076	0.077
S. Ute Tribe - Hwy 550/Bondad	CO	080677003	231.0	0.066	0.075	0.070	0.068	0.077	0.092	0.086	0.080	0.078	0.083
Cortez	CO	080830006	184.0	--	--	--	--	--	--	--	0.078	0.077	0.088
USFS - Shamrock Mine	CO	080671004	271.0	--	--	--	0.086	0.091	0.092	0.079	0.081	0.093	0.083
Bloomfield	NM	350450009	214.0	0.094	0.091	0.089	0.078	0.087	0.079	0.080	0.076	0.060	0.077
Navajo Dam	NM	350450018	244.0	--	--	--	--	--	0.104	0.094	0.083	0.075	0.080

Monitor Location	State	Monitor ID	Distance from Monitor to Kayenta Mine (km)	4th Highest 8-Hour Concentration (ppm)									
				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mesa Verde NP	CO	080830101	183.0	0.065	0.070	0.067	0.069	0.076	0.074	0.070	0.069	0.069	0.066
Petrified Forest NP	AZ	040170119	188.0	--	0.055	0.074	0.071	0.070	0.071	0.069	0.072	0.062	0.068
Grand Canyon NP	AZ	040058001	104.0	0.070	0.079	0.073	0.072	0.079	0.070	0.069	0.071	0.066	0.069
USBR Shiprock Substation	NM	350451005	172.0	0.074	0.075	0.075	0.069	0.072	0.071	0.073	0.069	0.059	0.063
Canyonlands NP	UT	490370101	226.0	0.066	0.072	0.074	0.072	0.069	0.070	0.072	0.071	0.068	0.068
Zion NP	UT	490530130	262.0	--	--	--	0.074	0.091	0.072	0.071	0.072	0.068	0.072
Glen Canyon	AZ			--	--	--	--	--	--	--	--	--	0.060
S. Ute Tribe - Ignacio	CO	080677001	253.0	0.052	0.060	0.062	0.063	--	--	0.058	0.067	0.065	0.068
S. Ute Tribe - Hwy 550/Bondad	CO	080677003	231.0	0.051	0.055	0.060	0.060	0.066	0.063	0.071	0.067	0.066	0.067
Cortez	CO	080830006	184.0	--	--	--	--	--	--	--	0.064	0.064	0.064
USFS - Shamrock Mine	CO	080671004	271.0	--	--	--	0.067	0.075	0.074	0.069	0.069	0.071	0.074
Bloomfield	NM	350450009	214.0	0.074	0.076	0.073	0.068	0.075	0.063	0.069	0.064	0.052	0.065
Navajo Dam	NM	350450018	244.0	--	--	--	--	--	0.079	0.079	0.075	0.061	0.069

SOURCE: U.S. Environmental Protection Agency

NAAQS

Ozone 1-hour[1]: 0.12 ppm

8-hour[2]: 0.075 ppm (2008)

8-hour[3]: 0.08 ppm (1997)

1 (a) EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard (“anti-backsliding”).
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.

2 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)

3 (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) EPA is in the process of reconsidering these standards (set in March 2008).

Table E-7 Regional SO_2 Monitoring Summary

Monitor Location	State	Monitor ID	Distance from Monitor to Kayenta Mine (km)	Highest 24-hour Concentrations (ppm)									
				1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USBR Shiprock Substation	NM	350451005	172.0	0.052	0.033	0.020	0.017	0.019	0.014	0.030	0.013	0.013	0.004
Bloomfield	NM	350450009	214.0	0.007	0.010	0.010	0.006	0.006	0.009	0.010	0.003	0.002	0.002

Monitor Location	State	Monitor ID	Distance from Monitor to Kayenta Mine (km)	Annual Average Concentrations (ppm)									
				1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USBR Shiprock Substation	NM	350451005	172.0	0.010	0.008	0.004	0.003	0.003	0.003	0.002	0.002	0.002	0.001
Bloomfield	NM	350450009	214.0	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001

SOURCE: U.S. Environmental Protection Agency AIRData
NAAQS: SO_2 24-Hour: 0.14 ppm (not to be exceeded more than once per year)
SO_2 Annual: 0.03 ppm

Table E-8 Regional NO_2 Monitoring Summary

Monitor Location	State	Monitor ID	Distance from Monitor to Kayenta Mine (km)	Annual Average Concentrations (ppm)									
				1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
USBR Shiprock Substation	NM	350451005	172.0	0.009	0.009	0.009	0.009	0.009	0.008	0.008	0.012	0.010	0.006
S. Ute Tribe - Ignacio	CO	080677001	253.0	0.004	0.005	0.005	--	0.005	0.005	0.004	0.003	0.003	0.003
S. Ute Tribe - Hwy 550/Bondad	CO	080677003	231.0	0.006	0.009	0.009	0.008	0.009	0.006	0.006	0.003	0.003	0.003
Bloomfield	NM	350450009	214.0	0.012	0.011	0.012	0.014	0.013	0.013	0.013	0.014	0.016	0.014

SOURCE: U.S. Environmental Protection Agency AIRData
NAAQS: NO_2 Annual: 53 ppb (0.053 ppm)

peak particle velocity of 1.25 inches per second at a distance of 300 feet or 0.75 inches per second at 5,000 feet (Rosenthal and Morlock 1987). The nearest occupied residences are located approximately 1 mile from the permit period mine area affiliated with coal resource area J-21 (Map D-8). Although blasting activities would continue to result in periodic intense sound levels, sensitive noise receptors are located at a distance where the noise intensity will typically be within standards established in 30 CFR 816.67. Temporary effects from vibration and airblast levels within standards established in 30 CFR 816.67 are not considered capable of producing injury or property damage, but could cause annoyance depending on the distance to the receptor (Mohamed 2010). With the nearest sensitive receptor at a distance of approximately 1 mile from the active mining area, noise and vibration impacts are not expected to exceed federal regulations. Blasting activities will be conducted in accordance with administrative regulations established to minimize adverse impacts resulting from noise and vibration in 30 CFR 816.61. OSM requires that airblast levels be limited to a maximum of 134 dB. PWCC's blasting program requires 16 hours of training for PWCC employees and contractors, establishes qualification standards for drillers and shooters, and stresses adherence to pattern design and establishes loading procedures.

The anticipated rate of annual coal production, and the related blasting and vehicle traffic, will not increase beyond current levels, impacts from noise and vibration will remain at current levels with no detectable change. As these noise and vibration levels would remain at or near 2010 levels, the impacts would be minor and would not be considered significant.

E.1.8.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Sources of noise and vibration associated with Alternative 2 would decrease and ambient noise levels could have a lower dBA due to cessation of all mining and blasting activities. Similar to Alternative 1, areas where reclamation activities occur, noise sources would continue until reclamation activities are completed.

With mining activities associated with Alternative 2 limited to reclamation activities, nearby sensitive receptors would experience less noise and vibration impacts compared to Alternative 1. These impacts would be negligible to minor and would not be considered significant.

E.1.8.3 Unavoidable Adverse Impacts

Mining operations would result in short-term adverse noise impacts at the active mining sites but within standards established in 30 CFR 816.67. However, as previously discussed, this impact would not result in an adverse impact warranting further mitigation as a result of compliance with existing regulations and PWCC mitigation measures. Alternative 1 and Alternative 2 would have no unavoidable, residual adverse effects to area noise levels.

E.1.9 Landforms and Topography

The analysis of landforms and topography considers the removal of coal resources and non-coal bearing rocks removed from the coal resource areas.

E.1.9.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Mining activities to remove up to 250 feet of overburden and coal resources would directly alter landforms and topography. Mining and reclamation activities would result in local smoothing and flattening of slopes and modified surface-drainage patterns. Short-term grading and spoil stockpiles of crushed overburden rock would result in localized changes to landforms and topography; however, consistent with the requirements of SMCRA, these areas will be regraded and stockpiles removed during subsequent reclamation activities. Prior approved reclamation plans (which are not a part of the proposed action but will apply to the mining areas) have been designed to approximate the natural slope and contours. Since reclamation activities are required to return disturbed areas to their approved post-mine land uses, impacts to landforms and topography would be minor and would not be considered significant.

E.1.9.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Effects from reclamation activities would be similar to those described under Alternative 1 and result in localized changes to landforms and topography. However, reclamation activities would occur over approximately 1,159 fewer acres than the mining areas associated with Alternative 1. Similar to Alternative 1, disturbed areas would be reclaimed to meet postmine land uses, and impacts on landforms and topography would be minor and would not be considered significant.

E.1.9.3 Unavoidable Adverse Impacts

Permanent sediment control facilities and reclaimed overburden piles are long-term modifications of local topography that would have an unavoidable adverse effect. Changes to landforms and topography that result in smoother and less diverse surfaces also would result in an unavoidable adverse impact. During the permit period total disturbance would alter landforms and topography on 1,159 acres of the 44,073 acre Kayenta Mine permit area, which based on the relative extent of the area, would not be considered significant.

E.1.10 Geology and Mineral Resources

The analysis on geology, minerals, and paleontological resources include the coal resources and non-coal bearing rock removed from coal resource areas due to mining activities.

E.1.10.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Geology

Mining would remove about 250 feet of non-coal-bearing rock above and between the coal on approximately 1,159 acres in coal resource areas N-9, J-19, and J-21. Over the long-term, the mined areas will be backfilled with unconsolidated, crushed rock from the strata overlying the coal seams that have been mined (coal combustion products will not be used). This material would be graded to approximate the original topographic contours, considering the needs of minimizing erosion and supporting post-mining land uses. Unconsolidated backfill material would not be placed on steep slopes where geologic hazards such as landslides can develop. The loss of the consolidated stratigraphy is a permanent nonreversible impact. However there are no unique or valuable geologic resources within the permit renewal period areas mined, and the impacts to geologic resources from the permit renewal period mining are minor and not considered significant.

Mineral Resources

In accordance with SMCRA, coal-mining activities must be conducted in a manner that maximizes recovery of the coal resources and protects the coal resources that remain after mining (Appendix A). Mining activity at the Kayenta Mine permit area removes coal seams in the Wepo Formation. PWCC estimates that approximately 11.6 percent of the coal reserves would be lost during mining activities due to normal overburden stripping. The impact of this permanent loss of coal resources is considered normal for the type of proposed activities, given current mining technology and the stratigraphic nature of the coal being mined. Impacts on coal resource development with this recovery rate would be minor and would not be considered significant.

There would be no effect on coal resources in the Toreva Formation and Dakota Sandstone because these are below 250 feet and cannot be mined by surface-mining methods. Coal-mining operations during the permit renewal period would not affect uranium and vanadium deposits located under the Wepo Formation. These mineral and coal deposits would remain available for future development and effects on these resources would be considered not significant.

If present, oil and gas resources under the Kayenta Mine permit area would occur in sedimentary rock formations below the mineable coal seams. These resources are not likely to be developed in the reasonably foreseeable future, and would remain available for future use. Valuable minerals other than coal are in uneconomical trace amounts and would not be developed during the permit renewal period. The potential effects on oil, gas, and valuable minerals from mining during the permit renewal period are minor and would not be considered significant.

Paleontological Resources

Paleontological resources (fossils) are non-renewable resources that cannot be used for scientific study if damaged, destroyed, or removed without proper scientific documentation. Coal mining activities and road construction for mine operations could damage undiscovered paleontological resources. These activities could improve access to fossil locations, which could increase theft and vandalism. However, mining operations in these areas could also uncover fossil resources that would otherwise remain unexposed and un available for scientific study. These impacts will be minor and would not be considered significant.

Damaging or destroying important fossils are not likely to occur from permit renewal period mining because fossils in these rocks are common throughout Black Mesa. Field surveys in coal resource areas N-9, J-19, and J-21 would document any important fossils that are discovered. In the event that mining activities would result in impacts on fossils not detected prior to mining activity, work in the area would cease and a qualified professional would evaluate the area. PWCC will work with regulatory officials for the recovery of important fossils prior to resuming mining operations. PWCC will recover any important fossils discovered during mining operations. The impacts to paleontological resources are minor and would not be considered significant.

E.1.10.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Mining coal resources would cease within the Kayenta Mine permit area under this alterantives, and there would be no additional impacts to geologic, mineral, and paleontological resources. Reclamation activities due previous mining activities would restore slopes, and similar to Alternative 1, ceasing coal mining in N-9, J-19, and J-21 would retain existing oil and gas and mineral resources that could be present in the sedimentary rock below the Kayenta Mine permit area. Under Alternative 2, impacts on geology, paleontological resources, and minerals from ceasing mining in the N-9, J-19, and J-21 be negligible and would not be considered significant.

E.1.10.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts under Alternative 1 would result from altering geologic resources and the removal of coal in N-9, J-19, and J-21. The geology in the coal resource areas from the base of the coal to the surface would convert from a consolidated stratigraphy to unconsolidated backfill material. Any potentially rare or unique regionally, diagnostically, or taxonomically important geologic and/or paleontological resources that were not identified and preserved or removed prior to or during mining operations would be lost. However, the 1,159 acres of disturbance from mining during the permit renewal period is less than 1 percent of the geologic resources in the study area. Unavoidable adverse impacts on geology and minerals would be minor and would not be considered significant.

E.1.11 Climate

As explained in Section D.2.11.1 above, attempts to disaggregate global climate models in order to predict the future of local or regional weather patterns is highly uncertain and speculative, particularly as it might apply to the five-year proposed renewal. Moreover, scientific uncertainty remains as to human contribution to global climate change. Virtually all scientific sources agree, however, that it is not possible to attribute complex global climate change reactions within a local region to a particular source of GHG emissions.

Unlike criteria air emissions, which are constituents that are viewed in the context of regional and local concern, greenhouse gases are constituents that, if viewed at all, must be viewed in a global context. Any impacts of GHG emissions would have to be a function of their total atmospheric concentration, and most GHGs are globally well-mixed atmospheric constituents. This means that the location of a particular GHG emission, in contrast to the situation for criteria pollutants, does not change its environmental impact.

On July 11, 2008, the U.S. EPA gave *Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act* (CAA). It reviewed various CAA provisions that could be applicable to regulate GHGs and examined the issues that regulating GHGs under those provisions could raise. It also provided information regarding potential regulatory approaches and technologies for reducing GHG emissions and raised issues relevant to possible legislation and the potential for overlap between legislation and CAA regulation.

The Mandatory Greenhouse Gas Reporting Rule was promulgated on December 17 and 27, 2010. The Rule requires annual reporting of GHG emissions by certain underground coal mines, stationary combustion sources that emit 25,000 tpy or more CO_2e, and other specific categories of stationary sources. Unlike the proposed Rule, the final Rule does not require reporting by suppliers of fossil fuels. Surface coal mines are also not one of the source categories designated for GHG reporting. Kayenta Mine is not subject to EPA's Mandatory GHG Reporting Rule.

Methane (CH_4) is the predominant GHG emitted from surface coal mines. To date, estimates of CH_4 emissions from surface coal mines can only be roughly approximated based on crude estimates of the representative concentrations of methane in regional coal basins throughout the U.S. On that basis, Kayenta Mine's total CH_4 emissions are roughly approximated to be in the range of 120,000 tpy (109,000 metric tons) CO_2e. Another estimated 60,000 tpy (54,000 metric tons) CO_2e are emitted by fuel combustion at the Mine.

For PSD and Title V applicability purposes, EPA's GHG Tailoring Rule has defined a "major stationary source" of GHG emissions to be one with a potential to emit (PTE) 100,000 tpy CO_2e or more. However, when determining whether a surface coal mine is a "major source," fugitive emissions from mining are not included in calculating the PTE, although fugitive emissions from coal preparation are included in that calculation. Kayenta Mine's non-fugitive emissions of CH_4 are estimated to be about 17,000 tpy CO_2e. Accordingly, Kayenta Mine does not constitute a "major stationary source."

At the present time there is no analytical methodology for quantifying incremental climate change impacts due to GHG emissions from a surface coal mine. Conclusions as to the significance of Kayenta Mine's GHG emissions on climate change cannot be reached because the geographic scope and predicted air emissions of Alternative 1 are too small to allow calculation of any measurable change on global climate under any scenario about whether and how climate might be changing. Although some scientists have postulated potential effects of global climate change as including alteration of water supplies, agriculture, sea levels, ultraviolet radiation levels, and variances in the ecosystem, neither Alternative 1 nor Alternative 2 would alter these effects. Because climate change must be viewed in the context of global conditions, the magnitude of the emissions potentially contributed by Alternative 1 activities need to be viewed in that context. PWCC estimated its GHG emissions from all sources at the Kayenta Mine to be 163,000 metric tons total CO_2e for all of 2009. Globally, CO_2 emissions in 2008 from all sources were estimated 29,000,000,000 metric tons (International Energy Agency [IEA] 2010).

E.1.11.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, the coal production from N-9, J-19, and J-21 would remain at the annual rate of 8.2 million tons per year using existing coal processing facilities (see Appendix D for detailed information on the coal processing facilities). As noted above, Kayenta Mine is not a major source of GHG emissions. The rough approximation of the overall GHG emissions from the Kayenta Mine would remain relatively constant for the permit term, and that amount is not expected to have a significant impact on climate change under any scenario about whether and how climate might be changing. Because climate change must be viewed in the context of global conditions, the magnitude of the emissions potentially contributed by Alternative 1 activities needs to be viewed in that context. Globally, CO_2 emissions in 2008 from all sources were estimated to be 29,000,000,000 metric tons (IEA 2010). PWCC estimated its footprint to be 163,000 metric tons total CO_2e for all of 2009 using USEPA's tailoring rule method calculation. The contribution of greenhouse gases from Alternative 1 would be negligible when compared to total greenhouse gases produced globally, which would not be considered significant.

E.1.11.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, emissions of CH_4 would decrease due to the cessation of mining. Although an abandoned coal mine continues to emit some methane, the quantity of those emissions would be but a small fraction of CH_4 emitted when the mine was active. Similar to Alternative 1, reclamation activities produce $CO_{2.}$ However, emissions of that GHG from the Mine would be less, as the coal mining would cease. The overall decrease in GHG emissions under Alternative 2 would remain negligible under this Alternative, which would not be considered significant.

E.1.12 Land Use

This section analyzed potential effects on existing land use practices including residential use, garden plots and livestock grazing. The analysis assumed that post-mine land uses are livestock grazing and wildlife habitat, which are the primary current land uses. The Kayenta Mine operation is the only industry currently within the study area and there are no commercial land uses in the study area.

E.1.12.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

PWCC would continue its ongoing mining operations and use of existing facilities. In accordance with Federal regulations, PWCC will relocate four Navajo households within the J-21 coal resource area that are located on top of coal resources or within 0.5 mile of the coal recovery line during the permit period. PWCC has been coordinating with these households over the past two years regarding this relocation and the selection of alternate sites for the households. PWCC and the four households have agreed to a location that is still in the southern part of the J-21 coal resource area and in the vicinity of the households' customary use areas, but away from the areas to be mined. The householders also will be compensated for the replacement of all structures and any lost grazing acreage in accordance with PWCC's established relocation procedures (refer to Section D.2.12). PWCC also will relocate family garden plots that are currently located on mine property, as needed, to accommodate surface mining activities in accordance with Federal regulations. The four Navajo household relocations will have a negligible effect on land use and the impacts would not be considered significant.

Ongoing mining activities will have a minor effect on traditional land use practices such as livestock grazing. Approximately 1,159 acres of potential rangeland dominated by piñon-juniper woodland with low forage availability and quality would be disturbed as a result of mining in the N-9, J-19, and J-21 coal resource areas during the permit period. In the short-term, this would remove about 11 AUMs based on the weighted average stocking rate of 107 acres/AUM for piñon-juniper (67%) and sagebrush (33%); however, reclamation would eventually improve the forage productivity and quality of the land by converting the piñon-juniper woodlands to shrubland and grassland vegetation communities that have higher grazing productivity. Reclamation activities occur immediately after an area is mined to completion, returning mined-out areas to productive livestock grazing lands, which is the primary historical land use in the area. With final reclamation, mined-out areas will be re-graded to the approximate original contour, mine soil will replace the topsoil, and vegetation will be replanted according to the approved post-mining land uses of livestock grazing, wildlife habitat, and cultural plant use. The resulting shrub grassland communities will increase the livestock carrying capacity and will improve the potential for grazing management. Mitigation measures will continue to be implemented to control the spread of weeds and noxious weeds in the mine lease area, reducing the effects of weeds on livestock production. Within the Kayenta Mine permit area, seed and mulch are specified to be free of noxious weeds and best practice efforts insure compliance. PWCC routinely controls diffuse knapweed by applying herbicides along roadsides. Reclaimed sites are monitored twice a year for the adequacy of reclamation and the presence of weed species. Prescriptions for reseeding, grazing, mowing, or chemical control are made based on the results from statistical sampling of plots in reclaimed areas. Based on the revegetation monitoring results, forage production for livestock could increase to as much as 10 times over the original forage productivity of the land (OSM 1990). Reclamation activities will result in an increase in the amount and quality of forage available for livestock grazing. The stocking rate after reclamation is managed at 4.6 acres/AUM, which will increase AUMs to 252. Management and reclamation practices in the Kayenta Mine permit area will reduce the presence of noxious weeds and invasive species and their potential to indirectly effect livestock and other traditional or cultural land uses. The moderate effects from the temporary decrease in AUMs is offset by the increase in productivity in reclaimed areas, and because changes on the number of livestock long-term would be negligible and the impacts would not be considered significant.

Water quality at impoundments and ponds within the PWCC permit area could exceed water quality standards for livestock as a result of developing the N-9, J-19, and J-21 coal resource areas. Localized water quality exceedances could include high total dissolved solids, low pH, high levels of sulfate, or high levels of selenium. Permanent water impoundments must meet specific performance standards as outlined in 30 CFR 816.49(b), including making water quality suitable for the intended land use of livestock grazing. PWCC is required to submit information to OSM to demonstrate that each of the permanent impoundments meets these performance standards. If any of the impoundments do not meet the performance standards, OSM will not approve these for retention in the landscape. PWCC's seepage management plan and other mitigation measures to protect water quality will help maintain or improve water-quality standards, protect livestock, humans, and the environment. Localized areas with poor water quality could affect the health of livestock until reclamation of these areas is completed (approximately 6 years); however, mitigation measures using fence enclosures, a seep management plan, and pond reclamation would reduce these effects to negligible levels. Negligible impacts would not be considered significant.

Continued mining activities within the N-9, J-19, and J-21 coal resource areas would disturb 1,159 acres of land used for grazing and traditional land uses, resulting in a localized moderate short-term impact. However, reclamation of these disturbed areas would improve the productivity and quality of grazing lands within the coal resource areas in the long-term, and approximately 20,000 acres in the Kayenta Mine permit area are already in reclamation. In addition, the amount of grazing land that would be disturbed within the resource areas is less than one percent in relation to the approximately 17 million acres of agricultural land within the Navajo Nation and Hopi Reservation (USDA 2007). As required in the AZ-0001D permit, disturbed areas will be reclaimed as specified in the approved mining and reclamation plan to support the anticipated post-mining land uses of livestock grazing, wildlife habitat, and cultural plant use. The reclamation procedures will include stockpiling and redistributing soil, using reclamation seed mixtures approved by OSM, and replacing stock water sources. After completing reclamation, because the areas would meet or exceed the local carrying capacity of pre-mine conditions, these effects would be minor and would not be considered significant.

E.1.12.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, mining operations would cease, and facility removal and reclamation operations would begin according to the requirements of the current Kayenta Mine permit closure plan. No additional disturbance on Navajo households, family garden plots, traditional resources, and grazing lands would occur, however reclamation activities would be the same as Alternative 1.

Short-term livestock production relative to native grazing potential would not be disrupted with the termination of mining in the Kayenta Mine permit area. However, the potential for improving range conditions through reclamation over the long-term would be slightly reduced under this alternative (0 acres versus 1,159 acres under Alternative 1), which is minor in comparison to the 20,000 acres already in reclamation in the coal resource areas. Impacts to livestock resulting from poor water quality in temporary and permanent impoundments and ponds also would not differ substantially from Alternative 1, because of short-term mitigation measures, such as fence enclosures, designed to limit or eliminate these impacts. Like Alternative 1, the effects of Alternative 2 would be negligible on traditional cultural resources and grazing lands because reclamation and mitigation would restore the areas to meet or exceed conditions or resources prior to mining. After completing reclamation, because the reclaimed areas would meet pre-mine conditions for environmental quality and forage production would increase locally, these effects on land use would be negligible. Negligible effects would not be considered significant.

E.1.12.3 Unavoidable Adverse Impacts

Reclamation would restore the landscape to its approximate original contour and would return disturbed areas to meet the post-mining land use of livestock grazing and wildlife. No unavoidable adverse impacts to land use are anticipated.

E.1.13 Social and Economic Conditions

This section addresses the social and economic impacts of the Kayenta Mine operation on the communities within the region of influence. The analysis considered potential effects on revenue, employment and the future abilities of the various governmental entities to generate revenue (including various revenue sources). Three assumptions were used in the analysis: (1) government legislation and regulations controlling taxation, royalty payments, employment wage rates, and hiring practices will remain in effect through the permit period, and (2) the various rates and the manner in which government agencies receive the revenue will not change; and (3) the revenue to the Navajo Nation and to the Hopi Tribe that is attributable to the Kayenta Mine will be related to the amount of coal extracted from the mine in any given year.

E.1.13.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, employment opportunities, and revenues to the Navajo Nation and Hopi Tribe will continue through the permit renewal period. The number of people employed at the Kayenta Mine during the permit period will increase from 422 in 2010 to 432 in 2015 (Table D-12), while the total annual amount paid in salaries to the employees remains similar to the 2010 value of approximately $50 million. This will help maintain the employment rate and number of people employed by the mining sector at 2010 levels (see Appendix F, Table F-2 and Table F-4). The salaries paid to the employees pay, in part, for living expenses such as shelter, food, and other necessities; based on the higher dependency ratios on the Navajo Nation and Hopi Reservation (Table D-10), the salaries also provide similar needs for those family members, or non-family members that reside in the home. Continued employment during the permit renewal period will help maintain the existing dependency ratio in the study area.

In addition, the average annual revenue paid to the tribes from 2005-2009 was $43.2 million; $15.7 million to the Hopi and $27.5 million to the Navajo Nation. Coal production rates will remain constant through the permit period, and revenue from PWCC to the Navajo and Hopi tribes will be similar. Likewise, the average annual payment of $6.2 million from PWCC to NTUA and scholarships funds will also continue at approximately the same rate.

Additional employees needed at the Kayenta Mine may be available from the existing workforce in the Navajo Nation and Hopi Reservation and no influx residents will occur as a result of filling those new positions. Indirectly the continued operation of Kayenta Mine during the permit period will not increase the population within the census-designated places, the Navajo chapters of Chilchinbito, Forest Lake, Kayenta, and Shonto, or Hopi Reservation area. As the employment, population and revenues to Navajo and Hopi tribes will remain at or near 2010 rates. No additional demands on the existing infrastructure or services in the communities on or near the Kayenta Mine permit area are anticipated.

During the permit renewal period four households in the J-21 coal resource area will be relocated at least 0.5 mile from active coal mining. This may alter their existing social network and activities. However, the relocation sites are selected by the households, which may result in no residual effects on each household's existing social network and activities. Long-term residents may return to their original home sites after reclamation is completed and the land is returned to tribal control. Under Alternative 1, employment opportunities, and revenues to the Navajo Nation and Hopi Tribe will continue through the permit renewal period and impacts on socioeconomics will be negligible and would not be considered significant because there would be no change from current conditions.

E.1.13.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2 employment at Kayenta Mine will be reduced from 432 jobs through 2015 to 172 jobs through 2012; 60 people will be employed from 2013 to 2014; eight people will be employed from 2014 to 2024; and four people will be employed from 2024 to 2025. After 2026, zero people will be employed at the Kayenta Mine. Over the next 15 years, cessation of mining activities will result in a major effect from reduction of the approximately $50 million in salaries currently paid to mine employees (refer to Table D-11 for detailed employment data). The reduction in employment will directly cause hardship to those employees and their dependents and indirectly affecting the local region in areas such as housing, commerce, travel, and education. The salaries currently paid to the employees pay, in part, for living expenses such as shelter, food, and other necessities; based on the higher dependency ratios on the Navajo Nation and Hopi Reservation (Table D-10), the salaries also provide similar needs for those family members, or non-family members that reside in the home. A loss in employment may also increase the ratio of dependency in the local area. The reduction in salaries will reduce the amount of revenue that is put back into the local economy either through direct royalty payments to tribes or indirectly through the purchase of goods and services.

In recent years, the revenue from the Kayenta Mine operation has been the single largest source of revenue in the Hopi and Navajo tribal budgets. The discontinuation of the mining operations at the Kayenta Mine will significantly influence tribal facilities, such as internal payroll, education, and the tribes' annual operating budget as the recent (2005-2009) average annual payment made from PWCC to the tribes totals $43.2 million, $15.7 million to the Hopi Reservation and $27.5 million to the Navajo Nation. Local mining revenues support as much as 50 percent of the Hopi tribal government revenue, and as many as 500 jobs in the Hopi Tribe and local mining revenue funds as much as 26 percent of the total Navajo Nation non-grant budget. The loss of PWCC's contribution to local mining revenues will reduce the number of employment opportunities within the tribal organizations. As is shown in Table D-11, Public Administration is the second highest employment sector within the Hopi Reservation, employing 26.0 percent of the people; Public Administration on the Navajo Nation is a close third behind construction, and employs 10.8 percent of the people. The total estimated payment made to the tribes beginning in 2012 is $1.9M, $1.2M to the Navajo Nation and $0.7M to the Hopi Tribe. These payments will continue until final reclamation is complete and OSM has terminated federal regulatory jurisdiction. While the Kayenta school district, which receives the most benefits from mining tax revenue, is an Arizona public school district, the majority of the students and employees of the district are American Indian. The loss of employment and revenues paid to Navajo and Hopi tribal governments may be considered a major long-term impact on socioeconomics that would be significant.

E.1.13.3 Unavoidable Adverse Impacts

Under Alternative 1, there will be no unavoidable adverse impacts on social and economic conditions as employment opportunities and tribal revenues will remain near 2010 levels. Unavoidable adverse impacts to the social and economic conditions under Alternative 2 include the loss of several hundred high-paying jobs at the Kayenta Mine, of which 94 percent are held by American Indians. The direct and indirect impacts of the employment and income loss affect the employees as well as other local areas of commerce. In addition, the tribal governments that are recipients of revenues from coal royalties and bonuses, water use fees, and educational scholarships will be adversely impacted by the Kayenta Mine closure. According to March 2010 written comments made by the Hopi Tribe in response to the Environmental Protection Agency's Advanced Notice of Proposed Rulemaking Regarding Best Available Retrofit Technology for Nitrogen Oxide Emissions at the Navajo Generating Station Docket Number EPA-R09-OAR-2009-0598, Kayenta Mine coal revenues fund as much as 88 percent of the Hopi Tribe's annual governmental budget; Of the fiscal year 2009 Navajo Nation General Fund budget of $150.5 million, $20 million (calendar year 2009), or 13.3 percent, is contributed by coal royalties and bonuses paid by PWCC (Table F-7, Appendix F).

E.1.14 Environmental Justice

Executive Order 12898 requires all Federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. Executive Order 13045 requires Federal actions and policies to identify and address disproportionately adverse risks to the health and safety of children. The alternatives for the Kayenta mine permit renewal was evaluated in accordance with EO 12898 for minority and/or low-income populations within the project area for their potential to be burdened disproportionately by adverse impacts. As discussed in Section D.14, the study area predominately consists of minority and low-income individuals. The minority population in the study area is predominately Native American in composition, which is considerably higher than for Arizona as a whole or Navajo County (see Section D.14 and Table D-11).

American Indian environmental justice populations on or near reservations are the majority population because the reservations are tribal homelands. The environmental justice analysis for this study is being conducted to evaluate whether the Alternatives being considered could result in a disproportionately adverse impacts on minority and/or low-income groups, including Native Americans, as a result of physical location, perception, design, noise, or public health and safety.

E.1.14.1 Alternative 1: Issue an authorization to proceed with the proposed projectApprove the Renewal of Permit AZ-0001D

Under Alternative 1, as indicated in Section E.1.13.1, employment opportunities and revenues paid to the Navajo Nation and Hopi Tribe will continue through the permit renewal period. American Indians hold a majority of the jobs at Kayenta Mine and those related to the mining operation. In addition, the Township of Kayenta, which has an economy driven by the mine, the 14 Navajo Chapters within the Western and Chinle agencies that were identified within the area of socioeconomic influence, and the Hopi Village of Moenkopi are American Indian communities. The number of Kayenta Mine employees would remain at or near 2010 levels and there would be no direct or indirect effects on the local workforce. Mine employees would travel from the communities identified in Table E-11 and the continued operation of the

Kayenta Mine will not require employees to move into or closer to the permit area. Directly or indirectly, the Kayenta mine provides the bulk of the jobs available in this low-income area and tribal governments are recipients of many of the mining revenues. During the permit renewal period, employment and revenues to tribes will continue at approximately the same rate and the direct and indirect effects on environmental justice populations will be negligible. Negligible impacts would not be considered significant.

The Black Mesa Review Board, established within the Legislative Branch of the Navajo Nation pursuant to 2 N.N.C. and § 901-920, Title 2, Chapter 3, Section 902, to advocate for fair and just compensation for Navajo families within the Navajo Nation Chapters whose boundaries overlap the leasehold and whose cultural, social, economic, and environmental interests are affected or impacted by the mining operations. The Board consists of a representative from the Navajo Nation, each affected Chapter, and an employee of PWCC. The Board is certified to exercise governance and decision making on behalf of the affected families in each Chapter. The households that will experience the effects of mining on grazing lands are American Indian households, which include largely minority and low-income populations. As described in Section E.1.12, the effects on land use will be negligible after reclamation is completed. Noise from mining operations would remain at or near 2010 levels and the potential effects on environmental justice populations is negligible (see Section E.1.8). Health and safety effects of continued mining operations also could have negligible effects on residents and employees of Kayenta Mine (see Section E.1.18) but would not result in an unequal treatment of environmental justice populations described in Section D.2.14. The required adherence to various occupational health and safety regulations will include the continuation of onsite occupational health-treatment facilities and these effects would not result in a disproportionate effect on environmental justice considerations.

Kayenta mine operations meet NAAQS for air quality. However, PM (e.g., fugitive dust from the mining operations) is the air pollutant that remains a concern of residents in the immediate vicinity of the Kayenta Mine. Alternative 1 would meet all NAAQS standards. Impacts on air quality in the local area are described in Section E.1.7.

The population directly affected by and concerned about the effects of water withdrawals upon the continuing availability of local water for grazing and agriculture is almost entirely an American Indian population. Continuing use of the N aquifer wells by the Kayenta Mine operations would result in a continued concern that withdrawal of water from the N aquifer for mine-related purposes would interfere with water use for grazing, agriculture, and domestic wells. Almost all of the use of the N aquifer water other than by the Kayenta Mine is by the American Indian population. However, impacts on the N aquifer would be considered negligible, as there would be less pumping of the N aquifer than in the past (refer to Section E.1.2 for more information).

No adverse human health or environmental effects are falling disproportionately on minority or low-income populations through the permit period as a result of mining activities at the Kayenta Mine. Potential impacts to environmental justice populations that may result from the implementation of Alternative 1 would be mitigated through compensation for household and family garden plot relocation, reclamation of land impacted by coal mining activities, and compensation for the temporary loss of grazing lands. To reduce potential impacts to air quality, the Kayenta Mine has an extensive dust-control program (Section E.1.7) and air quality would continue to meet all NAAQS standards. Consequently, mine operations during the permit period would extend the current health and environmental effects created by the Kayenta Mine operations, but would not result in an unequal treatment of environmental justice populations described in Section D.2.14. These effects would not result in a disproportionate effect on environmental justice considerations and the impacts would be negligible and would not be considered significant.

E.1.14.2 Alternative 2: Do not issue an authorization to proceed with the proposed project Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2, mining operations would cease, and facility removal and reclamation operations would begin according to the provisions of the current Kayenta Mine authorizations. As described in Section E.2.13.2 Social and Economic Conditions, the cessation of mining activities in coal resource areas N-9, J-19, and J-21 would have long-term impacts on the economy of the local area of influence if employment and tax revenues are not replaced with new economic activity. Revenues related to coal production paid to both the Navajo Nation and Hopi Tribe would cease, which could result in a long-term reduction in resources and programs that assist with environmental justice populations in the regional and local area of influence. However, this reduction in Navajo and Hopi tribal revenues and employment opportunities are adverse the effects are similar to Alternative 1, but would not result in an unequal treatment of environmental justice populations described in Section D.2.14. These effects would not result in a disproportionate effect on environmental justice considerations and the impacts would be negligible and would not be considered significant.

The tribal people near the Kayenta Mine permit area would no longer be affected by mining traffic and noise and mining would no longer interfere with the availability of plants and other materials used for medicinal, ceremonial, or household needs. Over the long-term, since 1,159 acres of the 44,073 acres within the Kayenta Mine permit area would not be mined and reclaimed, less land would have improved productivity for livestock grazing. This reduction in reclaimed lands and indirectly the amount of forage available for livestock grazing would be minor and would not be considered significant.

E.1.14.3 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts associated with environmental justice under either Alternative 1 or 2.

E.1.15 Indian Trust Assets

This section analyzes the Indian Trust Assets that could be affected by the alternatives. Indian Trust Assets are minerals, water rights, lands, hunting and gathering rights and other natural resources.

E.1.15.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, coal production would continue at the current rate of about 8.2 million tons per year. Mining operations would continue to expand within the limits of coal resource areas N-9, J-19, and J-21, which have been partially disturbed by prior mining and reclamation activities. In accordance with lease agreements, PWCC would make royalty payments to the Hopi Tribe and Navajo Nation for the mined coal. The existing lease agreements, permits, and rights-of-way reflect the opinion of the governments of the Navajo Nation and Hopi Tribe that the use of the land, coal, water, and other natural resources in the Kayenta Mine area are an appropriate and equitably compensated use of the tribe's trust assets. The Navajo Nation reservation land that would be mined under Alternative 1 within coal resource areas N-9, J-19, and J-21 will be reclaimed pursuant to the approved reclamation plan and existing lease agreements. Reclamation will restore the land with greater forage productivity than pre-mining conditions or for other uses as determined appropriate by the tribal government. Renewal of the permit would represent a continuation of the agreements regarding use of trust assets of the Navajo Nation and Hopi Tribe within the Kayenta Mine area. Renewal of the permit would not be considered a significant impact on Indian Trust Assets.

The Kayenta Mine operations pump about 1,236 acre feet of water annually from the N aquifer for mining operations, with a minor amount made available as a potable water supply for local residents. The amount of water project to be pumped from the N aquifer would continue at approximately the same rate during the permit renewal period. As discussed in Section E.1.2.1, potential impacts during the permit renewal period will be negligible on hydrology, and there would be no significant impact on water as an Indian Trust Asset.

E.1.15.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2, mining operations would cease and the land surface in previously mined areas would be reclaimed for grazing and other uses. No additional coal and land assets of the Navajo Nation and Hopi Tribe would be used. Reclamation activities and associated use of pumped groundwater would continue to fulfill requirements of the current lease agreements. As described under Alternative 1, reclamation would return to the post-mine land use of livestock grazing, wildlife habitat, and cultural plant use. The potential effects on Indian Trust Assets will be negligible and would not be considered significant.

E.1.15.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts of Alternative 1 on Indian trust assets would include use of coal and other land and water resources. Extraction of coal is an irreversible and irretrievable commitment of a nonrenewable resource, but the tribal governments, with BIA oversight, have determined that royalty payments are appropriate compensation for use of the coal and a benefit for the tribes. Use of water from the N aquifer for coal mining activities also is an unavoidable adverse impact of Alternative 1. The groundwater is a long-term renewable resource and the amount of water pumped from the N aquifer for mining operations under Alternative 1 is not expected to exceed the amount of recharge. Unavoidable adverse impacts would be negligible to minor and would not be considered significant.

E.1.16 Visual Resources

Potential impacts to visual resources are determined by analyzing the contrast of the proposed permit renewal period mining in N-9, J-19, and J-21 to the existing landscape, the sensitivity of the viewers, and the visibility of the mining operations.

E.1.16.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Continuing mining in the three coal resource areas would result in an additional 1,159 acres of disturbance. This would create high visual contrasts with the surrounding natural and reclaimed landscapes. Short-term visual contrasts that would occur include changes in form and line of the topography, changes in color of the vegetation and soil, changes in texture of the vegetation and soil. However, topography and vegetation screen the most sensitive viewers from the mining operations. Occupied structures that are located in valleys are blocked from viewing mining operations by the valley sides. Occupied structures on elevations above the mining operations in N-9, J-19, and J-21 have topography that blocks their views of the mining operations. Vegetation also could screen views, and the more distant viewers would perceive less contrast. The views of the mining operations from nearly all of the 220 occupied structures would be completely or partially screened by topography and vegetation (PWCC 2011b). Sensitive viewers traveling on Navajo Route 41, from U.S. 160 have most of their views screened by hills. Views of the mining operations would be brief for viewers moving along the road. Views from U.S. 160 and Arizona 564 would be screened by topography.

Reclamation would reduce the short-term contrasts of colors and textures related to vegetation removal. Most of the reclaimed areas would be revegetated with over 20 species of grasses, forbs, and shrubs. Some sections of the reclaimed areas would be chosen for cultural plant, woodland, and wildlife habitat revegetation. These sections would be planted with selections of over 50 species of trees, shrubs, forbs, and grasses.

Reclaimed topography would vary from the natural landscape in scale, complexity, and slopes. This would create contrasts in form, line, and texture. Mine highwalls will be graded to a slope of 3:1 or less, and linear rock features and rock structures will be established for wildlife habitat. Once the vegetation has matured, the newer reclaimed areas would blend into the older ones, and there would be less contrast between the reclaimed landscape and the adjacent undisturbed landscape. The scenic integrity would blend from one landscape to another.

With little visibility of continued mining operations by the moderately and highly sensitive viewers, the relatively short-term high visual contrasts of the mining operations are anticipated to result in minor effects on visual resources. However, after reclamation is completed according to the requirements of as the permit closure plan and SMCRA regulations, impacts on visual resources during the permit renewal period will reduce to a negligible level and would not be considered significant.

E.1.16.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Impacts from reclamation under Alternative 2 would be similar to Alternative 1 except, mining operations would cease, facilities would be removed or turned over to the tribes, and reclamation operations would begin in previously mined areas according to the permit closure plan and SMCRA regulations. With the ending of operations, approximately 1,159 acres of the natural landscape would not be mined and would not be converted to a reclaimed landscape. The short-term visual contrasts from mining operations in the three coal resource areas would cease. The long-term effects on visual contrasts of the reclaimed areas would be similar to Alternative 1. The reclamation activities would reduce the effects on visual resources to a negligible level and would not be considered significant.

E.1.16.3 Unavoidable Adverse Impacts

There are no unavoidable adverse impacts to visual resources because the landscape will be because the landscape will be reclaimed to approach existing conditions.

E.1.17 Transportation

This section describes the impacts that could result from the alternatives on the transportation network. This analysis evaluates traffic volumes from mine operations and changes the transportation network.

E.1.17.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, the existing roads will continue to be used until the mining and reclamation operations are completed. Mining will be an extension of existing operations and would rely on existing transportation facilities. Ancillary roads leading to exploration and development areas, pit, and spoil ramps will be constructed and used to complete mining activities in the three coal resource areas. As the rate of coal production during the permit period will remain constant, vehicle traffic on the Kayenta Mine permit area roads, Navajo Route 41, US Highway 160, and State Route 89 will not increase from 2010 levels. The Kayenta Mine related vehicle traffic will not change during the permit period, and no changes to the transportation network are required from mine related vehicle traffic.

All roads used or built by PWCC on or after December 16, 1977 will be reclaimed to their original state by the conclusion of the reclamation period, unless these have been approved by the regulatory authority as part of the post-mining land use plan. Due to the size and nature of PWCC’s mining activities, very few of the roads identified as part of the post-mining land use plan will be reclaimed until the end of mining activities in the Kayenta Mine permit area. Exceptions include roads in the immediate vicinity of pits and ramps, which are created in the spoil and reclaimed as reclamation activities progress within a coal resource area. Consistent with 30 CFR Sections 133 and 150, mitigation measures will continue to be enforced through regulatory inspections and reporting (see Appendix A, Section D). Mitigation requirements will continue through the conclusion of the reclamation period. The potential effects on traffic volumes and the existing transportation network will be negligible and would not be considered significant.

E.1.17.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

If authorization to proceed is not issued, mining operations in N-9, J-19 and J-21 would cease. Although vehicle traffic will be less than Alternative 1, reclamation-related traffic will still need to use the transportation network to complete reclamation activities restoring areas to their original state. However, under Alternative 2, there will be no increase in roadway development within the Kayenta Mine permit area, and roads not identified for retention in the post-mining land use plan will be reclaimed. This could alter the transportation network approved by the regulatory authority. However, as the post-mining land use plan has not been finalized, and there will be changes to the existing transportation network, the potential effects will be negligible and would not be considered significant.

E.1.17.3 Unavoidable Adverse Impacts

An unavoidable adverse impact that will occur under either alternative is the disturbance already created by the roads and traffic in the project area. However, under either alternative, reclamation of the roads will occur, and the lands will be restored to a pre-mine state, resulting in no unavoidable adverse impacts to the transportation network from renewing the permit.

E.1.18 Health and Safety

Health and safety at the Kayenta Mine operation is managed by establishing appropriate policies and procedures and monitoring those procedures to verify that they are properly observed and executed. Kayenta mine operations safety and health standards include requirements for ground support systems, coal piles, electrical systems, combustible fluid storage, shops, equipment specifications and maintenance, explosives storage and handling, dust control, monitoring and reporting requirements, alarm systems, worker personal safety equipment, and restrictions for public access. To comply with MSHA standards, all proposed mining operations during the permit renewal period will require the necessary MSHA mine permit and an MSHA-approved miner training plan, escape and evacuation plan. Since work carried out in the presence of heavy equipment and machinery inherently bears a degree of risk, it is acknowledged that air quality is also a health and safety consideration which is considered in terms of NAAQS under Air Quality Section E.1.7. NAAQS are determined based on the USEPA's assessment of health-protective air quality levels. In addition, transportation at and near the Kayenta mine site also poses risk for workers as well as the public. Along Navajo Route 41, PWCC assists with maintenance of the road surface and slopes and coordinates maintenance with the Navajo Nation Department of Transportation for repaving, seal coating the road or through their own roadway maintenance contract to maintain roadway shoulders and drainage. To ensure public safety along the mine roads, public traffic is excluded from active mine areas by security gates. All roads are signed and maintained by grading and dust suppression, and school buses and deliveries are escorted by PWCC security vehicles.

E.1.18.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, the current health and safety practices, described above, will continue as they do under existing mine operations. Regulatory changes in health and safety requirements will be included in standard operating procedures, and compliance with mandated safety rules will continue to be required.

Similar safety risks will continue to be present, including exposure to dust, noise, heat stress, and chemicals. The opportunity for accidents due to working directly with or in proximity to large equipment will also continue. Blasting operations will continue to occur, and pre-blast surveys will be conducted as requested. Residents will continue to be notified and warned of blasting operations, and notification of the blasting schedule will continue to be posted and advertised. Blasts will continue to be monitored for air blast and ground vibration by the five seismographs located throughout the Kayenta permit area. Kayenta Mine's blasting records will continue to be monitored by OSM on a monthly to quarterly basis. The mine will continue to provide emergency health care services to the workforce and local residents.

If the proposed project is authorized to proceed, neither the type or quantity of any wastes generated and disposed of by the mine would change. Impacts on public health and safety will be negligible and short-term and would not be considered significant.

E.1.18.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2 mining activities in the N-9, J-19, and J-21 mining areas will cease and public health and safety risks related to mining operations and blasting will be eliminated. During the reclamation period, PWCC will continue to comply with all applicable federal, tribal, and state rules and regulations regarding health and safety and handling and disposal of hazardous materials and wastes. Safety procedures regarding truck traffic will continue to be observed through the reclamation activities, although fewer vehicles will be required for these activities. Emergency health care services provided by the mine will continue during the reclamation period but will cease following the completion of reclamation activities (see Section E.13 Social and Economic for additional details). This could increase the response time by trained service providers to medical emergencies in the study area. Impacts resulting from cessation of mining activities on public health and safety in terms of job-related accidents would be minor and would not be considered significant. The loss of community health care services in the area could be moderate, long-term and could be considered significant if these services are not provided by another entity.

E.1.18.3 Unavoidable Adverse Impacts

Under Alternative 1, unavoidable adverse impacts may occur in the form of a serious accident or loss of life. However, if all safety policies and procedures are followed, the probability of this occurring is considered minor.

E.2 CUMULATIVE IMPACTS

The cumulative impact analysis is required to evaluate the incremental impacts of the proposed action when added to other past, present and reasonably foreseeable future actions (40 CFR 1508.7). Cumulative impacts could result from individually minor but collectively significant actions that take place over time. The following analysis identifies those resources where adverse effects from the alternatives identified in Section E.1 may combine with the effects of other past, present and reasonably foreseeable future actions, and assesses the incremental effect of the alternative compared to the combined effect on those resources.

According to the CEQ's *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis*, "[t]he environmental analysis required under NEPA is forward-looking, in that it focuses on the potential impacts of the proposed action that the agency is considering." With regard to past actions, agencies "look for present effects of past actions that are, in the judgment of the agency, relevant and useful because they have a significant cause-and-effect relationship with the direct and indirect effects of the proposal for agency action and its alternatives" (CEQ 2005).

Table E-9 describes each action that was considered for the cumulative analysis; however, not all actions have a combined effect on all resources. As explained above, the following cumulative impact analysis looks only at those resources for which adverse direct and indirect impacts from the alternatives described in Section C would overlap and combine with the effects of those past, present and reasonably foreseeable future actions identified on Table E-9. The future actions described in this analysis are those that are "reasonably foreseeable"; that is, they are ongoing (and would continue into the future), are funded for future implementation, or are included in firm near term plans. Current contracts could obligate PWCC to extract coal at Kayenta Mine from coal resource areas N-9, J-19, and J-21 through 2026 if future renewals are granted by OSM and contract terms are fully exercised. Beyond 2026, coal extraction rates and operational details regarding Kayenta Mine are speculative.

CEQ has further advised that "[t]here may be instances when the time frame of the project-specific analysis will need to be expanded to encompass cumulative effects occurring further into the future" (CEQ, *Considering Cumulative Effects Under the National Environmental Policy Act*, January 1997). For this proposed action, the temporal and geographic scope of cumulative analysis depends upon the affected resource and the extent to which there is a combined effect from the various actions. Consequently, the Cumulative Impacts Analysis Area (CIAA) and the duration of the combined effects are described below in relation to each relevant resource or group of resources. The analysis has included future renewals of the Kayenta mine permit as reasonably foreseeable future actions based upon the existing approved mine plan, to the extent that the effects of those future renewals would overlap or combine with the proposed alternatives. Impacts from continued operation of NGS are not a consequence of OSM's permit renewal action, and are addressed in cumulative effects only to the extent they overlap or combine with those of OSM's action. Nevertheless, any future renewal of the Kayenta mine permit would require additional review prior to approval by OSM.

The analysis has also looked at direct and indirect effects of the alternatives that could potentially combine with the effects from ongoing operations of the Navajo Generating Station (NGS). The Kayenta Mine supplies coal to NGS, located near Page, Arizona, via an 83-mile long railroad. NGS is located approximately 60 miles from the closest boundary of the three coal resource areas subject to the proposed action in Alternative 1. The term "Navajo Project" is used in this EA to encompass both NGS and the railroad. The electric power from NGS is used to serve residential, commercial and industrial customers in Arizona, Nevada and California, and provides most of the pumping energy for Central Arizona Project water deliveries to numerous cities, Indian tribes, and other water users in south-central Arizona. The Navajo Project is partially owned and operated by the Salt River Project Agricultural Improvement and

Power District (SRP).[9] The NGS obtains all water required for operation through an intake system connected to Lake Powell. Supplied from storage in Lake Powell, NGS water could include a portion of groundwater stored in the Navajo sandstone adjacent to the Lake Powell near the intake system. This water supply is isolated from the N Aquifer in Black Mesa by a groundwater divide that occurs between Black Mesa and Lake Powell.

The environmental effects from the continued operation of the Navajo Project, with the exception of air quality, climate change, and socioeconomic effects, do not overlap with the direct and indirect effects of the two alternatives described in Section C. Combined impacts for cultural resources, vegetation, soil, landforms and topography, geology and mineral resources, land use, and visual resources are not included because the Navajo Project operation does not result in surface disturbance that could directly or indirectly increase effects on these resources. In addition, as there are no cumulative impacts for these resources, there would be no cumulative impacts on the Indian Trust Assets related to these resources.

The CIAA for fish and wildlife does not include NGS because the Navajo Project operation does not result in surface disturbance that could directly or indirectly increase effects to fish and wildlife caused by the mining operations. However, a discussion is included in E.2.3 below regarding the potential effects of atmospheric deposition of metals on fish and wildlife populations.

Cumulative impacts for noise and vibration are not included because the distance between the Navajo Project and the Kayenta Mine operations would be attenuated by the approximately 50-mile distance between the noise and vibration sources from either location, thus the effects do not overlap. Likewise, the cumulative impacts on hydrology are not included in this analysis due to the source of water for the Navajo Project being isolated within the N aquifer by the groundwater divide that occurs between the Black Mesa and Lake Powell.

As discussed in Section E.1 no direct or indirect impacts on recreation, transportation, health and safety or environmental justice would be anticipated from the alternatives described in Section C. Thus, there would be no cumulative effects on these resources from continued operation of the Navajo Project and the alternatives.

The cumulative effects were assessed by considering those projects in the region that may have an effect on the natural or human environment within the CIAA for each resource. Table E-9 describes each project by name and project type, as well as by location and status. Collectively, these projects represent activities with the potential to contribute to a cumulative impact on the environment.

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[9] The owners of the Navajo Project are Arizona Public Service Company, City of Los Angeles Department of Water and Power, Nevada Power Company, SRP and Tucson Electric Power Company, and the U.S. Bureau of Reclamation.

Table E-9 Cumulative Project List

Type	Project	Status	Description
Power Plant	Navajo Generating Station (NGS)	Existing	Located about 5 miles east of Page, Arizona, NGS is a coal-fired power plant with a capacity of 2,250 megawatts from three 750-MW units. NGS provides power to more than one million electric customers in Arizona, California, and Nevada. It began producing commercial power in 1974. Coal mined at PWCC's Kayenta Mine operations (60 miles to the southeast) serve the power plant and is hauled by the Black Mesa and Lake Powell Railroad. The generating station currently employs 553 full- and part-time employees, almost 80 percent of whom are Navajo or Hopi, with a payroll for 2010 that exceeded $43 million. About 75 percent of the employees live in Page, Arizona, where NGS is located, and about 20 percent live in communities within the Navajo and Hopi reservations. The other 5 percent reside in Gallup, New Mexico; southern Utah; Flagstaff, Arizona; and the Phoenix, Arizona metropolitan area. NGS also employs hundreds of other Native Americans on a part-time basis doing maintenance activities. NGS provides a significant source of revenue to the Hopi Tribe and Navajo Nation through royalties, permit fees, lease payments, scholarships, and other contributions. Between 2005 and 2010 the average annual Environmental Protection Agency Title V Emission Permit fee was $367,208 and lease payments are $608,000 per year. NGS also has provided more than $83,000 in college scholarship funding over the last six years. NGS regularly provides financial support for various community efforts in the City of Page and surrounding Navajo community including the Technology Center at the Page campus of Coconino Community College, and the LeChee Chapter of the Navajo Nation for the LeChee Senior Citizen Center (URS personal communication 2011).
Water Supply Improvements	Manymules	Future	Using two PWCC existing water wells and a portion of a PWCC water line the Manymules project when completed would convey a high-quality sustainable water supply to residences within the Kayenta Mine permit area and enable the use of funds from Indian Health Service and other entities. The project includes 46 miles of water pipeline, two water treatment units, pump stations, and water storage. The total 2030 water demand projected for the Manymules project is about 252 acre feet per year. Based on conceptual level designs, the Navajo Nation Department of Water Resources estimates the project cost is approximately $10.6 million dollars. PWCC has committed to providing power and water for the project.

Type	Project	Status	Description
Groundwater Use	Community Well Fields	Future	The BIA, Navajo Tribal Utility Authority (NTUA), and Hopi Tribe operate about 70 N aquifer wells that are combined into 28 water supply systems that provide water to communities near Black Mesa. The closest communities to the PWCC wells are Forest Lake, Kitsillie, Chilchinbito, and Kayenta. The largest water users are Tuba City, Kayenta, and Shonto (Truini, Macy and Porter2005). Projected community pumping rate-based data through 1986 found that community pumping would increase at a rate of 2.7 percent annually on average (GeoTrans. 2006). Recent data show that the rate of growth in the area has decreased over the last 10 to 15 years and reported community pumping was approximately 2,900 af/y for 2008 (Macy 2010). In 2009, the reported community pumping was slightly lower (Macy, written communication).
Mineral and Energy Development	Coal Resource Development	Future	Successive permit renewal in not more than five-year increments as established by the SMCRA regulations, for coal production from the N-9, J-19, and J-21 coal resource areas would continue if future applications are approved after review by OSM. Mining in these three coal resource areas would continue through 2026 to meet PWCC contractual agreements. Cumulative surface disturbance and reclamation in these areas would result in approximately 3,079acres of land disturbed and subsequently reclaimed to sustain current production from coal resource areas N-9, J-19, and J-21. During the permit renewal period 1,159 acres would be disturbed, and between 2015 and 2026 an additional 1,920 acres would be disturbed. All areas disturbed by the mining operations will be reclaimed in accordance with permit requirements to meet post mining land uses of livestock grazing, wildlife habitat, and cultural plant use.

Resources where no cumulative impacts are anticipated are not included in this section. Those resources without cumulative impacts are cultural, recreation, environmental justice, transportation, and health and safety.

E.2.1 Hydrology

The cumulative hydrology analysis area, or CIAA for surface- and groundwater, is the Black Mesa basin area of the N aquifer extending to the gauges on measured streams and other tributary streams and springs located in the unconfined portions of the aquifer. The cumulative actions included in this analysis are reclamation activities, future coal mining through 2026 in the N-9, J-19, and J-21, the proposed Manymules community water supply project, and community well fields (see Table E-9).

E.2.1.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Future changes in the N aquifer groundwater system would be caused by past and future usage of water by PWCC and tribal communities. Thus, the modeling in Appendix B included an evaluation of the cumulative effects of PWCC and community pumping through 2015 and through 2026.

The effects of community pumping on drawdown within the confined portion of the N aquifer can be evaluated by comparison of the two drawdown figures provided for both 2015 and 2026 (Appendix B, Figures B-8, and B-9, respectively). The figures show simulated water level recoveries of between 20 and 30 feet through 2015, and more than 30 feet through 2026 as a result of combined pumping by both PWCC and nearby communities near the center of the basin (i.e., Forest Lake, the nearest community to the Kayenta Mine permit area). The simulated water levels are relative to July 2010 water levels and largely reflect reduced PWCC pumping since 2005.

Communities produce more water from the confined part of the aquifer than the unconfined part of the aquifer, and the estimated effects of their pumping are summarized in Appendix B, Table B-4. At these locations, estimated drawdown due to PWCC pumping is minimal. For example, the modeling predicts 2 feet of drawdown at Kykotsmovi in 2015, and only 3 feet in 2026 attributable to PWCC pumping. Comparatively, community pumping at Kykotsmovi is predicted to cause drawdowns of 23 feet in 2015 and 53 feet in 2025. In general, the combined drawdown is expected to increase through 2026 because of the community well field pumping (see Appendix B, Figures B-8, and B-9), but is not expected to be large enough to affect use of the aquifer. The drawdown caused by PWCC is only a small part of the total drawdown and the incremental effects caused by future mining through 2026 would decrease and would not be considered significant (see Appendix B, Table B-3 and Table B-4).

The combined pumping of PWCC's and community well field pumping does not result in noticeable movement of the boundary between the confined and unconfined portions of the N aquifer except near the community of Kayenta. There, where the N aquifer is hundreds of feet thick, the boundary may shift several feet. This shift would not impact the productivity of the community wells resulting from the combined pumping (see Appendix B, Tables B-3 and B-4, and Figures B-8 and B-9).

The GeoTrans model is not designed to simulate discharge from individual springs because of the difficulty of accurately simulating these features and limited drawdown in unconfined areas caused by distant pumping (PWCC 2005b). However, cumulative impacts on groundwater discharge into streams were evaluated (Tables B-6 and B-7). Local community pumping is predicted to cause declines in discharge to the streams by up to 2.24 percent by 2025. This decline is predicted at Laguna Creek located north and northeast of the Kayenta Mine. The model predicts a very slight increase in discharge of 0.03 percent as a result of PWCC's reduced pumping since 2005, for a cumulative decline of 2.21 percent. The largest predicted decline in discharge occurs at Pasture Canyon, but PWCC's pumping has no effect on this discharge because the decline at Pasture Canyon is due solely to community well field pumping (see Appendix B, Table B-7).

The Navajo Nation's proposed Manymules Water Supply Project contemplates using N aquifer water provided by PWCC to supply water to local residents within and near the Kayenta Mine leasehold. If started in 2012, the project would initially utilize 154 af/yr then increase to a maximum of 322 af/yr as early as 2026. Consequently pumping from the PWCC well field could increase from 1,236 af/yr to 1,390 af/yr the first year that Manymules started production. Pumping from the PWCC well field for future coal mining and reclamation and the Manymules project would increase to approximately 1,461 af/yr in 2026.

Modeling results provided in GeoTrans (2006) for the Alternate Water Supply/N-aquifer backup (AWS/N-Aq Backup) pumping scenario provide an upper bound for evaluating the effects of the proposed Manymules project. This analysis evaluated the potential effects on the N aquifer and included 1,236 af/yr for the period 2006 through 2009 followed by 2,500 af/yr for the period 2010 through 2026. For the period 2010 through 2026, the analysis evaluates a total volume pumped that is approximately 40 percent higher than the proposed water use by PWCC combined with the proposed Manymules project pumping, producing a conservative cumulative assessment for predicted future use. Actual effects on the N aquifer could be less since recovery of the N aquifer water levels that has been occurring since December 2005.

Based on this conservative cumulative analysis approach, there would be continuing water level recovery at Forest Lake between 2005 and 2026 with no adverse effect on the productivity of the N aquifer. In addition, the effect on discharge to Begashibito Wash (where the highest percentage effect due to PWCC well field pumping was calculated) was predicted to be a 1.02 percent reduction through 2026. The predicted reductions in discharge through 2026 at Begashibito Wash and at all other washes based on cumulative pumping in the AWS/N-Aq Backup modeling scenario are too small for the gauging stations to measure and are considered to be negligible.

Potential effects on the sulfate concentration in the N aquifer, a prime indicator of water quality changes, due to increased leakage through the Carmel confining bed, was predicted to be less than 0.5 mg/L for the time period 1955 through 2038 (see Section C.1.6, Appendix B). This regional, long-term effect on water quality is negligible. The incremental cumulative effect of mining through 2026 is not considered to be significant on groundwater or surface water.

E.2.1.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2, withdrawals from the N aquifer would be reduced from an average rate of 1,236 af/yr to about 500 af/yr to support reclamation activities. After reclamation activities are completed, which includes regrading, spreading topsoil, revegetating disturbed areas, and completing required monitoring, PWCC would cease withdrawals from the N aquifer for industrial uses. During this reclamation period, the Manymules Water Supply Project would continue to pump about 154 af/yr from the N aquifer. By 2026, pumping to support the Manymules project would approach 225 af/yr from the N aquifer near the PWCC well field, which is well below the projected rates evaluated under Alternative 1 where the effects were deemed negligible (GeoTrans 2006). The reduced pumping from the N aquifer under this alternative would be less and would not be considered significant.

E.2.2 Vegetation

The CIAA for vegetation are the communities that overlay the Black Mesa coal field (see Map A-1). This area is described in Section D.2.3 in Table D-5 and is approximately 1.8 million acres. Cumulative projects included in the analysis with the permit renewal period are the future coal mining activities and Manymules (see Table E-9).

E.2.2.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Coal mining during the permit renewal period, and Manymules would result in surface disturbance that convert existing vegetation communities to a reclaimed vegetation community and increase the potential for establishment of noxious weeds and invasive species in the CIAA. Reclamation to restore slopes, spread topsoil, and revegetate 1,159 acres (see Table C-1, total acres disturbed) would continue while additional coal mining in the future mine areas of N-9, J-19, and J-21 continues. The ongoing reclamation activities would restore areas to reclaimed vegetation community of an all-purpose rangeland composed of similar species to existing grassland-shrublands. Increasing the extent of reclaimed vegetation in the CIAA by 3,079 acres (see Table C-1 total acres to be mined and reclaimed in the future) during the permit renewal period and future coal mining activities would increase the amount of this vegetation community within the CIAA to approximately 20,548 acres (see Table D-5). This incremental effect of converting 1,159 acres (see Table E-9) of existing vegetation communities increases the reclaimed vegetation community by approximately 5 percent (see Table D-5). This increase in reclaimed vegetation communities would not be considered significant as the vegetation in reclaimed areas would transition to a stable state and includes native species that could provide a seed source for other areas (Peters et al. 2006).

Vehicles used during the permit renewal period mining, reclamation, and surface disturbance from future coal mining and Manymules could facilitate the establishment of noxious weeds. Weed control measures and monitoring vegetation twice per year in areas reclaimed by PWCC would reduce the potential for noxious weeds and invasive species establishment. The incremental cumulative effects from the permit renewal period mining would not be considered significant because there would be no change in the composition of the vegetation communities from noxious weeds or invasive species.

While emissions vary depending on the amount of equipment operating, during 2012 11.44 micrograms (Appendix D, Table D-10) would be the greatest amount of NO_x emissions during the permit period (see Appendix D, Figures D-10 through D-12). The estimated NO_2 deposition includes a conversion factor based on the Plume Volume Molar Ratio Method (PVMRM) option in the AERMOD dispersion model and while NO_2 could represent a smaller portion of the total nitrogen emissions these values are below the levels where changes in vegetation communities are detected. Future coal mining and reclamation of areas mined during the permit renewal period would result in NO_x emission into the local environment south of the mined coal resource areas, and could affect plant communities at a local level and on a species-specific basis. Nitrogen emissions from reclamation activities for the permit renewal period and future mining in N-9, J-19, and J-21 would occur from 2010 through 2018 and as discussed in Appendix D, Table D-10, the greatest amount of emissions would be 11.44 micrograms per cubic meter from mining activities. Deposition of nitrogen at this rate is far below the 1.5 to 30 kilograms per hectare per year, which according to studies by the National Park Service (NPS), resulted in changes to vegetation community composition (Fenn et al. 2003, National Park Service [NPS] 2009). The incremental cumulative effects of nitrogen emissions from the permit renewal period would not be considered significant.

E.2.2.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Not renewing the permit under Alternative 2, would decrease the extent of surface disturbance and the potential opportunities for noxious weed and invasive species establishment. However, as reclamation activities will continue in all areas disturbed by previous mine operation, this along with the construction of Manymules could increase the number of vehicles and the potential for seed dispersal. This could increase the potential for the localized establishment of noxious weeds or invasive species. However similar to Alternative 1, weed control measures and monitoring vegetation twice per year in areas reclaimed by PWCC would reduce the potential for noxious weeds and invasive species establishment in part of the CIAA.

While reclamation would occur in all of the disturbed areas (see Map D-5) after mining ceased, due to the relatively slow growth rate of vegetation, the effects on vegetation communities would be similar to Alternative 1 (Jacobs 2008). Reclamation would restore 8,013 acres (see Table C-1, total acres active mining and reclamation) of existing disturbed areas to a reclaimed grassland-shrublands vegetation community within the CIAA. This increase results in approximately 5 percent increase of reclaimed (disturbed) vegetation community within the CIAA from post-mining reclamation.

Nitrogen emissions would be from mine reclamation vehicles and Manymules if that project were implemented, which could affect vegetation in localized areas near N-9, J-19, and J-21. However, the nitrogen depositions from reclamation activities and vehicles used during construction for Manymules would be far less than the 9.34 micrograms per cubic meter for Year 2010 (see Appendix D) under Alternative 1. The incremental cumulative effects from reclamation would not be considered significant because there would be no change in vegetation community composition.

E.2.3 Fish and Wildlife

The CIAA for fish and wildlife includes the area that overlies the Black Mesa coal field (see Map A-1). This area is described in Section D.2.3 in Table D-5 and is approximately 1.8 million acres. Cumulative projects included in the analysis with the permit renewal period are the future coal mining activities and Manymules (see Table E-9).

E.2.3.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Surface disturbance in areas mined during the permit renewal period, future coal mining, and Manymules could degrade or remove wildlife habitat in the CIAA. Mine permit renewal under Alternative 1 could increase the extent of degraded or lost wildlife habitat, and increase barriers to wildlife movement in the CIAA. However, reclamation activities to replant these areas with grassland/shrubland species overall and cultural plantings in select areas will reduce these short-term effects, such that these constitute minor impacts that will not eliminate any of the currently documented species from the region. Minor effects on wildlife would not be considered significant.

The 9.34 micrograms per cubic meter nitrogen emissions (Appendix D, Table D-10) from reclamation activities for the permit renewal period and future mining activities would be deposited south of N-9, J-19, and J-21 coal resource areas (see Appendix D, Figures D-10 through D-12). Nitrogen deposition could potentially lead to habitat degradation in localized areas south of the three coal resource areas, however, the minimal amounts of nitrogen released from the proposed action would not be expected to change the vegetation community composition (Fenn et al. 2003, NPS 2009), which would represent a negligible impact. Negligible impacts would not be considered significant.

Under Alternative 1, reclamation areas disturbed from permit renewal period mining, future coal mining in N-9, J-19, and J-21 coal resource areas, and vehicles used for the Manymules water development project would remove or degrade wildlife habitat in the CIAA. Wildlife species such as collard lizards and sagebrush lizards are some of the more common wildlife species that would be displaced by the loss of woodland and shrubland vegetation or complex, rocky habitats in areas disturbed by these actions. Cumulative impacts would be moderate, depending on the degree to which the habitats are modified by these actions; however, reclamation would reduce these effects to a minor level. Incremental cumulative impacts on wildlife habitats from the permit renewal period would not be significant because the 1,159 acres of disturbance affects approximately 0.1 percent of the approximately 1.6 million acres of these wildlife habitats within the CIAA. The small loss of wildlife habitats relative to the larger CIAA would be a minor impact. The cumulative impacts to wildlife range from minor to moderate. Minor to moderate impacts would not be considered significant.

With regard to atmospheric deposition of metals, ENVIRON conducted an analysis of the emissions, environmental transport, transformation, and aquatic impacts of mercury and selenium emissions from the NGS facility (see Appendix E). ENVIRON summarized the risk to the aquatic and sediment dwelling invertebrate community, fish populations and fish/aquatic invertebrate eating birds and mammals from NGS emissions of mercury and selenium as follows:

- Modeled Se, Hg and MeHg concentrations in sediment are below ecological screening levels.
- Modeled Se, Hg and MeHg concentrations in surface water are below ecological screening with the exception of Se(VI) in Lake Segment 4 where concentrations slightly exceeded only the most conservative screening benchmark.
- All calculated critical body residues resulted in HQs well below one suggesting *de minimis* risk to aquatic receptors including fish and piscivorous birds and mammals.

To correspond with the ENVIRON analysis, PWCC performed atmospheric model runs for TSP emissions from Mine operations handling coal and for TSP emissions from Mine operations handling overburden (see Exhibit D). As shown in Table D-11, modeling of trace concentrations of metals found in the overburden and coal at the Kayenta Complex are shown to be on the order of a few nanograms per square meter per year for selenium and roughly one hundred times less for particulate-phase mercury. In contrast even to the miniscule metals emissions from the NGS facility, the deposition rates of mercury and selenium from the Kayenta Mine are at least two (2) orders of magnitude lower than those attributable to NGS. Therefore, the cumulative effects of mercury and selenium deposition are still below ecological screening levels and do not pose a significant risk to aquatic receptors in the region. With metal depositions being below levels that could harm wildlife or reduce population sizes, the impacts to wildlife would be minor. Minor effects would be considered insignificant.

E.2.3.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Under Alternative 2, the permit would not be renewed and therefore Kayenta Mine operations would cease after final reclamation is complete. The impacts leading to loss of habitat forage and dispersal barriers to wildlife would be reduced in the CIAA. Similar to Alternative 1, reclamation activities in the 8,013 acres of existing disturbance (see Table C-1 total acres active mining and reclamation) would reduce these effects on wildlife habitat. Under this scenario impacts would be negligible or minor, which would be a smaller impact than Alternative 1. Negligible and minor impacts would not be considered significant.

E.2.4 Soil Resources

The CIAA for soil resources are the soils within the approximately 1.8 million acre Black Mesa coal field (see Table D-5 and Map A-1). Cumulative projects included in the analysis with the permit renewal period mining are the future coal mining activities and Manymules (see Table E-9).

E.2.4.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Coal mining during the permit renewal period, future coal mining, and Manymules water improvement project would disturb soils and alter the existing soil profiles in the CIAA. Soils removed from N-9, J-19, and J-21 during the permit renewal period and future coal mining in these areas would be either directly replaced on the regraded slopes or stockpiled for use during reclamation activities. These stockpiles could result in wind and water erosion in localized areas; however, PWCC reclamation activities of diverting runoff away from stockpiles, placing stockpiled soil on a stable site protected from wind and water erosion, replanting the stockpiles with a stabilizing seed mix and not disturbing them until required for redistribution reduces the potential for soil loss. Soils disturbed by the Manymules project would be temporary in nature, but at this time, it is unknown if stockpiles would be used during construction.

Mined areas are reclaimed using soils replaced directly or stockpiled soils and other mitigation measures such as recontouring slopes including drainages and reestablishing vegetation. Reclamation of the renewal permit areas would improve soil productivity and stability on 4,222 acres (See Table C-1, total acres reclaimed) of the soils within the CIAA. Therefore, the incremental effects of the renewal period mining and reclamation on soil loss and productivity when combined with the other cumulative projects would not be considered significant.

E.2.4.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Ceasing mining in the permit renewal period in N-9, J-19, and J-21 would reduce the amount of soil disturbed within the CIAA. This would result in 1,159 fewer acres (See Table C-1, total acres disturbed) of soil disturbed compared to 2010 conditions, and would reduce the areas where topsoil would be replaced to meet the 9-12 inch depth during reclamation and reduce the total acres of reclaimed vegetation within the CIAA.

Impacts from reclamation would be similar to Alternative 1, however reclamation in the disturbed areas of N-9, J-19, and J-21 would begin as mining in the permit renewal areas would cease. This would result in 1,159 fewer acres of reclaimed areas within the CIAA, decreasing soil productivity compared to Alternative 1. The cumulative effects of ceasing mining in the permit renewal period areas on soil loss and productivity would not be considered significant.

E.2.5 Air Quality

Cumulative, regional impacts on air quality are quite limited from all surface coal mining operations for two fundamental reasons. First, the only pollutant emitted in substantial quantities is particulate matter. Second, concentrations of airborne particulate matter released from surface mining operations decrease rapidly with distance from mines because they are released at near-or-below surface levels. Because concentrations decrease rapidly with distance, mining-related emissions are not likely to interact significantly with distant, regional sources, regardless of the magnitude of those sources.

As shown in Tables E-5 through E-7 in Section E.1.7.1, existing concentrations of criteria pollutants as measured in the region remain well below applicable National Ambient Air Quality Standards (NAAQS). Thus, emissions from low level releases from mining operations will not significantly impact any existing non-attainment area nor interact significantly with other sources, including NGS.

With regard to atmospheric deposition of metals, ENVIRON conducted an analysis of the emissions, environmental transport, transformation, and aquatic impacts of mercury and selenium emissions from the NGS (see Appendix E). To correspond with the ENVIRON analysis, PWCC provided analytical data describing typical concentrations of mercury (Hg) and selenium (Se) in the coal and in the overburden at Kayenta Mine, and AERMOD model runs were performed separately for TSP emissions from Mine operations handling coal and for TSP emissions from Mine operations handling overburden (see Exhibit D).

As shown in Table D-11, modeling of trace concentrations of metals found in the overburden and coal at the Kayenta Complex were modeled upon seven (7) distant drainage areas representing seven (7) different sections of Lake Powell and the Colorado River. Those deposition rates are shown to be on the order of a few nanograms per square meter per year for selenium and roughly one hundred times less for particulate-phase mercury.

As discussed in Section E.2.3 and in Appendix E in more detail, the risk to ecosystems from mercury and selenium deposition from the NGS facility is well below ecological screening levels. As shown in Table D-11, the deposition rates of mercury and selenium from the Kayenta Mine based on conservative modeling predictions are at least two (2) orders of magnitude lower than those attributable to the NGS facility. Therefore, the proposed action's incremental effect on mercury and selenium deposition is negligible and the cumulative effects are still below ecological screening levels and do not pose a significant risk to aquatic receptors in the region.

E.2.6 Noise

The CIAA for noise is a 3-mile buffer from the boundary of coal resource areas N-9, J-19, and J-21 (see Section D.2.8). Cumulative actions included in the analysis include mining during the permit renewal period, reclamation, future coal mining, and the Manymules water supply project (see Table E-9).

E.2.6.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Noise from the future coal mining in N-9, J-19, and J-21 and the reclamation activities for the permit renewal period mining is not expected to increase over 2010 levels. If construction of the Manymules water supply project occurs during this same time and construction occurred near N-9, J-19, or J-21, there could be an increase in noise to sensitive receptors. However, at this time, the Manymules water supply project has not identified specific construction areas. Future coal mining activities and permit renewal period reclamation are expected to remain at current levels and noise is not expected to increase, as there are no changes to the mining operation. The incremental effect of potential noise sources from the cumulative actions when added to the permit renewal period mining and associated reclamation activities would not be considered significant.

E.2.6.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Ceasing mining in N-9, J-19, and J-21 would eliminate the noise from mining equipment; however, reclamation activities, as well as the Manymules water supply project, would continue. Permit renewal period reclamation would use heavy equipment to regrade mined areas, spread topsoil, and revegetate the area for approximately three years. Noise levels would decrease after reclamation activities in N-9, J-19, J-21, N-06, N-10, N-11 Extension, and J-16 (see Table D-7) cease using heavy equipment. Similar to Alternative 1, construction for the Manymules project could occur in areas near reclamation activities and increase noise to sensitive receptors. However, at this time, the Manymules water supply project has not identified specific construction areas. The incremental effect from permit renewal period reclamation activities would not be considered significant.

E.2.7 Landforms and Topography

The CIAA for landforms and topography is defined as Black Mesa physiographic feature (see Map A-1). The cumulative actions include mining during the permit renewal period, reclamation, and future coal mining (Table E-9).

E.2.7.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Surface disturbance from permit renewal period coal mining, future coal mining and Manymules would alter existing landforms and topography. Although reclamation activities would restore the landscape and topography to approximate original contours, land surfaces would typically be flatter, with more uniform slopes. Reclamation of the 1,159 acres (see Table C-1) of landforms and topography disturbed during the permit renewal period would increase the area within the CIAA with flatter and more uniform slopes. Future coal mining in N-9, J-19, and J-21 would increase this area by about 30 percent. These cumulative impacts from the permit renewal period mining on landforms and topography would not be considered significant.

E.2.7.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Impacts would be similar to those described under Alternative 1; however, the disturbance of landforms and topography would be less. Reclamation activities would restore areas disturbed from mining activities increasing the area within the CIAA with flatter and more uniform slopes. These impacts on landforms and topography would not be considered significant.

E.2.8 Geology and Mineral Resources

The CIAA for geology and paleontological resources (fossils) is the Black Mesa coal field (see Map A-1). Cumulative actions that are included in this analysis include mining during the permit renewal period and future coal mining.

E.2.8.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Removing the overburden from the permit renewal period areas and future coal mining alters the existing orientation of the geology, removing coal resources and fossils in the process. The removal of overburden from N-9, J-19, and J-21 would reduce the existing geologic orientation from 4,222 acres (see Table C-1 total acres reclaimed) of the approximately 1.8 million-acre Black Mesa coal field. Disturbing less than 1 percent of the geologic orientation within the CIAA would not be considered significant. When combined with future mining operations, PWCC could potentially remove an additional 131.2 million tons of coal by 2026, about 6.5 percent of the estimated 2 billion tons that are considered suitable for mining (see Map A-1) (Nations, Swift, and Haven 2009). Incremental effects from the permit renewal period of removing approximately 41 million tons of the estimated coal resources available in the CIAA would not be considered significant.

The removal of overburden during the permit renewal period and future coal mining could remove fossils from 4,222 acres (see Table C-1 total acres reclaimed), within the 1.8 million acres of the CIAA. Conversely, mining activities during the permit renewal period and future coal mining could expose areas that contain fossils, which otherwise would have been undetected. If paleontological resources were discovered during the permit period mining or future coal mining, the appropriate land-managing agency would be notified so that the discovery would be addressed in accordance with any applicable regulations. The incremental effects from the 1,159 (See Table C-1, total acres disturbed) acres disturbed during the permit renewal period mining on paleontological resources would not be considered significant.

E.2.8.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Ceasing mining would reduce disturbance to the existing orientation of the geology and retain coal resources within the CIAA. In addition, this would retain the existing fossils in these areas, but could reduce the possibility of discovering new fossils, as no additional fossil bearing areas of the formations would be exposed. Ceasing the permit renewal period areas and not removing 41 million tons of coal from the estimated 2 billion tons of coal resources from the Black Mesa coal field would not be considered significant.

E.2.9 Climate

As explained in Section D.2.11.1, attempts to disaggregate global climate models in order to predict the future of local or regional weather patterns is highly uncertain and speculative, particularly as it might apply to the five-year proposed renewal. Moreover, scientific uncertainty remains as to human contribution to global climate change. Virtually all scientific sources agree, however, that it is not possible to attribute complex global climate change reactions within the environment to a particular source of GHG emissions.

As previously documented, the International Energy Agency estimated global emissions of CO_2 to be 29,000,000,000 metric tons in 2008. Current GHG emissions from all of Kayenta Mine's stationary and mobile facilities and activities are approximately 163,000 metric tons per year CO_2e.

Annual CO_2, CH_4 and N_2O emissions from NGS in 2009 were 17,175,167 metric tons, 209 metric tons and 258 metric tons, respectively, which total approximately 17,259,639 metric tons of CO_2e.[10] There would be no additional increase in NGS greenhouse gas emissions as a result of renewal of the Kayenta Mine permit. However, continued combustion of coal at NGS will result in a relatively small continued contribution to the global cumulative greenhouse gas emissions described in the previous paragraph. Regardless of the continued operation of NGS, projections anticipate an increased amount of fossil fuel-fired electricity generation, including coal-fired generation in the United States and around the world over the next several decades (IEA 2010).

E.2.9.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

The proposed action would continue the current operation of the Kayenta Mine. The annual level of coal mining would not change, nor would any additional mining equipment with its associated emissions be added during the Mine's operations under this alternative. As previously demonstrated, because the nature and the level of activity at the Kayenta Mine would not change, there will be no significant emissions increase of annual emissions of GHGs or of any other air pollutant during the Mine's operation caused by the proposed action.

The geographic scope and predicted air pollutant emissions of Alternative 1 are too small to allow calculation of any measurable change on global climate given any scenario about whether and how climate might be changing. Although some scientists have postulated potential effects of global climate as

[10] These values were reported to The Climate Registry, where SRP voluntarily reports its GHG emissions. These values were 3rd party verified by Ryerson, Master and Associates, Inc. as required by The Climate Registry.

including alteration of water supplies, agriculture, sea levels, ultraviolet radiation levels, and variances in the ecosystem, neither Alternative 1 nor Alternative 2 would alter these effects. The incremental contribution of greenhouse gases from Alternative 1 would be negligible when compared to total greenhouse gases produced globally. A negligible effect would not be considered significant.

E.2.9.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, all operations at Kayenta Mine would eventually cease. Although a relatively small amount of GHGs continue to be emitted from a closed mine, GHG emissions from the existing permitted area at Kayenta Mine under Alternative 2 would only be a small fraction of the Mine's current estimated emissions. However, an analytical methodology that links changes in climate to reductions in GHG emissions from a specific source does not currently exist. Thus, it is highly unlikely that the GHG emission reductions from Alternative 2 would be sufficient to cause any direct effect on climate change under any scenario about whether and how climate might be changing, especially given the contribution of Kayenta Mine GHG emissions compared to global GHG emissions. Under this alternative, the reduced GHG contributions and the impacts on climate change would remain negligible and would not be considered significant.

E.2.10 Land Use

The CIAA for land use was defined as the boundaries of the Hopi Reservation and Chilchinbeto, Forest Lake, Kayenta, and Shonto Chapters within the Navajo Nation. Cumulative actions included in the analysis are the permit renewal period mining, reclamation, future coal mining, and the Manymules water supply project (see Table E-9).

E.2.10.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Approximately 952 acres of piñon-juniper woodland with low forage availability and quality will be disturbed by mining in the N-9, J-19, and J-21 coal resource areas during the permit period, and up to 11,091 acres (see Table C-1 total acres) of existing vegetation communities will be disturbed by future coal mining. Reclamation activities of regrading, spreading topsoil, and revegetating disturbed areas will increase forage productivity and quality for livestock use by converting the piñon-juniper woodlands to more productive shrubland and grassland vegetation communities. After completing reclamation, reclaimed areas will meet post-mining land uses for livestock grazing, wildlife habitat, and cultural plant use. Reclaiming areas disturbed by coal mining will increase the amount of forage and the quality of forage available for livestock grazing in local areas. The cumulative impacts from mining during the permit renewal period and future coal mining on livestock grazing will not be considered significant because the total reclaimed area is less than 1 percent of the CIAA.

The Manymules will provide a reliable water supply to areas within the CIAA, including the four relocated Navajo Nation households from the J-21 coal resource area during the permit renewal period mining. Manymules may provide piped water to relocated households that currently rely on water hauled in from outside sources and the two water stands within the PWCC lease. Indirectly this could improve residents' quality of life, help maintain family garden plots, and livestock grazing land uses. At the time of this EA, it is not known which individual households within Kayenta Mine will be connected to a permanent water supply by the Manymules project. However, the four households relocated during the permit renewal period may be provided a permanent water supply from the Manymules project in their new location. Impacts on land use associated with relocations from the permit renewal period mining would not be considered significant.

E.2.10.2 Alternative 2: Disapprove the Renewal of Permit AZ0001 D [No Action]

Ceasing coal mining will result in approximately 952 fewer acres of piñon-juniper woodlands converted to the more productive shrubland and grassland vegetation communities. Reducing the approximately 20,000 acres of reclaimed vegetation community within the Kayenta Mine permit area by 952 acres with the original livestock carrying capacity results in approximately 4 percent less grassland-shrubland vegetation community with improved livestock carrying capacity compared to Alternative 1. The cumulative impacts to livestock grazing would not be considered significant.

Under Alternative 2, cumulative impacts would be similar to Alternative 1 except that the four households in coal resource area J-21 would not be relocated. These four relocated households could have a permanent water supply from the Manymules water supply development project. Although the Manymules project is reasonably foreseeable to occur, at the time of this EA remains uncertain whether or not the subject households will obtain water from this project.

E.2.11 Social and Economic Conditions

The cumulative impact analysis areas studied are the Navajo Nation and Hopi Reservation boundaries. Cumulative actions included in the analysis are the permit renewal period mining, future coal mining in N-9, J-19, and J-21 and NGS (Table E-9). Table E-10 lists the cities and places within the Navajo Nation and Hopi Reservation where Kayenta Mine and NGS employ more than 10 percent of the total population employed.

Table E-10 Arizona City or Place where Kayenta Mine and NGS Employ 10 Percent of the Total Population Employed

City / Place	Population Employed (2000)	Number/Percentage of Employees Residing in Each Place				2010 Total	Total (%)
		Kayenta Mine (2010 total)	Kayenta Mine (%)	NGS (2010 total)	NGS (%)		
Kaibito	350	11	3%	36	10%	47	13%
Kayenta	1,273	229	18%	8	1%	237	19%
Page	3,396	17	1%	414	12%	431	13%
Shonto	206	19	9%	12	6%	31	15%
Tonalea	132	31	23%	13	10%	44	33%

SOURCE: U.S. Census Bureau 2000 (SF3, QT-P24), URS personal communication December 2010

E.2.11.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Under Alternative 1, the permit renewal period mining, future coal mining, and NGS will result in revenues to tribes and employment opportunities. This may help maintain employment levels within the CIAA during the permit renewal period and through 2026 from future coal mining.

During the permit renewal period and future coal mining in N-9, J-19, and J-21 through 2026, the number of employees at the Kayenta Mine will remain at current levels. The total annual amount paid in salaries during the permit renewal period, future coal mining, and NGS will be approximately $93 million with 985 employees (Table E-9). Employment opportunities and revenues paid to tribes will be similar to the 2010 values as current coal production rates are expected to be 8.2 million tons of coal per year. Kayenta Mine is the sole source of coal for NGS, and continued coal resource mining will result in continued operations at NGS and will maintain the employment rate and salaries paid to the workers in the communities listed in Table E-10. As employment and revenues paid to the tribes will remain near 2010 levels, the incremental effect of the permit renewal period mining will not be considered significant.

E.2.11.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, the Kayenta Mine operations will cease, reducing employment opportunities within the CIAA and revenues paid to tribes. Ceasing operations at Kayenta Mine would reduce employment in towns where Kayenta Mine and NGS employees reside. As shown in Table E-10 there are five cities and towns where 10 percent or more of the total population are employed by either the Kayenta Mine or NGS. This could indirectly increase the unemployment in other communities within the CIAA and the loss of tribal revenues if other businesses close due to the loss of revenues from employees purchasing goods or services. The closure of Kayenta Mine operations could result in a long term moderate effect on socioeconomics that could be considered a significant impact.

E.2.12 Indian Trust Assets

The CIAA for Indian Trust Assets are the Navajo Nation and Hopi Tribe lands, water, and coal within Black Mesa. The cumulative projects included in the analysis are the permit renewal period mining, future coal mining, community well field pumping, and Manymules (Table E-9). The effects on land as an Indian Trust Assets are incorporated into Section E.2.10, and Section E.2.1 addresses water (hydrology). The potential cumulative effects on coal as an Indian Trust Assets are addressed in Section E.2.8, whereas the socioeconomic effects of coal revenues are addressed in Section E.2.11.

E.2.13 Visual Resources

The CIAA for visual resources is a 5-mile buffer from the boundary of the permit renewal areas and future coal mining in N-9, J-19, and J-21 coal resource areas (see Section D.2.16). Cumulative actions included in the analysis are the permit renewal period coal mining, future coal mining activity, reclamation, and the Manymules water development project (Table E-9).

E.2.13.1 Alternative 1: Approve the Renewal of Permit AZ-0001D

Four occupied structures in the J-21 mining area would require relocation (G. Wendt, PWCC personal communication). The relocated structures would be further from the permit renewal period reclamation activities or future coal mining and topography and vegetation could completely or partially screen views from the relocated structures.

Future coal mining in N-9, J-19, and J-19, permit renewal period reclamation, and if implemented construction of Manymules water pipelines and facilities could increase the area where vehicles and equipment are visible. Sensitive viewers, including the relocated households, on higher ground views would be partially or totally screened by the intervening topography and distant viewers would perceive less contrast. Views of the reclamation, future coal mining, and Manymules construction would be partially or completely screened. In addition, the view for travelers on Navajo Route 41, from U.S. 160 to Red Peak Valley Wash, would continue to be brief, as most of their view would be screened by topography and vegetation.

Long-term reclamation from the permit renewal period mining, and future coal mining, would increase visual resource contrast. However, as reclamation of the permit renewal period mining would occur at the same time as future coal mining, the contrast would be similar to the existing landscape conditions. The incremental cumulative effects on visual resources from the permit renewal period mining would not be considered significant.

E.2.13.2 Alternative 2: Disapprove the Renewal of Permit AZ-0001D [No Action]

Under Alternative 2, reclamation activities from the permit renewal period mining and the construction of Manymules water supply project could increase the area where construction vehicles are visible on the landscape. This effect on visual resources would persist during the first two years of reclamation, however, once regrading, spreading topsoil and replanting are completed in N-9, J-19, J-21, N-06, N-10, N-11 Extension, and J-16 (Table C-1) these effects on visual resources from reclamation would cease.

Similar to Alternative 1, reclaimed areas in N-9, J-19, and J-21 and Manymules facilities could increase the visual contrast for sensitive viewers. The reclaimed areas would result in less contrast as these areas would blend in with the approximately 20,000 acres of reclaimed lands within the Kayenta Mine permit area. However, the Manymules facilities such as pump houses and water treatment plants could increase contrasts with existing form, line, and color for some sensitive viewers. However, these views could be completely or partially screened by topography and vegetation. At this time, specific construction plans for the Manymules project are not known. The impacts on visual resources from reclaiming the permit renewal period mining would be not considered significant.

F. SUMMARY

F.1 BACKGROUND

The OSM has received an application from PWCC for the renewal of Permit AZ-0001D. This renewal application regards mining operations from 2010 through 2015 at the Kayenta Mine located in Navajo County, Arizona (Map A-1). This approval would authorize ongoing mining operations in coal resource areas N-9, J-19, and J-21 from July 6, 2010 through July 5, 2015.

Surface coal mining and reclamation activities are authorized in up to five-year periods to provide an opportunity for OSM to review the mine's compliance with applicable permit terms. Federal regulations in accordance with the Surface Mining Control and Reclamation Act (SMCRA) grant a right of successive renewal within the approved boundaries of an existing mining permit. Kayenta Mine operations are authorized under a permanent Indian Lands Program permit originally issued by OSM in 1990. The proposed permit renewal does not include any revisions to the mining and operations plan or the addition of any new mining areas. Coal-mining techniques and mine reclamation are described in more detail in Appendix A.

F.2 ALTERNATIVES

OSM considered two alternatives. Under Alternative 1, the OSM Western Region Director would approve the renewal permit AZ-0001D that would authorize continued mining in coal resource areas N-9, J-19, and J-21 of the Kayenta Mine permit area. Previously authorized existing mining facilities that would be used for the Kayenta Mine operations under this alternative include water supply wells, transportation facilities, office and equipment facilities, utilities, coal handling facilities, explosive storage facilities, environmental monitoring sites, water control facilities, and topsoil stockpiles. Appendix A provides details of mining operations, reclamation, and mitigation. Under Alternative 2, OSM would disapprove the permit application.

F.3 SUMMARY OF IMPACTS ASSESSED

This EA describes and evaluates the potential effects of the alternatives and Table F-1 briefly summarizes the effects of each of the alternatives including cumulative effects. Section E Environmental Impacts contains detailed information on the effects of the alternatives.

Table F-1 Environmental Consequences Summary

Impact Topic	Alternative 1 Approve the Renewal of Permit AZ-0001D	Alternative 2 Disapprove the Renewal of Permit AZ-0001D
Cultural Resources	Minor	Negligible
Hydrology	Negligible to Minor	Negligible
Vegetation	Minor	Negligible
Fish and Wildlife	Negligible to Minor	Negligible
Special Status Species (Federal and Navajo Nation listed species)	Negligible to Minor	Negligible to Minor
Soils	Minor	Minor
Recreation	Negligible to Minor	Negligible
Air Quality	Negligible	Negligible
Noise and Vibration	Negligible	Negligible
Landforms and Topography	Minor	Minor
Geology and Mineral Resources	Negligible to Minor	Negligible
Climate	Negligible	Negligible
Land Use	Negligible to Minor	Minor
Socioeconomic Conditions	Negligible	Major
Environmental Justice	Negligible	Minor
Indian Trust Assets	Negligible	Negligible
Visual Resources	Negligible to Minor	Negligible
Transportation	Negligible	Negligible
Human Health and Safety	Negligible	Negligible to Moderate

Impacts to federally listed species also have been analyzed in a supplemental biological assessment. This technical document was prepared as part of a Section 7 consultation with the USFWS. The findings were consistent with the conclusions reached for the same species in this EA.

G. PERSONS AND AGENCIES CONTACTED TO ASSIST IN THE PREPARATION OF THE ENVIRONMENTAL ASSESSMENT

Table G-1 Preparers

Name	Project Responsibility	Education
OSM Western Region		
Rick Williamson	Mine Team Leader/Permit Coordinator	MS, Botany/Rangeland Ecology BS, Wildlife/Plant Ecology
Amy McGregor	Soil Scientist	MS, Soil Chemistry BS, Agronomy/Environmental Science
Paul Clark	Hydrologist	MS, Hydrology BA, Geology
Foster Kirby	Archaeologist	MA, Archaeology BA, Archaeology BA, Anthropology
Rick Pruszka	Hydrologist	BS, Geography BS, Geology
Dawn Pacula	Natural Resources Specialist	BA, Biology
Marcelo Calle	Hydrologist	BA, Anthropology BS, Watershed Science
Mychal Yellowman	Civil Engineer	BS, Civil Engineering, P.E.
Karen Jass	Mining Engineer	BS, Mine Engineering
Alex Birchfield	Ecologist	MS, Restoration Ecology BS, Zoology
Office of Environmental Policy and Compliance		
Robert F. Stewart	Regional Environmental Officer	MA, History BA, History
Peabody Western Coal Company		
Brian P. Dunfee	Project Oversight	MS, Range Ecology BS, Wildlife Biology
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URS		
Cary Roberts	Technical Review, QA/QC	MS, Environmental Management BS, Ecology and Evolutionary Biology
David Konopka	Visual Resources	BS, Natural Resources and Landscape Architecture
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Patricia Renter	Geographic Information Systems	Certified GISP
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Name	Project Responsibility	Education
Kirsten Johnson	Cultural Resources, Land Use, Environmental Justice, Indian Trust Assets, and Recreation	MA, Public History and U.S. History BA, History
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Allison Getty	Project Coordination	MA, Natural Resources
Leslie Watson	Project Management	BA, Zoology
A.E. (Gene) Rogge, PhD	Cultural Resources	PhD, Anthropology MA, Anthropology BA, Anthropology
Robert DeBaca, PhD	Vegetation, Fish and Wildlife, Land Use (Livestock Grazing)	BA, MS, PhD, Biology BA, Environmental Conservation
Mitch Meek	Graphics	BFA, Graphic Design
Meg Quarrie	Technical Editing	BA, Liberal Arts
Bill Jackson	Technical Review, QA/QC	BS, Wildlife & Fisheries Science
GeoTrans		
Richard Waddell	Principal Hydrologist, Vice President	PhD, Geology MA, Geology BA, Geology
McVehil/Monnett		
Bill Monnett	Vice President	BS, Atmospheric Sciences
Gary Garman	Modeling	BS, Biology

H. PREPARER (OSM)

A. Rick L. Williamson; Program Director Indian Lands Program

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Signature of Agency

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Date

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Appendix A
Mining and Reclamation Procedures

A. GENERAL

A.1 AUTHORIZATION TO MINE

Since the 1970s, Peabody Western Coal Company (PWCC) has been surface mining coal in Navajo County, Arizona through coal leases located within the boundaries of the Hopi and Navajo Indian Reservations. In operation since 1973, the Kayenta mine operates under an Office of Surface Mining Reclamation and Enforcement (OSM) Permanent Program Permit AZ-0001D, originally issued as Permit AZ-0001C, on July 6, 1990. Permit AZ-0001D is renewable at up to five-year intervals and currently authorizes mining operations in active coal resource areas N-9, J-19, and J-21, and in reserve coal resource areas N-10 and N-11 Extension under future mining sequences. These five coal resource areas combined contain enough coal to sustain the Kayenta mining operation through 2026 at the current production rate of 8.2 million tons of coal per year. Permit AZ-0001D has been renewed on three occasions: July 6, 1995; July 6, 2000; and July 6, 2005. The proposed action would renew Permit AZ-0001D to allow continued mining in coal resource areas N-9, J-19, and J-21 through July 5, 2015. Future renewals of the permit beyond July 5, 2015 would require additional action by OSM only after subsequent review of environmental effects in accordance with NEPA at the time.

The following table provides a list of permits or approvals for the Kayenta Mine operations issued to PWCC.

Table A-1 Federal and Tribal Entities and Permitting Requirements

Agency	Permit/Authorization/Filing
FEDERAL	
Army Corps of Engineers	Authorization of Dredge and Fill Activities Authorized under Nationwide Permit 21
Bureau of Alcohol, Tobacco, and Firearms	Explosives Use and Storage Permit
Bureau of Indian Affairs	Approval of Coal Lease on Tribal Coal Approval of Surface Use Agreements Grant of Easement for a Right-of-Way
Bureau of Land Management	Approval of Mine Plans
Department of Transportation	Hazardous Waste Shipment Notification
Environmental Protection Agency	National Pollution Discharge Elimination System (NPDES) Spill Prevention Control and Countermeasure (SPCC) Plan Pollution Prevention Plan Toxic Release Inventory (TRI)

Agency	Permit/Authorization/Filing
Fish and Wildlife Service	Compliance with Endangered Species Act
Mine Safety and Health Administration Safety	Permit and Legal ID Ground Control Plan Major Impoundments Explosives Use and Storage Permit
Office of Surface Mining Reclamation and Enforcement	Permit to Mine EA and Record of Decision Mitigation of Historic Properties and Archaeological Sites
TRIBAL ENTITIES	
Navajo Nation	
Environmental Protection Agency (on behalf of the U.S. Environmental Protection Agency)	Title V Air Permit to Operate Hazardous Waste Permit Stormwater Discharge Permit Public Water System Permit Public Water Systems Construction Permit Clean Water Act Section 401 Water Quality Certification Clean Water Act Section 402
Historic Preservation Department	Mitigation of Historic Properties and Archaeological Sites
Resources Committee	Revocable Use Permit
Fish and Wildlife Department	Biological Investigation Permit
National Heritage Program	Biological Investigation Permit
Department of Water Resources	Notice of Intention to Drill and Abandon an Exploration Well Notice of Intention to Drill, Deepen, Replace or Modify a Well Appropriations of Surface Water Withdrawal and Use of Groundwater Individual Aquifer Protection Permit
Minerals Department	SMCRA Oversight
Hopi Tribe	
Department of Natural Resources	SMCRA Oversight Clean Water Act Section 401 Water Quality Certification Clean Water Act Section 402
Cultural Preservation Office	Mitigation of Historic Properties and Archaeological Sites

A.2 COAL MINING LEASES

PWCC holds coal-mining leases with the Hopi Tribe and Navajo Nation, shown on Figure A-1, to produce up to 290 million tons from the exclusive Navajo Lease Areas (Contract 14-20-0603-8580 originally executed on February 1, 1964) and up to 380 million tons from the Hopi and Navajo Joint Minerals Ownership Lease Area (Contracts 14-20-0603-9910 and 14-20-0450-5743 originally executed on June 6, 1966) for a combined total of 670 million tons. While the specified leased coal tonnages are certain, the assignment of coal parcels to a particular buyer of the coal may change, depending upon customer demand and coal-quality needs.

The coal-mining leases also provide PWCC rights to prospect, mine, and strip leased lands for coal and kindred products, including other minerals, except for oil and gas, as may be found. PWCC also is given the right to construct support facilities such as buildings, pipelines, tanks, plants, and other support structures; make excavations, openings, stockpiles, dumps, ditches, drains, roads, spur tracks, transmission lines, and other improvements; and to place machinery and other equipment and fixtures and do all other things upon the leased lands necessary for the efficient operation of mining. PWCC may occupy that portion of the leased lands as is necessary to carry on mining operations, including right of ingress and egress, and may develop and use water for the mining operations.

A.3 RIGHTS-OF-WAY AND EASEMENTS

There are several existing grants of rights-of-way and easements allowing PWCC access and use of lands outside the existing coal lease areas. A grant of right-of-way and easement for an overland conveyor and coal-loading site was issued to the Navajo Generating Station project participants by the Secretary of the Interior with the approval of the Navajo Nation on December 10, 1969, that was ultimately transferred to PWCC. A grant of right-of-way and easement for two parcels of land providing access for utilities, haul roads, maintenance roads, sediment-control ponds, and a rock-borrow area was approved by the Navajo Nation and BIA on August 19 and 28, 1996, respectively. The BIA with the consent of the Navajo Nation issued a grant of right-of-way for an electrical transmission line on September 9, 1984.

A.4 COAL-SUPPLY AGREEMENTS

PWCC has an amended coal-supply agreement with the participants of the Navajo Generating Station containing a term ending in December 2019. This coal supply agreement provides the right to extend the term for a period or periods of time not to exceed 15 years from April 30, 2011.

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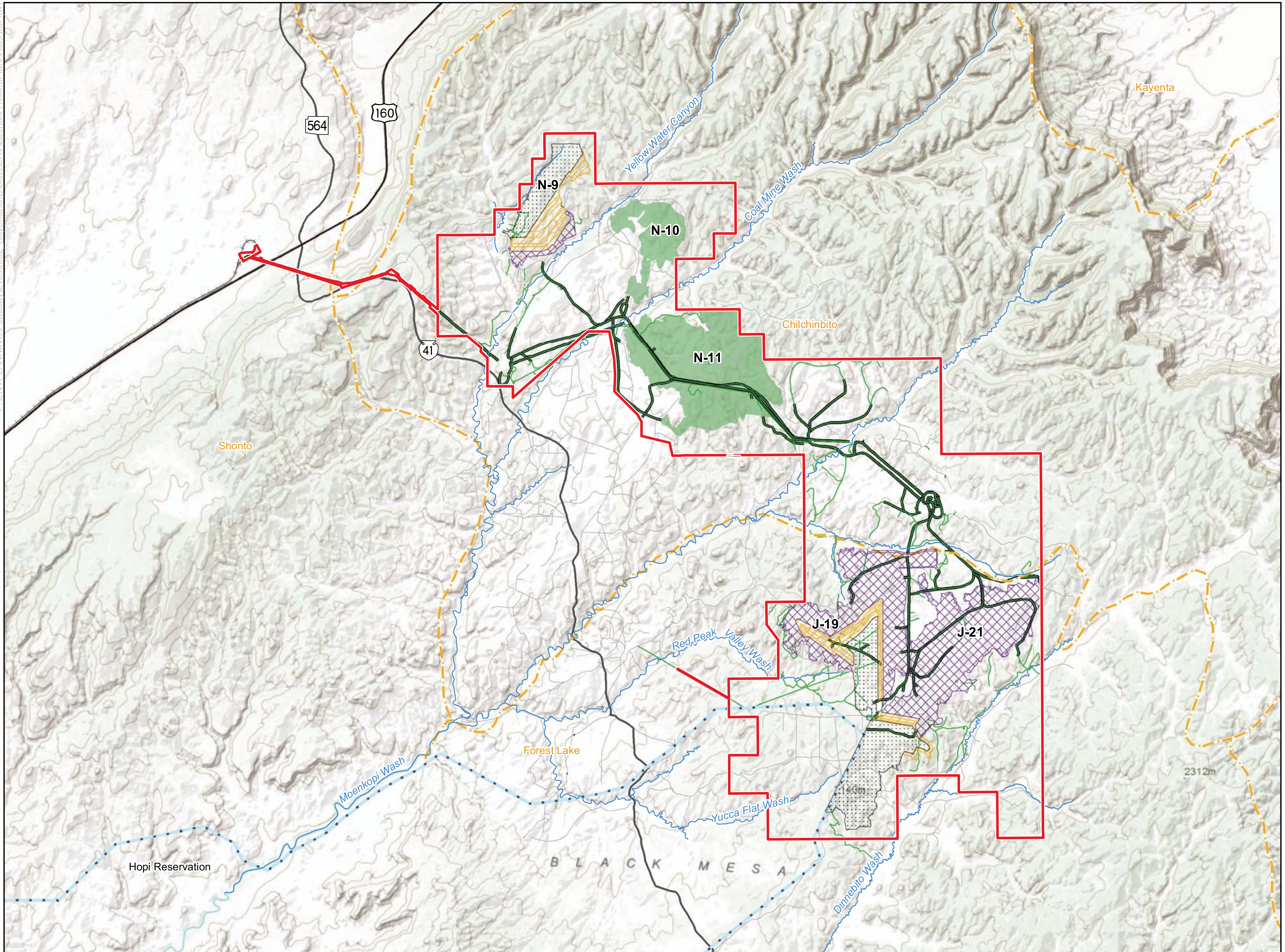


Figure A-1

Mine Plan Areas

Kayenta Mine Permit Renewal EA

Legend

- Kayenta Mine Permit Area
- Permit Renewal Period Mine Area
- Coal Resource Previously Mined Area
- Future Mine Area
- Future Project Mining
- Hopi Reservation
- Navajo Nation Reservation Chapter Boundary
- Wash or Ephemeral Stream
- Highway
- Rails

PWCC Mine Road

- Primary
- Ancillary
- PWCC Mine Road

Source:
Base Map: ADOT 2009, ESRI 2010
Project Data: PWCC 2010, 2011
Imagery: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA

N

0 0.5 1 2

Miles

PWCC URS

B. MINE FACILITIES

This section contains a description of the existing and proposed facilities that do and would support the mining operation. These facilities include water-control facilities, transportation facilities, and other support facilities. The mine facilities within the PWCC lease area but outside the Kayenta Mine permit area have been separately authorized by OSM as part of the Initial Regulatory Program and are authorized for use in Kayenta mining operations in accordance with SMCRA regulations. This Environmental Assessment includes effects from the use of all mine facilities, within and outside the permit area, to the extent such facilities are necessary to the mining operations that would be authorized by the proposed action.

B.1 WATER-CONTROL FACILITIES

B.1.1 Sediment- and Water-Control Facility Plan

PWCC must design, construct, and maintain appropriate sediment-control measures including sediment ponds, diversions, culverts, and other sediment- and water-control structures in accordance with 30 CFR 816.45 in order to prevent, to the extent possible, additional contributions of sediment to stream flow or to runoff outside the permit area due to mining activity, and to minimize erosion. Sediment-control measures include practices used within and adjacent to the mining-disturbance areas. Sediment-control measures consist of the use of proper mining and reclamation methods and sediment-control practices, singly or in combination. Sediment-control methods may include, but are not limited to, the following:

- Disturbing the smallest practicable area at any one time during the mining and construction operation;
- Stabilizing graded material to promote a reduction in the rate and volume of runoff;
- Retaining sediment within disturbed area;
- Diverting runoff away from disturbance areas, including stockpiles, back slopes, and material storage;
- Diverting runoff through disturbed areas using stabilized earth channels, culverts, or pipes so as to prevent, to the extent possible, additional contributions of sediment to stream flow or to runoff outside the permit area;
- Using straw dikes, silt fences, small V-ditches, riprap, mulches, check dams, ripping, contour furrowing, vegetative sediment filters, small depressions, sediment traps, and other measures that would reduce overland flow velocity, reduce runoff volume, or trap sediment; and
- Treating traffic areas with water or dust suppression to reduce the potential for wind and water erosion.

Siltation structures or sedimentation ponds are used primarily for controlling sediment from all disturbed areas, except those permitted areas exempted by the requirements of these regulations. Other alternative sediment-control methods may be used in conjunction with the siltation structures or, in the case of the permitted areas that are exempt (i.e., roads), they may be used individually.

B.2 TEMPORARY SEDIMENTATION PONDS

PWCC constructs sedimentation ponds to control runoff and sediment from disturbed areas pursuant to 30 CFR 816.46, 816.47, 816.49, and 816.56. Sediment ponds generally are recognized in the coal-mining industry as the best available control technology to prevent, to the extent possible, additional contributions of suspended solids sediment to stream flow or runoff outside the permit area due to mining disturbance. All surface drainage from the disturbed areas passes through a siltation structure before leaving the permit area, except in certain small areas that are exempt from these regulations. In the exempt areas, alternative sediment-control methods are used to eliminate additional contributions of sediment off the permit area. Most of the sediment ponds are designed to be temporary, and are reclaimed when they are no longer needed to treat runoff from disturbed areas. Certain temporary ponds may be proposed for permanent retention in the post-mining landscape, but must be upgraded to meet permanent impoundment regulatory requirements.

One hundred fifty six sedimentation structures exist within or adjacent to the Kayenta Mine permit area, and 73 temporary sedimentation structures have been removed and reclaimed as of 2010. During the five-year permit term, PWCC proposes to construct 10 new temporary sedimentation ponds, and plans to reclaim 32 additional temporary sedimentation ponds through 2014.

PWCC plans to construct an additional ten temporary sediment ponds to control runoff from surface coal mining and related activities in the N-9 and J-21 mining areas during the five-year permit term. Seven of these are located in N-9 and within the Moenkopi Wash drainage. Three are in J-21, within the Dinnebito Wash drainage. No additional sediment control ponds are anticipated to be needed in the J-19 mining area during the permit term.

Sedimentation ponds and impoundments are designed to comply with the requirements of 30 CFR 780.11, 780.12, 780.25, 816.46, 816.47, 816.49, and 816.56, and other applicable regulations.

B.3 PERMANENT IMPOUNDMENTS

Fifty-one water sources consisting of three categories of impoundments determined to be needed to provide water for wildlife and livestock have been or are being proposed to exist permanently after mining is completed. These categories include pre-SMCRA internal impoundments, existing and proposed post-SMCRA internal impoundments, and existing and proposed water-control structures (sediment ponds). Nineteen permanent internal impoundments currently exist that are available for wildlife and livestock use as a part of the post-mining landscape. One additional internal permanent impoundment has been approved in the permit application (J-19-RB). It is located in the J-19 coal resource area. In addition, PWCC is proposing 31 existing or proposed temporary sediment-control structures as permanent impoundments. These include 9 existing Mine Safety and Health Administration structures, 20 existing sediment-control structures, and 2 proposed sediment-control structures. Being multi-purpose structures, these structures are used for sediment control during the life of the mine and reclamation operations and would be converted to permanent structures prior to final bond release.

Mine Safety and Health Administration-Size Impoundment Structures

PWCC uses 11 existing structures that meet the criteria of 30 CFR 77.216(a). Two structures would be temporary and nine structures would be permanent. The primary purpose of these structures, except for the Kayenta mining operation fresh-water pond, is to control sediment from disturbed mining areas. The Kayenta mining operation fresh-water pond's purpose is to hold groundwater pumped from nearby Navajo-aquifer wells used for dust suppression.

B.4 TOPSOIL STOCKPILES

Where prompt replacement of topsoil recovered ahead of mining disturbances is infeasible, numerous topsoil stockpiles are developed throughout the mine areas to store topsoil pursuant to 30 CFR 780.14(b)(5) and 816.22(c) until it is needed for revegetation operations. Stockpiled topsoil remains in place from less than 3 months to more than 10 years, depending on the location with respect to revegetation operations and the revegetation schedule. Stockpile dimensions, slopes, and volumes vary based on total salvage volumes, the configuration of the location site, and proximity to access roads. Using best management practices, stockpiles are placed on a stable site protected from wind and water erosion, and are not disturbed until required for redistribution.

B.5 ROADS

There are four types of roadways inside or crossing PWCC's permit area: primary roads, ancillary roads, non-mining-related roads (i.e., public roads and private roads), and pit ramps or routes of travel that are within the mining and spoil grading areas.

Primary and ancillary roads are located, designed, constructed, used, maintained, and reclaimed in accordance with the regulations and performance standards set forth under 30 CFR 816.150 and 816.151. Appropriate regulatory approval must be obtained for mine-related road crossings of stream buffer zones prior to construction of these crossings.

Within the primary and ancillary road classifications there are five sizes of roads based on use and traffic volume. There are three typical sizes of primary roads: (1) haul roads and mine-vehicle roads; (2) coal-haulage, mine-vehicle, and dragline-deadheading roads; and (3) mine-access roads. Two types of ancillary roads are used by lighter duty vehicles on a less frequent basis to access remote mine-facility sites, such as environmental monitoring sites; the first type is typically a two-lane road where an all-weather road is required to access remote sites, and the second type is usually a single-lane road that follows the natural topography (typically less frequently used than the first type).

All roads used or built by PWCC on or after December 16, 1977, would be reclaimed, unless they have been approved by the regulatory authority as a part of the post-mining land use plan. Because of the size and nature of PWCC's mining activities, very few of the roads in the latter category would be reclaimed until the end of mining activities on the entire leasehold. Exceptions include roads in the immediate vicinity of pits and ramps, which are created in the spoil and reclaimed as the general reclamation activities progress within a specific coal resource area.

B.6 SUPPORT FACILITIES

Support facilities include, but are not limited to, the following: mine buildings, offices and shops, bath houses, storage silos and cap magazines, coal-loading facilities, coal-crushing and -sizing facilities, coal-storage areas, equipment storage areas, water diversions and culverts, sheds constructed on permanent foundations and greater than 100 square feet in size, utilities, permanent fuel-storage and -tank farms, environmental monitoring sites, wells, and railroad and surface-conveyor systems. New support facilities would be approved by OSM prior to construction regardless of their location. All disturbances for construction of facilities to support mining operations are contained within a designated disturbance area. Maintenance of all facilities and reclamation of temporary facilities is in accordance with the approved mining plan.

B.7 PWCC WELL FIELD

Used primarily for mining operations, the PWCC well field consists of eight wells that are located on the PWCC lease area (refer to Map D-2). These previously authorized wells within the PWCC lease area are shown on Map D-2. No new wells are proposed in the current permit renewal application.

C. COAL MINING

This section contains a description of the mining methods, equipment, and coal production rates proposed by PWCC for the Kayenta mining operations for July 2010 through July 2015.

C.1 MINING METHODS AND EQUIPMENT

The mining operation practices a conventional form of strip mining called "area mining" wherein the overburden above the uppermost coal seam and the innerburdens or partings between the lower coal seams are removed in parallel strips across the coalfield until the area is completely mined. The overburden and partings are disposed of behind the active pit in previously mined pits where the bottom seam has been completely removed.

C.1.1 Clearing and Grubbing

Immediately prior to topsoil removal the area to be mined is cleared of large vegetation consisting primarily of piñon and juniper trees to facilitate topsoil recovery. The vegetation debris removed is placed at locations that would not interfere with mining operations. A majority of this material is made available to local residents as firewood and the remainder is either piled at the edges of the mining area to provide cover and nesting habitat for wildlife or buried in the pit during mining operations.

C.1.2 Topsoil Removal

All suitable topsoil is removed from disturbed areas prior to initiating mining or mining-related activities. Prior to the start of removal operations, the proper salvage depth is staked or otherwise identified under the supervision of a soil scientist or other qualified person. Salvage-depth information must be adhered to by equipment operators. Topsoil material is removed throughout the year, weather permitting in 1,000- to 2,000-foot-long by 300-foot-wide sections. It is removed using scrapers or other earth-moving equipment and either hauled directly to recontoured areas for redistribution or transported to topsoil storage areas (stockpiles) located throughout the mine area for storage prior to eventual redistribution. Topsoil materials are removed up to 1,500 to 2,000 feet in advance of the active mining operation (i.e., active pit highwall) for safety and resource protection reasons.

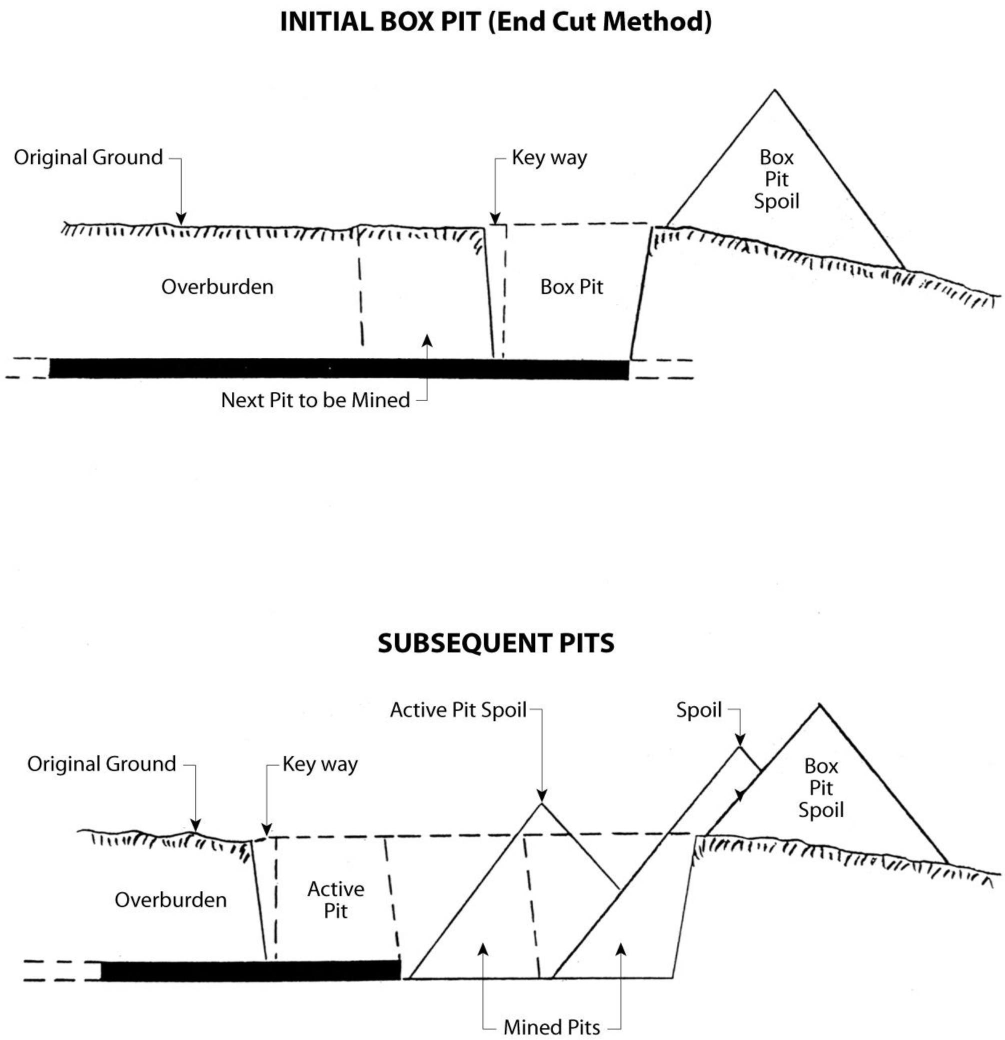
PWCC implements dust control measures for topsoil stripping and redistribution operations. The cut of the topsoil removal areas and the ingress and egress routes to this area are included in watering operations. The ingress and egress routes to the topsoil lay-down area, where the final grading has occurred, also are watered. To reduce compaction, the lay-down area generally is not watered. Similarly, topsoil removal operations that place salvaged soil in stockpiles include watering as described above and often on the stockpile itself. Additional watering operations are conducted in the access routes to and from the equipment parking lot and the equipment parking and support areas.

Overburden Removal

After being drilled and blasted, overburden material covering the shallowest coal seam is removed. The overburden is placed in piles in the previously mined pit along the side of the current cut using draglines and auxiliary excavating equipment. This process is repeated in sequential fashion as the pit advances into the coalfield (Figures A-2 and A-3).

Overburden and spoil material that would be used as topsoil supplements is identified and removed in much the same manner as topsoil material. Topsoil supplements may be handled throughout the year. Topsoil supplements are not stockpiled and therefore are hauled directly to recontoured areas for redistribution.

Draglines are also the primary excavators of partings or innerburdens (material between the coal seams) as thickness and field conditions indicate. Partings may vary in thickness from 6 inches to more than 50 feet in the lateral distance of one cut. After being drilled and blasted, partings are removed and placed within or alongside the cut by draglines, backhoes, bulldozers, and/or truck and backhoe combinations, according to the operational requirements of each pit. Equipment such as trucks and backhoes or loaders and scrapers also may be used to assist with overburden or parting removal. When trucks and backhoes or scrapers are used, excavated material remains in the cut or pit area. A bulldozer is continually assigned to each dragline to perform bench leveling, access road preparation, trailing cable relocation, and miscellaneous duties.



Note: Not to Scale

Figure A-2

Typical Pit Cross Sections

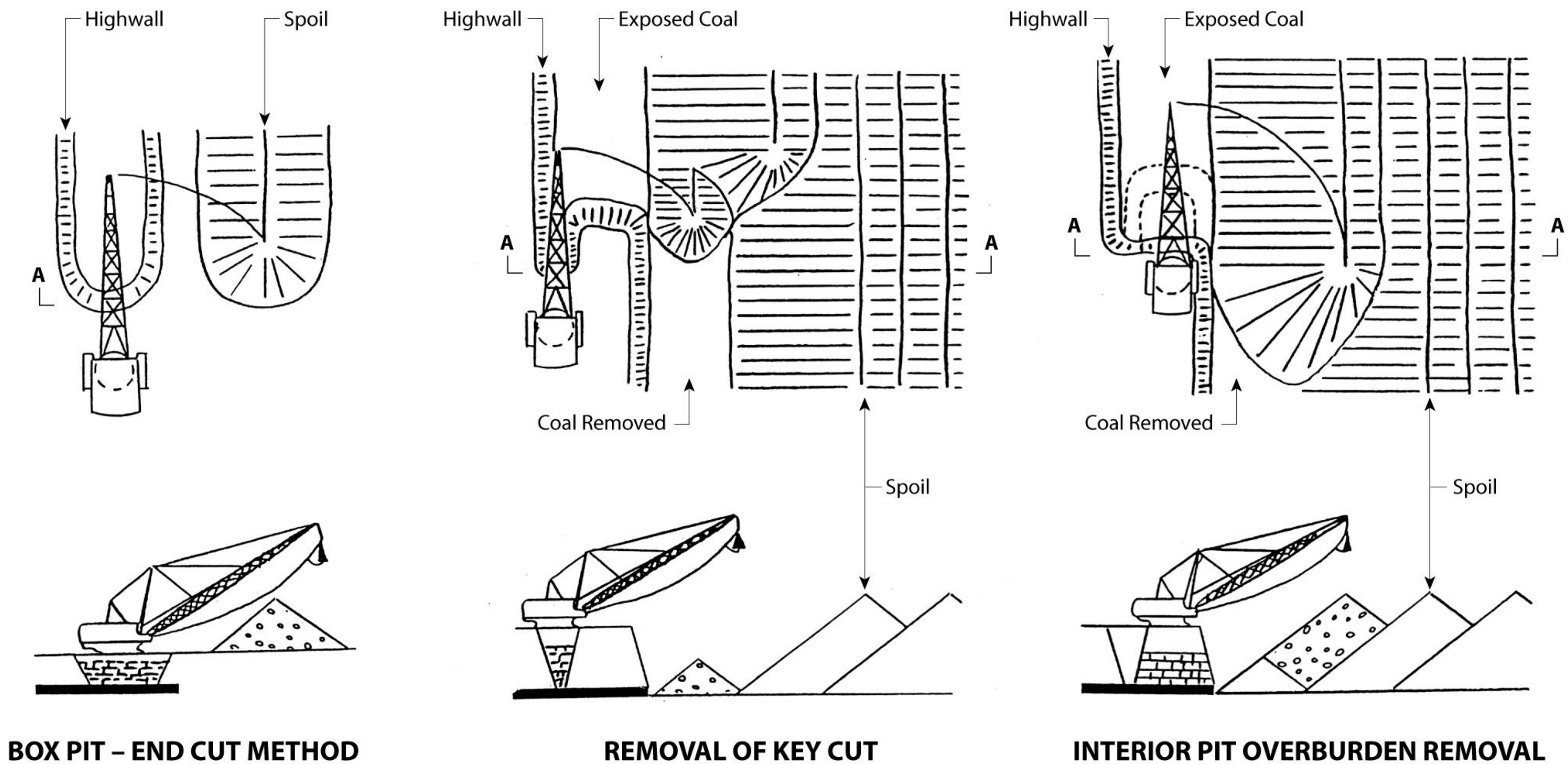


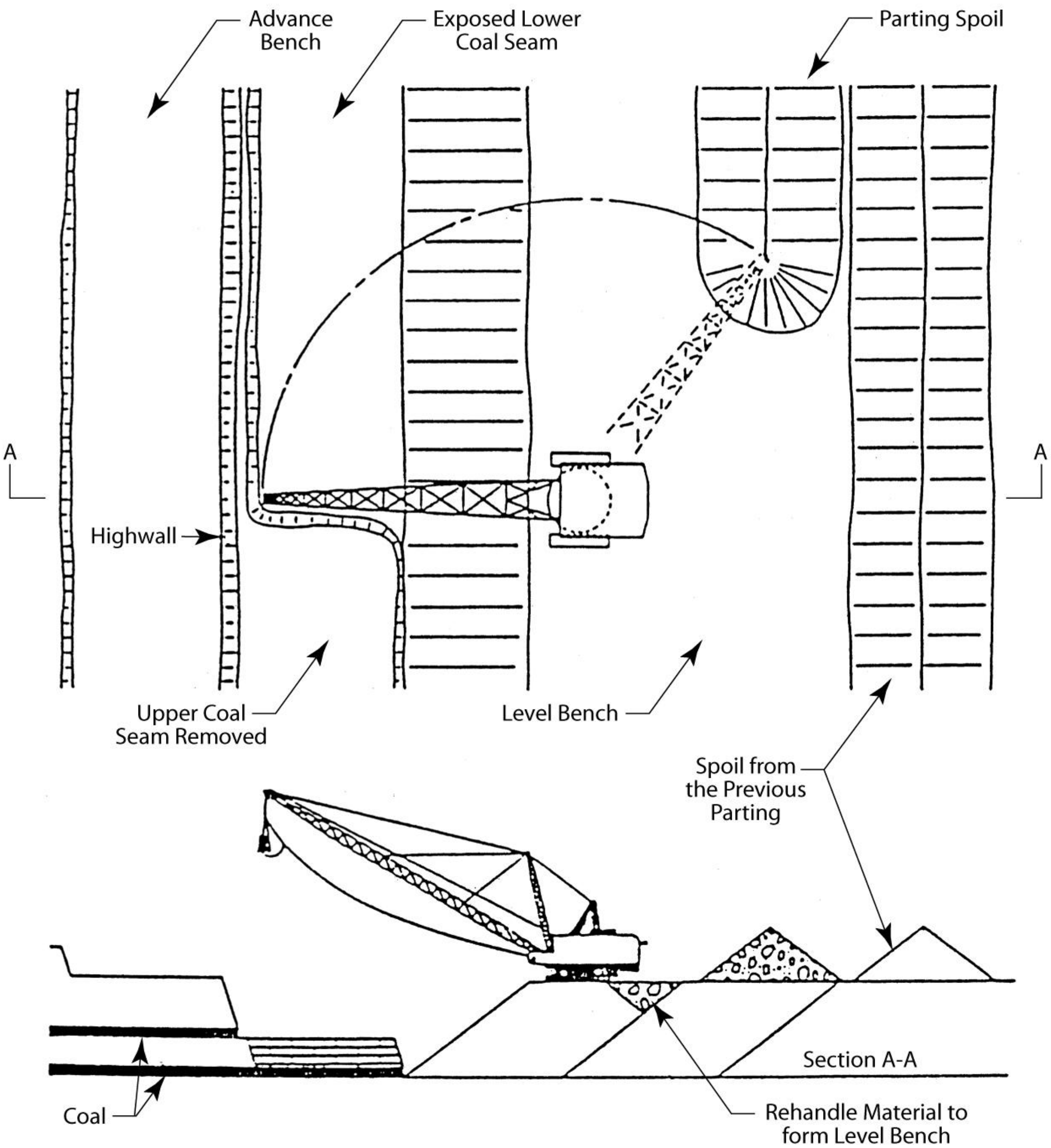
Figure A-3

Typical Pit Cross Section Showing Initial Box Pit and Subsequent Pits

The overburden excavation process begins with the digging of a narrow slot, or key cut, down to the coal seam to establish the highwall (refer to Figure A-3). The location of the key cut and the spoil establishes the width of the pit. The dragline is positioned above the area to be excavated and in line with the direction the cut is progressing. The dragline bucket is lowered to the material to be excavated, drawn toward the dragline, lifted, and swung to the side, at which point it dumps or spoils the excavated material into a previously mined cut or along the side of the cut onto unmined ground. This process is repeated until the entire area in front of the dragline has been excavated. The dragline then is repositioned and begins another key cut and starts the process again. This procedure is followed until the operational limits of the machine are achieved or pit boundaries are reached. At this point, the dragline "walks," or deadheads, to where the next cut is to begin. The entire process starts again with each successive cut being excavated parallel to the previously mined cut and continues until excavation activities are complete within the pit.

An alternative to the highwall-side overburden excavation process is to level a bench on the spoil side and position the dragline on the spoil side to excavate the overburden and pull back the spoil over the coal seam (Figures A-4 and A-5). The main advantage of this method is to enable the dragline, which has limited operating radius to handle overburden covers of greater depth than would normally be contemplated. Other advantages of this overburden excavation process include better coal recovery in deeper overburden, reduced auxiliary equipment required for overburden excavation, increased spoil stability, reduced material rehandle, and maintaining an adequate pit width. The disadvantages include the need to prepare a spoil-side bench, sequencing the spoil-side benching operation with the pit operations, and increased dragline cycle times.

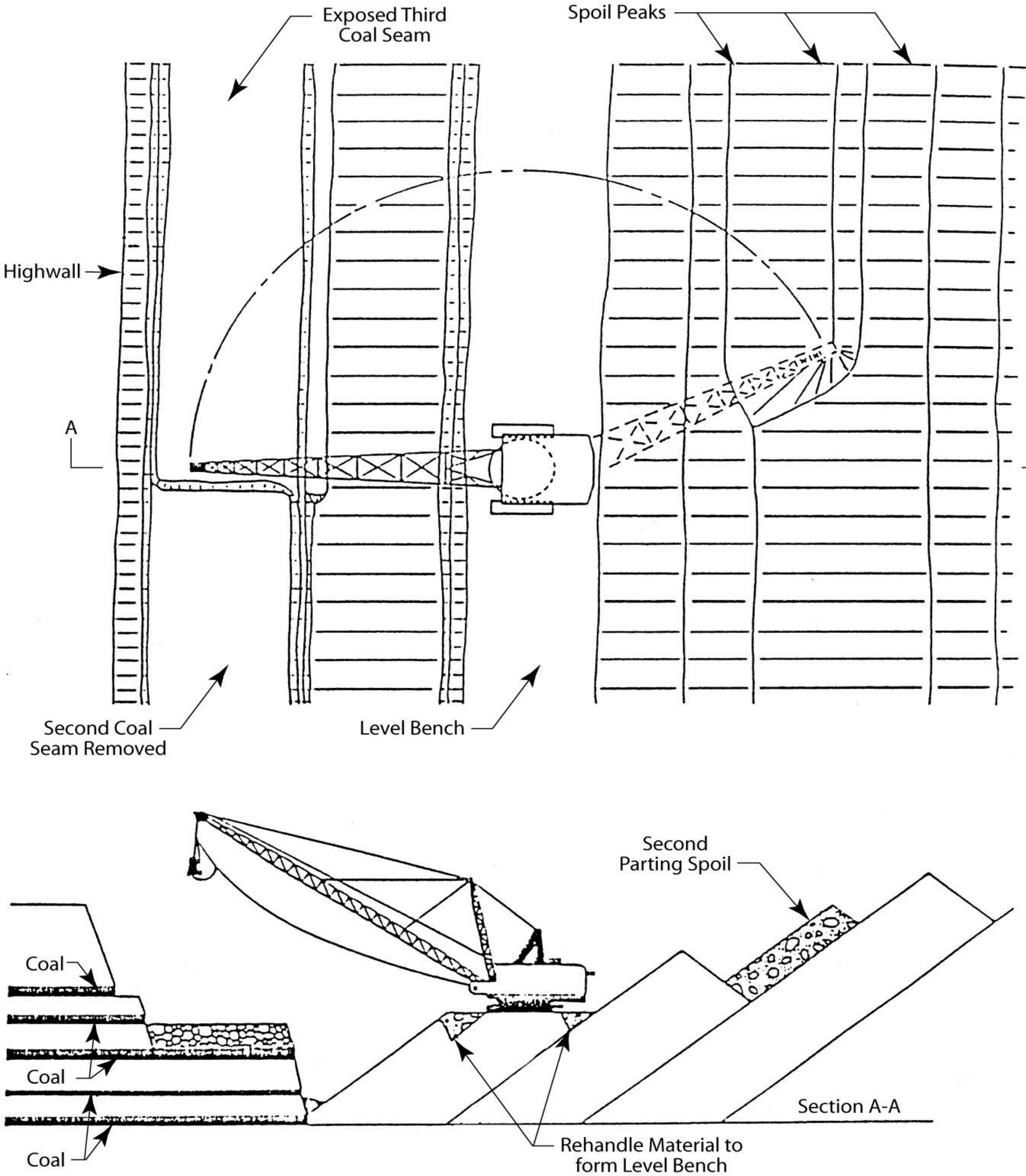
Typically, in deeper overburden, the upper coal seams may be uncovered on the highwall side and the lower seams uncovered on the spoil side. The positioning of the overburden removal equipment would be determined pit-by-pit to allow the most efficient coal recovery.



PLAN AND CROSS-SECTIONAL VIEW

Figure A-4

Spoil-Side Overburden Stripping



PLAN AND CROSS-SECTIONAL VIEW

Figure A-5

Spoil-Side Overburden Stripping

The selection of parting removal equipment is dependent upon the operational requirements within each pit. A dragline generally removes partings in excess of 15 feet; however, it may occasionally remove partings as thin as 5 feet. Backhoes and front-end loaders are used to remove partings that range in thickness from 3 to 15 feet. Occasionally, end-dump trucks are used in conjunction with a backhoe or front-end loader to remove partings within a pit. Bulldozers may remove partings that are less than 3 feet thick by first ripping the parting and afterwards pushing it off the coal seam to be removed.

Once the overburden or parting has been removed from above the coal seam, any remaining overburden material is cleared from the top of the coal seam using rubber-tired or track-type dozers.

The coal seam then is drilled and blasted using the same procedures that are followed to fragment overburden and partings. Rubber-tired front-end loaders and backhoes primarily are used to load the coal into haulage trucks for transportation to preparation areas. Backhoes are used in areas where thicker coal seams are to be loaded and mobility of the loader is not a prime consideration.

Haulage from pits to preparation areas is accomplished by bottom-dump trucks ranging in capacity from 150 to 250 tons. Occasionally, 150-ton end-dump trucks or smaller equipment also may be used. Haulage trucks are routed to pits as necessary to meet production and coal-quality requirements.

C.2 BACKFILLING

When all of the coal has been removed from the pit, overburden from the next parallel cut would be placed in the initial pit for backfilling. This would produce, in effect, an advancing pit that would continue until all the coal has been removed from the given coal resource area.

D. RECLAMATION AND MITIGATION

D.1 SURFACE STABILIZATION

PWCC has developed a plan in the permit application for establishing a reclaimed landscape that would minimize erosion and support post-mining land uses. The plan is currently implemented and is based on 25 years of reclamation operations at the Kayenta Mine. Under this plan, factors such as hill slope gradient and length, soil properties, surface-soil mechanical manipulation techniques, site characteristics, and revegetation practices are evaluated using prescribed criteria to design the surface form, soil placement, and drainage plan. With this plan, soil losses are predicted to be less than soil losses in pre-mining conditions.

D.2 POST-MINING LAND USES

The primary historical land use in the area has been livestock grazing—primarily sheep and goats. In recent years, the numbers of cattle and horses have increased. Other land uses include agriculture (primarily corn production in dry land, small area family plots), gathering of plant materials (for cultural, medicinal, and edible purposes), commercial trapping, various forms of outdoor recreation, and preservation of wildlife habitat. Reclamation efforts at the mine are directed toward restoring the land to be used for livestock gazing, wildlife habitat, and cultural plant use.

D.3 POST-MINING TOPOGRAPHY

Backfilling and grading operations are designed to produce a diverse topography similar to the original premining landform , as discussed above regarding the surface stabilization plan. Overburden that is spoiled in the previously mined pit is graded to eliminate spoil ridges and to produce the approved postmining topography. Material, including highwalls, would be graded to slopes of 3 horizontal:1 vertical or less. Bulldozers, scrapers, and occasionally draglines would perform rough-grading operations. Bulldozers and scrapers are used for final grading.

D.4 MINE-SOIL RECONSTRUCTION

Topsoil and topsoil-supplement redistribution operations ensure the replacement of a minimum of 4 feet of suitable plant growth media for revegetation, of which a minimum of 9 to12 inches would be topsoil. Coal combustion residuals (byproducts) are not allowed as plant growth media at any permitted surface coal mine including the Kayenta Mine. Graded spoils determined to be suitable as a rooting medium would be covered by a minimum of 9 to 12 inches of topsoil. Graded spoils determined to be unsuitable are covered with a minimum of 4 feet of suitable material (overburden and/or topsoil). Redistribution of plant-growth media is accomplished whenever weather and soil moisture conditions permit, using scrapers, bulldozers, front-end loaders, backhoes, and end-dumps, and miscellaneous support equipment (road graders, water trucks, and farm tractors). This material is obtained from topsoil storage piles or hauled directly from topsoil material removal areas and supplemental sources (highwalls and spoil banks). Scoria or red rock that is suitable for plant growth is used in localized areas for reclamation of cultural plants, woody plants, and wildlife habitat.

Mine spoils are scarified prior to or immediately after topsoil material is distributed, to increase adhesion at the interface between the respective materials and relieve compaction. After redistribution operations are complete, contour furrows are installed perpendicular to the slope, using an offset disk unit with 36-inch disks. Revegetation treatments such as seeding, mulching, and erosion repair are all conducted on the contour to reduce the potential for downslope water flow.

D.5 REVEGETATION PLAN

D.5.1 General

The revegetation plan has been developed to meet the requirements of 30 CFR 816.95, 816.97, 816.111, 816.113, 816.114, 816.116, and 816.133. The plan is currently implemented and is based on 25 years of reclamation operations at the Kayenta Mine. Following topsoil replacement, surface mechanical manipulations, and seedbed preparation, revegetation is completed using a combination of applied seed mixes, mulching, and seedling planting programs. The best technologically available practices are used to accomplish all revegetation activities. The Rangeland Seed Mix, the primary seed mix used for revegetation, is composed of a minimum of 21 species, including warm and cool season grasses, forbs, and shrubs. The predominantly native seed mix is designed to meet the requirements of the above-cited regulations and meet nutritional requirements for livestock and wildlife. The Rangeland Seed Mix is split into drilled and broadcast components based on seedbed ecology needs of the seeded species and physical seed characteristics. Specialized seeding equipment is used to seed both components at the proper depths in one pass to reduce equipment traffic on the reclaimed surface. Several additional seed mixes are used in revegetating drainages or establishing wildlife habitat and sites for re-establishing cultural plants. The primary seeding season is from May to September, with a secondary seeding season available during spring and fall when ground conditions permit equipment operations.

Immediately following seeding of topsoiled areas, a native grass hay mulch is applied at 2 tons per acre and crimped. Native grass hay is more effective than straw and does not establish volunteer crops. Sites established with suitable plant growth substrates such as red rock or scoria are not mulched because of rough surface configuration and high coarse-fragment content. Following revegetation activities, the reclaimed areas are fenced to exclude livestock and are monitored for establishment. PWCC maintains a twice per year vegetation monitoring and weed program for a minimum of 10 years after reseeding areas. The twice per year vegetation monitoring and weed program identify the measures to control noxious weeds and invasive species establishment.

D.6 CULTURAL PLANT, WOODLAND, AND WILDLIFE HABITAT REVEGETATION

PWCC has developed and implemented a cultural plant restoration program on select reclaimed areas that also serves to reestablish woodland and wildlife habitat. Sites of one to several acres are prepared on north-facing slopes using red rock (scoria) suitable plant growth substrates. These sites are developed to simulate native site requirements of the target species. The sites contain numerous planting microsites due to roughened conditions created during substrate replacement operations. Plant materials are developed from local native seed collections with some regional sourcing as needed to ensure that plants are adapted to environmental conditions at the site and are capable of regeneration. Seedlings from these sources are grown in nurseries specializing in native plants. Specialized nursery cultural practices for the species being grown are used to develop these native plant materials. All seedlings receive mycorrhizal fungi applications for enhanced survivability and growth following planting. This ecological approach considers plant adaptations and symbiotic relationships common to plants in the arid Southwest. Seedlings are specially handled following greenhouse operations and are hand planted in a random distribution in the microsites present in the planting areas. More than 50 grass, forb, shrub, and tree cultural plant species are commonly included in this program.

Piñon/juniper woodland sites are re-established as a part of the cultural plant restoration program. Seedlings of piñon pine, Utah juniper, and to a lesser extent Gambel oak, are included in these planting efforts. Planted tree densities are 250 to 350 stems per acre and the minimum established density is 75 trees per acre. Live piñon transplants from salvage of 3- to 5-foot-tall trees in grubbing areas ahead of mining are transplanted annually to complement tree seedling planting. Approximately 200 trees are transplanted to select reclaimed sites annually during the winter dormant season.

Revegetation practices to restore wildlife habitat include the overall rangeland-seeding program, cultural plant and piñon/juniper woodland restoration, and additional woody species plantings around ponds and small depressions. The revegetation program is designed to establish diverse vegetation capable of meeting wildlife nutritional needs and other habitat factors such as cover or nesting. High-density shrub areas (greater than 800 stems per acre) are interspersed within the reclaimed landscape. Cultural plant/woodland/wildlife habitat sites also are interspersed within the reclaimed landscape. These features combine to increase edge and habitat diversity.

D.6.1 Revegetation Success

Revegetation success standards and their evaluation are structured to meet the criteria of 30 CFR 816.111 and 816.116. Standards are based on a combination of native reference areas and approved technical standards that reflect environmental site conditions, ecological considerations, and post-mining land uses. The criteria for evaluation follow both 30 CFR 816 requirements and other Federal guidelines and address the parameters of cover, production, woody density, and diversity.

Revegetated areas are included in a spring and fall annual vegetation monitoring program to identify any needed remedial action, document trend and vegetation performance of reclaimed areas, contribute to the database for revegetation success evaluations, and provide data for implementation of post-mining land uses. The vegetation monitoring data are used to establish grazing levels in an approved grazing management program designed to enhance vegetation community characteristics and demonstrate achievable post-mining land uses.

D.7 PROTECTION OF FISH AND WILDLIFE, AND RELATED ENVIRONMENTAL VALUES

D.7.1 General

PWCC's plan for protection of fish, wildlife, and related environmental values addresses the requirements of 30 CFR 816.97. The previous discussion under Revegetation Plan addresses re-establishment, mitigation, and enhancement of vegetative habitat features and needs. Various sections of the approved permit address operations conducted to minimize hazards to raptors from electric power lines and how to design, locate, and operate roads and facilities that avoid or minimize impacts on wildlife and permit passage.

Nonvegetative wildlife-habitat-enhancement-or-replacement features include linear rock features and rock structures established at 1 per 100 acres with specified design criteria in the AZ-0001D permit. Raptor perches are established at a density of 1 per 400 acres. The perches are constructed based on the most appropriate technologically sound design criteria at the time of installation. Permanent impoundments and their numbers have been discussed previously in this appendix. These impoundments significantly enhance habitat, establish wetland vegetation, and provide a critical habitat feature previously not readily available in the pre-mine landscape.

Mine front raptor surveys are conducted adjacent to and within 1/4 mile of active advancing mining operations (currently N-9, J-21, and J-19). These are conducted during the breeding season to minimize and mitigate any impacts to breeding birds and avoidance of activity around nests. Targeted species are

Cooper's hawks and northern goshawks. These surveys have been conducted annually for a number of years and to date none have been observed.

Red-tailed hawk nest monitoring is conducted annually on the PWCC lease area. Additionally, information is gathered throughout the year on the presence of red-tailed hawks. This has been ongoing annually for a number of years.

Gunnison's prairie dog colony assessments are conducted annually on and immediately adjacent to the PWCC lease area. The surveys are conducted to determine the potential habitat suitability for black-footed ferrets and if the minimal requirements present are triggering formal black footed ferret surveys. The annual monitoring has been conducted for a number of years and the colony parameters and requirements for formal black footed ferret surveys have not been detected in the surveys. An added benefit of these surveys is that prairie dog colonies may be a source of mountain plover habitat and the emphasis here and the inclusion of special status monitoring during annual surveys has shown no presence of mountain plover in monitored prairie dog colonies or other areas on the PWCC lease area.

Annual monitoring addresses special status species which include the federal and the Navajo Nation listed endangered, threatened, candidate, and sensitive species of concern. These surveys also look at the presence of suitable habitat, topographic features, and unique areas on the PWCC lease that are or could be important to a variety of wildlife. Mexican spotted owl surveys have been initiated in 2011 in the region on and adjacent to the northeast portion of the PWCC lease area.

Reclaimed area surveys are conducted with the above in mind but with emphasis on reclaimed areas to further broaden the annual wildlife survey base while collecting information to identify species presence and support information as to the success and suitability of the reclaimed areas as habitat for a variety of species.

The annual wildlife monitoring is conducted periodically from February until December with seasonal emphasis based on specific monitoring requirements in the above areas.

D.8 THREATENED AND ENDANGERED SPECIES, AND SPECIES OF SPECIAL CONCERN

Baseline studies and annual wildlife and vegetation monitoring address current species listed as threatened, endangered, or of special concern by Federal, tribal (Hopi or Navajo), or State agencies. PWCC promptly notifies the regulatory authorities of any Federal, tribal, or State listed species occurring on the permit area and would conduct the required mitigation or monitoring following consultation.

Surveys for nesting raptors in advance of active mining operations are conducted annually, and mitigation procedures are implemented as necessary after consultation with the regulatory authority if nesting raptors are located within the survey area. Prairie dog colonies are monitored annually for areal extent and sign of black-footed ferrets. If the size of a prairie dog colony exceeds the minimum acreage requirements in effect at the time, black-footed ferret surveys are conducted in accordance with guidelines specified by the regulatory authority. Mexican spotted owl surveys and monitoring were conducted over a seven-year period ending in 2000. Consistent with Special Condition 2, Mexican spotted owl surveys would be reinitiated when mining activities are within 2 miles of any known nest site or the mixed-conifer habitat type adjacent to the lease area. Mexican spotted owl surveys have been reinitiated in 2011 as a result of the N-9 mining progression and the requirements of Special Condition 2. Surveys or monitoring have been coordinated with the regulatory authority following approved protocols. Peregrine falcons were delisted in August 1999, and PWCC ended monitoring and breeding surveys in 2000. If listing status for the peregrine falcon changes or if the proximity of mining operations dictates, monitoring would be reinitiated after consultation with the regulatory authority. Mexican spotted owls and peregrine falcons were intensively monitored by PWCC from 1994 to 2000 and 1989 to 2000, respectively, with no apparent impacts on either species.

E. ABANDONMENT OF MINING FACILITIES

Abandonment activities would begin when particular facilities are no longer required to support mining operations. Facilities such as buildings, parking lots, roads, wells, and utilities that are requested to be kept by the tribes would be turned over to them. Other materials having economic value (such as structures and equipment) would be salvaged or recycled. All other materials would be disposed of using approved procedures and in accordance with the Navajo Nation Solid Waste Disposal regulations. All sites would be recontoured to conform to the natural landform, covered with topsoil, and revegetated, using the same post-mining techniques as those proposed for areas disturbed by mining.

In the event that cessation of mining operations was to occur in a coal-resource area with unmined but recoverable coal resources remaining, the following procedures would be implemented. If no further mining operations were to occur in the coal-resource area, final reclamation procedures, including backfilling and grading, topsoil replacement, and revegetation, would be carried out similar to all other areas proposed for mining disturbance as required under 25 CFR 211 and 30 CFR 59 and 132. Accurate survey information at the time of final mining operations would provide the location of final highwalls and coal-recovery limits in case mining is reinitiated at a future date resulting in a minimal loss of the coal resource. These procedures would minimize reaffecting the land in the event of future surface coal-mining operations. In cases where the abandonment is temporary (temporary cessation), the coal seam(s) would be covered, access to the pit area would be blocked, and the highwall would be bermed for safety. Any backfill or cover material that contacts the remaining coal seam(s) would be inert and contain no combustible material. Sediment control and environmental monitoring of the area would be continued. Survey information at the cessation of operations would provide accurate location of the final highwall and coal-recovery limits to facilitate reinitiation of mining operations with minimal loss of the coal resource and minimizing any reaffecting of the land as specified in 30 CFR 59 and 131. The decision to temporarily or permanently abandon operations is dependent on many factors including operational, market, contract, or customer.

APPENDIX B
SUPPLEMENTAL INFORMATION
WATER RESOURCES (HYDROLOGY)

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LIST OF ABBREVIATIONS AND ACRONYMS

2-D	two-dimensional
3-D	three-dimensional
af/yr	acre-feet per year
cfs	cubic feet per second
CHIA	Cumulative Hydrologic Impact Analysis
D aquifer	Dakota aquifer
EA	Environmental Assessment
EIS	Environmental Impact Statement
ET	evapotranspiration
LOM	life of mine
mg/L	milligrams per liter
N aquifer	Navajo aquifer
NPDES	National Pollutant Discharge Elimination System
NTUA	Navajo Tribal Utility Authority
OSM	Office of Surface Mining Reclamation and Enforcement
PHC	Probable Hydrologic Consequences
PWCC	Peabody Western Coal Company
TDS	total dissolved solids
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

APPENDIX B
SUPPLEMENTAL INFORMATION
WATER RESOURCES (HYDROLOGY)

A. IMPACT ASSESSMENT METHODOLOGY

This appendix describes the rationale and impact factors applied to assessing changes to the water resources of the study area due to the proposed action. The definition of key hydrologic impacts and the rationale for assigning impacts are described. A section also is presented that describes the analytical tools that were available for quantifying impacts, where appropriate and possible.

B. IMPACT ASSESSMENT TOOLS

SURFACE WATER

Chapter 18, Probable Hydrologic Consequences (PHC) in the approved Kayenta Mine permit application package (PAP) for the Kayenta Mine permit No. AZ-0001D provides detailed impact analyses on surface water flow and water quality. The PHC addresses potential impacts on runoff in Moenkopi and Dinnebito Washes at points just below the downstream portion of the Peabody lease area and for each entire basin at their confluence with the Little Colorado River. OSM recently updated the Cumulative Hydrologic Impact Assessment (CHIA) to evaluate the potential for damage to the hydrologic balance outside the Kayenta Mine permit area (USDI 2008). The hydrologic balance is the relationship between the quality and quantity of water inflow to, and water outflow from, a hydrologic unit such as a drainage basin or aquifer. The 2008 CHIA includes updated water resource information and determines potential mining-related hydrologic impacts on the existing and foreseeable water uses. The Cumulative Impact Area for surface water includes the uppermost portions of the Moenkopi and Dinnebito Wash watersheds down to a point in each wash that encompasses all of the potentially impacted areas of mining related activities within the Peabody lease area.

The assessment of impacts on surface water in this EA used data and analysis presented in the PHC of the Kayenta Mine PAP. Design drawings for typical sedimentation ponds, impoundments, and diversions as approved by OSM were utilized for assessing surface water impacts as appropriate. Potential impacts to surface water runoff were evaluated using data collected at gaging stations operated by the United States Geological Survey (USGS), and by Peabody Western Coal Company (PWCC) in accordance with procedures approved by OSM as described in Chapter 16, Hydrologic Monitoring Program in the Kayenta Mine PAP. Other runoff volumes were estimated using the program SEDIMOT II. SEDIMOT II was also used to predict the suspended sediment concentration of runoff entering the major washes (PWCC, 2005). Other water-quality impacts were evaluated using data collected by PWCC in accordance with methods described in Chapter 16, Hydrologic Monitoring Program.

GROUNDWATER

The effects of groundwater pumping for the Kayenta mining operation on the shallow aquifers (Wepo and stream alluvium) and on the deeper Navajo aquifer (N aquifer) have been investigated in numerous studies. Evaluation of project effects on groundwater considered information available from these studies and models and are discussed below.

B.1.1 Wepo and Alluvial Aquifers

Potential groundwater impacts of the mining plan were assessed for this EA using a variety of methods. Inflow to the mining pit from the Wepo Formation (coal) aquifer was assessed using an analytical model based on the constant drawdown, variable-discharge formula for confined aquifers (Jacob-Lohman method, in Kruseman and de Ridder 1994). Other modeling was accomplished using the computer code TWODAN.

Tests on wells drilled into the Wepo aquifer indicate transmissivity values of between 0.07 and 1,990 gallons per day per foot. This large range indicates considerable heterogeneity in hydraulic conductivity, consistent with a deltaic depositional environment. Reported storage coefficients for the Wepo aquifer are between 1.9×10^{-5} and 1.45×10^{-4}, indicating confined or delayed yield conditions in the area of the test wells. PWCC has evaluated the hydrogeology of water flow to the open pits from the Wepo aquifer using simple models, which assume homogeneous hydrostratigraphy (PWCC 2005). Aquifer testing indicated that some flow in the Wepo aquifer is confined and that coal beds act as confining layers in some sequences. In general, however, groundwater modeling assumed that the alluvial and Wepo aquifers were hydraulically connected and, upon excavation, groundwater would flow towards the face of the mine pits. Wepo-aquifer water from background wells located a significant distance from the area disturbed by mining indicates median sulfate concentrations may be as high as 1,100 milligrams per liter (mg/L).

B.1.2 N Aquifer

N Aquifer Description

The N aquifer includes the Navajo Sandstone, sandstones of the Kayenta Formation, and the Lukachukai member of the Wingate Formation. The N aquifer consists of 4 million acres within the Little Colorado River basin. The aquifer is composed of fine-grained sandstone alternating with siltstone and ranges in thickness from a few feet to 1,300 feet thick (Farrar 1979). The average thickness of the aquifer is approximately 400 feet (Eychaner 1983). Groundwater primarily occurs in the Navajo sandstone, where the total water in storage has been estimated at 166 million acre-feet (Eychaner 1983). Transmissivity values in the N aquifer range from 560 to 2,600 gallons per day per foot and storage coefficients are estimated to range from 0.00022 to 0.008 for the confined portions of the aquifer and 0.10 to 0.15 for the unconfined aquifer areas (PWCC 2005).

The underlying Kayenta and Wingate Formations also contain water, and a volume of 450 million acre-feet was calculated from the 3D flow model developed by GeoTrans and Waterstone for PWCC (1999). Recharge to the N aquifer occurs primarily from precipitation falling on outcrops of the Navajo sandstone and is estimated to range between 2,500 and 3,500 af/yr (for the outcrop area north of Black Mesa) to 20,248 af/yr (Brown and Eychaner 1988 ; Eychaner 1983; GeoTrans 1987; Lopes and Hoffman 1997; and Zhu 2000), with a median recharge rate of 13,000 af/yr. Most of the N aquifer is confined in the center of the basin. As recharge is largely limited to the margins, water levels in the N aquifer throughout most of the basin do not respond to short-term changes in recharge. However, water levels in the recharge areas can respond to precipitation events.

Recharge of this system generally occurs in the north-central part of the aquifer, north and west of Kayenta, where N aquifer formations are exposed at the land surface and precipitation is relatively high. Some N aquifer groundwater flows to the northeast, where it discharges into Laguna Creek; to the northwest where it discharges into Navajo Creek; and to the southwest where it discharges into Moenkopi Wash and other washes southwest of the PWCC lease area. Navajo Creek is separated from the N aquifer underlying the Black Mesa basin by a 40-mile wide unconfined area, which isolates Navajo Creek from any pumping effects in the aquifer beneath Black Mesa (see Figure D-2).

Perennial stream reaches and springs occur along washes in the unconfined part of the N aquifer, and could be affected by groundwater pumping from the N aquifer. Areas of groundwater discharge that have been modeled to assess potential impacts due to pumping include:

- Chinle Wash
- Laguna Creek
- Pasture Canyon
- Moenkopi Wash
- Dinnebito Wash
- Oraibi Wash
- Polacca Wash
- Jaidito Wash
- Begashibito Wash/Cow Springs

In the 1989 CHIA, N aquifer groundwater impacts were analyzed using a reconstructed version of the USGS groundwater model of Eychaner (1983). The model used in the 1989 CHIA was a two-dimensional (2-D) model of the N aquifer system based on MODFLOW (Brown and Eychaner 1988). PWCC commissioned HSI GeoTrans and Waterstone to develop a three-dimensional (3-D) groundwater flow model of the N aquifer and Dakota aquifer (D aquifer) (PWCC 1999). These models are described below.

- ***USGS Black Mesa Model***. The USGS developed a finite-difference model of the N aquifer in 1983. This model was upgraded, including reformatting to the MODFLOW code, in 1988 by Brown and Eychaner and again in 2000 to reflect 1999 conditions. The model was designed to evaluate the impacts of current and future groundwater withdrawals for PWCC coal mining, as well as municipal withdrawals from surrounding Indian communities.

  The model is 2-D and is comprised of one layer that represents the N aquifer. A general head boundary was used to simulate vertical flow between the D aquifer and N aquifer. The model was calibrated to equilibrium conditions (pre-1965) and to transient conditions (1965-1984). The aquifer's response to pumping was predicted to 2051 for five pumping alternatives.

  This model has undergone the most extensive peer review of the available models. It is generally recognized as providing a reasonable simulation of the N aquifer's response to pumping.

- ***GeoTrans D and N Aquifer Model***. PWCC retained HSI GeoTrans and Waterstone to develop a finite-difference model of the D and N aquifers using the MODFLOW numerical code (PWCC 1999). This is a regional 3-D groundwater flow model developed to estimate the effects of pumping by PWCC and several Indian communities on the aquifers and on surface water flows.

The GeoTrans model covers a slightly larger area than the USGS model. Additional hydrogeologic field data were collected and compiled as part of studies to develop the model. The model has seven layers and simulates the D aquifer, N aquifer, and intervening Carmel Formation aquitard. Recharge is estimated through a complex function of precipitation, soils, and topography. Predevelopment water levels (1956) were used for steady-state calibration of the model. Initial transient calibration used 1956 to 1996 water levels. The model has undergone extensive sensitivity testing and validation. Evaluation of the model indicates that it successfully simulates historic water-level response to pumping in the N aquifer. It also produces N aquifer drawdowns that are essentially the same as the USGS model.

Both the USGS and GeoTrans models estimate changes in groundwater levels and aquifer discharge over time. Aquifer discharge occurs primarily through discharge to streams and springs. However, neither model attempts to simulate individual spring flows, which typically occur within a limited local area. This is due to (1) the regional nature of the models (including grid size); (2) the lack of detailed hydrogeologic information on individual springs, including measured spring flow; and (3) the limited drawdown in the unconfined area of the aquifer where springs occur (PWCC 1999). The models do simulate groundwater discharge to streams on a regional scale where discharge occurs over many miles of stream reach. This discharge is essentially made up of multiple spring discharges, in that groundwater is moving into the stream channel or alluvium, such as at Begashibito Wash/Cow Springs, discussed previously. In an arid environment such as Black Mesa, not all of this groundwater discharge appears as stream flow; much of it is evapotranspired or becomes alluvial-aquifer subflow.

OSM independently reviewed the GeoTrans model and determined that the model satisfies the intended objectives and is the most comprehensive groundwater assessment tool for predictive impact evaluations necessary to address concerns related to PWCC's pumping of the N aquifer. For the following reasons, the GeoTrans model, rather than the USGS model, is used to describe the impacts (water-level and streamflow changes) due to N aquifer pumping scenarios evaluated in this EA:

- It has a more comprehensive inclusion of hydrologic features and multiple aquifers;
- It has a finer grid spacing, which allows for a more accurate simulation of pumping effects near both the mine and adjacent communities;
- It incorporates more recent data on water levels and withdrawals;
- It examined a longer historical data period (beginning in 1956 rather than 1965);
- It provides a more detailed characterization and analysis of system recharge;
- It evaluates geologic structure that influences groundwater flow;
- It provides better model boundaries and increases the model extent; and
- It provides a more complex definition of the hydrologic system, using additional model layers to simulate the D aquifer system.

Groundwater models are widely acknowledged to be "non-unique." Different models (boundary conditions, geometries, material properties, solution techniques) can produce equally good agreement with available information. However, they may yield different results when used to make predictions. Therefore, after the base model was developed by GeoTrans and Waterstone, three additional models that used different assumptions for recharge rate and upland evapotranspiration (ET) were also calibrated to determine if different water-budget assumptions had much of an effect on the predictions made by the models. This effort determined that although the modeling results were slightly different, the impact on the predictions was very minor. Because more effort had been spent calibrating the base-case model, its agreement with water-level data was slightly better than the agreements of the other three models, and the base-case model has been adopted for the predictions used in this EA.

An important aspect of using models to guide resource management decisions is to evaluate whether the model results agree with data not used to calibrate the model, such as newly collected water-level data. If the agreement is good, confidence in the model's predictive ability is increased. However, if the agreement is poor, the need for additional calibration work is indicated.

The accuracy of the 3D model to simulate water-level changes beyond the calibration period was tested using pumping and water level data through 2009, which includes the period beginning in January 2006 when PWCC pumping was considerably less than in previous periods. Water-level data from the BM-series wells and annual community pumping data were obtained from USGS through the end of 2009. Monthly pumpage data from each of the PWCC production wells were used in the simulations.

Simulations were performed using the four different models described in PWCC (1999). As mentioned above, these four models, each individually calibrated, use a combination of two different recharge rates and two different upland (non-stream) discharge values simulated using different maximum ET rates. For the model validation tests, only the pumping rates for the period 1997 through 2009 were updated from the 1999 report; no other changes were made to the modeling data sets.

In the following temporal drawdown figures, the drawdown is calculated based on the time of the first available measurement in the indicated well. Errors in the first measurement would affect the calculation of the measured drawdown values. The effects of errors may be greatest at BM-3, which displays considerable variation in water level because of local pumping.

Figures B-1 through B-6 provide comparisons of measured and predicted drawdown for the four models for the BM-series wells through 2009. At BM-1, the agreements of the two models using the full recharge values are better than for the two models using half the full recharge values; the base case provides the best fit to the data. There is a measured long-term trend of declining water levels, with less than 1 foot of decline over more than 30 years. All four of the models predicted more drawdown for the calibration period than was actually observed. Thus, it is expected that they continue to predict more drawdown than has actually occurred.

At BM-2, the predicted drawdowns for the four models are about 15 feet less than the total drawdown observed over the calibration period. The agreement between measured and simulated drawdown appears to have improved after about 1992, and all four models do a reasonably good job of approximating measured drawdown through the end of the calibration period. The base case and low upland discharge models provide the best fit to measured data. In recent years, measured drawdown has been occurring more rapidly than predicted drawdown. The simulations show a small response to the reduction in pumping by PWCC in 2006. The measured values show that the rate of drawdown has decreased but that water levels have not yet started to rise.

The comparison of simulated and measured values is more difficult at BM-3 because the impacts of variable local pumping and the resultant high variability of water levels in the well. The four models approximate the measured water level changes equally well. The low upland discharge model provides better simulation results to an increase in drawdown between approximately 1977 and 1984 than the other three models. Although variability in the measured values makes comparison with the simulated values uncertain, the four models appear to simulate a slightly greater rate of drawdown than the measured values from end of calibration through 2009. Effects of reduced pumpage by PWCC are not apparent in the data. The simulations show a slight decrease in the rate of drawdown.

Little change has occurred in water-level measurements in BM-4. A decline in water levels of approximately 1 foot occurred between 1998 and the beginning of 2003, but levels increased back to pre-1998 levels, and then began to decline again. The cause for the short-term decrease is not known. The models are beginning to simulate a small (<0.1 foot) amount of drawdown at this well.

The most recent 13 years of water level data (since the end of the calibration dataset) at BM-5 are approximated very well by the four models, although the agreement of the full recharge/low ET model is not quite as good as the other three. The rate of drawdown at the well has decreased slightly since PWCC pumping decreased at the end of 2005. Water levels at BM-5 will likely remain depressed due to nearby community pumping centers. The models match this change well.

At BM-6, the full recharge/low ET model simulates about 20 percent less total drawdown than that measured over the calibration period, and less than the other three models. The rates of change calculated by the other three models agree quite well with the measured rate of change, although the base-case (full recharge/ET) and the half-recharge, low upland discharge models provide the best overall fit to the calibration data. The reduction in PWCC's pumping at the beginning of 2006 is apparent in the data and the simulation results, with the models having a slightly earlier and slightly faster recovery than the measurements. From the end of calibration through 2007, the base-case and half-recharge, low upland ET models continue to provide the best fit to the measured drawdown. The agreement between measured drawdown and the predicted drawdowns calculated from these two models over this time period indicates that the two models should reliably predict drawdown for many years.

The four models match the observed water-level changes at the six BM monitoring wells reasonably well. The base-case model provides the best overall fit. The comparisons indicate that model recalibration is not warranted at this time, and support the ability of the models to reasonably predict the effects of pumping by PWCC within the groundwater basin.

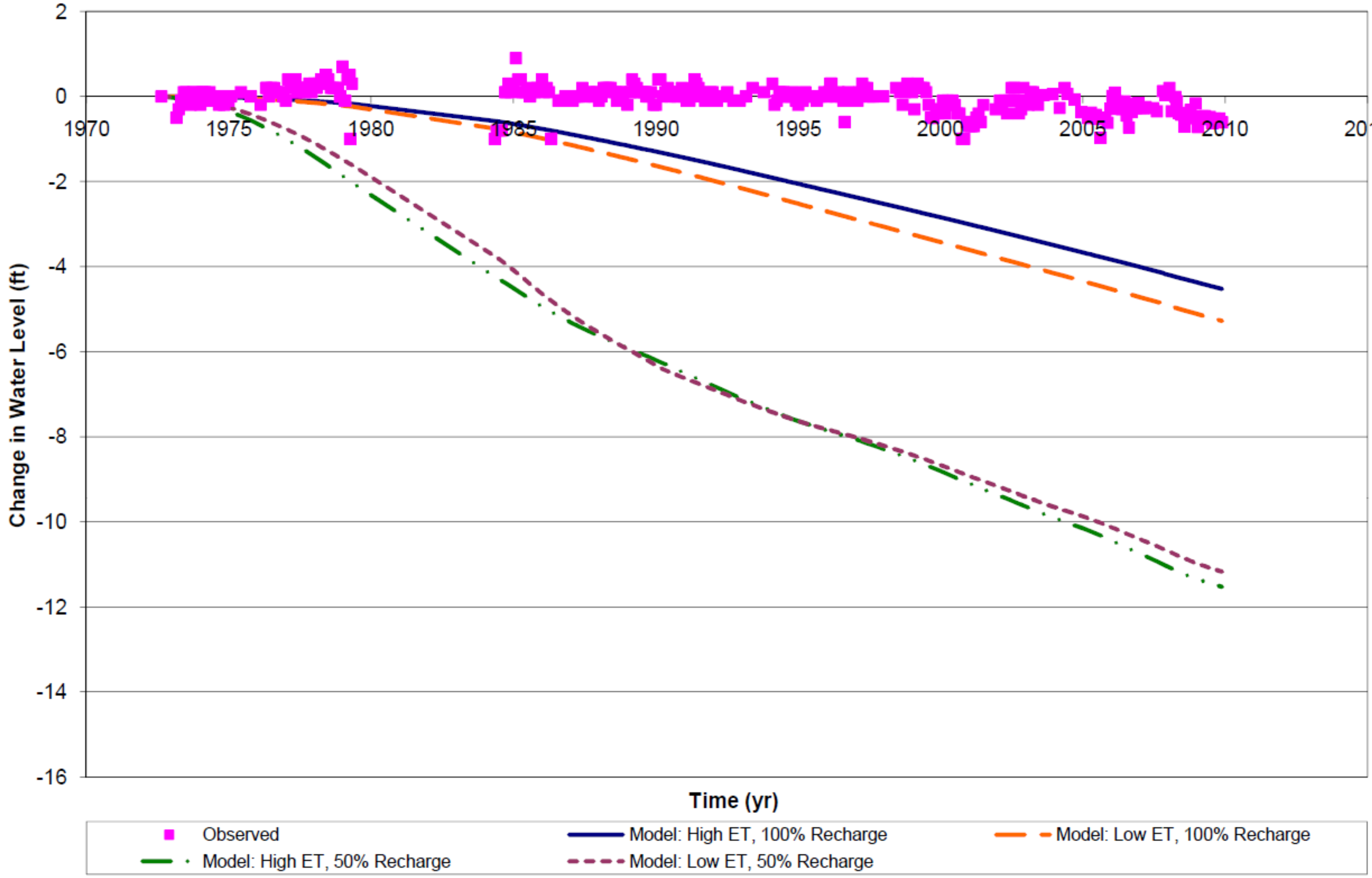


Figure B-1 Simulated and Measured Drawdown at BM-1

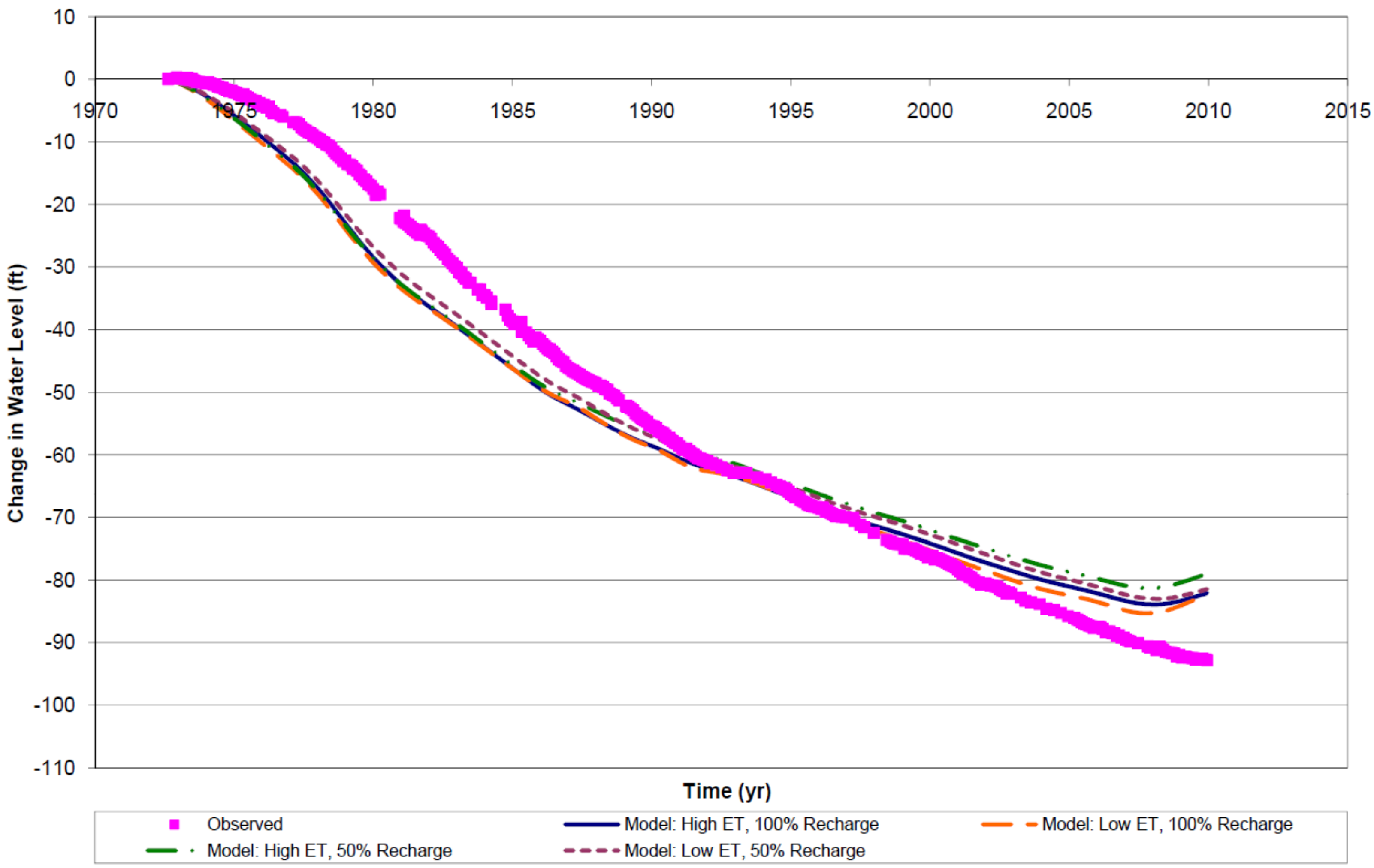


Figure B-2 Simulated and Measured Drawdown at BM-2

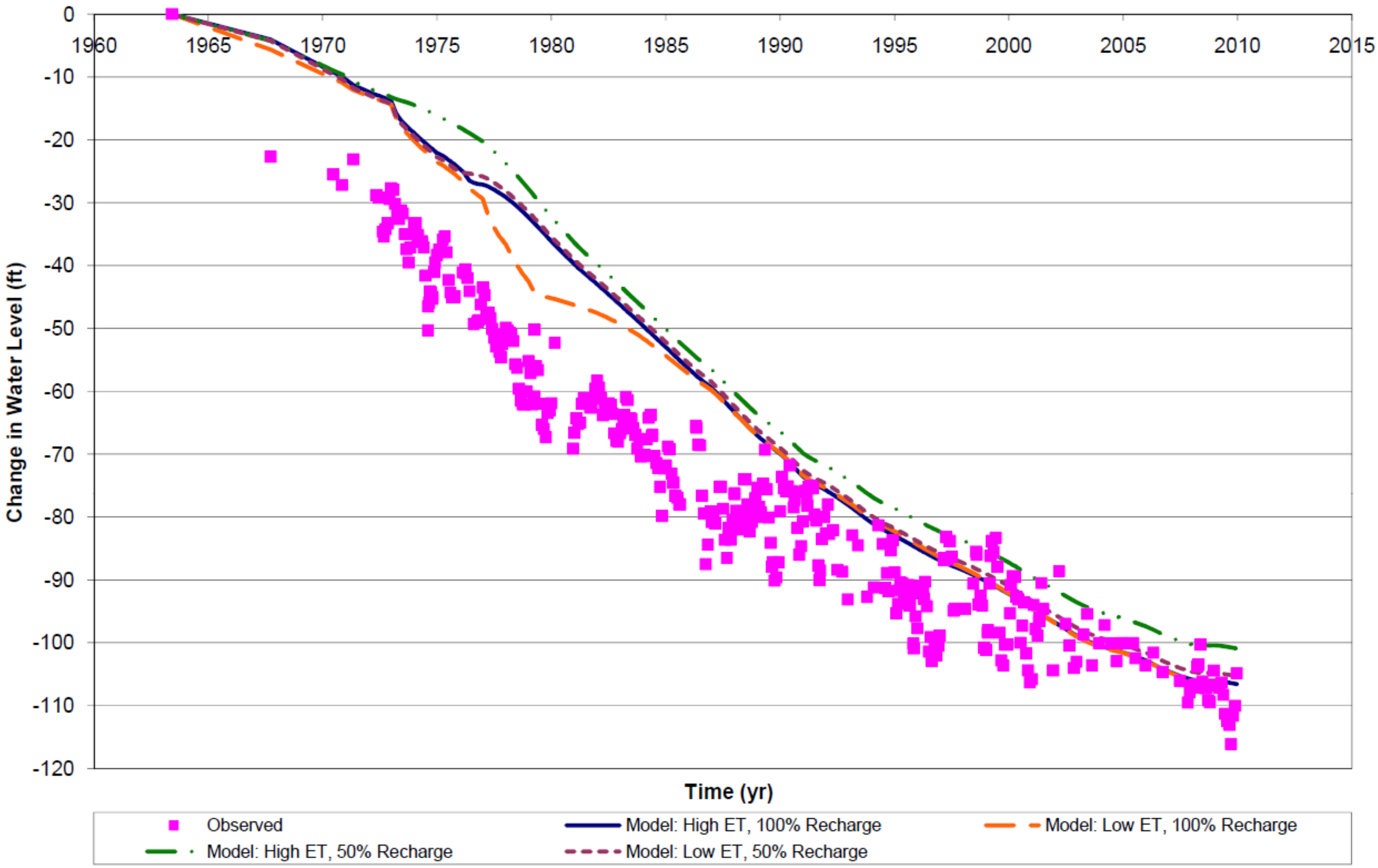


Figure B-3 Simulated and Measured Drawdown at BM-3

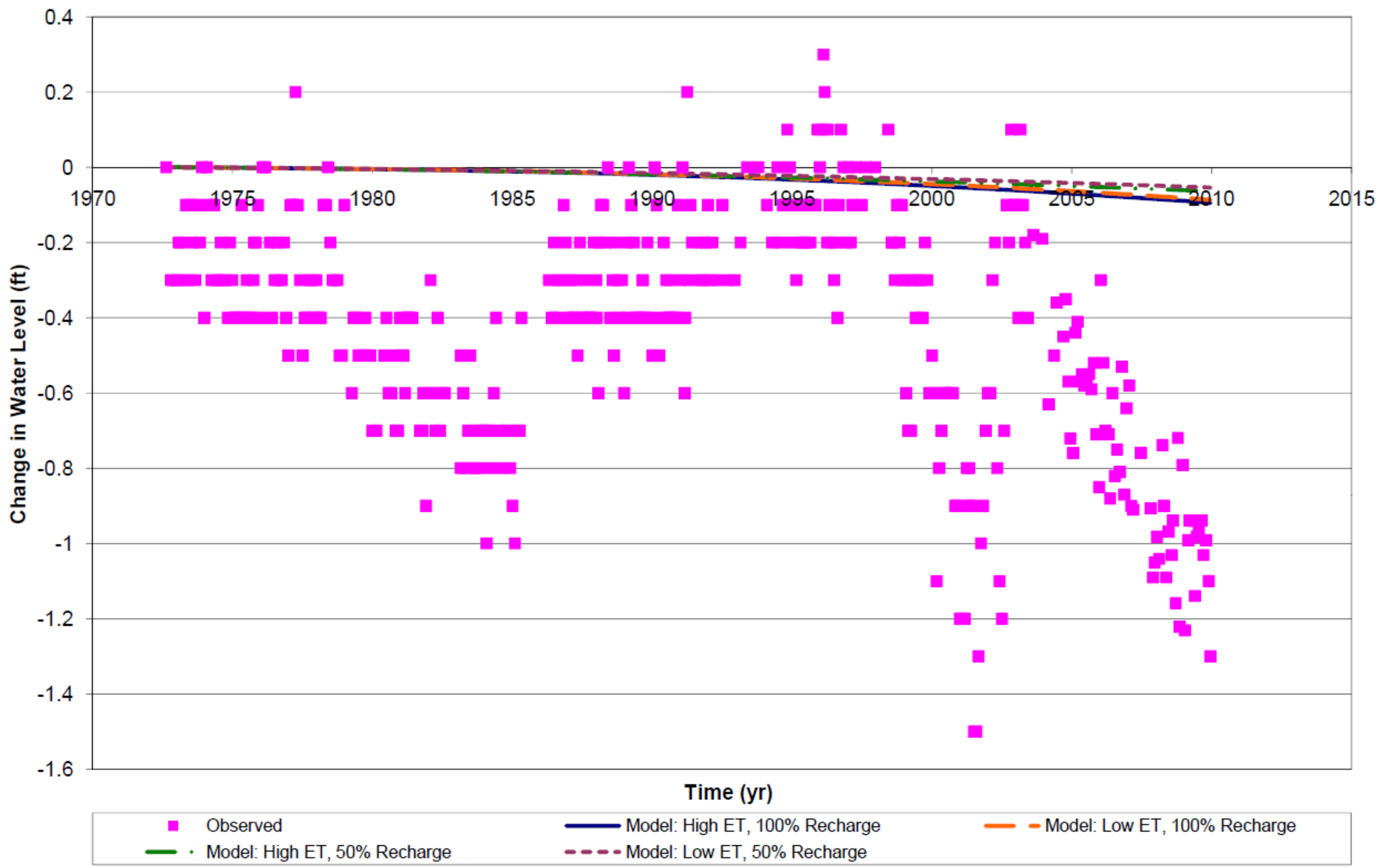


Figure B-4 Simulated and Measured Drawdown at BM-4

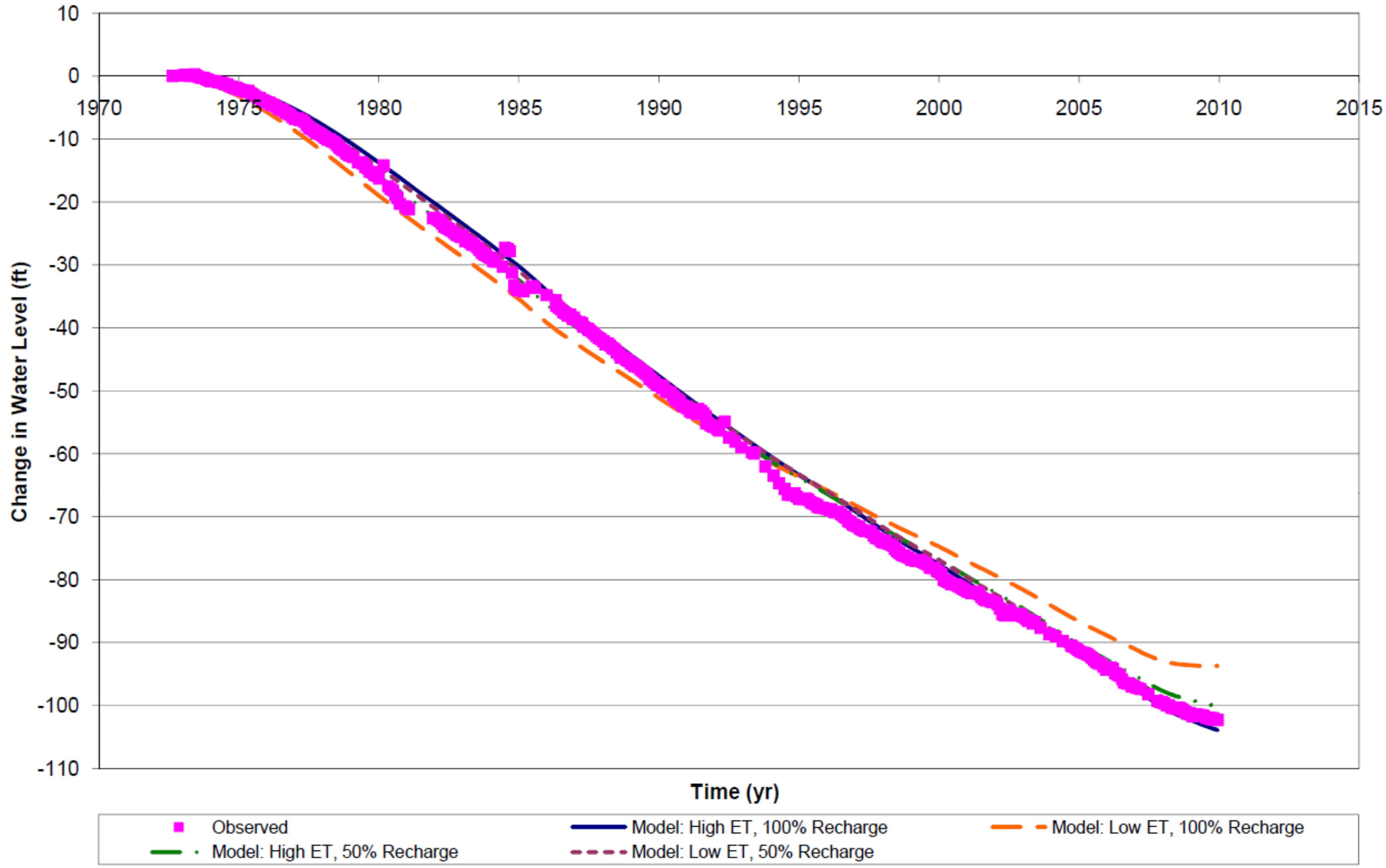


Figure B-5 Simulated and Measured Drawdown at BM-5

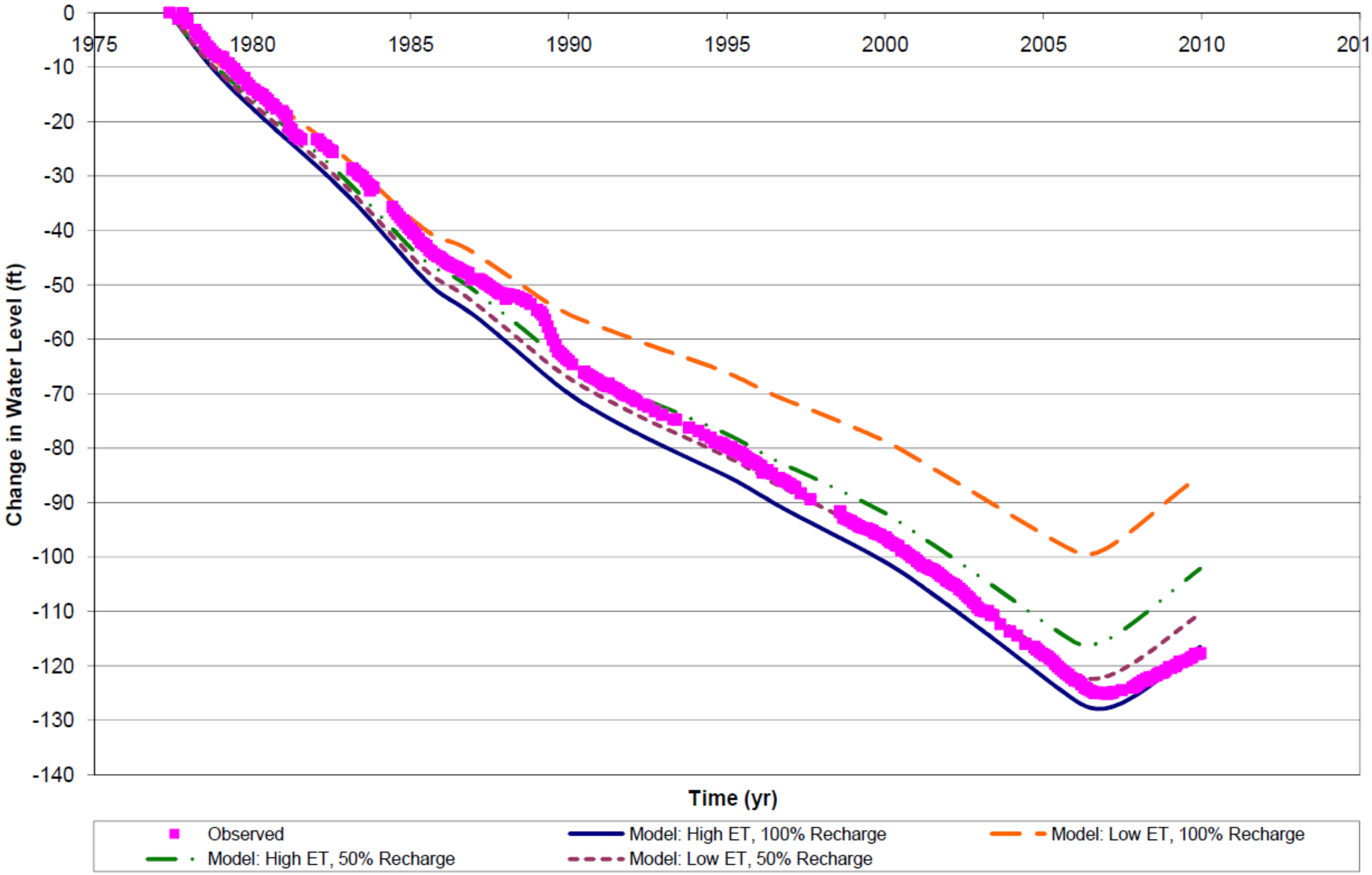


Figure B-6 Simulated and Measured Drawdown at BM-6

C. HYDROLOGIC IMPACTS

REGION OF INFLUENCE

C.1.1 Groundwater

The primary region of influence from groundwater pumping is the area that would be impacted by the projected drawdown caused by that pumping. As a practical matter, the area might reasonably be defined as the area within the 0.1-foot drawdown contour under the maximum pumping scenario, as this is the lower limit of what is assumed to be potentially measurable (water levels are often measured to 0.01 foot; however, this is arguably within the measuring error of most commonly used equipment). Furthermore, ambient water-level fluctuations due to tides, barometric pressure, and temperature changes usually exceed 0.01 foot and even 0.1 foot, making it difficult if not impossible to measure changes relative to ambient conditions.

For the N aquifer, the region of influence includes the confined area of the aquifer and extends to the gauges on measured streams and springs located in the unconfined portions of the aquifer. Gauged streamflow data are available for four washes that are supported by N aquifer discharge—Moenkopi Wash, Laguna Creek, Dinnebito Wash, and Polacca Wash. Measured N aquifer springs include Moenkopi School, Pasture Canyon, Burro, and the unnamed spring near Dennehotso (U.S. Geological Survey [USGS] 2005). Location of the washes, springs, and other key features relative to the N aquifer well field are shown on Map D-2.

C.1.2 Surface Water

The region of influence encompasses Moenkopi and Dinnebito Washes at points just below the downstream portion of the Peabody lease area and for each entire basin at their confluence with the Little Colorado River.

C.1.2.1 Key Hydrologic Impacts

Hydrologic impacts can be summarized under three key types. These include:

- impacts of drawdown on the aquifer and other water users;
- diminution of stream and spring flow; and
- changes in groundwater and surface water quality.

C.1.2.2 Impact Levels

In assessing the principal hydrologic impacts it is necessary to assess the severity of an impact. This is accomplished through the assignment of an *impact level* to the identified impact. Impact levels for hydrology are defined below.

- *Major* – Adverse impacts: effects that result in a violation of water-quality standards or that economically, technically, or legally eliminate use of the resource. Beneficial impacts: those that would improve water quality or contribute to or restore water resources capability to the region, such as to greatly increase the potential for human or ecological use.
- *Moderate* – Effects that are outside of the random fluctuations of natural processes but do not cause a significant loss of the use of the resource. Moderate beneficial impacts would simply extend the beneficial use beyond natural variations about the current mean value.
- *Minor* – Changes that would affect the cost or quality but not the use of water or are similar to those caused by random fluctuations in natural processes.
- *Negligible* – Impacts of less magnitude, but still predictable under current technology (e.g., computer models) or measurable under commonly employed monitoring technology.
- *None* – Effects that are not predicted or cannot be measured.

Assignment of the impact levels is based on analysis and professional judgment. In general this study follows the impact evaluation criteria developed for the Bureau of Reclamation's Assessment of Western Navajo and Hopi Water Supply Needs, Alternatives and Impacts (HDR 2003). The analysis and determination of impact levels for each of the key hydrologic impacts are described below. It should be noted that the hydrologic impacts in this section focus on the quantity and quality of surface and groundwater available for municipal, irrigation and industrial uses; it is understood, however, that other uses, such as for fish and wildlife are also important. Impacts on these uses have impact values developed separately (see Section E.1).

C.1.2.3 Impacts of Drawdown on the Aquifer and Other Water Users

The impact of pumping is commonly measured by a projected lowering of the water level in the pumping wells and in wells located within the cone of depression created by the pumping well(s). The lowering of the water level creates five primary effects, as follows:

- Increase the cost of pumping by increasing the lift to get the water to the land surface.
- In unconfined aquifers a reduction in saturated thickness of the aquifer surrounding the well and consequently the transmissivity (ability of the aquifer to transmit water to the well). In severe cases, a well can cease to produce water or "go dry."
- In confined aquifers a reduction in saturated thickness of the aquifer surrounding the well if the water level drops below the top of the aquifer and consequently reduces the aquifer transmissivity.
- Lowering of aquifer water levels in the area of perennial streams and springs. Lowered aquifer water levels can result in a diminution of groundwater discharge and/or depletion of stream base flow and spring flow.

- Migration of man-caused or natural poor quality groundwater toward the well field.
- Extensive long-term pumping can increase the potential for subsidence in unconsolidated aquifer systems due to compression of fine-grained layers and, in some limestone aquifers, can foster sinkhole development due to removal of cavity filling material and dissolution of the limestone.

C.1.2.4 Cost of Pumping

The cost of pumping groundwater is given by the following equation (Campbell and Lehr 1974):

$$Cost \ / \ Hour = \frac{(pumping\ rate\ (gpm))\ x\ (Lift + friction\ (ft))\ x\ (0.746)\ x\ (power\ (K/kW-hr))}{(3960)\ x\ (pump\ efficiency)\ x\ (motor\ efficiency)}$$

The cost of groundwater pumping in the study area was estimated by applying power costs ($0.074 per kilowatt hour) cited by the Navajo Tribal Utility Authority (NTUA) for residential power, and typical Arizona well values for the following parameters (HDR 2003):

- Pump efficiency (75 percent)
- Motor efficiency (90 percent)

There is a cost for lifting the water, and a separate cost for associated with the pressure loss caused by friction in the pump column. The following discussion only addresses the cost for lifting the water, as that cost is a function of the depth to water, and thus the drawdown caused by pumping at the PWCC wellfield. The term “friction” in the above equation is set to zero, so that the calculated cost only reflects the cost to lift the water.

Wells that tap the confined portion of the N aquifer (where the greatest N aquifer pumping impacts occur) are generally deep and limited to industrial (e.g., PWCC) or municipal users. Based on modeling studies, NTUA Forest Lake Well #1 is projected to experience the greatest drawdown due to mine pumping (GeoTrans 2006). Depth to water in this well in 2009 (latest measurement available) was 1,186 feet below ground surface (USGS 2010). Assuming the above unit cost factors and the 2008 average pumping rate of 10.2 acre-feet per year (af/yr), the average cost per hour is $0.154, or $1,356 per year for NTUA Forest Lake Well #1.

Community wells at Piñon produce more water, supplying about 319.1 af/yr in 2008 with a lift of 904.9 feet (measured in 2009). Annual lifting cost of power for these wells is estimated to be $27,526. Wells at Piñon are farther from the mine than Forest Lake and will experience less recovery. For example, under the proposed N aquifer pumpage (1,236 af/yr), the reduced lift resulting from the reduction in PWCC’s pumping is predicted to be 15 feet at Piñon at the end of 2025 (compared to 2010) versus 51 feet at Forest Lake. This translates into an estimated decrease in annual lifting power cost of $456 at Piñon and $49 at Forest Lake, or a 1.7 and 4.4 percent decrease, respectively.

It should be noted that many D aquifer stock-watering wells have windmills and not electric pumps. For these wells, costs do not increase when the water level declines, as long as the decline does not require the pump to be set deeper. The pump setting depth in wells in the area is generally unknown. Assessing the impact of project pumping on these wells relies on available data on the height of the water column in the well (depth of the well minus the static water level) and is evaluated in the same manner as the potential reduction in aquifer saturated thickness, as described in the subsequent subsection, Impacts on Aquifer Thickness (Saturation).

Impact on Pumping Cost

The annual cost of pumping (in 2010 dollars) at Piñon at five different times [pre-mining (1955), reduction in pumping in 2005, present day (2010), proposed action (2015), and proposed action (2025)] are given in Table B-1. All costs assume a constant annual average pumping rate (2009 water use) and 2010 electricity cost. The estimated pumping costs (lift only) due to the effects of PWCC pumping and community pumping are identified.

Table B-1 Estimated Cost of Pumping Years 1955, 2005, 2010, 2015, and 2025

Condition (Year)	Total ($/year)	PWCC ($/year)	Community ($/year)
Pre-mining (1955)	26,612	0	26,612
Reduction in mine pumping (2005)	31,113	2,581	28,532
Present (2010)	31,640	2,806	28,834
Proposed action (2015)	31,756	2,715	29,041
Proposed action (2025)	31,982	2,286	29,696

This analysis shows that the incremental cost of pumping due to drawdown caused by mine-related pumping is between 7 and 9 percent of the community’s lift-only pumping cost. Table B-2 provides the impact level and the correlated percent increase in pumping cost. Pressure drop in the pump column is not considered in the cost estimate because that is determined by the depth of the pump, not the lift. The cost caused by pumping at the mine increased slightly between 2005 and 2010, and is estimated to decrease from 2025 and beyond. The estimated cost resulting from drawdown caused by local pumping increases from 2005 to 2025.

The lease agreements with the tribes provide for royalty payments for use of the N aquifer water based on the amount of water withdrawn. The total yearly average of water use fees paid to the Hopi and Navajo by PWCC is $3.2 million. Each Tribe has sole discretion on the distribution of the $1.6 million average yearly fee.

Table B-2 N Aquifer Impact Levels, Increase in Pumping Cost Criteria

Impact Level	Percent Increase in Pumping cost
Major	>51
Moderate	26-50
Minor	11-25
Negligible	1-10
None	0

C.1.3 Impacts on Aquifer Thickness (Saturation)

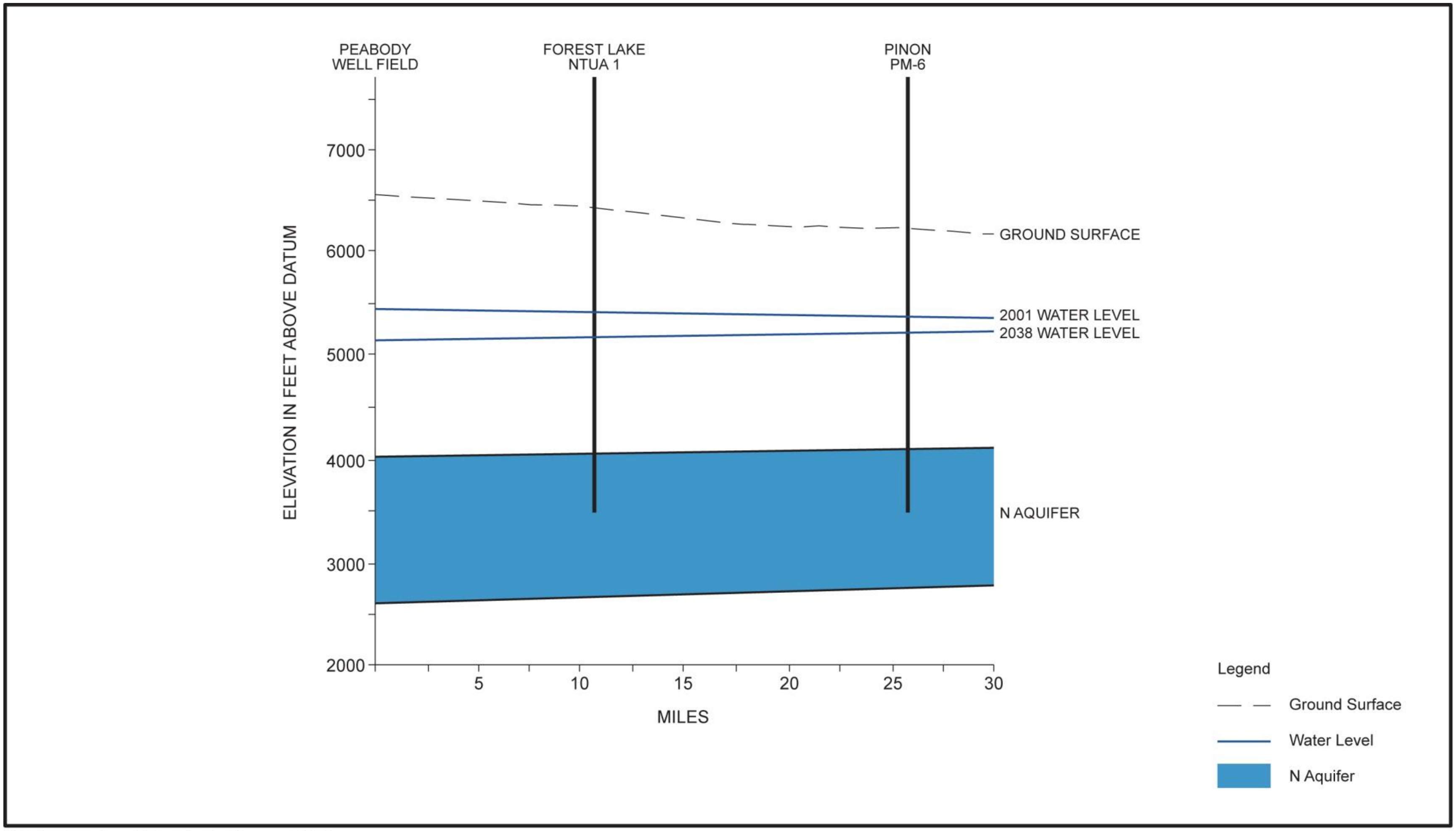
When water levels in the area of influence of the well fields are below (or fall below) the top of the aquifer, the aquifer is potentially subject to dewatering over time (so long as aquifer water levels decline). Dewatering reduces the aquifer's saturated thickness (amount of the aquifer that is full of water) and therefore its ability to yield water to wells (transmissivity) in the area of the well field. For unconfined aquifers, 90 percent of the maximum well yield is obtained at 67 percent of the maximum drawdown (Driscoll 1986). In practice, however, the water level cannot be drawn down to the bottom of the aquifer. In addition, most wells exhibit some well loss (a function of the aquifer, well construction and pumping rate), resulting in the pumping water level inside the well deeper than the water level in the aquifer immediately outside the well. A conservative range of between 20 percent (negligible) and 50 percent (major) reduction in aquifer thickness criterion was selected for this study to account for these expected variations from the theoretical.

In the N and D aquifers, almost all of the wells that are predicted to experience water-level declines due to PWCC-related pumping are located in the confined portion of the aquifer and are not predicted to have their water levels lowered below the top of the aquifer (Figure B-7). In other words, the aquifer remains fully saturated and no reduction in saturated thickness or transmissivity is predicted for the N and D aquifers.

The criteria shown in Table B-3 are applied to assess the effect of aquifer dewatering on a well's ability to sustain its long-term yield.

Table B-3 Impact Levels, Reduction in Saturated Thickness Criteria

Impact Level	Percent Reduction in Saturated Thickness
Major	>51
Moderate	31-50
Minor	21-30
Negligible	1-20
None	0



SOURCE: Southwest Ground-water Resources 2006

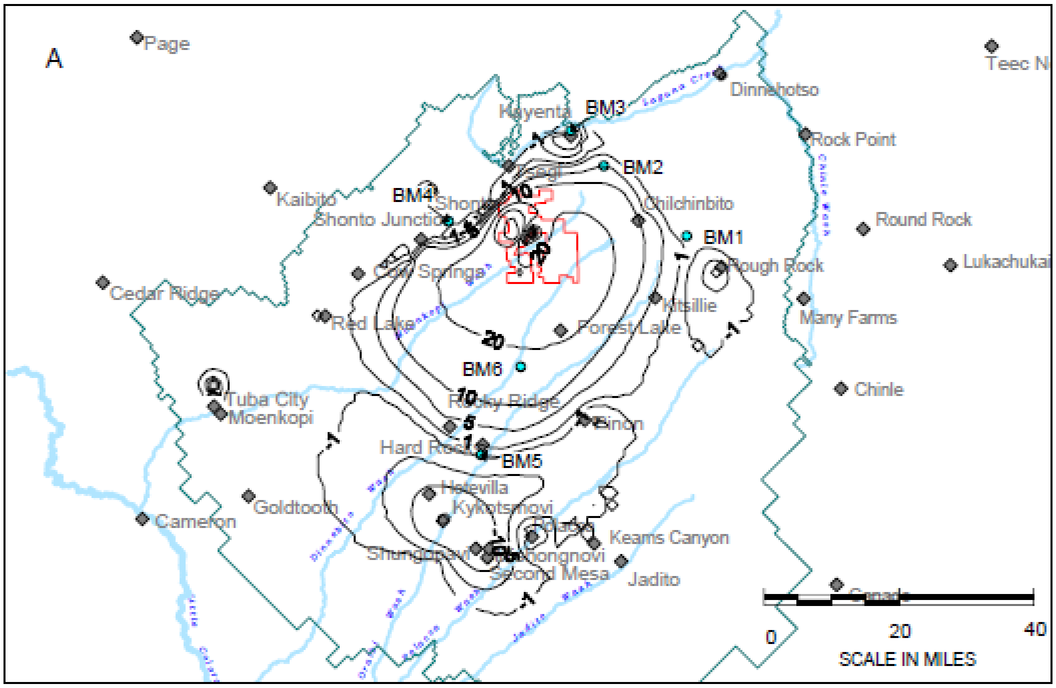
Figure B-7 N Aquifer Relationship Between Maximum Project Pumping and Aquifer Saturated Thickness

Effects in N Aquifer

The GeoTrans numerical model is used to assess the impacts of pumping from the N aquifers because it is the most representative of the complexities of this aquifer system. In the simulations, actual pumping rates were used for the PWCC well field through June 2010. From July 2010 through June 2025 (which includes the 5-year period that is the subject of this EA), the pumping rate was assumed to average 1,236 af/y. This period was followed by three years of pumping at 505 af/y (to 2028), and an additional 10 years at 444 af/y (to 2038). The database used to specify the community pumping rates was updated through 2009. However, the future community pumping rates were projected based on an evaluation performed using data through 1986, which found that community pumping would increase at a rate of 2.7 percent on average (GeoTrans. 2006). More recent data show that the rate of growth has decreased over the last 10 to 15 years. The forecast for community water usage was estimated at 4,400 af/y for 2008, but the reported usage was approximately 2,900 af/y (Macy 2010). In 2009, the reported community water usage was slightly lower (Macy, written communication). Thus, the model used higher community pumping rates for the period of 2010 through 2038 than will probably occur unless there is significant community growth.

Figures B-8 through B-10 show the simulated changes in water levels in the N aquifer for July 2015, July 2025, and July 2038. The predicted water levels are shown relative to a July 1, 2010 baseline. The maps (A) at the top of each of these figures show the predicted drawdown in the N aquifer as the result of all pumping (community and PWCC), and the maps (B) at the bottom show the simulated drawdown caused by PWCC's pumping alone. Because PWCC's pumping was reduced in December 2005 after many years of pumping at rates approximately four times higher than has occurred since then, the predicted water levels have risen (indicated as drawdown values that are less than zero) throughout the period of the simulation in the central part of the basin. In 2015, the simulated water level recovery near the PWCC lease area is between 20 and 30 feet during this 5-year time period. [Note that this recovery is the simulated rise in water levels after July 2010; recovery also occurred between December 2005 and July 2010, when the pumping rate was reduced, but is not shown on these figures.] Near some of the PWCC production wells, the simulated recovery is greater. The simulated recovery decreases to small values near the N aquifer boundary between confined and unconfined conditions, as the total drawdown prior to 2005 was also small near this boundary. The greatest differences in simulated drawdowns shown on Figures B-8 through B-10 are near the communities, where local pumping is predicted to cause continued drawdown. [Recall that the community pumping used in the predictions is greater than is likely to actually occur, and that the drawdown caused by community pumping will likely be less than predicted.]

By 2025, the water level recovery is predicted to be more than 30 feet (relative to 2010 levels) within most of the central part of the basin. Recovery will continue until 2038 (and beyond), so that water levels in the central part of the basin are predicted to recover more than 50 feet. These predicted recoveries are in addition to the recoveries that occurred in the period from the end of 2005 to July 2010.



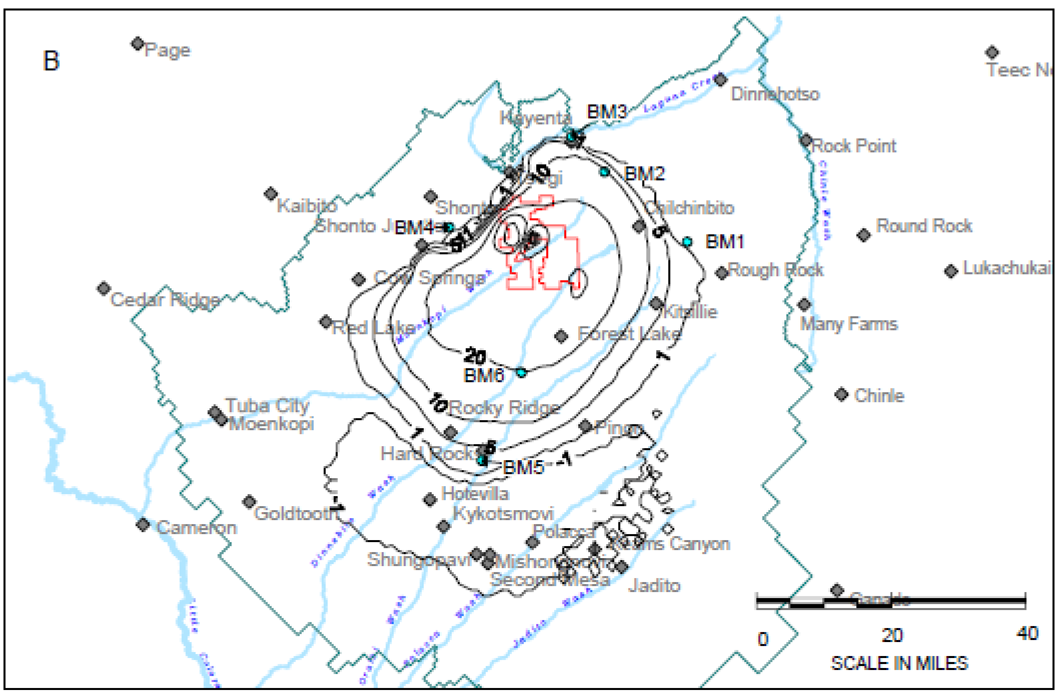
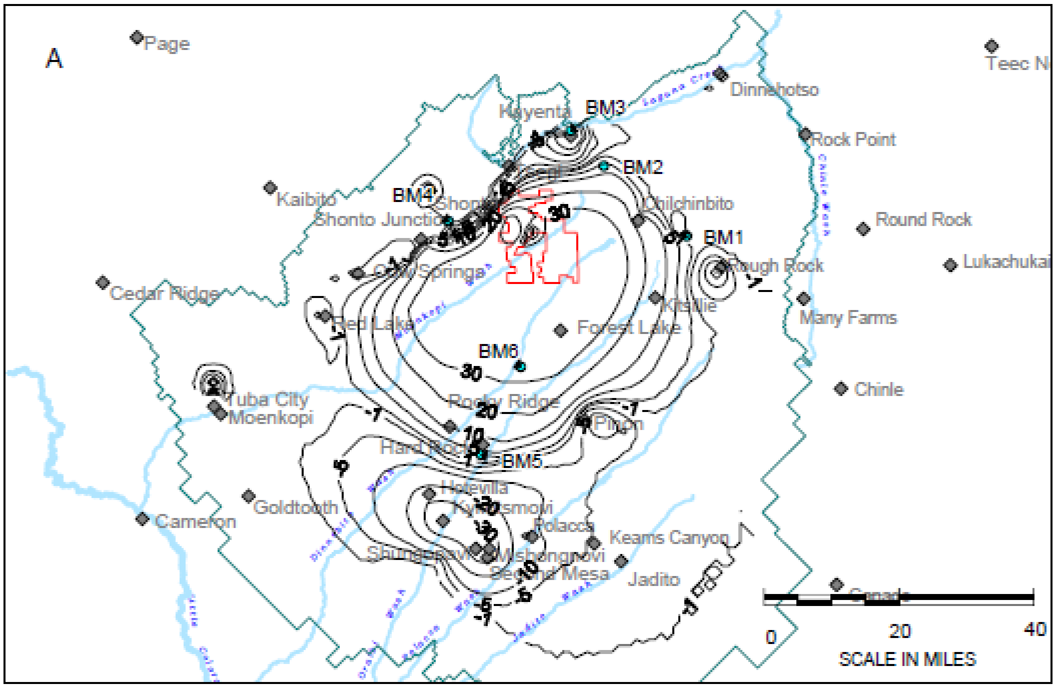


Figure B-8 Simulated Change in N Aquifer Water Levels 2010-2015

NOTE: A: Peabody and community pumping.
B: Peabody pumping only.
The contour interval is 50 feet, with supplemental contours for 1, 5, 10, 20, and 30 feet.



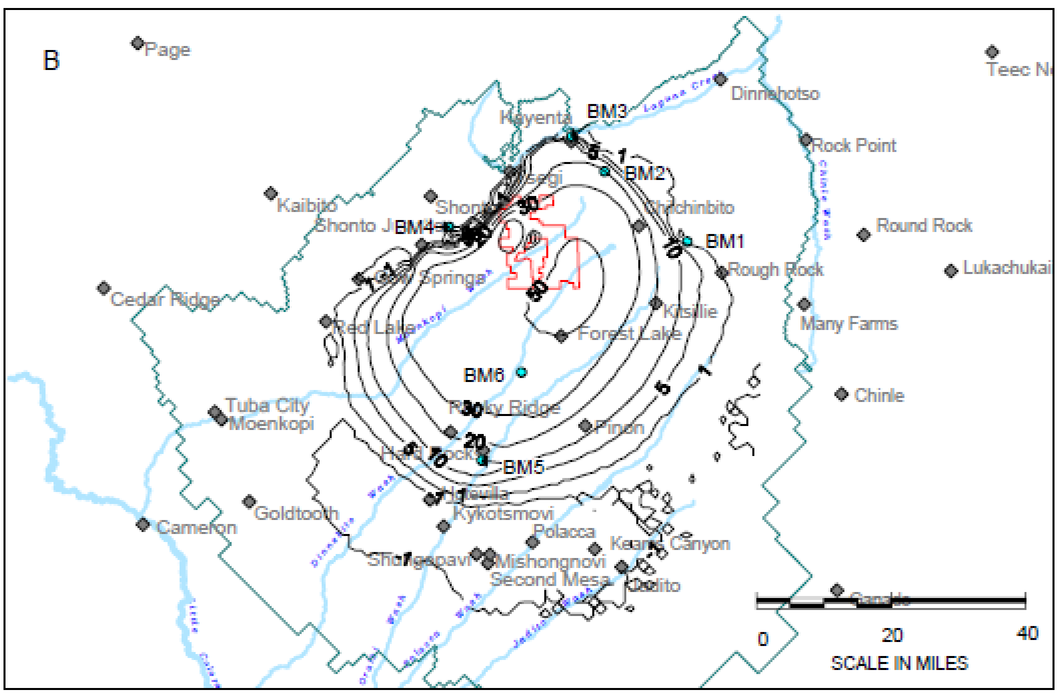


Figure B-9 Simulated Change in N Aquifer Water Levels 2010-2025

NOTE: A: Peabody and community pumping.
B: Peabody pumping only.
The contour interval is 50 feet, with supplemental contours for 1, 5, 10, 20, and 30 feet.

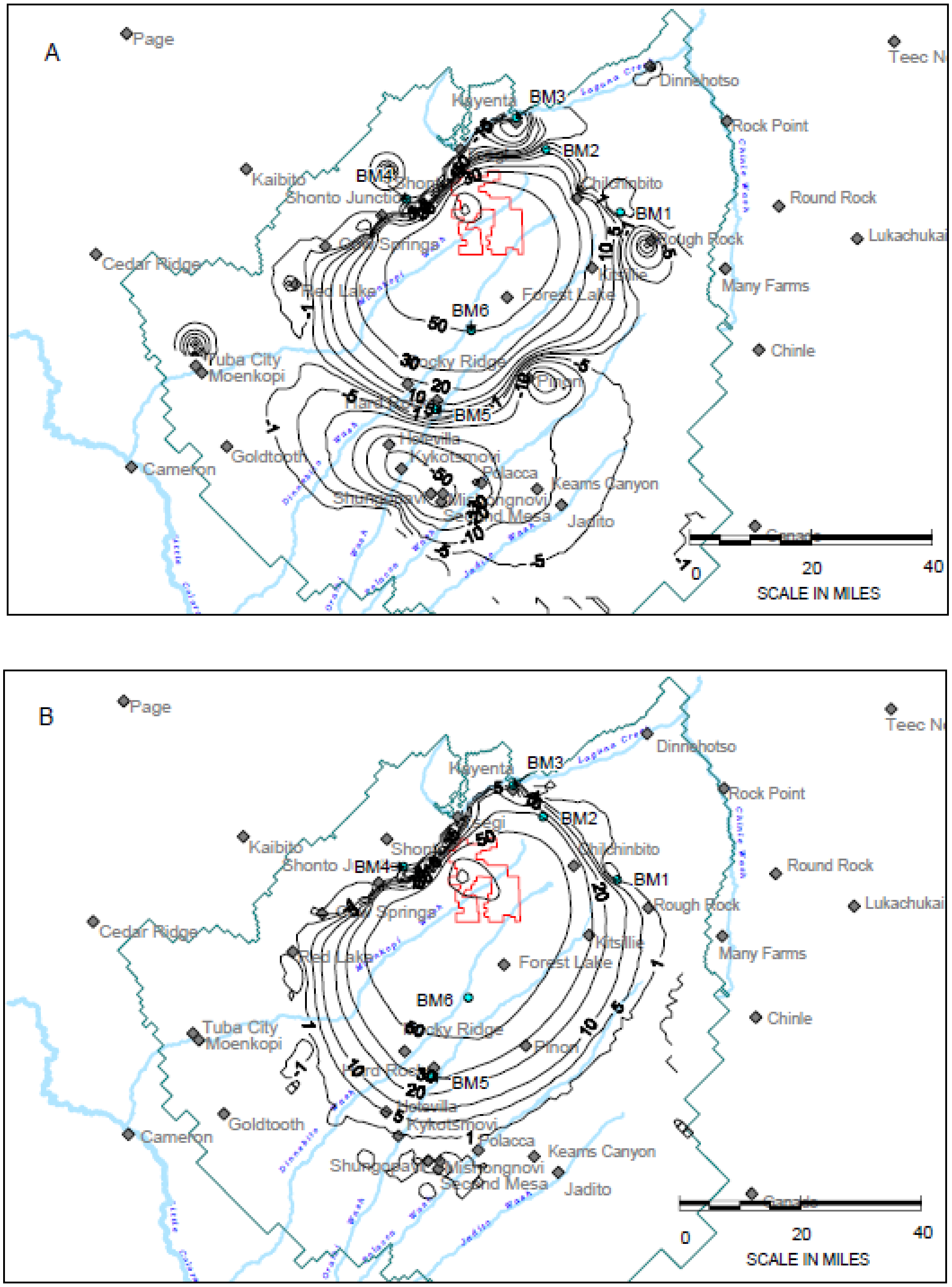


Figure B-10 Simulated Change in N Aquifer Water Levels 2010-2038

NOTE: A: Peabody and community pumping.
B: Peabody pumping only.
The contour interval is 50 feet, with supplemental contours for 1, 5, 10, 20, and 30 feet.

WATER SUPPLY

Table B-4 shows the water level change (relative to a July 2010 baseline) for selected community wells in 2015, 2025, and 2038. In most wells, the simulated drawdown (with both community and PWCC pumping) increases with time. However, the drawdown caused by PWCC's pumping is estimated to decrease with time. The predicted increases in drawdown are caused by local community pumping. In all instances but one, water is predicted to be above the top of the screened intervals by hundreds of feet. At Rough Rock, the water level was only 40 feet above the top of the screen interval when first measured. The model predicted that PWCC's pumping causes only 2 feet of drawdown in this well. Pumping by PWCC has caused drawdown in these wells, but has not limited the ability of these wells to produce water. With the reduction in pumping that occurred at the end of 2005, the effects of PWCC's pumping have become smaller.

Table B-4 Simulated Water Level Change at Selected Community Wells from July 1, 2010

Community	Well	Initial DTW (ft)	Simulated Water Level Change (ft)	PWCC Allocation (%)	PWCC Allocation (ft)	Depth to N or Top of Open Interval	Remaining Excess Water Column (ft)
a. 2015							
Chilchinbito	PM3	405.0	-9	126%	-11	1136	742
Forest Lake NTUA	4T-523	1096.0	-22	116%	-26	1870	800
Kayenta West	8T-541	227.0	14	-47%	-6	700	479
Keams Canyon	PM2	292.5	3	49%	1	900	606
Kykotsmovi	PM1	220.0	23	13%	3	880	657
Pinon	PM6	743.6	3	-79%	-3	1870	1129
Rocky Ridge	PM2	432.0	-3	254%	-6	1442	1016
Rough Rock	10R-111	170.0	1	16%	0	210	40
b. 2025							
Chilchinbito	PM3	405.0	-13	197%	-25	1136	756
Forest Lake NTUA[1]	4T-523	1096.0	-40	128%	-51	1870	825
Kayenta West	8T-541	227.0	37	-37%	-13	700	486
Keams Canyon	PM2	292.5	12	14%	2	900	606
Kykotsmovi	PM1	220.0	53	7%	3	880	657
Pinon	PM6	743.6	10	-152%	-15	1870	1141
Rocky Ridge	PM2	432.0	-9	229%	-21	1442	1031
Rough Rock	10R-111	170.0	2	6%	0	210	40
c. 2038							
Chilchinbito	PM3	405.0	-10	400%	-38	1136	769
Forest Lake NTUA[1]	4T-523	1096.0	-58	141%	-82	1870	856
Kayenta West	8T-541	227.0	69	-25%	-17	700	490
Keams Canyon	PM2	292.5	29	1%	0	900	607
Kykotsmovi	PM1	220.0	96	-1%	-1	880	661
Pinon	PM6	743.6	30	-96%	-29	1870	1155
Rocky Ridge	PM2	432.0	-13	290%	-39	1442	1049
Rough Rock	10R-111	170.0	3	-1%	0	210	40

NOTE: [1] Negative sign (-) indicates rise in water level.

N Aquifer Water Supply

The coal mining considered in this EA will require continued use of water from the N aquifer. The annual usage varies, however, the average annual usage is estimated to be 1,236 af/y. The GeoTrans 3-D model was developed considering the effects of both community and PWCC water usage. The estimated community pumping rates are believed to be higher than will actually occur, and thus the simulation results will likely be conservative.

Municipal (community) and industrial (PWCC) N aquifer annual water usage from 1965 to 2008 as reported by the USGS is provided in Table B-5. Although PWCC's water use was higher than that of the communities in the past, the communities now collectively use more water.

Table B-5 Municipal and Industrial N Aquifer Annual Usage from 1965 to 2008

Use	1965 to 2008 (acre-feet per year)
Community	70 to 3,100
PWCC (started in 1968)	0 to 4,450
Total	**70 to 8,930**

SOURCE: U.S. Geological Survey 1985-2010

Total water-level decline since 1955 (starting date in the model) through 2005 in the closest community well (Forest Lakes NTUA No. 1) was estimated by the model to be approximately 217 feet. The model indicates that approximately 38 feet recovery occurred from 2005 to 2010 because of reduced PWCC pumping, and that the net drawdown (i.e., historical drawdown minus recovery) at Forest Lakes was approximately 179 feet. As shown in Table B-4, modeling predicts that the groundwater level in the N aquifer will rise by another 40 feet over 2010 levels by 2025. The continuing rise over the 2010 to 2025 time period, due to reduced PWCC pumping, is 51 feet; however, continued community pumping is predicted to result in a water-level decline (drawdown) of 11 feet at this well between 2010 and 2025. The net drawdown (compared to 1955 water levels) is estimated to be 139 feet, of which 107 feet is attributed to PWCC pumping from 1968 to 2025.

Wells located farther from the well field would have less PWCC-related drawdown and a lower percentage of total drawdown due to PWCC pumpage. For example, Kykotsmovi Well PM1 is predicted to have a net 2010 to 2025 drawdown of 53 feet, of which about 7 percent, or 3 feet, would be due to PWCC pumping.

C.1.4 Impacts on Stream and Spring Flow

The major streams are fed by groundwater producing baseflow, and by precipitation. In the summer when the demand for water by plants increases, evapotranspiration consumes water discharged from the groundwater system and decreases the flow in the stream. USGS streamflow measurements indicate that the demand by evaportranspiration causes Moenkopi Wash at Moenkopi, Laguna Creek at Dennehotso and Polacca Wash near Second Mesa to be dry during the summer. The flows in Dinnebito Wash at Sand Springs are reduced, but flow typically continues through the summer.

The USGS monitors streamflow in four washes (Moenkopi Wash, Laguna Creek, Dinnebito Wash, and Polacca Wash) that overlie the N aquifer. These washes (and others) were modeled by PWCC to assess potential changes in streamflow due to mine pumping. Of the monitored and modeled washes, Moenkopi Wash is predicted to experience the greatest, albeit small (2.3 af/yr or 0.003 cubic feet per second [cfs]), depletion due to pumping from the N aquifer well field from 2010 to 2025. Begashibito Wash is closest to the PWCC well field and is predicted by the model to have the greatest depletion, but flow in this wash is not monitored (refer to Table B-7). Streamflow in Moenkopi Wash near Tuba City has been measured since 1976. The wash is intermittent with zero flow during many of the summer months. The measured flow during the period November through February was selected by the USGS to best represent the baseflow in the stream. At the Moenkopi gaging station currently being monitored, the median flow rate during this winter period has been approximately 3 cfs (Macy 2010). Assuming that 100 percent of the simulated decline in discharge into Moenkopi Wash affects the flow at the gaging station (i.e., assuming that there are no channel losses or evaporation transpiration losses), the pumping at the PWCC lease area is estimated to reduce the flow at the gaging station by about 0.01 percent of its median winter value.

The USGS has been monitoring N aquifer spring flow from four springs (Moenkopi School, Pasture Canyon Spring, Burro Spring, and an unnamed spring near Dinnehotso) for a minimum of 10 years (some springs have been monitored for much longer but not always at the same location). The closest USGS monitored spring (the unnamed spring near Dinnehotso) is more than 35 miles from the PWCC lease area. The USGS concludes that "for the consistent periods of record at all four springs, the discharges have fluctuated but long-term trends are not apparent" (USGS 1985-2005). It appears that pumping to date has not measurably reduced the monitored N aquifer spring flow. However, modeling of N aquifer groundwater discharge suggests that as future non-mining related groundwater pumping in close proximity to some of these springs increases, flows from springs could be impacted (GeoTrans 2006).

There are other N aquifer springs that are not monitored and past changes to these springs, if any, are unknown. As discussed in a subsequent section of this appendix, numerical models of the N aquifer are not designed to simulate discharge from individual springs (Brown and Eychaner 1988; PWCC 1999). However, the GeoTrans model does simulate groundwater discharge to Begashibito Wash approximately 25 miles west of the lease area. Cow Springs, located at the southwestern extent of Begashibito Wash, is an area of groundwater discharge as expressed by seeps and small springs. Cow Springs is the closest modeled area of seeps and springs to the mine and would therefore experience the greatest impact due to PWCC pumping. Predicted reduction in groundwater discharge into Begashibito Wash due to maximum PWCC-related pumpage (1,236 af/yr) at the end of 2025 is estimated to be 10.5 af/yr, or 0.49 percent of the estimated 2010 groundwater discharge (refer to Table B-7).

Impact levels for the effects on surface water uses in washes, creeks, and springs are defined as shown in Table B-6.

Table B-6 Diminution of Groundwater Discharge (Base Flow) to Streams and Springs

Impact Level	Percent Reduction
Major	>31
Moderate	21-30
Minor	11-20
Negligible	<10
None	0

IMPACT ON SURFACE WATER

Predicted 2015 reduction of groundwater discharge to streams is greatest at Begashibito Wash (refer to Table B-7), the closest point of stream/spring discharge to the PWCC well field (GeoTrans 2006). The total predicted 2010 to 2015 reduction in groundwater discharge is 3.8 af/yr, of which 3.4 af/yr is due to project pumping, and 0.4 af/yr is from community pumping. When pumping to 2025 is simulated, the estimated decrease in groundwater discharge is 12.1 af/yr, of which 1.6 af/yr is from community pumping. The predicted total 2015 and 2025 percent reductions in groundwater discharge to Begashibito Wash are 0.18 percent and 0.56 percent, respectively. Total reduction in groundwater discharge since 1955 is predicted to be approximately 24 af/yr in 2025, a 1 percent reduction in pre-mining groundwater discharge. As with wells, the further the point of groundwater discharge from the PWCC wellfield, the less the reduction in groundwater discharge due to PWCC pumping and the higher the percentage due to community pumping. For example at Pasture Canyon, near Tuba City, the predicted 2025 reduction in discharge from 2010 rates is 45 af/yr, and from 1955 rates is 94 af/yr (not shown in the table), all of which is attributed to community pumping.

The percentage reduction in the discharge to all of the streams and washes predicted for 2025 (based on 1955 discharge rates) is 2.6 percent for the combined PWCC and community pumping, 2.1 percent for community pumping, and 0.5 percent for PWCC pumping. The greatest volumetric reduction (149.4 af/yr) is predicted to occur in the discharge to Laguna Creek, resulting primarily from community pumping (140.6 af/yr). The greatest percentage reduction (22 percent) is predicted to occur at Pasture Canyon, all because of local community pumping.

The total (PWCC and community) diminution of flows at Begashibito Wash, where modeling shows the largest decreases in flows, from pumping of the N aquifer is predicted to be 3.8 af/yr in 2015. This is 0.18 percent of the estimated 2010 discharge of 2,166 af/yr, a negligible effect. The combined effect on Begashibito Wash discharge in 2038 is a reduction of 23.1 af/yr, or a 1.07 percent decline. The decline attributable to PWCC is 0.88 percent, both considered negligible. Because of the distance from the PWCC wellfield to the areas where groundwater discharge occurs, these small, long-term effects are regional in scale, but only occur in small areas.

Table B-7 Predicted Groundwater Discharge (af/yr) to Washes near the Vicinity of the Kayenta Mining Operation After July 2010

Drainage	2010 All	2010 Non-PWCC	2015 All	2015 Non-PWCC	Change Due to Pumping All	Change Due to Pumping Non-PWCC	Change Due to Pumping PWCC	Percent Total All	Percent Total PWCC
2015									
Chinle Wash	498.8	498.8	498.8	498.8	0.0	0.0	0.0	0.00	0.00
Laguna Creek	2440.6	2450.6	2418.3	2427.8	22.2	22.9	-0.6	0.91	-0.03
Pasture Canyon	377.6	377.6	363.1	363.1	14.5	14.5	0.0	3.84	0.00
Moenkopi Wash	4279.6	4302.1	4277.0	4301.4	2.7	0.7	1.9	0.06	0.05
Dinnebito Wash	514.8	515.3	514.6	515.2	0.2	0.1	0.1	0.04	0.02
Oraibi Wash	455.4	456.0	454.4	455.2	1.0	0.8	0.2	0.21	0.04
Polacca Wash	429.8	431.0	427.3	428.9	2.4	2.2	0.3	0.57	0.06
Jaidito Wash	2011.4	2015.6	2007.3	2012.9	4.1	2.7	1.4	0.20	0.07
Begashibito Wash	2166.0	2177.0	2162.2	2176.6	3.8	0.4	3.4	0.18	0.16
2025									
Chinle Wash	498.8	498.8	498.8	498.4	0.0	0.0	0.0	0.01	0.00
Laguna Creek	2440.6	2450.6	2385.8	2395.1	54.8	55.5	-0.8	2.24	-0.03
Pasture Canyon	377.6	377.6	332.8	332.8	44.8	44.8	0.0	11.86	0.00
Moenkopi Wash	4279.6	4302.1	4274.9	4299.6	4.7	2.4	2.3	0.11	0.05
Dinnebito Wash	514.8	515.3	514.2	515.0	0.6	0.3	0.3	0.13	0.07
Oraibi Wash	455.4	456.0	452.6	453.9	2.7	2.1	0.6	0.60	0.14
Polacca Wash	429.8	431.0	422.9	424.8	6.9	6.2	0.7	1.60	0.15
Jaidito Wash	2011.4	2015.6	1999.0	2007.4	12.4	8.2	4.2	0.62	0.21
Begashibito Wash	2166.0	2177.0	2153.9	2175.4	12.1	1.6	10.5	0.56	0.49
2038									
Chinle Wash	498.8	498.8	498.7	498.7	0.1	0.1	0.0	0.02	0.00
Laguna Creek	2440.6	2450.6	2336.7	2347.6	103.8	103.1	0.8	4.26	0.03
Pasture Canyon	377.6	377.6	294.4	294.4	83.2	83.2	0.0	22.02	0.00
Moenkopi Wash	4279.6	4302.1	4273.0	4296.8	6.6	5.2	1.4	0.16	0.03
Dinnebito Wash	514.8	515.3	513.0	514.6	1.2	0.7	0.6	0.24	0.11
Oraibi Wash	455.4	456.0	450.1	451.6	5.3	4.4	1.0	1.17	0.21
Polacca Wash	429.8	431.0	419.0	419.4	11.7	11.6	0.1	2.73	0.03
Jaidito Wash	2011.4	2015.6	1987.1	1998.0	24.3	17.6	6.6	1.21	0.33
Begashibito Wash	2166.0	2177.0	2142.9	2172.9	23.1	4.1	19.0	1.07	0.88

NOTE: 1 Negative sign (-) indicates relative increase in model-predicted stream discharge resulting from reduction in PWCC's pumping since 2005. Non-PWCC = Community pumping sources, PWCC = PWCC pumping sources, All = All combined sources, including PWCC and Non-PWCC sources.

IMPACTS ON GROUNDWATER AND SURFACE WATER QUALITY

C.1.5 Migration of Poor Quality Groundwater

In some situations, extensive long-term groundwater pumping can cause poor quality groundwater to migrate toward a pumping center. Concerns have been raised that pumping from the N aquifer could cause poorer D aquifer water to migrate downward into the N aquifer. Geochemical studies have shown that downward leakage from the D aquifer to the N aquifer has been occurring for thousands of years. Most natural leakage occurs in the southern portion of Black Mesa Basin where the intervening Carmel Formation confining bed is less than 120 feet thick and has a higher sand content than in other areas of the basin (Truini et al. 2005). The areas of known leakage are located more than 20 miles from the PWCC wellfield. While leakage has occurred under natural conditions over a long period of time, water-quality monitoring of the N aquifer for more than 10 years during the period that mining-related and coal-slurry pumping has been occurring has shown no trend in water-quality degradation (USGS 1985-2005). PWCC monitors the quality of water produced from its production wells. Over the more than 20-year period that pumping has occurred, there has been no discernible trend to suggest that water quality is declining. Total dissolved solids, sulfate, and chloride have all remained stable over the life of the wells. If leakage is occurring, it is too small to be detected in the concentration of these constituents.

PWCC conducted an analysis of potential leakage from the D aquifer to the N aquifer using the GeoTrans model and standard mixing calculations. Pumping from the N aquifer was simulated at several different rates, including 6,000 af/yr in one scenario. Results of this analysis indicated a maximum increase in N aquifer sulfate concentration of approximately 0.5 percent in 2038 in the eastern part of the aquifer (PWCC 2005).

C.1.6 Water Quality Impacts on N Aquifer

The USGS suggested that an increase in downward leakage from the D aquifer to the N aquifer would first appear as increased total dissolved solids (TDS) or electrical conductivity (PWCC 2005). The USGS also identified increased Cl and SO_4 concentrations as important indicators of downward groundwater leakage from the D aquifer to the N aquifer. The USGS monitors water quality in the confined N aquifer throughout the Black Mesa region as part of a 1991 Cooperators Agreement among BIA, USGS, ADWR, and PWCC. The USGS monitoring program collects samples at some of the PWCC's pumping wells to validate PWCC's N aquifer water-quality-monitoring program, which began in 1980. USGS' and PWCC's N aquifer water-quality results have shown no apparent increasing or decreasing trends in TDS, Cl, or SO_4 concentrations, although small year-to-year variations in concentrations do occur (USGS 1985-2005). The USGS analyzed TDS data from six wells, including NAV2 and NAV4, and did not detect any increasing trends for TDS (Macy 2010).

Most of PWCC's production wells are partially screened in the water-bearing units composing the D aquifer, as well as being screened in the N aquifer. Hydraulic heads in the D aquifer are about 250 feet higher than in the N aquifer in the area of the well field. When the production wells are not pumping, D aquifer water has the hydraulic potential to flow downward from the D aquifer screened interval to the

N aquifer. Reduction in pumping since December 2005 has resulted in some of PWCC's production wells being turned off for extended periods (weeks), with the potential for D aquifer water to mix with N aquifer water in the immediate vicinity of those wells. However, PWCC's water-quality-monitoring data from 2006 through the first half of 2009 indicate that degradation of the N aquifer in the vicinity of PWCC's production wells is not occurring with the existing wellfield management practices in place. Water-quality samples collected in February and March 2006 from the production wells that had been idle since December 2005 showed no increases in electrical conductivity, TDS, Cl, or SO_4 concentrations compared to the historical data (OSM 2006). A shutdown of the mine well field also occurred in the fall of 1985. In a 1987 USGS report on the Black Mesa monitoring program, no degradation of water quality in the well field was noted (Hill and Sottilare 1987).

PWCC analyzed the potential for groundwater leakage from the D aquifer to the N aquifer through the Carmel Formation confining bed using the GeoTrans model and standard mixing calculations. Results of this analysis indicated a maximum increase in N aquifer SO_4 concentrations beneath the leasehold of 0.05 percent (from 30 mg/L to 30.016 mg/L) by 2038. In some areas, the estimated percentage increase is higher (up to 0.5%), but the increase in SO_4 concentration is estimated to be less than 0.5 mg/L everywhere.

Table B-8 Maximum Predicted Sulfate Concentrations (mg/L) Resulting from PWCC Pumping, 1956-2038.

Subarea	Initial Concentration (mg/L) D Aquifer	Initial Concentration (mg/L) Navajo sandstone	Final Concentration (mg/L) Navajo sandstone	Percent Change
Northeast	250	70	70.056	0.080%
East	850	100	100.498	0.498%
Hopi Buttes	360	50	50.113	0.226%
Forest Lake	1000	100	100.057	0.057%
Kitsillie	75	30	30.002	0.007%
Pinon	200	5	5.006	0.122%
Rocky Ridge	250	10	10.012	0.118%
Preston Mesa	400	10	10.000	0.000%
Leasehold	400	30	30.016	0.054%
Pinon to Kitsillie	1000	20	20.036	0.178%
Surrounding leasehold	100	45	45.002	0.004%
Red Lake to Tuba City	400	50	50.012	0.024%
Hotevilla to Kabito	200	35	35.006	0.016%
Pinon to Rocky Ridge	210	140	140.003	0.002%

SOURCE: Peabody Western Coal Company 2005
NOTE: mg/L = milligrams per liter

SURFACE WATER QUALITY IMPACTS

During 2009, seeps were observed at 12 of the 25 National Pollutant Discharge Elimination System (NPDES) sediment ponds that were inspected by PWCC personnel. Of those 12 sediment ponds, four exhibited seep-water quality that exceeded at least one of the livestock standards (see EA, Section D, Table D-4). Analytical results for both cadmium at BM-A1-S1 and copper at J7-JR-S1 were qualified by the laboratory as being between the method detection limit and practical quantitation limit, effectively yielding inconclusive results with respect to whether values of both trace elements were higher than the standard value. Nitrate levels at BM-A1-SP1 are likely influenced by sheep and other livestock waste in the vicinity, and the selenium value (36 micrograms per liter) was only slightly higher than the standard (33 micrograms per liter). The aluminum value measured at J3-E-S2 was the first value that exceeded the standard at the two seeps monitored below Pond J3-E since monitoring began, and may be anomalous. Finally, the aluminum value that exceeded the standard at Seep N6-F-S1 and the low pH measurements are similar to historical measurements at this site. The embankment at Pond N6-F was removed and reclaimed during the fall of 2009, effectively removing Seep N6-F-S1 permanently. At the remaining eight NPDES sediment ponds, seeps met livestock water-quality standards. Flow rates of the seeps monitored in 2009 were within the historical range of seep flows (ranging from pooled water [no flow] to 9.5 gallons per minute). During 2009, there were fewer NPDES ponds exhibiting poor seep-water quality than in prior years. The constituent results that exceeded water-quality standards were comparable to historical ranges.

Diversions of natural streamflow also are designed to preserve geomorphic stability and prevent uncontrolled or destructive erosion and sedimentation. All diversions on the Kayenta Mine permit area are developed using quantitative hydraulic modeling programs (e.g., SEDIMOT II) that simulate the geometry required to maintain geomorphic equilibrium in a natural channel. Where this is not possible, short, specific structures (such as grade-control structures) are designed and constructed in the channel to correct the problem. Similar to the pond discharges, these channels and structures are regularly inspected and maintained by PWCC staff and reviewed by OSM and tribal inspectors.

Under the current Seepage Management Plan, PWCC dewaters sediment ponds at the earliest practicable opportunity to prevent seeps, and constructs fences around the areas below dams to prevent livestock from accessing those seeps that do not meet livestock water-quality standards. In addition, PWCC has planted willows and cattails in the area below a dam to reduce downstream flow from several seeps. These activities have proved to be effective to some degree. However, fencing provides only a limited measure of protection for livestock access, and does not completely protect the beneficial use of seep water for livestock and wildlife. The U.S. Environmental Protection Agency (USEPA) has recommended other measures to protect water-quality and beneficial uses, such as treating the water, eliminating the sediment pond, sealing the pond, capturing the water and infiltrating it upstream of the pond, or intercepting the seep water and pumping it back into the pond. PWCC has submitted an application to USEPA to renew its NPDES permit (No. NN0022179), and USEPA issued a renewed permit that currently is under review by the USEPA's Environmental Appeals Board. In the interim, PWCC continues to operate under the terms and conditions of the previous NDPES permit by an administrative extension. The renewed permit requires enhanced seep management measures to improve the effectiveness of the Seepage Management Plan and to ensure compliance with the Clean Water Act. The improved seep management measures would be applied at all NPDES sediment ponds with poor seep water quality, including proposed permanent impoundments. The measures include installing passive treatment systems to treat seep water below two existing impoundments, and reclaiming several existing NPDES sediment ponds with seeps exhibiting poor water quality to comply with requirements under the Western Alkaline Coal Mining effluent limitations (40 CFR Part 434). The Western Alkaline Coal Mining effluent limitations allow operators to remove the embankments of NPDES outfalls if the watersheds above meet certain criteria related to implementation of best management practices under a sediment control plan as approved by USEPA, OSM, and both the Navajo Nation and Hopi Tribe. Removing and reclaiming the embankments of NPDES ponds that have exhibited seeps with poor water quality is expected to eliminate seeps with poor water quality by removing the potential for impounding runoff that otherwise would seep through embankment soils and surrounding geologic formations. The renewed NPDES permit will require continued implementation of a modified Seepage Management Plan, including using existing seep-management measures, performing pond inspections, and reporting the monitoring results.

PWCC also would use design and construction methods that would minimize seeps for new sediment ponds by identifying geochemically inert materials for constructing the embankments, compacting the embankments to meet engineering design standards, and siting embankments at locations with low permeability geologic units to the extent practicable.

SUBSIDENCE AND SINKHOLES

The N aquifer is principally comprised of sandstone, which are indurated and are not subject to significant compaction and subsequent land subsidence. Studies of the lithology and compressibility of the Navajo Sandstone in the Kayenta Mine permit area indicate that it would be subject to compaction of less than 1 percent if the water level was drawn down to the top of the aquifer (GeoTrans 1993). None of the N aquifer pumping scenarios result in the water level being lowered to the top of the aquifer within the Black Mesa Basin. No evidence of casing distress has been noted in any of the surveyed PWCC production wells as might be expected if significant compression of the Navajo Sandstone or overlying units had occurred (OSM 2006).

In 2003 land subsidence features in the form of sinkholes, cracks, and slumps were reported near Forest Lake, about 7 miles south of the PWCC lease area. After investigation by OSM, Navajo Nation Minerals Department, Navajo Nation Water Resources Department, and USGS, all of the subsidence features of concern were determined to be either in or adjacent to unconsolidated alluvial valley deposits and due to surface water entering and eroding desiccation features following an extended period of drought (OSM 2004). These features are unrelated to the mining or water production facilities on the PWCC lease area.

Subsidence and formation of sinkholes in the N aquifer well field area is considered highly unlikely.

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Appendix C
Special Status Species

Table C-1 Federally Listed, Candidate, and Proposed Species

Species	Status	Habitat Requirements	Analysis Summary
AMPHIBIANS			
Chiricahua Leopard Frog *Lithobates chiricahuensis*	LT	Occurs in a wide variety of man-made and natural ponds and pools. Also occupies stream habitats. Primarily associated with wetland habitats in oak, mixed-oak, and pine woodlands.	Kayenta Mine permit area is outside species geographic range of the species.
FISH			
Roundtail Chub *Gila robusta*	C	Occupies cool to warm water, mid-elevation streams and rivers where typical adult microhabitat consists of pools up to 6.6 feet (2 meters) deep adjacent to swifter riffles and runs with objects that provide cover. Sub-adults occur in slow moving water adjacent to overbank cover.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Little Colorado Spinedace *Lepidomeda vittata*	LT	Found in water ranging from 0.5 to 4.3 feet (0.16 to 1.3 meters) in depth, but most abundant in depths of around 1.9 feet (0.6 meters). Most common in slow to moderate water currents, over fine gravel bottoms. Avoids deep, heavily-shaded pools and shallow, open areas. Prefers unshaded pools with rocks or undercut banks for cover.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Apache Trout (Arizona) *Oncorhynchus apache*	LT	Presently restricted to cold mountain streams with many low-gradient meadow reaches at elevations above 5,000 feet (1,524 m).	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Loach Minnow *Tiaroga cobitis*	LT	Large to small perennial streams with swift, shallow water over cobble and gravel at elevations below 8,000 feet (2,438 m).	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
REPTILES			
Northern Mexican Gartersnake *Thamnophis eques megalops*	C	Primarily occurs in densely vegetated habitat surrounding cienegas, cienegas sourced streams, stock tanks, and in or near water along streams in valley floors and generally open areas, but not in steep mountain canyon stream habitat.	Kayenta Mine permit area is outside species geographic range.
BIRDS			
Mexican Spotted-owl *Strix occidentalis lucida*	LT	Mexican spotted-owls occupy a variety of habitats for breeding and foraging. Breeding habitat includes dense old-growth mixed conifer forests along steep slopes and ravines (AGFD 2005). Within this habitat, the trees are dense, and form a closed canopy with a high basal area. The ground often is littered with numerous downed logs and snags.	This species occurs about two miles northeast of the Kayenta Mine permit area. Monitoring surveys suspended in 2000 have been reinitiated in spring 2011. Impacts from mining activities during the permit period to Mexican spotted-owls will be limited to noise and light.

Species	Status	Habitat Requirements	Analysis Summary
Southwestern Willow Flycatcher *Empidonax traillii extimus*	LE	It utilizes dense stands of riparian vegetation that have a layered canopy and are next to or are flooded by perennial sources of water (NNHP 2008). The primary vegetation can either be native blocks of cottonwood and willow or non-native stands of tamarisk or Russian olive (*Elaeagnus angustifolia*) that are taller than 3 meters (10 feet) (NNHP 2008).	No suitable habitat occurs near the coal resource areas N-9, J-19, and J-21. No riparian habitat will be removed as part of development of these areas.
Western Yellow-billed Cuckoo *Coccyzus americanus occidentalis*	C	Occurs in large blocks of riparian woodlands (cottonwood, willow, or tamarisk gallery forests).	No suitable habitat occurs on Black Mesa.
Mountain Plover *Charadrius montanus*	PLT	Although cultivated land is used by wintering mountain plovers and is more abundant than non-cultivated land, mountain plovers appear to prefer short-grass prairie, alkali flats, burned grasslands, and livestock-grazed annual grasslands to cultivated sites (Knopf and Wunder 2006).	Potential habitat of limited quantity and quality occurs nearby in the inactive Black Mesa Mine and for a season or less after reclamation in the Kayenta Mine permit area. The closest breeding records for the species are about 200 miles away. Possible migrants have been documented about 90 miles away.
California Condor *Gymnogyps californianus*	LE	Utilizes canyon country and mountainous habitats for nesting and roosting, and can forage widely in a variety of habitats around these areas (NNHP 2008).	This species is unlikely to occur within the Kayenta Mine permit area. Annual wildlife surveys have not documented the presence of this species, and reintroduced individuals have not used this part of the state. Condors that could fly into the study area would be transients, and the effects of mining will be negligible on any individuals in the area during the permit period.
MAMMALS			
Mexican Gray Wolf *Canis lupus baileyi*	LE	Typically occurs in chaparral, woodland, and forested areas. May cross desert areas. Reintroduced experimental non-essential in the Apache National Forest in Greenlee and Apache counties have expanded into Navajo, Apache, and Gila counties on White Mountain Apache Tribal lands.	Kayenta Mine permit area is outside the reintroduced population's geographic range.
Jaguar *Panthera onca*	LE	Occurs in a wide range of habitats from desert scrub to pine-oak woodland and is associated with areas that have permanent sources of water.	Kayenta Mine permit area is outside species geographic range.

Species	Status	Habitat Requirements	Analysis Summary
Black-footed Ferret *Mustela nigripes*	LE	Grassland plains on mountain basins and usually found in association with prairie dogs, which serve as their primary food source while also providing the ferrets with abandoned burrows for shelter.	Black-footed ferrets or evidence thereof have not been observed during monitoring studies for the species within the PWCC lease area (EMI 2010). The Kayenta Mine permit area is more than 200 miles northeast of a reintroduced population in the Aubrey Valley in Coconino County.
PLANTS			
Welsh's Milkweed *Asclepias welshii*	LT	Found on open, sparsely vegetated semi-stabilized coral pink sand dunes, in sagebrush, juniper, pine, and oak communities of the Great Basin desertscrub. Elevations range from 4,700 to 6,250 feet (1,434 to 1,906 meters).	No suitable habitat occurs in the Kayenta Mine permit area or on Black Mesa.
Navajo Sedge *Carex specuicola*	LT	Shady seep-spring pockets and hanging gardens, on vertical pink-red Navajo Sandstone cliffs and alcoves, from 4,600 to 7,200 feet (1,403 to 2,196 meters) elevation. Found within the piñon-juniper woodland zone.	No suitable habitat occurs in the Kayenta Mine permit area.
Peebles Navajo Cactus *Pediocactus peeblesianus var.peeblesianus*	LE	Occurs in exposed sunny situations on weakly alkaline, gravely soils of the Little Colorado paleo-channels. Occurs at elevations from 5,100 to 5,650 feet (1,556 to 1,723 meters) near Joseph City to the Marcou Mesa region.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.

SOURCE: Arizona Game and Fish Department 2010; Arizona Game and Fish Department Heritage Data Management System species abstracts

NOTES: Agency or Law: ESA = Endangered Species Act; NESL = Navajo Nation Endangered Species List

Status Definitions: **ESA:** LE = listed endangered; LT = listed threatened; PLT = Proposed listing as threatened; C = candidate

Table C-2 Navajo Nation Endangered Species, State Species of Concern, and Eagle Protection Act Species

Species	Status	Habitat Requirements	Analysis Summary
AMPHIBIANS			
Chiricahua Leopard Frog [1] *Lithobates chiricahuensis*	WSC	Occurs in a wide variety of man-made and natural ponds and pools. Also occupies stream habitats. Primarily associated with wetland habitats in oak, mixed-oak, and pine woodlands.	Kayenta Mine permit area is outside species geographic range of the species.
Northern Leopard Frog *Lithobates pipiens*	NESL-2 WSC	Requires warm, shallow ponds and pools for breeding that are free of predatory fish and frogs. Post-breeding adults move to mesic grassland habitats, and post-metamorphosed sub-adults migrate to larger ponds that are free of predators (Smith and Keinath 2007).	Kayenta Mine permit area is outside species geographic range.
FISH			
Little Colorado Sucker *Catostomus sp. 3*	WSC	Occurs in creeks, small to medium rivers, and impoundments. Predominantly found in pools with abundant cover. Also found in riffles.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Roundtail Chub [1] *Gila robusta*	NESL-2 WSC	Occupies cool to warm water, mid-elevation streams and rivers where typical adult microhabitat consists of pools up to 6.6 feet (2 meters) deep adjacent to swifter riffles and runs with objects that provide cover. Sub-adults occur in slow moving water adjacent to overbank cover.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Little Colorado Spinedace [1] *Lepidomeda vittata*	WSC	Found in water ranging from 0.5 to 4.3 feet (0.16 to 1.3 meters) in depth, but most abundant in depths of around 1.9 feet (0.6 meters). Most common in slow to moderate water currents, over fine gravel bottoms. Avoids deep, heavily shaded pools and shallow, open areas. Prefers unshaded pools with rocks or undercut banks for cover.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
REPTILES			
Northern Mexican Gartersnake [1] *Thamnophis eques megalops*	WSC	Primarily occurs in densely vegetated habitat surrounding cienegas, cienegas sourced streams, stock tanks, and in or near water along streams in valley floors and generally open areas, but not in steep mountain canyon stream habitat.	Kayenta Mine permit area is outside species geographic range.
Narrow-headed Gartersnake *Thamnophis rufipunctatus*	WSC	Occurs within the piñon-juniper and pine-oak woodland zone and into ponderosa pine forest where it is found in permanently flowing streams, sometimes sheltered by native broadleaf deciduous trees.	Kayenta Mine permit area is outside species geographic range.
BIRDS			
Northern Goshawk *Accipter gentilis*	NESL-4 WSC	Inhabits a variety of mature forest types in North America (Kennedy 2003). In the West, it typically nests in mature ponderosa or mixed-conifer forests with high canopy closure and moderately steep slopes (Kennedy 2003). Adjacent foraging habitat has a similar structure but may require a less dense understory (Kennedy 2003).	This species is occasionally observed near the Kayenta Mine permit area. Impacts to the species will be minor during the permit period, because dispersing juveniles would rarely use the piñon-juniper woodland habitats.

Species	Status	Habitat Requirements	Analysis Summary
Western Burrowing Owl *Athene cunicularia hypugaea*	NESL-4	Habitat is variable in open, well-drained grasslands, steppes, deserts, prairies, and agricultural land. Often associated with burrowing mammals. Sometimes nests in open areas near human habitation such as vacant lots, golf courses, or airports.	Annual wildlife surveys have not documented the presence of this species in more than 30 years, and impacts from coal mining during the permit period are not anticipated.
Northern Saw-whet Owl *Aeoglius acadicus*	NESL-4	Typically utilizes relatively open ponderosa pine, Douglas-fir, or mixed conifer forests for foraging and nesting activities (NNHP 2008). The species also may occur in old-growth riparian woodlands (NNHP 2008). It nests in tree cavities in these habitats (NNHP 2008).	Suitable habitat occurs about two miles northeast of the Kayenta Mine permit area. Annual wildlife surveys have not documented the presence of this species. Species could be impacted by noise and light pollution from mining, but topography and dense vegetation would attenuate the impacts.
Golden Eagle *Aquila chrysaetos*	NESL-3 BGA	Nests on steep cliffs normally directly adjacent to foraging habitat of desert grasslands or, with only sparse shrubs if present, that provides primary prey of cottontail and jackrabbits (NNHP 2008).	Species occasionally occurs in the Kayenta Mine permit area. Blasting and noises from vehicles may arouse or flush individual eagles near the coal resource areas, but impacts overall will be minor during the permit period.
Ferruginous Hawk *Buteo regalis*	NESL-3 WSC	The species occurs in grasslands, sagebrush scrub, saltbush-greasewood shrubland, and the periphery of piñon-juniper and other western forests (Bechard and Schmutz 1995).	This species could occur within the Kayenta Mine permit area. Annual wildlife surveys have not documented the presence of this species. Blasting and noises from vehicles may arouse or flush individual ferruginous hawks near the coal resource areas, but impacts overall will be minor during the permit period.
Mountain Plover [1] *Charadrius montanus*	NESL-4	Although cultivated land is used by wintering mountain plovers and is more abundant than non-cultivated land, mountain plovers appear to prefer short-grass prairie, alkali flats, burned grasslands, and livestock-grazed annual grasslands to cultivated sites.	Potential habitat of limited quantity and quality occurs nearby in the inactive Black Mesa Mine and for a season after reclamation in the Kayenta Mine permit area. The closest breeding records for the species are about 200 miles away. Possible migrants have been documented about 90 miles away.
Western Yellow-billed Cuckoo [1] *Coccyzus americanus occidentalis*	NESL-2 WSC	Occurs in large blocks of riparian woodlands (cottonwood, willow, or tamarisk gallery forests).	No suitable habitat occurs on Black Mesa.

Species	Status	Habitat Requirements	Analysis Summary
Southwestern Willow Flycatcher[1] *Empidonax traillii extimus*	NESL-2 WSC	It utilizes dense stands of riparian vegetation that have a layered canopy and are next to or are flooded by perennial sources of water (NNHP 2008). The primary vegetation can either be native blocks of cottonwood and willow or non-native stands of tamarisk or Russian olive (*Elaeagnus angustifolia*) that are taller than 3 meters (10 feet) (NNHP 2008).	No suitable habitat occurs near the coal resource areas N-9, J-19, and J-21. No riparian habitat will be removed as part of development of these areas.
Peregrine Falcon *Falco peregrinus*	NESL-4 WSC	Nests in a variety of habitats, with steep cliffs typically more than 148 feet (45 meters) tall (NNHP 2008). Suitable habitat requires an abundance of prey (birds of various species) near nest and roost sites. (NNHP 2008). These areas typically occur along wetlands, riparian forests, and other forest habitats.	This species could occur within the Kayenta Mine permit area and previous surveys detected nesting pair in the canyons within three miles of the Kayenta Mine permit area. Species has not been detected during surveys conducted in 2008 and 2009; however, Peregrine falcons occasionally forage in the Kayenta Mine permit area, and individual falcons could occur periodically in the N-9 coal resource area and other places with piñon-juniper woodland (BIOME 2003, EMI 2009, 2010).
Northern Pygmy Owl *Glaucidium gnoma*	NESL-4	Occurs in a variety of montane forest habitats, and possibly wooded canyons that include coniferous forest (spruce, fir, and ponderosa pine), mixed conifer-hardwood with oak and aspen, hardwood bottomlands, and occasionally aspen stands (NNHP 2008).	This species could occur about two miles northeast of the Kayenta Mine permit area. Annual wildlife surveys have not documented the presence of this species. Species could be impacted by noise and light pollution from mining, but topography and dense vegetation would attenuate the impacts.
California Condor[1] *Gymnogyps californianus*	NESL-4	Utilizes canyon country and mountainous habitats for nesting and roosting, and can forage widely in a variety of habitats around these areas (NNHP 2008).	This species is unlikely to occur within the Kayenta Mine permit area. Annual wildlife surveys have not documented the presence of this species. Condors that may fly into the study area would be transients, and the effects of mining would be negligible on any individuals in the area during the permit period.

Species	Status	Habitat Requirements	Analysis Summary
Bald Eagle *Haliaeetus leucocephalus*	NESL-2 BGA	Typically nest in riparian areas with mature trees, particularly large mature cottonwoods that are adjacent to large bodies of water (major rivers, lakes, or reservoirs) with abundant prey (large fish and waterfowl) (NNHP 2008).	Blasting may arouse or flush individual eagles in the area, but impacts overall would be minor during the permit period because eagles rarely occur in the area.
Flammulated Owl *Otus flammeolus*	NESL-4	The flammulated owl nests in tree cavities in open conifer (usually ponderosa pine) or aspen forests, often with brushy understory of dense saplings or oak shrubs and clearings (NNHP 2008).	This species could occur about two miles northeast of the Kayenta Mine permit area. Species has not been detected during surveys conducted in 2008 and 2009 (EMI 2009, 2010). Species could be impacted by noise and light pollution from mining, but topography and dense vegetation would attenuate the impacts.
Osprey *Pandion haliaetus*	WSC	In Arizona, nests in coniferous trees, alongside or near rivers and lakes in the White Mountains and across the Mogollon Plateau (usually within 6 to 7 miles).	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.
Sora *Porzana carolina*	NESL-4	Inhabits a variety of natural and man-made wetland habitats (Corman and Wise-Gervais 2005). Suitable habitat has dense emergent vegetation, and shallows are needed for adequate foraging.	This species is occasionally seen within the Kayenta Mine permit area. Additional artificial wetlands developed in conjunction with further mining of the N-9, J-19, and J-21 coal resource areas could provide additional habitat resources for the species within the Kayenta Mine permit area during the permit period.
Mexican Spotted-owl [1] *Strix occidentalis lucida*	NESL-3 WSC	Mexican spotted-owls occupy a variety of habitats for breeding and foraging. Breeding habitat includes dense old-growth mixed conifer forests along steep slopes and ravines (AGFD 2005). Within this habitat, the trees are dense, and form a closed canopy with a high basal area. The ground often is littered with numerous downed logs and snags.	This species occurs about two miles northeast of the Kayenta Mine permit area. Monitoring surveys suspended in 2000 have been reinitiated in spring 2011. Impacts from mining activities during the permit period to Mexican spotted-owls will be limited to noise and light, but topography and dense vegetation would attenuate the impacts.
MAMMALS			
Mexican Gray Wolf [1] *Canis lupus baileyi*	NESL-1	Typically occurs in chaparral, woodland, and forested areas. May cross desert areas. Reintroduced experimental non-essential population in the Apache National Forest in Greenlee and Apache counties has expanded into Navajo, Apache, and Gila counties on White Mountain Apache Tribal lands.	Kayenta Mine permit area is outside the reintroduced population's geographic range.

Species	Status	Habitat Requirements	Analysis Summary
Townsend’s Big-eared Bat *Corynorhinus townsendii*	NESL-4	Habitats include coniferous forests, piñon-juniper woodlands, deciduous riparian woodlands, and desert scrub habitats (NNHP 2008).	This species could occur within the Kayenta Mine permit area. Development of the coal resource areas could remove foraging habitat for the species during the permit period, but reclamation vegetation in these areas would replace the lost foraging habitats.
Navajo Mountain Vole *Microtus mogollonensis navajo*	NESL-4 WSC	Typically inhabits dry grassy vegetation in conifer forests and forest openings. The species also inhabits patches of sagebrush, greasewood, desert-olive (*Forestiera neomexicana*), and tamarisk with a heavy cover of grasses (NNHP 2008).	This species occurs within the Kayenta Mine permit area in native and reclamation habitats. Habitat for this species could be removed during mine development. Reclamation vegetation in mined areas replaces the lost habitats.
Jaguar [1] *Panthera onca*	WSC	Occurs in a wide range of habitats from desert scrub to pine-oak woodland and is associated with areas that have permanent sources of water.	Kayenta Mine permit area is outside species geographic range.
PLANTS			
Welsh's Milkweed [1] *Asclepias welshii*	NESL-3 HS	Found on open, sparsely vegetated semi-stabilized coral pink sand dunes, in sagebrush, juniper, pine, and oak communities of the Great Basin desertscrub. Elevations range from 4,700 to 6,250 feet (1,434 to 1,906 meters).	No suitable habitat occurs in the Kayenta Mine permit area or on Black Mesa.
Gladiator Milk Vetch *Astragalus xiphoides*	SR	Grasslands and alluvial plains from 5,000 to 6,000 feet (1,525 to 1,830 meters) elevation. Known to grow on Chinle and Moenkopi formations, and is generally associated with badlands of broken sandstone and clay bluffs, in washes, floodplains, or complexes of small arroyos.	Kayenta Mine permit area is outside species geographic range.
Navajo Sedge [1] *Carex specuicola*	NESL-3 HS	Shady seep-spring pockets and hanging gardens, on vertical pink-red Navajo Sandstone cliffs and alcoves, from 4,600 to 7,200 feet (1,403 to 2,196 meters) elevation. Found within the piñon-juniper woodland zone.	No suitable habitat occurs in the Kayenta Mine permit area.
Roundleaf Errazurizia *Errazurizia rotundata*	NESL-3 SR	Found on northeast-facing slopes in sandy soils in sandstone, gravelly soils in calcareous outcrops, and deep alluvial cinders in sandstone breaks. Occurs at elevations from 4,620 to 5,200 feet (1,409 to 1,585 meters).	Kayenta Mine permit area is outside species geographic range.
Paper-spined Cactus *Pediocactus papyracanthus*	SR	Grows in open flats in grasslands and piñon-juniper woodlands, associated with grama grass and sandstone derived substrates. Grows at elevations ranging from 5,000 to 7,300 feet (1,525 to 2,227 meters).	Kayenta Mine permit area is outside species geographic range.
Peebles Navajo Cactus [1] *Pediocactus peeblesianus var.peeblesianus*	HS	Occurs in exposed sunny situations on weakly alkaline, gravely soils of the Little Colorado paleo-channels. Occurs at elevations from 5,100 to 5,650 feet (1,556 to 1,723 meters) near Joseph City to the Marcou Mesa region.	Kayenta Mine permit area is outside species geographic range and no suitable habitat is present.

Species	Status	Habitat Requirements	Analysis Summary
Alcove Bog-orchid *Platanthera zothecina*	NESL-3	Occurs in several microhabitats in hanging garden communities at bases of alcove face-walls with flowing drip-line or with seepage down wall; in protection of dense vegetation or under rock debris of alcove foot slope; shaded sites along streams; and shaded seeps. Grows at elevations ranging from 3,950 to 6,400 feet (1,204 to 1,951 meters).	No suitable habitat occurs in the Kayenta Mine permit area. Species may be impacted by groundwater pumping associated with the Kayenta Mine permit area and regional pumping from municipal sources.

SOURCE: Arizona Game and Fish Department 2010; Arizona Game and Fish Department Heritage Data Management System species abstracts

NOTES: Agency or Law: NESL = Navajo Nation Endangered Species List; BGA = Bald and Golden Eagle Protection Act

Status Definitions: **Navajo Nation:** NESL-1 = Group 1 endangered species; NESL-2 = Group 2 endangered species; NESL-3 = Group 3 endangered species; NESL-4 = Group 4 endangered species. **State of Arizona:** HS = highly safeguarded plant in Arizona; SR = salvage restricted plant in Arizona; WSC = wildlife of special concern in Arizona.

[1] Species also has special status as a federally listed, candidate, or proposed species and appears in both Table C-1 and Table C-2.

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Appendix D
Air Quality Resources
Impact Assessment Methods and Results

Kayenta Complex

D.1 INTRODUCTION

OSM authorizes surface coal mining and reclamation activities in five-year incremental periods to provide an opportunity to review the mine's compliance with applicable terms and conditions of permits. Two of the criteria which allow OSM to deny a requested permit renewal for a five-year period are:

(1) The present surface coal mining and reclamation operations are not in compliance with the environmental protection standards of the SMCRA and the regulatory program; or

(2) The requested renewal substantially jeopardizes the operator's continuing ability to comply with the Act and the regulatory program on existing permit areas.

With respect to air quality protection standards, the predominant consideration with surface coal mining is whether impacts of particulate matter emissions from mining and reclamation activities comply with applicable national ambient air quality standards (NAAQS). In addition, air quality impacts due to emissions of nitrogen oxides from blasting and from exhausts of mining equipment and vehicles are frequently evaluated for compliance.

This analysis was prepared to evaluate if the requested permit renewal will jeopardize the ability of Kayenta's mining and reclamation activities to comply with the NAAQS for PM_{10}, $PM_{2.5}$ and NO_2 during the permit renewal period. Notably, emission rates of those pollutants during the permit renewal period will not differ appreciably from their emission rates during the current permit period. This analysis includes a modeling projection of the impacts of those pollutants from the Kayenta Complex during the permit renewal to evaluate if the applicable NAAQSs will not be threatened or exceeded at any location. Among the findings are predicted ambient impacts of those pollutants in many locations throughout the resource area are expected to be insignificant.

D.2 SOURCE REPRESENTATION

The Kayenta Complex has a variety of fugitive and process fugitive sources of particulate matter. The only significant sources of nitrogen oxides are blasting and tailpipe emissions from large mining equipment.

Fugitive emission sources at the Complex include excavation, haulage and land reclamation activities. Specifically, overburden removal by dragline and shovel, coal removal by shovel or front-end loader, dozer activity on spoil and coal piles, topsoil haulage, natural wind erosion of disturbed areas and stockpiles, and truck haulage of both coal and overburden are among the significant activities falling under this category of sources.

Process fugitive emissions include primary crushing, secondary crushing, screening, unloading and loading at the preparation facilities. Also included are conveyor transfer points at the preparation plants and along the belt to the train loadout.

While the locations of the preparation plants will remain fixed and their maximum emissions will be essentially constant throughout the permit renewal period, the situation for mining activities is different.

Mining activities at surface coal mines are not fixed at a single location from year-to-year, as they move with the progressions of the pits, roads, and backfill and reclamation areas. Emission rates vary as well with the varying quantities of overburden, disturbed acreages, haul distances, etc., encountered through the permit renewal period. Table D-1 presents the operating parameters for the three years examined for this analysis.

Table D-1 Mine Operating Parameters

Area	Activity	CY2010	CY2012	CY2018
J28	Truck Dumping at Pile (tons)	5,943,800	5,840,000	5,759,400
	Hopper Loading (tons)	5,943,800	5,840,000	5,759,400
	Transfer Points (tons)	5,943,800	5,840,000	5,759,400
	Primary Crushing (tons)	5,943,800	5,840,000	5,759,400
	Secondary Crushing (tons)	297,190	292,000	287,970
	Screening (tons)	5,943,800	5,840,000	5,759,400
	Sample System Transfer Points (tons)	106,988	105,120	103,669
	Sample System Crushing (tons)	4,707	4,625	4,561
	Wheeled Dozer (hr/yr)	2,000	2,000	2,000
	Coal Pile Wind Erosion			
	K5 (acres)	4.2	4.2	4.2
	K6/6A (acres)	11.8	11.8	11.8
N11	Truck Dumping at Pile (tons)	1,946,000	2,260,000	2,492,000
	Hopper Loading (tons)	1,946,000	2,260,000	2,492,000
	Transfer Points (tons)	1,946,000	2,260,000	2,492,000
	Sample System Transfer Points (tons)	19,460	22,600	24,920
	Primary Crushing (tons)	1,946,000	2,260,000	2,492,000
	Sample System Crushing (tons)	1,168	1,356	1,495
	Screening (tons)	1,946,000	2,260,000	2,492,000
	Wheeled Dozer (hr/yr)	1,000	1,000	1,000
	Coal Pile Wind Erosion (acres)	4.4	4.4	4.4
N8	Stacker/Hopper Loading (tons)	7,889,800	8,100,000	8,251,400
	Transfer Points (tons)	7,889,800	8,100,000	8,251,400
	Sample System Transfer Points (tons)	77,320	79,380	80,864
	Sample System Crushing (tons)	4,821	4,949	5,042
	Screening (tons)	7,889,800	8,100,000	8,251,400
	Secondary Crushing (tons)	395,437	405,972	413,560
	Track Dozers on Coal (hr/yr)	16,400	16,400	16,400
	Coal Pile Wind Erosion			
	K1 (acres)	7.8	7.8	7.8
	K2 (acres)	5.2	5.2	5.2
	K3 (acres)	5.4	5.4	5.4
Overland	Transfer Points Conv 20 – 25 (tons)	5,943,800	5,840,000	5,759,400
Conveyor	Transfer Points Conv 21A – 23 (tons)	7,889,800	8,100,000	8,251,400
Kayenta	Topsoil Scrapers (hr/yr)	13,648	13,648	13,648
Complex Pits	Overburden Blasting (number of blasts)	242	242	242
	Overburden Drilling (number of holes)	67,401	67,401	67,401
	Dragline Overburden Removal & Replacement (yds^3)	40,707,800	38,537,400	38,569,900
	Truck-Shovel Overburden Removal & Replacement (tons)	2,610,320	4,418,080	2,176,000
	Dozers on Overburden (hr/yr)	61,208	61,208	61,208

Area	Activity	CY2010	CY2012	CY2018
	Overburden Haul Trucks – Unpaved Roads (mi/yr)	55,539	94,002	46,298
	Coal Blasting (number of blasts)	273	273	273
	Coal Drilling (number of holes)	60,403	60,403	60,403
	Truck-Shovel Coal Removal (tons)	8,200,000	8,200,000	8,200,000
	Coal Haul Trucks – Unpaved Roads (mi/yr)	230,524	230,524	230,524
	Graders (hr/yr)	16,586	16,586	16,586
	Road Repair – Graders Travel Mode (mi/yr)	36,551	36,551	36,551
	Open Acres – Wind Erosion (number of acres)	5,283	5,287	4,605

D.3 EMISSION ESTIMATES – COAL PREPARATION FACILITIES

At the Complex, Peabody maintains coal preparation facilities at three locations referred to as N8, N11, and J28. These areas "prepare" coal by crushing and screening operations, which in turn are supported by various conveying, dumping and storage activities. Emission estimates were calculated for dust-generating activities at these areas by using emission factors found in U.S. EPA's AP-42, "Compilation of Air Pollutant Emission Factors," in conjunction with operational parameters provided by Peabody. Summaries of emissions by preparation plant and emission activity are provided in Table D-2.

Annual inventories were developed for years 2010, 2012, and 2018. The year 2010 was chosen as the baseline year for comparison, because this analysis was initiated in 2010 and sufficient mining data was not available to accurately characterize the latest actual operational parameters resulting in current emissions estimates needed for comparison with projected operational parameters and future emissions estimates. The year 2012 was selected because projected mine operational parameters in that year are estimated to result in the greatest or "worst-case" potential emissions during the five-year permit term. Finally, the year 2018 was evaluated because that year results in the greatest reasonably foreseeable air polluting emission levels during the permit renewal period through 2018 in the three coal resource areas currently approved for mining.

Table D-2 Preparation Plant Emission Summary (tons/yr)

Activity	2010			2012			2018		
	PM_{10}	$PM_{2.5}$	NO_x	PM_{10}	$PM_{2.5}$	NO_x	PM_{10}	$PM_{2.5}$	NO_x
J-28									
Truck dumping	0.37	0.06	0.00	0.36	0.06	0.00	0.36	0.05	0.00
Hopper loading	0.19	0.03	0.00	0.18	0.03	0.00	0.18	0.03	0.00
Transfer points	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Primary crushing	0.36	0.36	0.00	0.35	0.35	0.00	0.35	0.35	0.00
Secondary crushing	0.02	0.02	0.00	0.02	0.02	0.00	0.02	0.02	0.00
Screening	2.23	2.23	0.00	2.19	2.19	0.00	2.16	2.16	0.00
Sample system transfer points	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sample system crushing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wheeled dozer	9.60	0.80	4.17	9.60	0.80	4.17	9.60	0.80	4.17
Wind erosion from coal piles	26.27	3.94	0.00	26.27	3.94	0.00	26.27	3.94	0.00
	39.04	**7.44**	**4.17**	**38.98**	**7.39**	**4.17**	**38.94**	**7.35**	**4.17**
N-11 Extension									
Truck dumping	0.12	0.02	0.00	0.14	0.02	0.00	0.16	0.02	0.00
Hopper loading	0.06	0.01	0.00	0.07	0.01	0.00	0.08	0.01	0.00
Transfer points	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Primary crushing	0.12	0.12	0.00	0.14	0.14	0.00	0.15	0.15	0.00
Screening	0.73	0.73	0.00	0.85	0.85	0.00	0.93	0.93	0.00
Sample system transfer points	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sample system crushing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Activity	2010 PM$_{10}$	2010 PM$_{2.5}$	2010 NO$_x$	2012 PM$_{10}$	2012 PM$_{2.5}$	2012 NO$_x$	2018 PM$_{10}$	2018 PM$_{2.5}$	2018 NO$_x$
Wheeled dozer	4.80	0.40	2.08	4.80	0.40	2.08	4.80	0.40	2.08
Wind erosion from coal piles	6.63	0.99	0.00	6.63	0.99	0.00	6.63	0.99	0.00
	12.46	**2.27**	**2.08**	**12.63**	**2.41**	**2.08**	**12.75**	**2.52**	**2.08**
N-8									
Hopper loading	0.39	0.06	0.00	0.40	0.06	0.00	0.41	0.06	0.00
Transfer points	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Secondary crushing	0.02	0.02	0.00	0.02	0.02	0.00	0.02	0.02	0.00
Screening	2.96	2.96	0.00	3.04	3.04	0.00	3.09	3.09	0.00
Sample system transfer points	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sample system crushing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tracked dozers on coal	31.48	2.64	10.33	31.48	2.64	10.33	31.48	2.64	10.33
Wind erosion from coal piles	30.21	4.53	0.00	30.21	4.53	0.00	30.21	4.53	0.00
	65.08	**10.22**	**10.33**	**65.17**	**10.30**	**10.33**	**65.23**	**10.36**	**10.33**

D.4 EMISSION ESTIMATES – MINING ACTIVITIES

Emission factors endorsed by the Wyoming Department of Environmental Quality (WDEQ) were used to determine fugitive particulate emissions from the mining activities.[1] A summary of PM$_{10}$ and PM$_{2.5}$ emissions by activity type are provided in Table D-3. Mine-wide inventories of nitrogen oxides (NO$_x$) from vehicle tailpipes and blasting were also developed and are presented in Table D-4.

Table D-3 PM$_{10}$ and PM$_{2.5}$ Emission Summary from Mining Activities (tons/yr)

Activity	2010 PM$_{10}$	2010 PM$_{2.5}$	2012 PM$_{10}$	2012 PM$_{2.5}$	2018 PM$_{10}$	2018 PM$_{2.5}$
Scrapers	45.02	4.50	45.02	4.50	45.02	4.50
Overburden drilling	2.19	0.22	2.19	0.22	2.19	0.22
Overburden blasting	2.27	0.23	2.27	0.23	2.27	0.23
Overburden removal (truck/shovel)	9.79	0.98	16.57	1.66	8.16	0.82
Overburden truck travel	9.92	0.99	16.79	1.68	8.27	0.83
Overburden removal (dragline)	305.31	30.53	289.03	28.90	289.27	28.93
Coal drilling	0.33	0.03	0.33	0.03	0.33	0.03
Coal blasting	1.79	0.18	1.79	0.18	1.79	0.18
Coal removal	4.31	0.43	4.31	0.43	4.31	0.43
Coal truck travel	13.68	1.37	13.68	1.37	13.68	1.37
Dozers on overburden	23.04	12.66	23.04	12.66	23.04	12.66
Graders	43.77	4.38	43.77	4.38	43.77	4.38
Wind erosion of open acres	660.38	99.06	660.88	99.13	575.63	86.34
	1,121.79	**155.56**	**1,119.66**	**155.37**	**1,017.73**	**140.91**

Table D-4 NO$_x$ Emission Summary from Mining Activities (tons/yr)

Activity	2010 NO$_x$	2012 NO$_x$	2018 NO$_x$
Scrapers	26.20	26.20	26.20
Drills	3.53	3.44	3.00
Blasting	129.97	126.38	110.17
Overburden haul trucks	57.33	51.77	45.14
Wheeled dozers – pits	6.15	6.13	6.32

[1] Collins, Charles A., "Fugitive Dust Emission Factors," Wyoming Department of Environmental Quality, January 1979.

Activity	2010 NO_x	2012 NO_x	2018 NO_x
Track dozers – pits	37.33	33.72	29.40
Wheeled loaders	10.97	10.93	11.27
Coal haul trucks	63.61	63.35	65.32
Graders	5.91	5.91	5.91
Water trucks	19.68	19.60	20.21
	360.70	**347.43**	**322.93**

D.5 EMISSIONS CHANGES DURING PERMIT RENEWAL TERM

EPA's program for the prevention of significant deterioration of air quality defines when an emissions increase that results from a change at a stationary source is "significant," and thereby warrants investigation into the extent of the ambient air quality impact caused by that emissions increase. By definition, a PM_{10} emissions increase of 15 tpy or more is "significant." Similarly, an emissions increase of 10 tpy or more of direct $PM_{2.5}$ is "significant." Likewise, a NO_x emissions increase of 40 tpy or more is "significant."[2]

The preceding tables show that an increase in emissions of either PM_{10}, $PM_{2.5}$ or NO_x during the permit renewal term above the level of those pollutants' emissions during the baseline will not be, by definition, "significant." Some of those pollutants' emissions during the permit renewal term and beyond will actually be lower than their corresponding levels during the current permit term. Thus, the requested permit renewal will not result in any "significant" emissions increases from Kayenta Complex. In keeping with the protocol of the PSD program, that finding indicates that an examination of the air quality impacts associated with any emission changes during the permit renewal term would not be necessary.

D.6 AIR QUALITY IMPACTS CORRELATED WITH EMISSIONS CHANGE

A fundamental principle of air quality analysis is that the ambient air concentration of an air pollutant discharged from a source is proportional to the rate at which that pollutant is emitted from that source. Thus, if the permit renewal will not result in a "significant" emissions increase of PM_{10}, any change in ambient levels of PM_{10} due to the permit renewal is expected to be insignificant or negligible. Similarly, because the permit renewal will not result in a "significant" emissions increase of either $PM_{2.5}$ or NO_x, the permit renewal will not result in a significant increase in ambient concentration of either pollutant.

In keeping with requirements of the PSD program for the review of changes at stationary sources, the change in each pollutant's emissions due to the permit renewal is so minor that an evaluation of any air quality impacts due to that emissions change is not necessary. Nevertheless, this analysis includes the following projection of ambient air concentrations that result from the Complex's total PM_{10} emissions during the permit renewal term in order to demonstrate that the permit renewal will not jeopardize the ability of Kayenta's mining and reclamation activities to comply with the NAAQS for PM_{10}, $PM_{2.5}$ and NO_2 during the permit renewal period.

D.7 OVERVIEW OF MODELING METHODOLOGY

As previously explained, emission inventories for PM_{10} and $PM_{2.5}$ were developed for the coal preparation facilities using emission factors found in U.S. EPA's AP-42, "Compilation of Air Pollutant Emission Factors," and operational parameters provided by Peabody. PM_{10} and $PM_{2.5}$ inventories for

[2] 40 CFR 52.21(b)(23).

mining activities were calculated using emission factors endorsed by the WDEQ. Mine-wide inventories of nitrogen oxides (NO_x) from vehicle tailpipes and blasting were also developed.

The AERMOD dispersion model was run in regulatory default mode to predict short-term (24-hour) impacts for PM_{10}, short-term and annual impacts for $PM_{2.5}$, and annual impacts of NO_2 during each of the three years evaluated.

One year of on-site meteorological data was used to drive the atmospheric dispersion aspects of the AERMOD model. Relevant concentration predictions were made at receptors along the Complex permit boundary and at specific residences near the permit boundary. Concentrations were also predicted at other key cultural locations in the region

D.8 EMISSIONS APPORTIONING

Fugitive emissions for each of the worst-case years were apportioned into area sources based on the activity type. The number and location of the area sources, as well as their dimensions and orientation, were based on the pit configurations provided by Peabody. Emissions were divided by the cross-sectional area of each area source in which they occurred to arrive at an emission rate in grams/second/square meter.

D.9 METEOROLOGICAL DATA

For this modeling effort, a single year of data from meteorological monitoring site BM-MET9 was selected for modeling. Data obtained by BM-MET9 are representative of site-wide atmospheric transport and dispersion conditions. Data for year 2008 were used in this analysis.

The most recent version of AERMET (06341) was utilized to generate AERMOD-ready meteorological data files. AERMET processes data in three stages using on-site meteorological data and/or National Weather Service (NWS) data, along with NWS upper air data. For this project, AERMET was run for Stages 1 and 2 with on-site data from BM-MET9 and concurrent upper air data from Flagstaff. Because BM-MET9 collects both solar radiation and delta temperature (differential temperature between two levels), cloud cover from an off-site NWS station was not required.

For Stage 3 processing, results from Stage 2 are combined with land surface parameters (e.g., surface roughness) around the meteorological station. These parameters were obtained by importing USGS NLCD92 land use data from the USGS Seamless Data Server into the pre-processor program AERSURF (08009). Settings for AERSURF included the meteorological site not being at an airport, no continuous snow cover in the winter, an arid region, and standard seasons (winter is December, January and February; etc.). To assess whether 2008 was a climatologically wet, dry or average year, annual precipitation data for Winslow, Arizona was used as a proxy for the Complex. Annual Winslow precipitation data were compared against Winslow’s precipitation probabilities from 30-year climatology (1971-2000) based on guidance in the AERSURF User’s Guide. For 2008, the total amount of precipitation received was 4.66 inches. This is considered “dry” because the total precipitation is at or below the “0.3 30-year probability” of 6.89 inches (Table D-5). Output from AERSURF for dry surface parameters were incorporated into AERMET Stage 3 for 2008, and the two final surface and profile meteorological data files (*.sfc and *.pfl) were generated. These files are directly imported in AERMOD.

Table D-5 Precipitation Probabilities for Winslow, Arizona (1971-2000)

30-Year Probability	Precipitation Amount (inches)	Climatological Condition
≤0.3	≤6.89	Dry
0.31 to 0.69	6.90 to 8.91	Average
≥0.7	≥8.92	Wet

D.10 RECEPTORS

Receptors were placed around the permit boundary at a linear resolution of 500 meters. In addition, receptors were placed at residences which will not be affected during the permit renewal period for reasons directly related to mining and safety. Receptors were also placed at the nearest approach to the Navajo National Monument, the intersection of Highway 160 and Navajo Route 41, the town of Piñon, the Monument Valley Visitors Center, and the town of Kayenta. A receptor grid was created beyond the Complex boundary to determine whether significant pollutant concentrations would approach any sensitive areas. Receptor elevations were determined using USGS National Elevation Dataset digital files with 30-meter resolution. All receptor locations are referenced to the NAD1927 datum.

D.11 BACKGROUND CONCENTRATION FOR MODELING

PM_{10} monitoring data obtained from Peabody's air quality monitoring program was used to establish a background PM_{10} concentration for modeling purposes. Monitoring site AIRQ200 was not proximate to mining activities or preparation facilities for years 2007-2009, and was therefore determined to be representative of recent background concentrations. The annual average PM_{10} concentration for the three-year period at site AIRQ200 was 13.6 µg/m^3.

A $PM_{2.5}$ background value was obtained from EPA's AIRData website. The nearest $PM_{2.5}$ monitor with data available is located in Flagstaff. The annual average $PM_{2.5}$ concentration at this site for years 2007-2009 was 7.0 µg/m^3.

The NO_2 background was established at 2.1 µg/m^3 annual average based on guidance from the Arizona Department of Environmental Quality for a previous modeling analysis at the Complex.

D.12 MODEL RESULTS

Under its PSD program, EPA prescribes "significant impact levels" or "SILs" for particulate matter, NO_x and other criteria pollutants. The SIL is the level of ambient impact from an emission increase that is deemed significant enough to warrant a complete source impact analysis involving modeling the collective impacts of that source along with emissions from other existing sources. Evaluation of the source's ambient impact is only required when the emissions increase from the source will be "significant." However, even though the permit renewal will not cause any "significant" emissions increases, the relevant SILs have been used in this analysis to demonstrate the relatively minor, often insignificant, ambient impacts that result from a pollutant's total emissions from Kayenta Complex during the permit renewal.

D.12.1 PM_{10}

The SIL for PM_{10} is 5 µg/m^3 on a 24-hour basis for the resource area of this analysis. The AERMOD model was run to identify the 24-hour, 5 µg/m^3 significant impact areas (SIA) for PM_{10} for all three modeled years. That is, the total PM_{10} emissions from the entire Kayenta Complex during the baseline period, during the permit renewal term, and beyond that period were each modeled. The 24-hour SIA isopleths are shown in Figures D-1 through D-3 for years 2010, 2012 and 2018, respectively. Table D-6 shows that significant impacts (> 5 µg/m^3) are not predicted at the nearest culturally important locations, which are the Navajo National Monument and Monument Valley. The SIAs do not extend to any Class I areas.

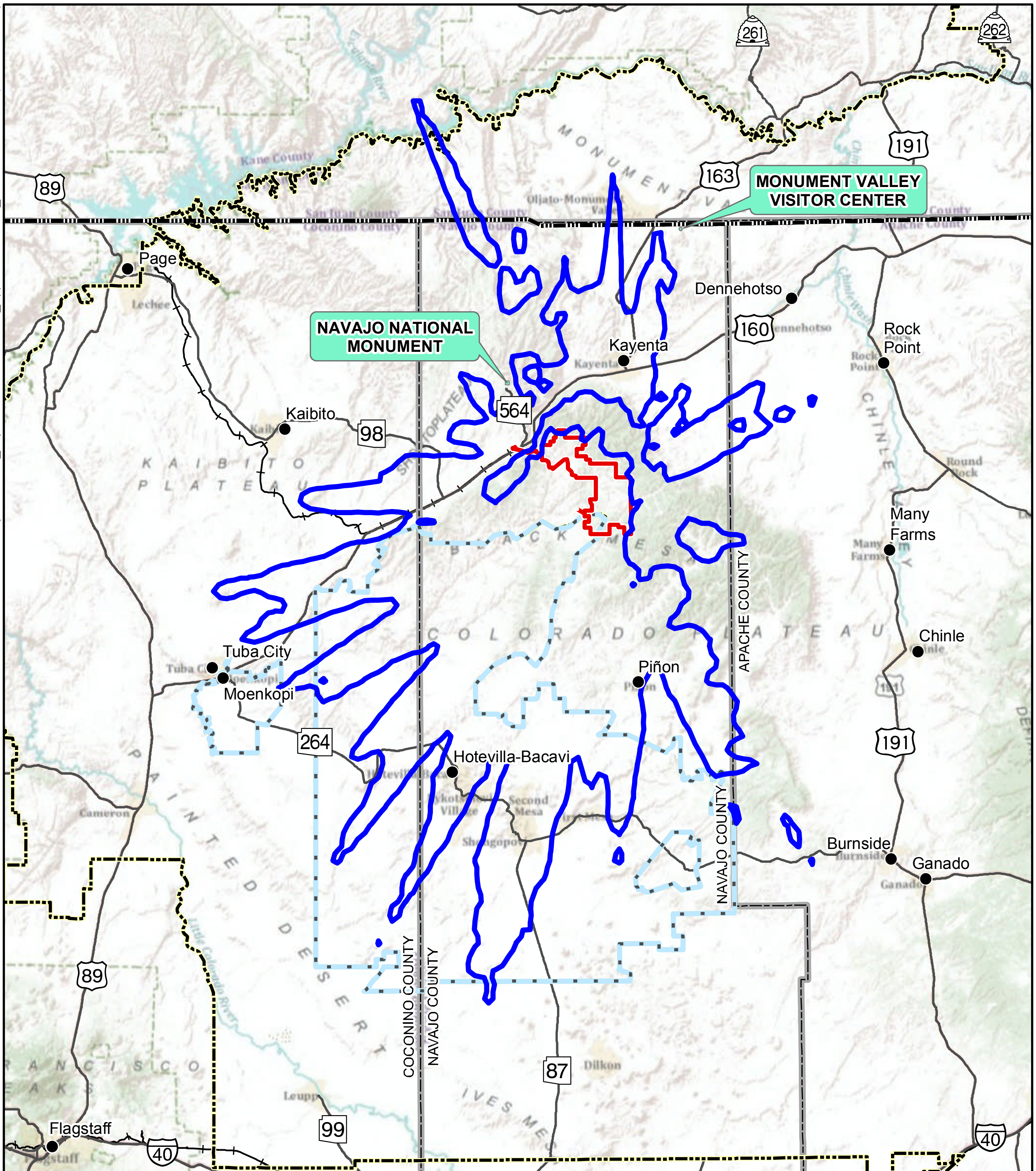
Table D-6 PM_{10} Impacts from the Complex on Local Sensitive Receptors

Receptor	PM_{10} 24-Hour Impact (µg/m^3)		
	2010	2012	2018
Navajo National Monument	0.86	1.03	1.04
Monument Valley Visitor Center	4.38	3.82	4.14

A summary of PM_{10} modeling results is provided in Table D-7 for each of the three modeled years. Importantly, predicted concentrations due to the Complex's total PM_{10} emissions in all cases were less than the NAAQS for PM_{10} for the 24-hour averaging period.

Table D-7 Kayenta Complex Maximum Predicted 24-Hour PM_{10} Concentrations

Model Year	Location	X-UTM	Y-UTM	PM_{10} Concentration (µg/m^3)	PM_{10} Concentration with Background (µg/m^3)	National Ambient Air Quality Standard (µg/m^3)
2010	Boundary	563581.26	4028888.44	110.58	124.18	150
2012	Boundary	564284.86	4029187.00	97.88	111.48	150
2018	Boundary	562794.76	4027179.78	124.70	138.30	150



Legend

- Kayenta Mine Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- 5 μg/m³ Impact Contour
- Sensitive Class II Area

Figure D-1

2010 24-Hour PM_{10}

Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16

Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

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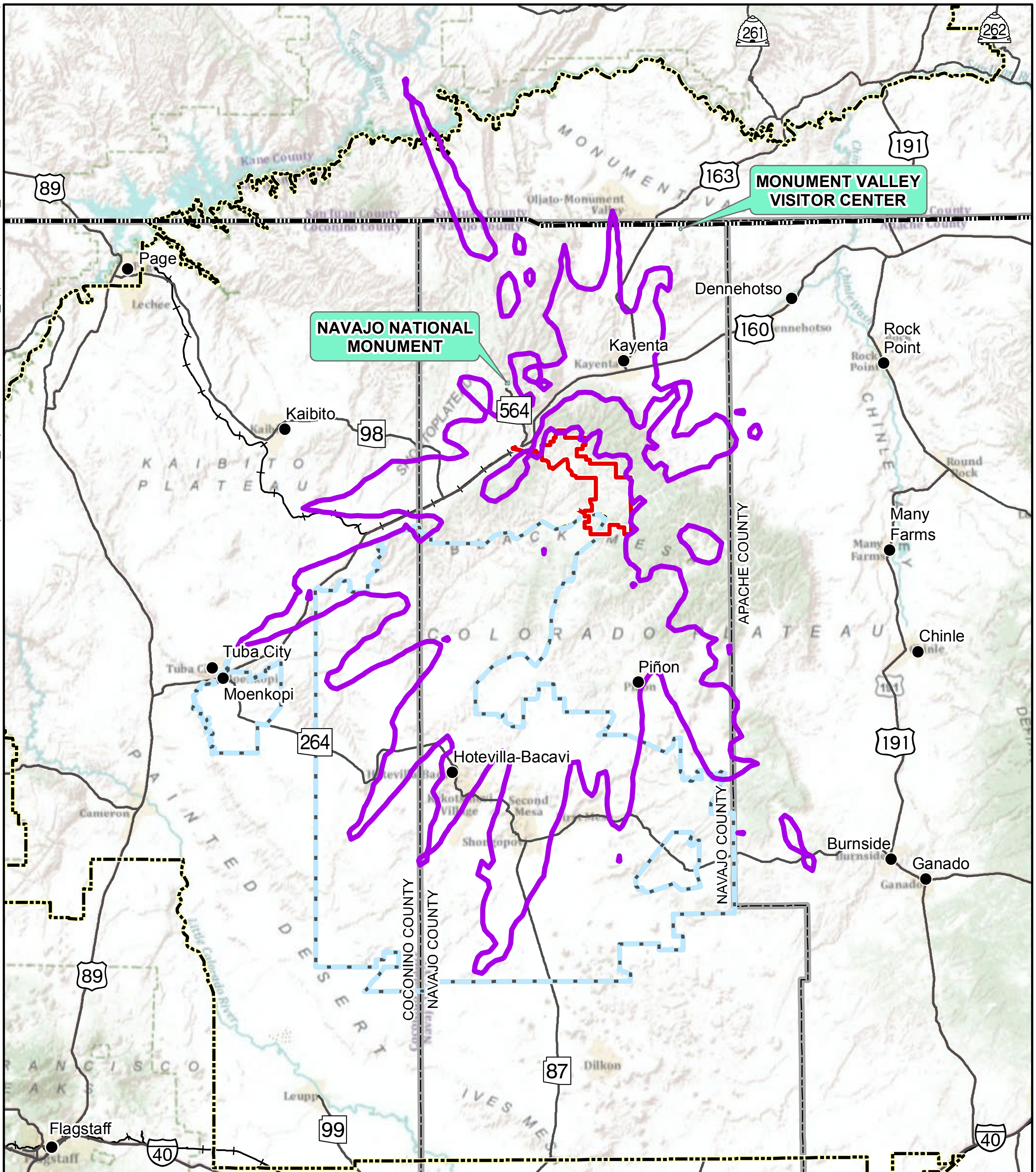

Legend

Kayenta Mine Area

Hopi Reservation

Navajo Nation Reservation Boundary

Highway

Railroad

Air Quality Feature

5 µg/m³ Impact Contour

Sensitive Class II Area

Figure D-2

2012 24-Hour PM_{10} Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16 Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

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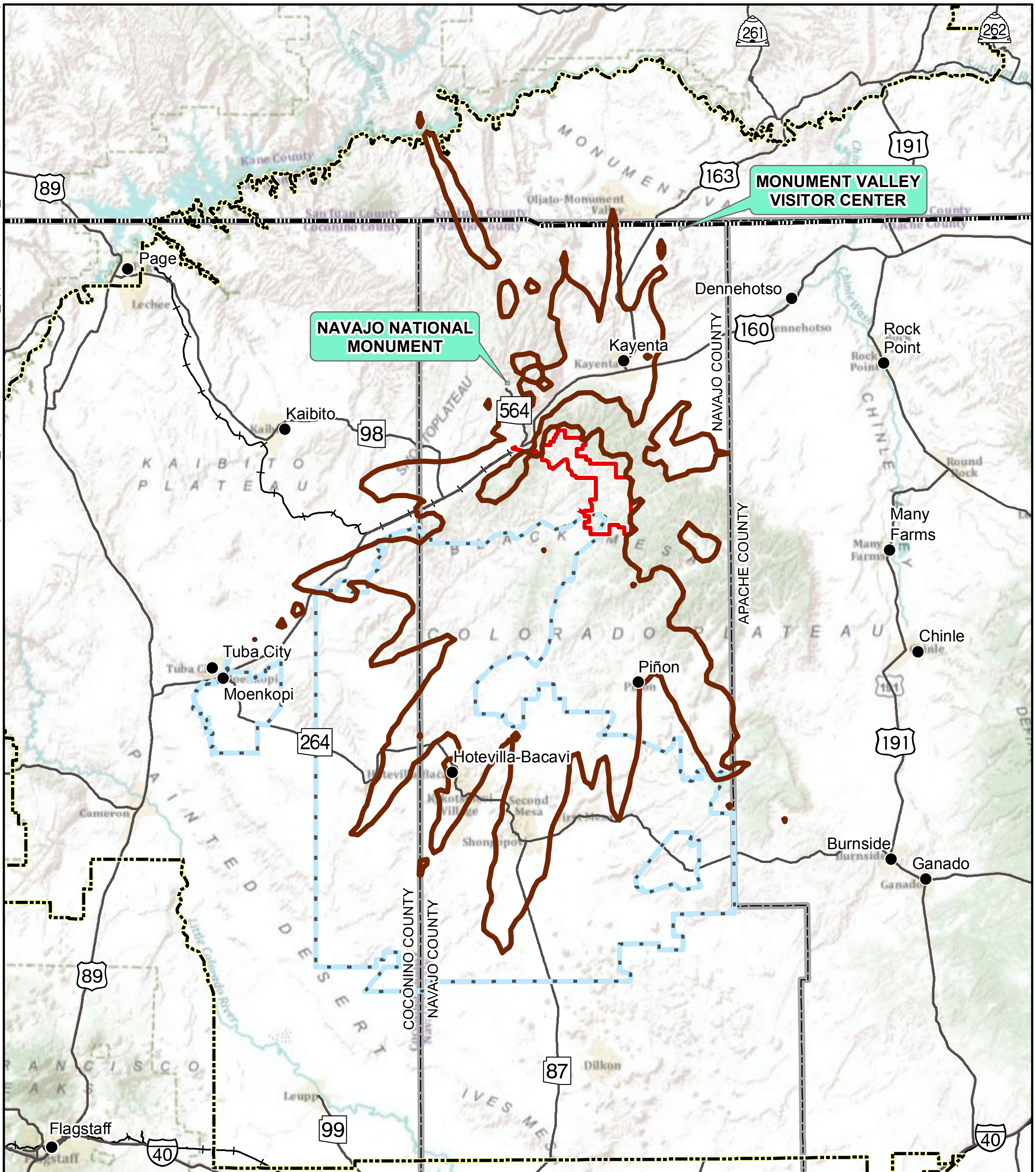


Legend

Kayenta Mine Area

Hopi Reservation

Navajo Nation Reservation Boundary

Highway

Railroad

Air Quality Feature

5 μg/m³ Impact Contour

Sensitive Class II Area

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

0 8 16
Miles

Figure D-3

2018 24-Hour PM_{10}
Significant Impact Area

Kayenta Mine Permit Renewal EA

PWCC URS

D.12.2 $PM_{2.5}$

The SILs for $PM_{2.5}$ are 1.2 µg/m^3 on a 24-hour basis and 0.3 µg/m^3 on an annual basis. Modeling was performed to identify the 24-hour SIA and the annual SIA for $PM_{2.5}$ for the three modeled years, using the corresponding total $PM_{2.5}$ emissions from the Complex for each year. Table D-8 shows that significant impacts are not predicted at the Navajo National Monument or Monument Valley. The 24-hour SIA isopleths are shown in Figures D-4 through D-6 for years 2010, 2012, and 2018, respectively. Annual SIA isopleths are shown in Figures D-9 through D-12.

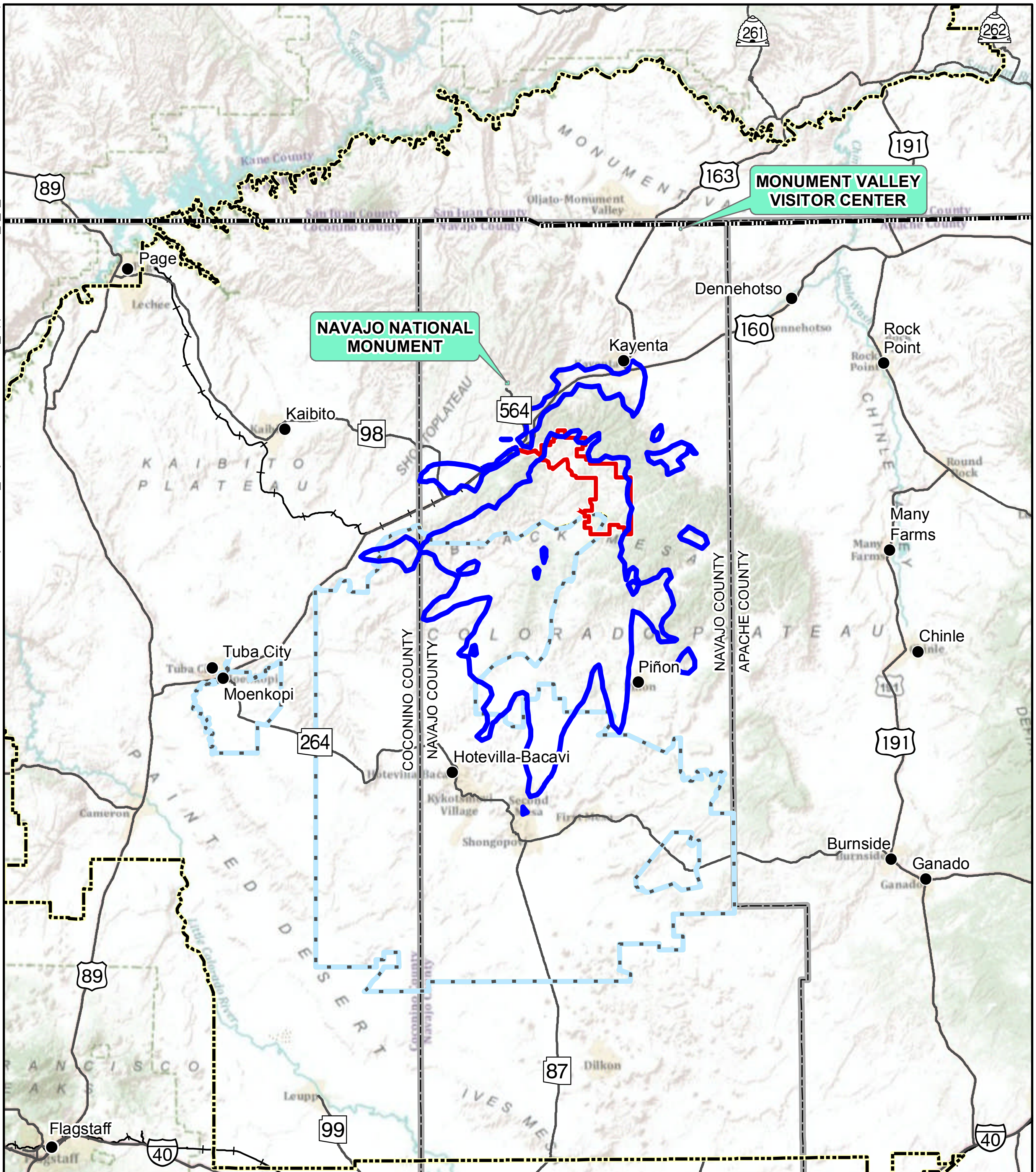
Table D-8 $PM_{2.5}$ Impacts from the Complex on Local Sensitive Receptors

Receptor	$PM_{2.5}$ 24-Hour Impact (µg/m^3)			$PM_{2.5}$ Annual Impact (µg/m^3)		
	2010	2012	2018	2010	2012	2018
Navajo National Monument	0.12	0.14	0.15	0.01	0.01	0.01
Monument Valley Visitor Center	0.61	0.54	0.59	0.01	0.01	0.01

A summary of 24-hour and annual $PM_{2.5}$ modeling results is provided in Table D-9 for each of the three modeled years. Predicted concentrations were less than the applicable NAAQS for both averaging periods.

Table D-9 Kayenta Complex Maximum Predicted $PM_{2.5}$ Concentrations

Model Year	Averaging Period	Location	X-UTM	Y-UTM	$PM_{2.5}$ Concentration (µg/m^3)	$PM_{2.5}$ Concentration with Background (µg/m^3)	National Ambient Air Quality Standard (µg/m^3)
2010	24-hour	Boundary	563581.26	4028888.44	15.31	22.31	35
2012	24-hour	Residence	564096.53	4028747.66	13.27	20.27	35
2018	24-hour	Boundary	562794.76	4027179.78	17.36	24.36	35
2010	Annual	Boundary	563581.26	4028888.44	3.46	10.46	15
2012	Annual	Residence	564096.53	4028747.66	4.37	11.37	15
2018	Annual	Boundary	562294.76	4027177.14	4.96	11.96	15



Legend

- Kayenta Mine Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- 1.2 µg/m³ Impact Contour
- Sensitive Class II Area

Figure D-4

2010 24-Hour $PM_{2.5}$
Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16
Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

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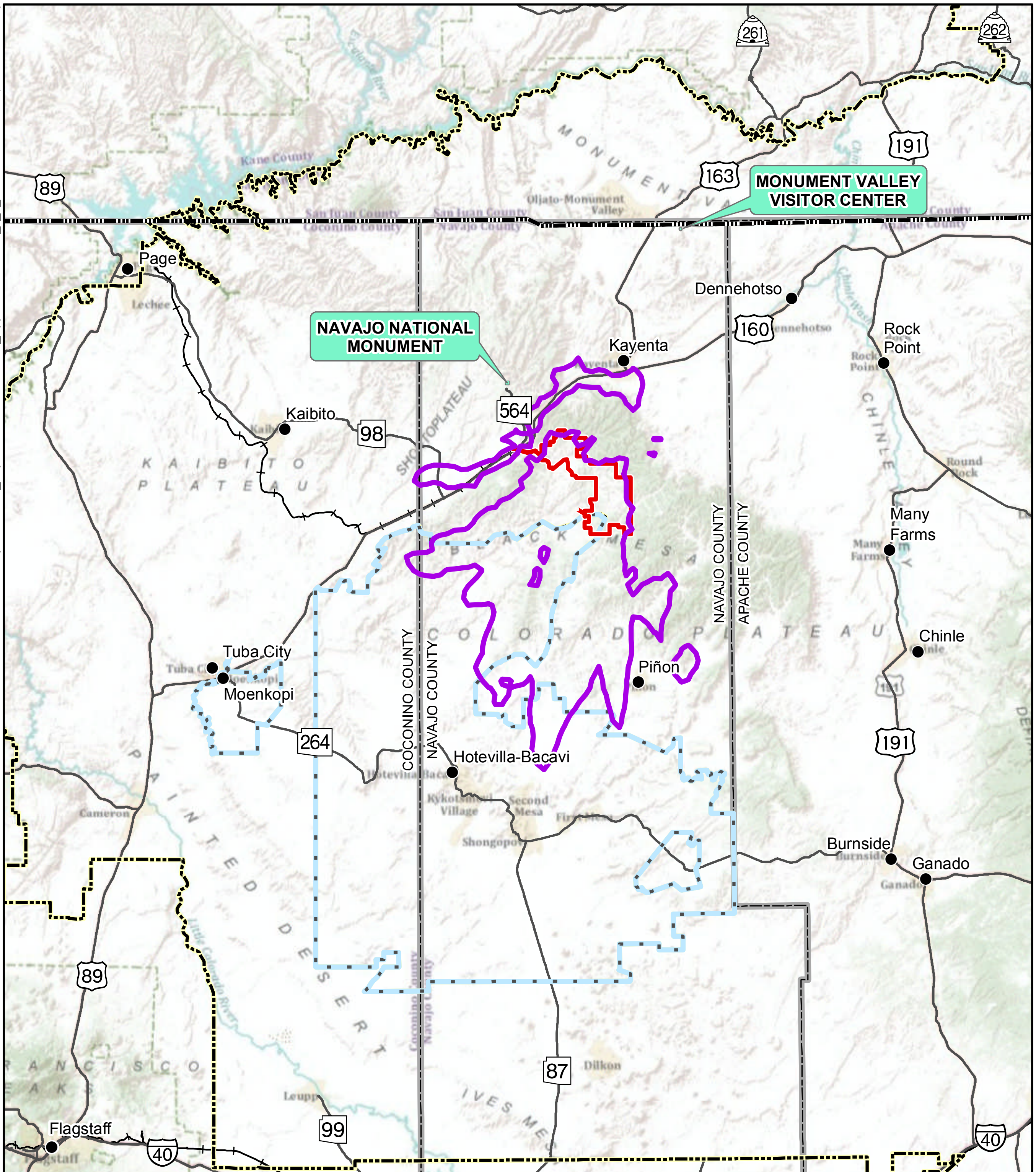

Legend

- Kayenta Mine Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- 1.2 µg/m³ Impact Contour
- Sensitive Class II Area

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

N

0 8 16
Miles

Figure D-5

2012 24-Hour $PM_{2.5}$
Significant Impact Area

Kayenta Mine Permit Renewal EA

PWCC URS

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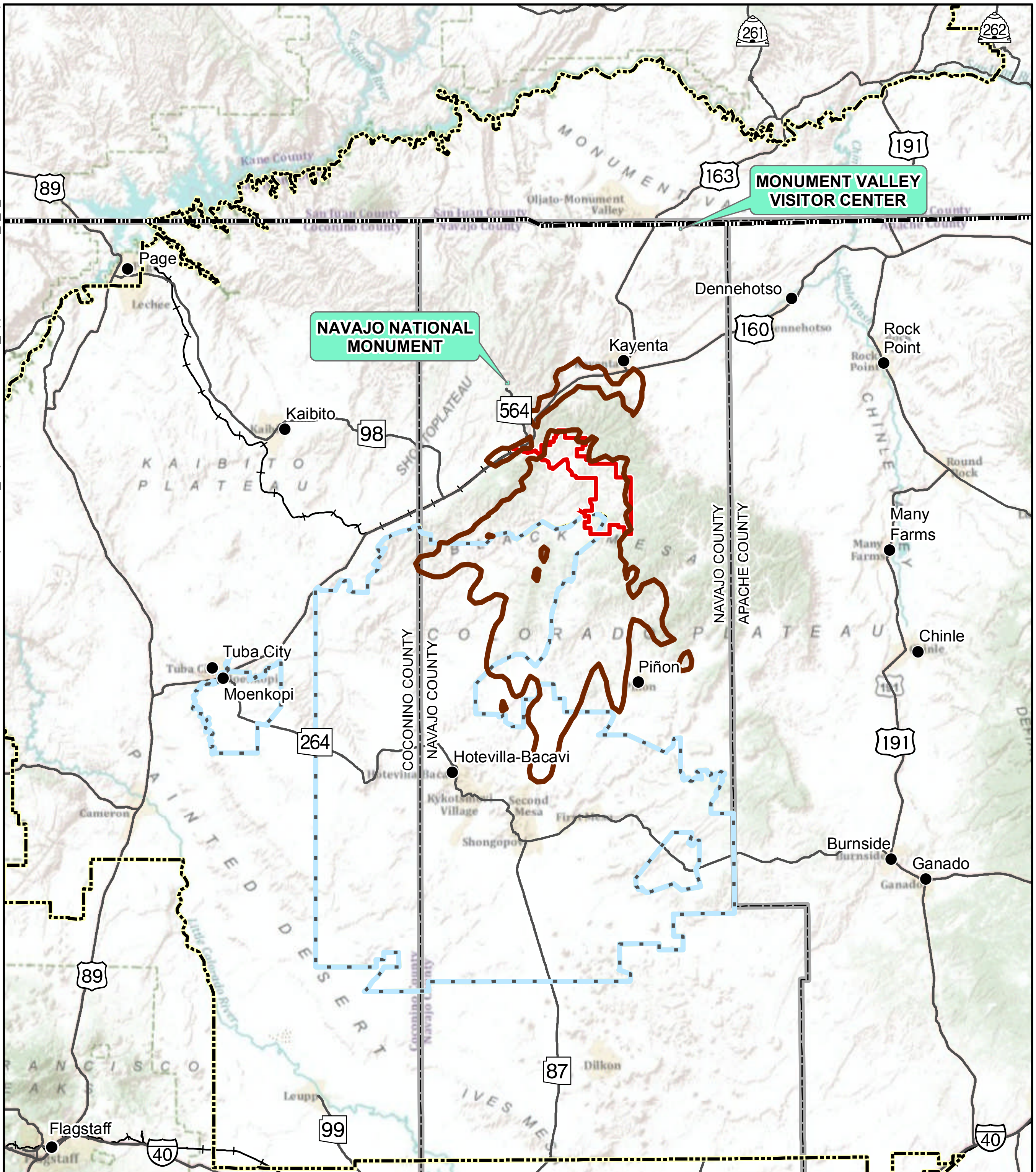


Legend

- Kayenta Mine Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- 1.2 µg/m³ Impact Contour
- Sensitive Class II Area

Figure D-6

2018 24-Hour $PM_{2.5}$
Significant Impact Area

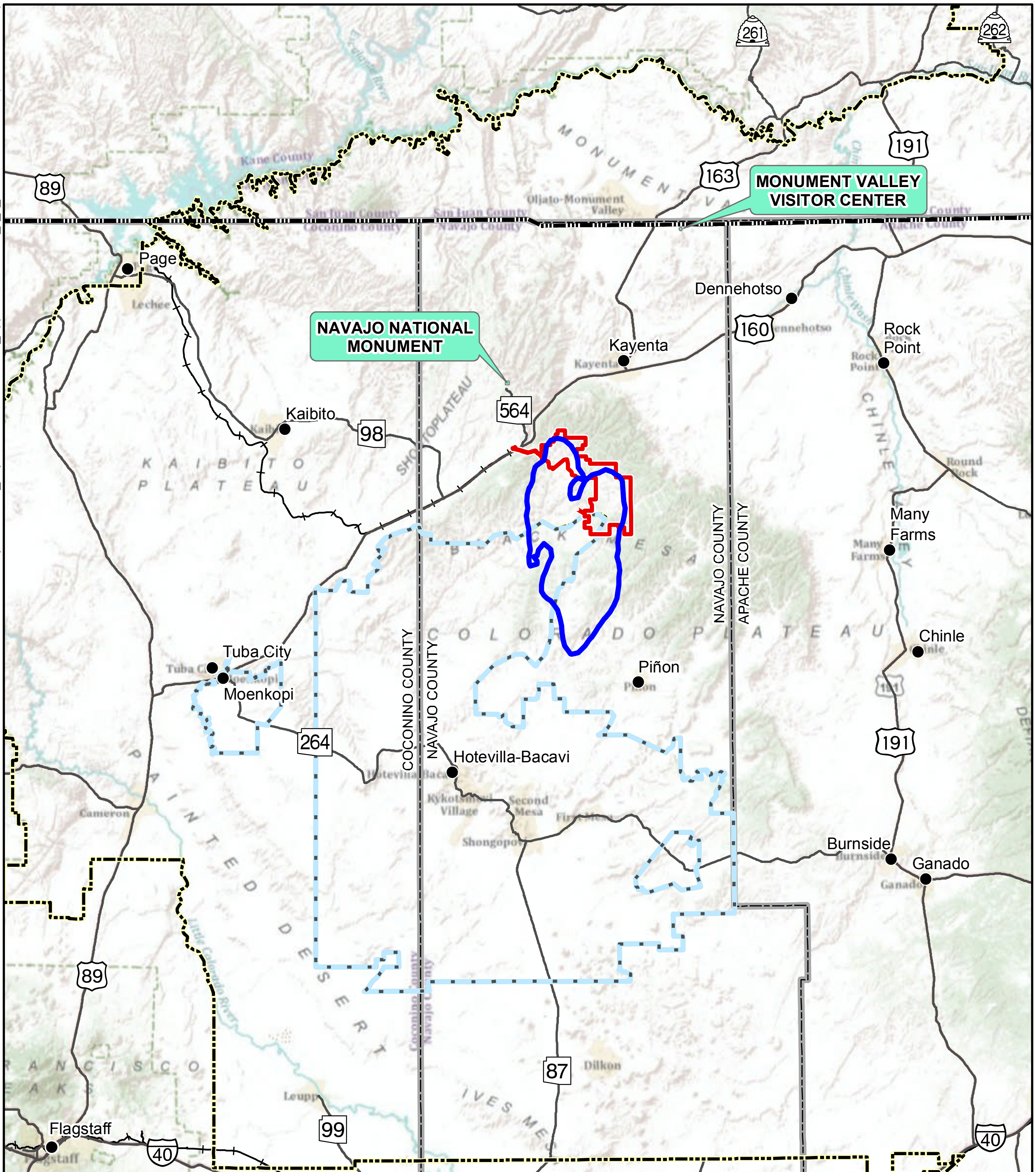
Kayenta Mine Permit Renewal EA

N

0 8 16
Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS



Legend

Kayenta Mine Area

Hopi Reservation

Navajo Nation Reservation Boundary

Highway

Railroad

Air Quality Feature

0.3 µg/m³ Impact Contour

Sensitive Class II Area

Figure D-7

2010 Annual $PM_{2.5}$ Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16
Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

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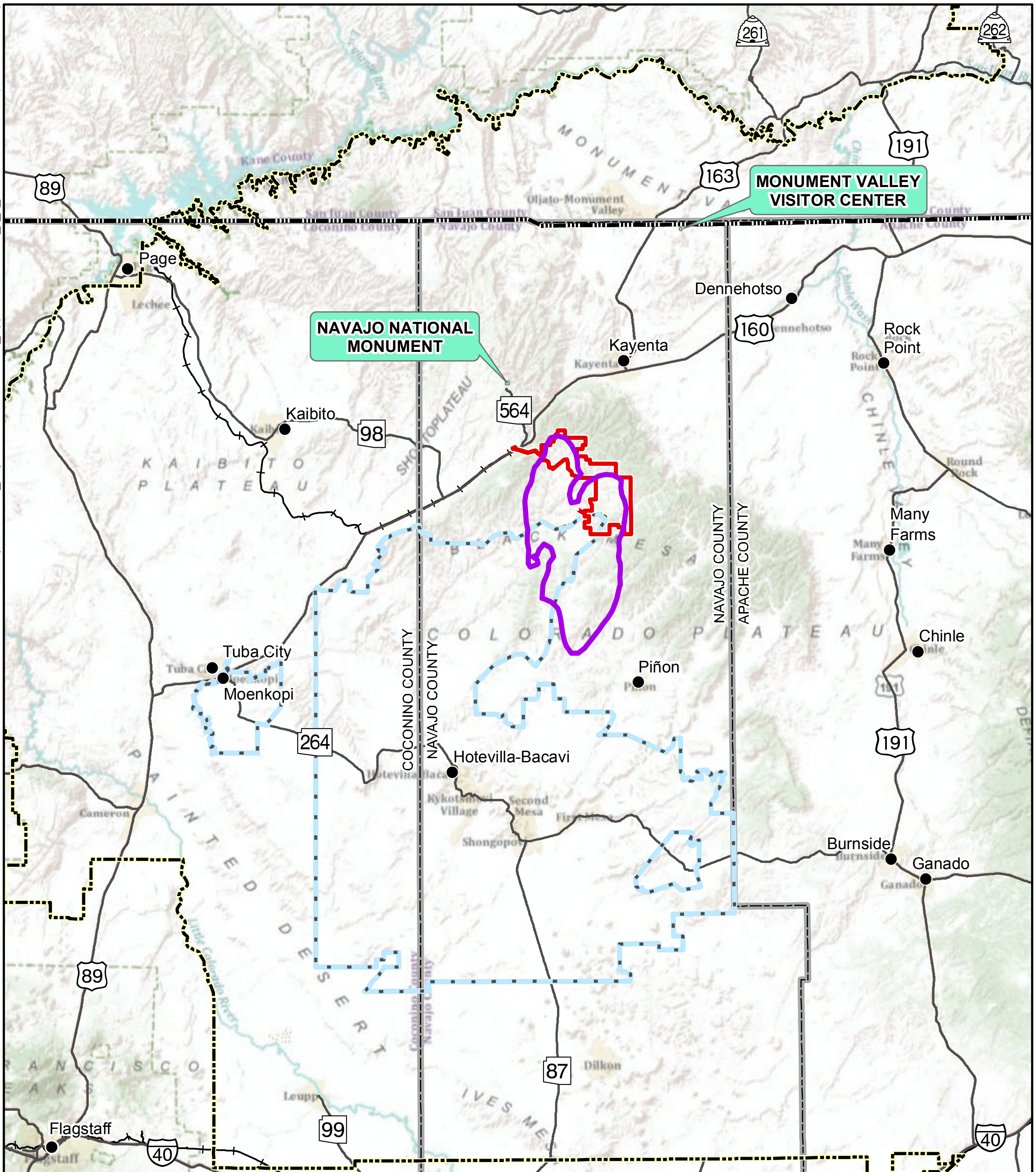

Legend

Kayenta Mine Area
Hopi Reservation
Navajo Nation Reservation Boundary
Highway
Railroad

Air Quality Feature

0.3 µg/m³ Impact Contour
Sensitive Class II Area

Figure D-8

2012 Annual $PM_{2.5}$
Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16
Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

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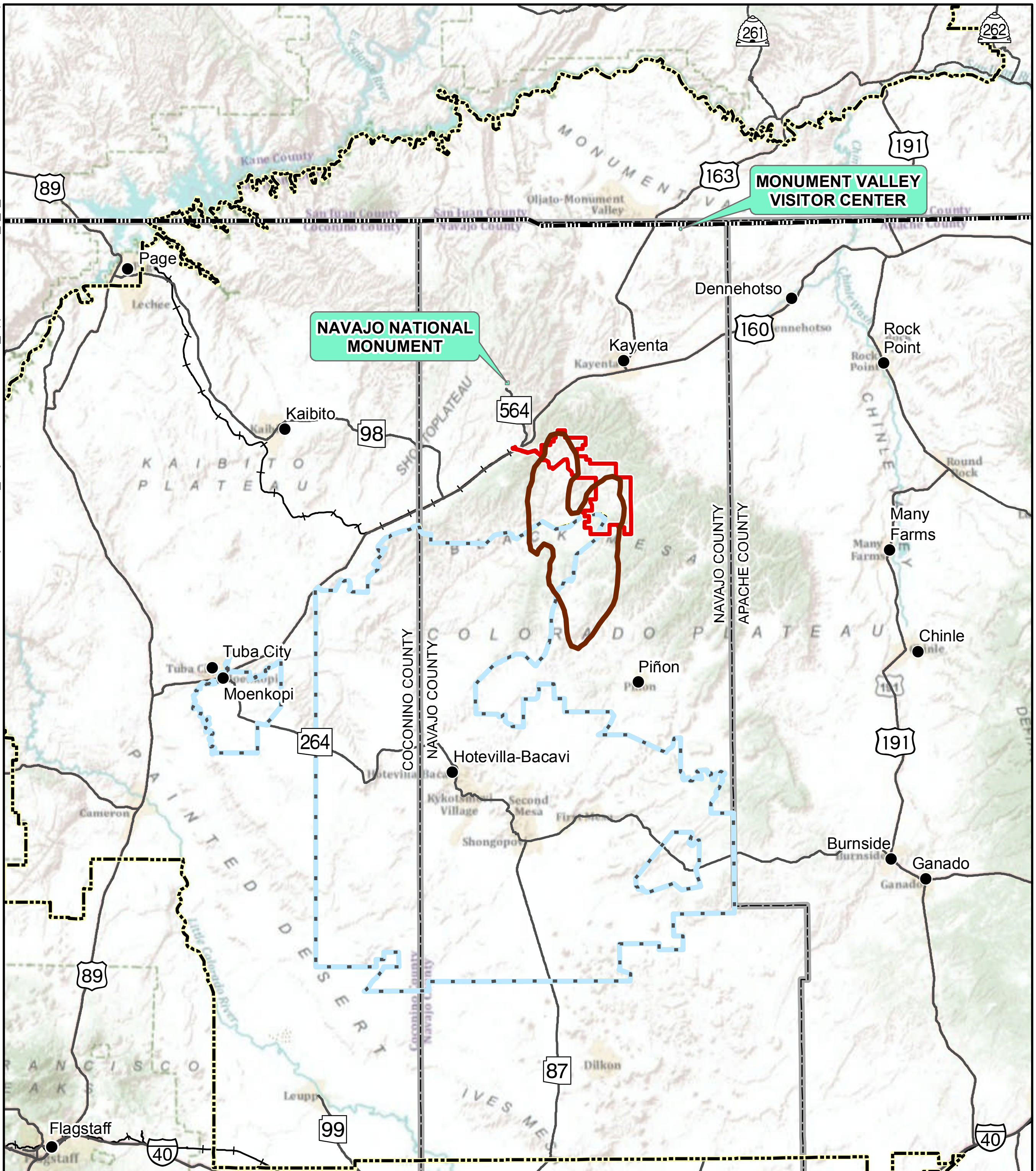


Legend

- Kayenta Mine Area
- Hopi Reservation
- Navajo Nation Reservation Boundary
- Highway
- Railroad

Air Quality Feature

- 0.3 µg/m³ Impact Contour
- Sensitive Class II Area

Figure D-9

2018 Annual $PM_{2.5}$
Significant Impact Area

Kayenta Mine Permit Renewal EA

N

0 8 16
Miles

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

PWCC URS

D.12.3 Nitrogen Dioxide (NO_2)

The SIL for NO_2 is 1 μg/m^3 on an annual basis. NO_2 SIAs were developed in the same manner as for PM_{10} and $PM_{2.5}$. The NO_2 SIAs are shown in Figures D-10 through D-12.

Predicted annual concentrations of NO_2 are provided in Table D-10. All predicted concentrations are well below the applicable NAAQS.

Table D-10 Kayenta Complex Maximum Predicted Annual NO_2 Concentrations

Model Year	Location	X-UTM	Y-UTM	NO_2 Concentration (μg/m^3)	NO_2 Concentration with Background (μg/m^3)	National Ambient Air Quality Standard (μg/m^3)
2010	Boundary	563581.26	4028888.44	5.29	7.39	100
2012	Boundary	564284.86	4029187.00	9.34	11.44	100
2018	Boundary	563581.26	4028888.44	6.61	8.71	100

D.12.4 Atmospheric Deposition of Metals

Potential environmental impacts to surface waters from the atmospheric deposition of metals contained in particulate matter emissions have been examined in prior NEPA analyses of proposed actions in the Four Corners region. Therefore, an evaluation of the possible extent of any metals deposition due to Kayenta Mine's particulate emissions was performed.

The rate of atmospheric deposition of metals from Kayenta Mine was estimated as a fraction of the deposition rate for total suspended particulate (TSP) from the Mine. Inventories of the Mine's TSP emissions were developed for years 2010, 2012 and 2018, using methods similar to those previously described for estimating PM_{10} emissions from the Mine. Annual, TSP deposition rates resulting from those TSP emissions were predicted with the AERMOD dispersion model, using the same meteorological data that was previously used with the PM_{10} modeling.

The Salt River Project Agricultural Improvement and Power District (SRP) retained ENVIRON to conduct an analysis of the emissions, environmental transport, transformation, and aquatic impacts of mercury (Hg) and selenium (Se) emissions from the Navajo Generating Station (NGS) (see Appendix E). ENVIRON provided an 84 km by 84 km modeling receptor grid that encompasses the area surrounding NGS, including seven different drainage basins for Lake Powell and the Colorado River.

Peabody provided analytical data describing typical concentrations of mercury and selenium in the coal and in the overburden at Kayenta Mine. AERMOD model runs were performed separately for TSP emissions from Mine operations handling coal and for TSP emissions from Mine operations handling overburden. An average annual TSP deposition rate from modeling TSP emissions from coal operations and an average annual TSP deposition rate from modeling TSP emissions from overburden operations were determined for each of the seven drainage basins.

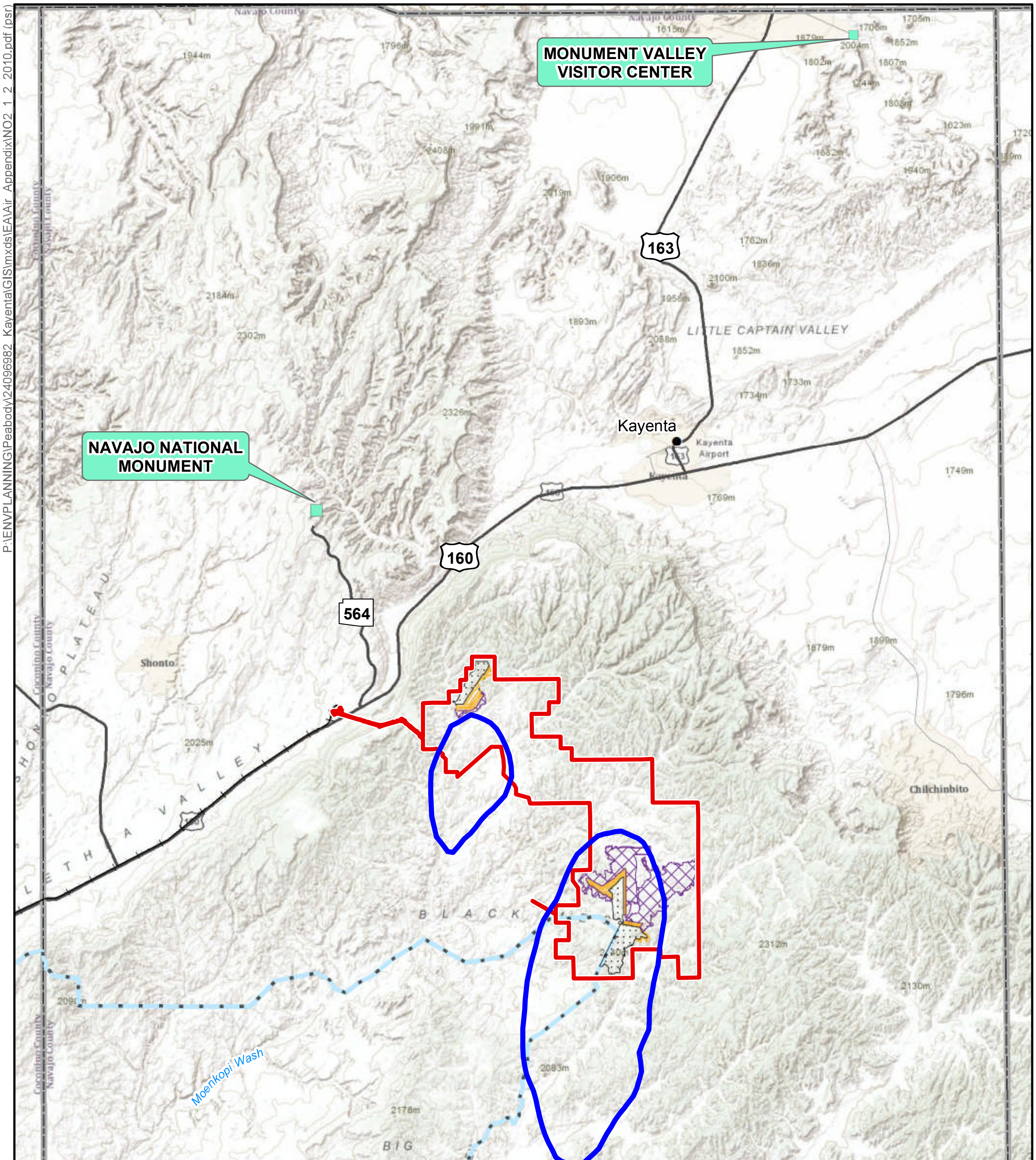
Average annual deposition rates of particulate mercury (Hg^P) from coal operations were determined for each drainage basin by multiplying the basin's TSP deposition rate from coal operations by the concentration of mercury in the Mine's coal. Likewise, average annual deposition rates of Hg^P from overburden operations were determined for each drainage basin by multiplying the basin's TSP deposition rate from overburden operations by the concentration of mercury in the Mine's overburden. The total average annual Hg^P deposition rate for each drainage basin was calculated as the sum of the basin's Hg^P deposition rate from coal operations and the basin's Hg^P deposition rate from overburden operations. The total average annual Se deposition rate for each drainage basin was calculated in an analogous manner. The resulting rates of deposition of Hg^P and Se in each drainage basin are shown in Table D-11.

Table D-11. Deposition Results (μg/m^2/year)

	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
2010 Hg^P	2.7E-05	2.1E-05	1.8E-05	1.3E-05	1.2E-05	2.2E-05	1.2E-05
2010 Se	3.7E-03	2.9E-03	2.5E-03	1.8E-03	1.7E-03	3.0E-03	1.7E-03
2012 Hg^P	2.7E-05	2.1E-05	1.8E-05	1.3E-05	1.2E-05	2.2E-05	1.2E-05
2012 Se	3.7E-03	2.9E-03	2.5E-03	1.8E-03	1.7E-03	3.0E-03	1.7E-03
2018 Hg^P	2.6E-05	2.0E-05	1.7E-05	1.2E-05	1.2E-05	2.1E-05	1.2E-05
2018 Se	3.4E-03	2.7E-03	2.3E-03	1.6E-03	1.5E-03	2.7E-03	1.6E-03
Max. Hg^P	2.7E-05	2.1E-05	1.8E-05	1.3E-05	1.2E-05	2.2E-05	1.2E-05
Max. Se	3.7E-03	2.9E-03	2.5E-03	1.8E-03	1.7E-03	3.0E-03	1.7E-03

D.12.5 Summary

The permit renewal will not result in any “significant” emissions increase. Consequently, any ambient impacts due to the permit renewal will also be insignificant or negligible. Modeling was nevertheless performed to demonstrate that the ambient impacts due the total emissions from the Complex during the permit renewal term are projected to be not only low but actually insignificant in many locations throughout the resource area. In sum, the modeling analysis confirms what a comparison of emissions before and after permit renewal has already demonstrated, i.e., that the requested permit renewal will not substantially jeopardize Kayenta Complex’s ability to comply with the national ambient air quality standards.



Legend

Kayenta Mine Area
Permit Period Mine Area
Previously Mined Area
Future Mine Area
Hopi Reservation
Highway
PWCC Mine Road
Railroad

Air Quality Feature
1.2 µg/m³ Impact Contour
Sensitive Class II Area

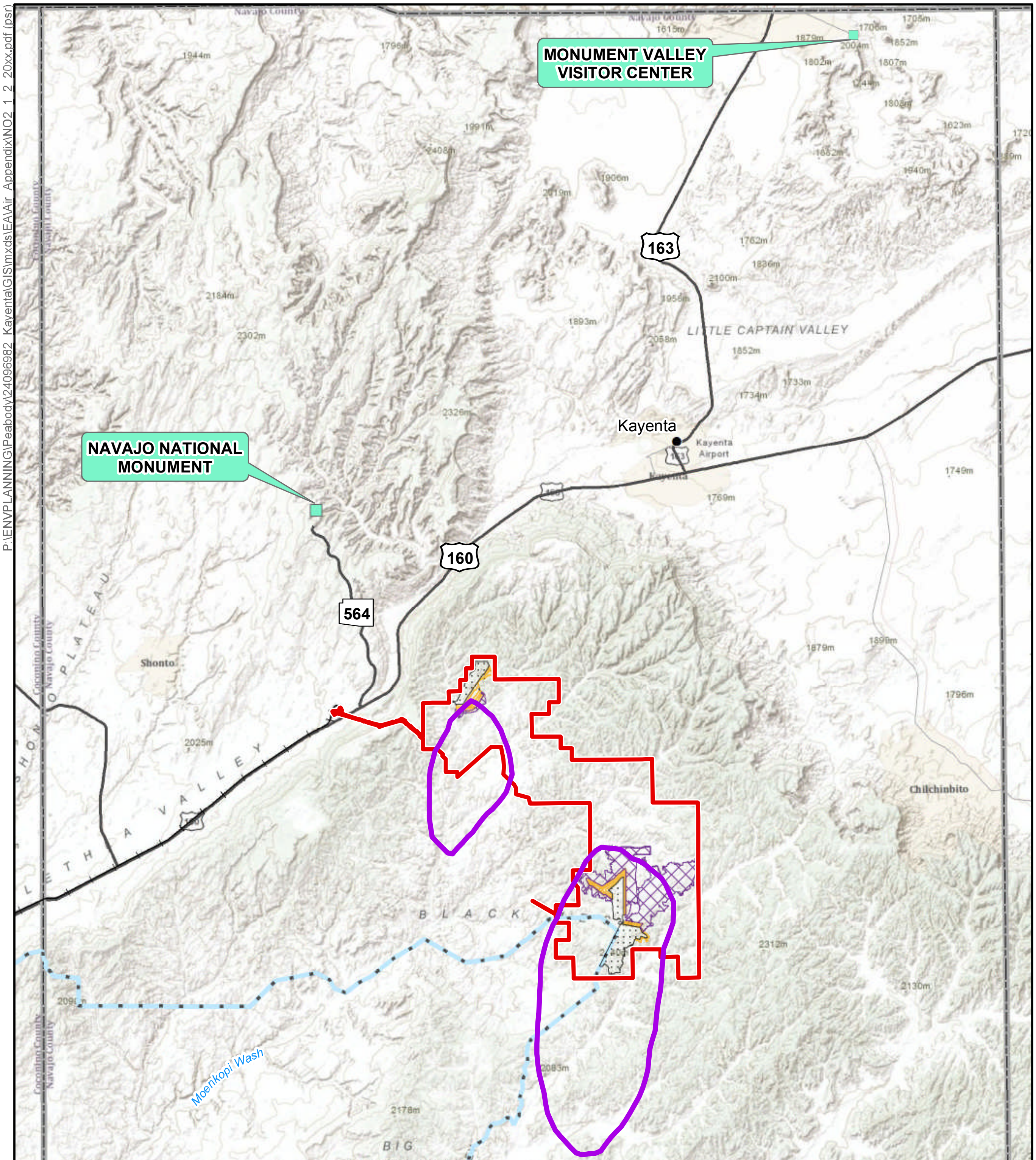
Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

0 2.5 5
Miles

N

Figure D-10
2010 Annual NO_2
Significant Impact Area
Kayenta Mine Permit Renewal EA

PWCC URS



Legend

- Kayenta Mine Area
- Permit Period Mine Area
- Previously Mined Area
- Future Mine Area
- Hopi Reservation
- Highway
- PWCC Mine Road
- Railroad

Air Quality Feature

- 1.2 µg/m³ Impact Contour
- Sensitive Class II Area

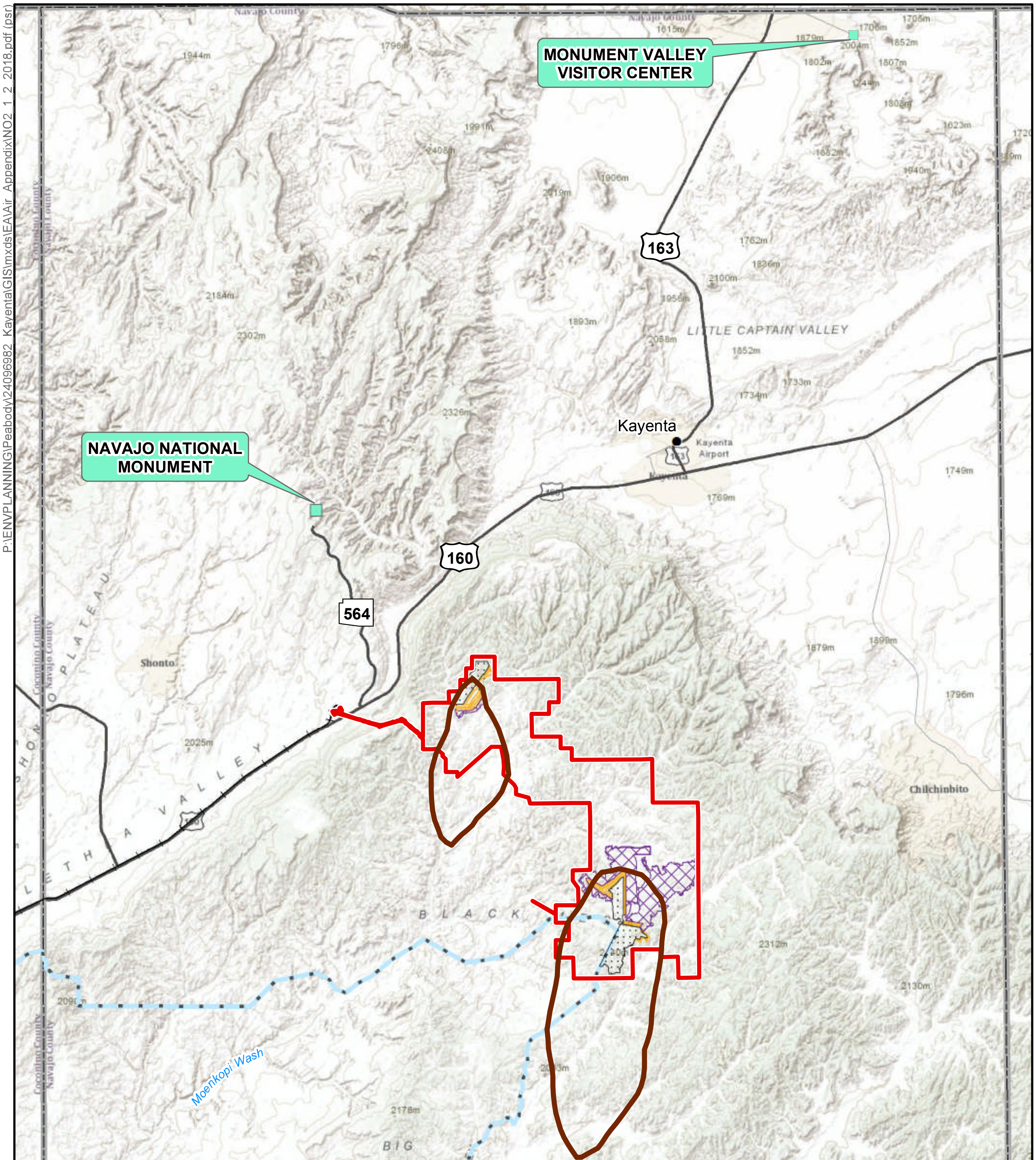
Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009,
PWCC 2010, ESRI 2010

N

0 2.5 5
Miles

Figure D-11
2012 Annual NO_2
Significant Impact Area
Kayenta Mine Permit
Renewal EA

PWCC **URS**



Legend

Kayenta Mine Area
Permit Period Mine Area
Previously Mined Area
Future Mine Area
Hopi Reservation
Highway
PWCC Mine Road
Railroad

Air Quality Feature
1.2 µg/m³ Impact Contour
Sensitive Class II Area

Source:
Air Quality: PWCC 2011
Base Map: ADOT 2009, PWCC 2010, ESRI 2010

N

0 2.5 5
Miles

Figure D-12
2018 Annual NO_2
Significant Impact Area
Kayenta Mine Permit Renewal EA

PWCC URS

D.11 MITIGATION

For obvious reasons, fugitive dust controls at the Complex focus on those substantive sources of particulate emissions which typically contribute the most to ambient levels of that pollutant, e.g., draglines, shovels and haul roads. Accordingly, design of the particulate monitoring network focuses on a general orientation of ambient monitors upwind and downwind of those activities which constitute major dust sources. Differences in measured upwind and downwind concentrations provide a relative indication of the “emissions strength” of the subject activities and success of the dust control practices being employed at those activities. Downwind measured concentrations likewise suggest whether ambient impacts from those activities might possibly cause or contribute to exceedances of the ambient standards. Should monitoring data indicate that the effectiveness of associated control practices for fugitive dust is not adequate, the Company can enhance the scope and frequency of its dust control measures as appropriate to further reduce downwind, ambient particulate concentrations.

The fugitive dust control plan for the Complex currently utilizes the following activities, practices and equipment to ensure that the mining operations do not result in a pattern of ambient impacts in excess of the applicable NAAQS:

- Exposed surface areas are protected and stabilized to control erosion and attendant fugitive dust by timely revegetation, stabilization of topsoil stockpiles, and revegetation management;
- Rills and gullies which form in regraded and topsoiled areas are filled, regraded or otherwise stabilized;
- Exposed surface areas are minimized to the extent practicable;
- Before or during loading, shot coal is watered as necessary;
- The drop height from earth excavating equipment is minimized to the extent feasible;
- Haulage and ancillary mine roads are watered at frequencies dependent upon the amount and timing of use, condition of the roads, and the amount of dust observed when in use;
- Frequently used haul roads and light-duty roads are chemically treated at least twice per year with a dust suppressant (35% magnesium chloride or equivalent at a chemical-to-water ratio of approximately 5:1);
- Magnesium chloride is stored year-round on site for use in spot treatment of roads, when necessary;
- Some light-duty roads and parking lots are paved;
- Water injection or rotoclones are employed on all overburden drills;
- Haul truck speeds are mechanically limited to 30 mph, and all other vehicles are limited to 45 mph, or as posted;
- Sprays of water or water and a surfactant are installed and used at coal handling and conveying equipment locations;
- Spoil and coal fires are suppressed and extinguished as soon as reasonably and safely possible;
- All conveyors are covered; and
- Chutes, drapes or other means are used to enclose conveyor transfer points, screens and crushers.

In summary, the Complex implements fugitive dust control measures as necessary to ensure that environmental requirements associated with fugitive dust and ambient standards are satisfied. A comprehensive meteorological and ambient PM_{10} monitoring program at the Complex is used to determine the effectiveness of those dust control practices. Should monitoring data indicate that ambient particulate standards are being threatened by impacts from mining operations, the Complex can adjust the nature, extent and frequency of its various, available dust control measures as necessary to reduce those impacts in order to maintain compliance with the applicable NAAQS.

Appendix E
Atmospheric Deposition of Metals
Navajo Generating Station

Summary of Analysis by ENVIRON, 2011

E.1 INTRODUCTION

An analysis was conducted of the emissions, environmental transport, transformation, and aquatic impacts of mercury and selenium emissions from the Navajo Generating Station (NGS) (ENVIRON 2011). The analysis provided a general assessment of the potential ecological risks from mercury and selenium emitted from NGS into nearby aquatic environments. The analysis was based on:

- Mathematically modeled atmospheric emissions of mercury and selenium to predict the distribution, transport, and speciation of mercury and selenium in soil, surface water, and sediment in and around the area of the NGS and Lake Powell.
- Comparison of modeled concentrations of mercury (Hg^{2+}), methylmercury (MeHg), and selenium (Se) against available water and sediment screening criteria.
- The potential presence of threatened and endangered species in the vicinity of the site.
- Conservative ecological models used to predict risks to wildlife with an emphasis on aquatic receptors.

E.2 ATMOSPHERIC MODELING

Atmospheric modeling was conducted to estimate the distribution, transport and speciation of mercury and selenium in soil, surface water, and sediment in and around the area of NGS (ENVIRON 2011). Emissions estimates calculated by the Electric Power Research Institute (EPRI) (EPRI 2010) were used for the modeling for the facility. EPRI provided emissions estimates for elemental mercury (Hg^0), divalent gaseous mercury (Hg^{2+}), particulate mercury (Hg^P) and selenium (Se) (Table E-1). The AERMOD modeling system was utilized in the analysis. Existing modeling files for meteorological data, stack parameter data, terrain data and facility data from previous air permitting actions were utilized. Deposition parameters specific to Hg^0, Hg^{2+}, Hg^P, and Se were selected from AERMOD guidance documents in order to allow AERMOD to correctly estimate deposition in the vicinity of the plant. The receptor grid used in the modeling is a Cartesian grid forming a square about the facility of 84 km x 84 km. This is the grid size for which existing meteorological and terrain data were available from recent air permitting actions. The receptors closer to the facility are on a fine grid of 100m x 100m. As the distance from the facility increases, so does the grid spacing, eventually reaching a 2 km x 2 km grid spacing.

Table E-1 Estimated Emissions (kg/year) of Hg and Se from the Navajo Power Plant

	Stack 1	Stack 2	Stack 3
Hg^0	72	83	82
Hg^2	5	6	6
Hg^P	2	2	2
Se	498	573	569

Five years of meteorology data were used representing 2001 through 2005. Both dry and wet deposition were calculated and then summed for each receptor. The average deposition at each receptor over those five years was calculated and applied as the long term deposition flux at that location. On average approximately 4% of the Hg^{2+}, Hg^P, and Se emitted from the facility were deposited within the modeling domain. This is within the expected range shown in other modeling studies (Seigneur et al. 2006).

In order to estimate the impact of the modeled deposition, the domain was divided into 7 drainage areas representing seven different sections of Lake Powell and the Colorado River. Figure E-1 shows the delineation of the drainage areas and the corresponding sections of Lake Powell and the Colorado River. The annual deposition results to each drainage area are shown in Table E-2. For comparison, the measured annual wet deposition flux at the nearest Mercury Deposition Network (MDN) monitoring site (Mesa Verde National Park in southwestern Colorado) was 11.0 $\mu g/m^2$ in 2009. Thus, the annual wet + dry deposition fluxes to each drainage area due to the power plant are typically less than 2% of the annual wet deposition flux due to all sources.

Table E-2 Deposition Results ($ug/m^2/year$)

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Hg^0	5.0E-02	7.1E-02	5.2E-02	4.1E-02	3.1E-02	1.2E-01	8.3E-02
Hg^2	4.7E-02	6.5E-02	7.0E-02	6.4E-02	5.1E-02	1.4E-01	8.2E-02
Hg^P	7.9E-03	8.4E-03	1.0E-02	9.7E-03	1.0E-02	2.8E-02	1.9E-02
Se	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01

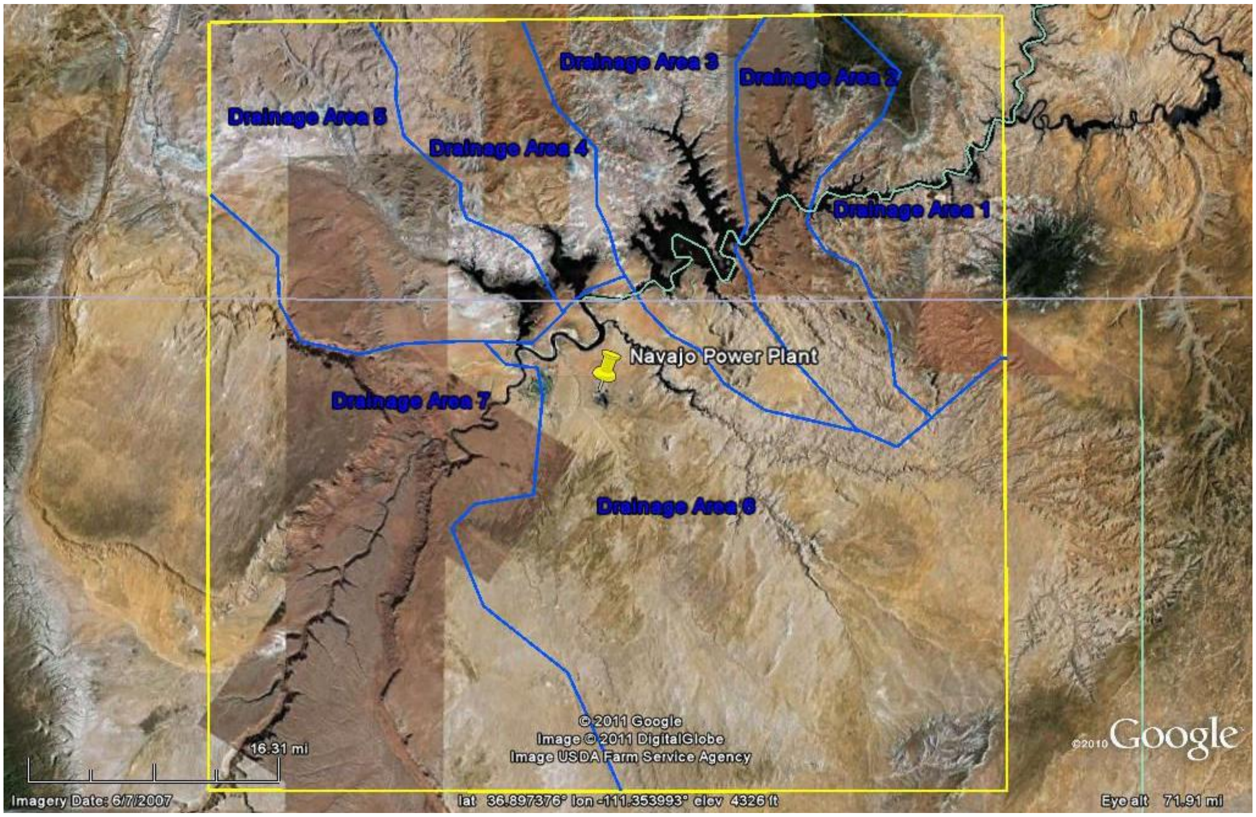


Figure E-1. Drainage Areas in the Modeling Domain

The deposition at each receptor was applied to the drainage area in which it is located. Both the terrestrial and aquatic concentrations were estimated for these seven drainage areas.

In order to calculate the fate of Hg and Se deposited to each drainage area, the U.S. Environmental Protection Agency's (USEPA) Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities (USEPA 2005a) guidance was used. This guidance lists equations appropriate for calculating estimates of metal concentrations in the soil and water in the vicinity of a facility. In many cases, it lists appropriate default values for calculation parameters as well.

The total chemical load (g/year) and the load due to erosion to each waterbody segment were calculated, as was the total concentration of each metal in the waterbody based on USEPA (2005a). Calculations were also performed on the dissipation rate, total concentration of Hg and Se (dissolved phase and associated with suspended solids) in the water column and concentrations in sediment.

For the Hg load to the waterbody, a uniform methylation efficiency of 15% was assumed in the waterbodies which is the recommendation of the HHRAP guidance (USEPA 2005a). The sediment portion was not split into dissolved and adsorbed for this study. Table E-3 provides estimates of the Hg^{2+}, MeHg, and Se concentrations in surface water and sediment in each of the Lake Powell and Colorado River segments.

Table E-3 Estimated Surface Water Concentrations (ng/L) and Sediment Concentrations (ng/g)

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Hg^2 Dissolved	3.2E.04	5.4E.04	5.0E-04	4.0E-04	3.0E-04	7.1E-04	4.4E-04
Hg^2 suspended	3.5E-05	5.8E-05	5.4E-05	4.3E-05	3.2E-05	7.6E-05	1.1E-05
Hg^2 Sediment	3.2E-02	5.4E-02	5.0E-02	4.0E-02	3.0E-02	7.1E-02	4.4E-02
MeHg Dissolved	5.7E-05	9.6E-05	8.9E-05	7.1E-05	5.2E-05	1.3E-04	7.8E-05
MeHg Suspended	3.7E-07	6.2E-07	5.8E-07	4.6E-07	3.4E-07	8.1E-07	1.2E-07
MeHg Sediment	5.7E-03	9.6E-03	8.9E-09	7.1E-03	5.2E-03	1.3E-02	7.7E-03
SE(IV) Dissolved	2.1E-01	2.7E-01	3.5E-01	4.7E-01	3.3E-01	9.1E-01	7.3E-01
SE(IV) Suspended	1.1E-02	1.5E-02	1.9E-02	2.5E-02	1.8E-02	4.9E-02	9.2E-03
SE(IV) Sediment	8.2E-01	1.1E+00	1.4E+00	1.9E+00	1.3E+00	3.6E+00	2.8E+00
SE(VI) Dissolved	1.1E+00	2.0E+00	3.9E+00	5.8E+02	3.3E+02	1.8E+01	2.8E+01
SE(VI) Suspended	1.6E-02	2.7E-02	5.3E-02	7.9E+00	4.6E+00	2.4E-01	8.9E-02
SE(VI) Sediment	4.5E-03	8.0E-03	1.6E-02	2.3E+00	1.3E+00	7.1E-02	1.1E-01

E.3 SELECTION OF ECOLOGICAL RECEPTORS OF INTEREST (ROIs)

Most healthy ecosystems support a large number of individual species representing a variety of feeding guilds. However, it is not feasible to complete risk calculations for all potentially exposed species. Moreover, such an effort would be duplicative because of the similarity of exposure patterns among closely related species and among those with similar feeding guilds. For these reasons, ROIs are selected to represent the different feeding guilds.

ROIs are selected based on six characteristics:

- economic and/or other value to humans;
- ecological relevance;
- potential for high exposure;
- toxicological sensitivity;
- expected presence in the study area; and
- availability of life history information and toxicological data.

Based on the ecological conceptual site model and the above considerations, aquatic and semiaquatic organisms pertinent to the study area are:

- benthic/epibenthic invertebrate community;
- channel catfish (*Ictalurus punctatus*), representing bottom-dwelling fish populations;
- threadfin shad (*Dorosoma petenense*), representing water column dwelling fish populations;
- striped bass (*Morone saxatilis*), representing piscivorous fish populations;
- mink (*Mustela vison*), representing piscivorous mammals;

- great blue heron (*Ardea herodias*); and
- belted kingfisher (*Ceryle alcyon*), representing piscivorous birds.

These ROIs are among the most highly exposed and ecotoxicologically sensitive (i.e., susceptible) of the species likely to inhabit or forage within the study area, so extrapolation of conclusions regarding these ROIs will be protective of other, less susceptible species including endangered species such as razorback sucker and Colorado pikeminnow.

E.4 EFFECTS ASSESSMENT

The effects assessment evaluates the potential for mercury and selenium to cause adverse effects in ROIs and estimates the relationship between the extent of exposure and severity of effects. For measurement endpoints based on direct observations (i.e., benthic invertebrate toxicity, benthic community structure), the effects assessment is the review and selection of toxicity reference values (TRVs) that are used to interpret the potential for adverse effects. TRVs are the literature-derived concentrations or doses, below which adverse effects are unlikely.

E.4.1 Effects Assessment for Aquatic and Sediment Dwelling Invertebrate Community

For the "chemistry" measurement endpoint, concentrations of mercury and selenium in surface water and sediment are compared to appropriate ecological screening benchmarks (ESBs) that are protective of invertebrates. The unitless ratio of the mercury and selenium concentration to the ESB is called a hazard quotient (HQs). A HQ of greater than one indicates that ecological risks may occur.

The surface water concentrations were compared to several ESBs. The USEPA's Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a constituent in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect (USEPA 2011). The State of Arizona also publishes surface water criteria, with a specific criterion for "Aquatic and Wildlife." These criteria are assumed to be protective of invertebrates in the sediment and in the water column, as well as aquatic vertebrates including amphibians, reptiles, and fish. These criteria are listed on Table E-4.

The sediment concentrations were compared to several ESBs. The National Atmospheric and Oceanic Administration (NOAA) developed values through its National Status and Trends program to rank areas that warranted further detailed study on the actual occurrence of adverse effects. The Effects Range Low (ERL) indicates a concentration below which adverse effects rarely occur. The Effects Range Median (ERM) indicates a concentration above which adverse effects frequently occur. These criteria are listed on Table E-5.

E.4.2 Effects Assessment for Fish Populations and Community

The effects assessment for fish relies on two types of effects metrics: surface water ESBs and critical body residues (CBRs) expressed as concentrations of mercury and selenium estimated in whole body invertebrate and fish tissue. Fish tissue-based CBRs are used as the effects metrics for the measurement endpoint of fish tissue chemistry (i.e., concentrations of mercury and selenium in fish tissue in relation to concentrations reported in the literature to be protective of fish). Fish tissue-based CBRs are literature-derived chemical concentrations in the tissue of fish that are protective of fish. Fish tissue-based CBRs integrate exposures across multiple pathways (e.g., gill transfer, sediment ingestions, diet) and reflect the bioavailable fraction of mercury and selenium in the environment. Fish tissue-based CBRs are based on Jarvinen and Ankley (1999), as identified in Table E-6.

E.4.3 Effects Assessment for Bird and Mammal Populations

The effects assessment for wildlife is based on TRVs that relate ingested daily dose to ecotoxicological endpoints. TRVs are literature-derived concentrations or doses, below which adverse effects are unlikely (e.g., ORNL 1996). No observed apparent effect level (NOAEL) TRVs are indicative of doses of constituents that have had no deleterious effects on a wildlife receptor. Lowest observed apparent effect level (LOAEL) TRVs are the minimum doses of constituents where deleterious effects are apparent. The TRVs are summarized in Table E-7.

E.5 RISK CHARACTERIZATION

Risk characterization for the measurement endpoints involves mathematical comparison of exposure and effects estimates for each measurement endpoint. Exposure estimates that are below the relevant effects metric (i.e., surface water quality benchmark, sediment quality benchmark, tissue-based benchmark, or TRV) indicate that adverse effects to a given ROI are unlikely. Exposure estimates that exceed the relevant effects metric indicate that further investigation is warranted to define the potential for adverse effects at the population level, as well as the spatial extent and severity of any such adverse effects (Barnthouse et al. 2008).

E.5.1 Risk Characterization for Aquatic and Sediment Dwelling Invertebrate Communities

The evaluation of chemistry as part of the assessment of risks to aquatic and sediment dwelling invertebrates compares concentrations of mercury and selenium in surface water and sediment to benchmarks (Tables E-4 and E-5, respectively). The risk characterization using chemistry results is based on the HQ, which is the ratio of measured concentrations and ESBs. The surface water and sediment concentrations of Hg and MeHg are far below the surface water and sediment ESBs resulting in HQs well below the threshold value of 1. The same applies for Se with the exception of Se(VI) in Lake Segment 4 where the HQ only slightly exceeds one (HQ = 1.49). Overall, these results indicate that the risk to surface water and sediment organisms from Hg, MeHg and Se is negligible.

E.5.2 Risk Characterization for the Fish Populations and Community

The characterization of risk to fish involves two lines of evidence, surface water chemistry and the evaluation of chemicals in fish tissues relative to CBRs. As seen in the previous section, the "water chemistry" measurement endpoint shows *de minimis* risks to surface water organisms including fish (Table E-4).

The second line of evidence for fish is the comparison of concentrations of chemicals measured in fish tissues to CBRs to generate wildlife HQs, as shown in Table E-8 and illustrated in Figures E-2a and E-2b. The resultant fish HQs range from 9x10-7 to 2x10-2. Generally, the MeHg HQs among higher trophic level receptors are higher than among the lower trophic level receptors, which is consistent with bioaccumulation of Hg up the food chain. Overall, fish HQs are highest for Se, followed by MeHg and then Hg^{2+}.

The two lines of evidence for fish, water chemistry and modeled fish tissue chemistry, both support a conclusion that the modeled concentrations of Se, Hg^{2+} and MeHg do not pose an unacceptable risk to fish populations or the fish community.

E.5.3 Risk Characterization for Bird and Mammal Populations

The characterization of risks for wildlife involves food web modeling using surface water, sediment, soil, and fish tissue chemistry results and comparison to protective TRVs. Food web modeling results are in Table E-9 and a summary of hazard quotients is provided in Table E-8 and illustrated in Figures E-2a and E-2b. As Figure E-2a shows, HQs for each receptor evaluated are well below the threshold of one. In Figure E-2b which provides the same information on a linear scale, the concentrations of inorganic and methylmercury are too small to be visible for most receptors.

While Hg^{2+} and MeHg HQs are very low at the bottom of the food chain, MeHg HQs are three orders of magnitude higher than for Hg^{+2} at the highest trophic level. For MeHg, concentrations are highest in the higher trophic levels. The total daily intake of MeHg is highest among piscivores but similar among the other aquatic receptors. Even combining MeHg and Hg^{2+} HQs results in HQs well below 1. For selenium, HQs were all well below one and very similar regardless of trophic level or feeding guild with HQs lowest for the Great Blue Heron.

To summarize the risk characterization for birds and mammals:

- Se HQs are substantially greater than Hg^{2+} and MeHg HQs.
- MeHg HQs are orders of magnitude greater than Hg^{2+} HQs depending on trophic level.
- MeHg HQs were highest among piscivorous birds (blue heron, kingfisher) which were higher than that of piscivorous mammals (mink).
- All HQs are well below one for each aquatic receptor evaluated.
- Se, Hg^{2+} and MeHg do not pose an unacceptable risk to piscivorous bird and mammal populations.

Figure E-2a: Summary of Hazard Quotients

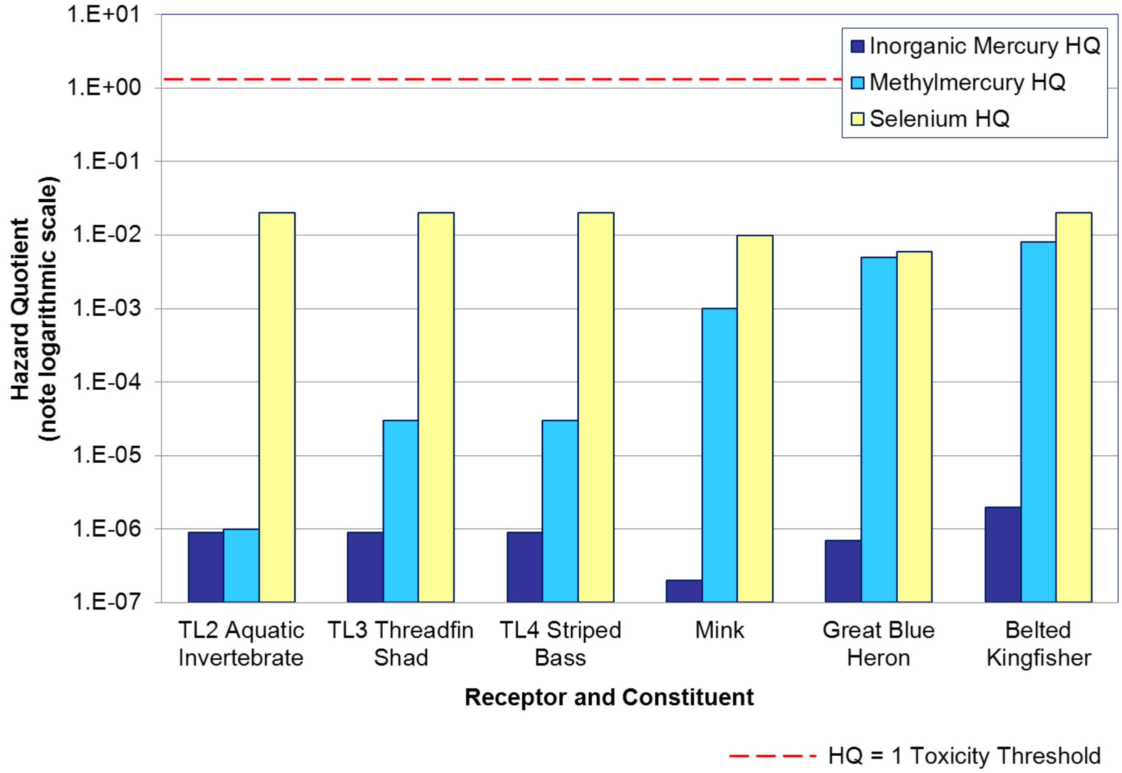
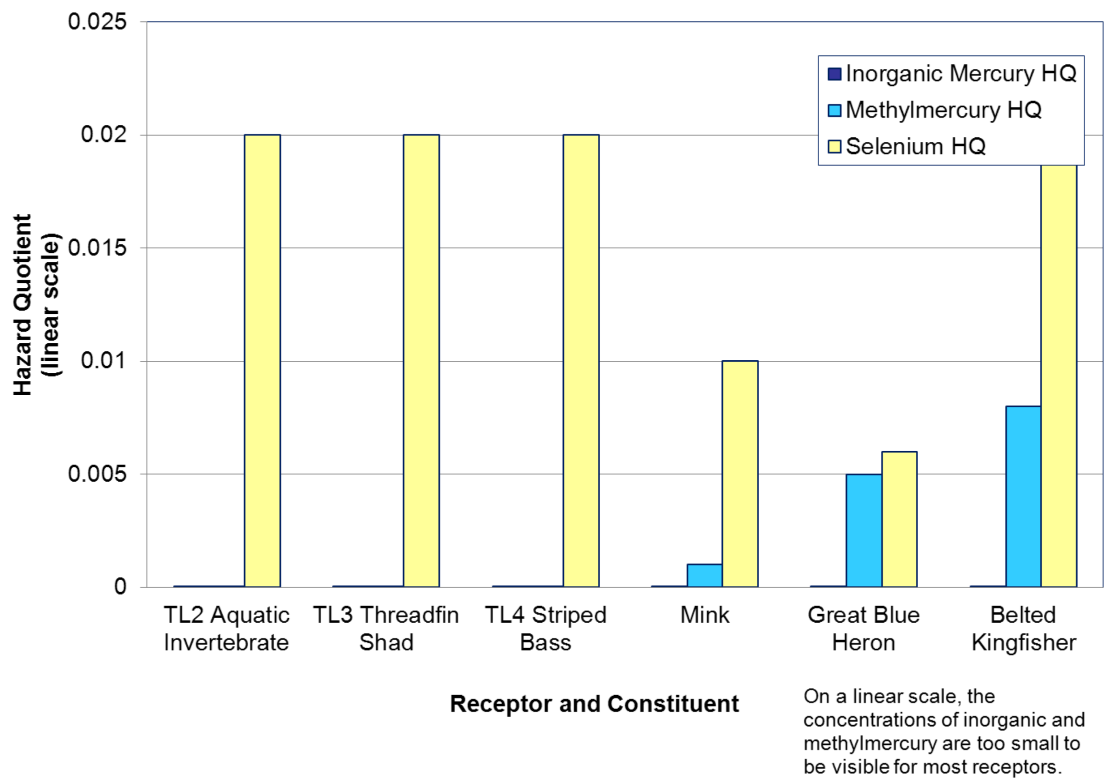


Figure E-2b: Summary of Hazard Quotients



E.6 UNCERTAINTIES

Uncertainties can be introduced into ecological risk assessment at every step in the process, as information of varying quality is gathered from diverse sources in order to be integrated into a complex framework. Conservative assumptions are generally employed to compensate for that uncertainty, to ensure the protectiveness of the overall assessment. Varying levels of uncertainty exists with the available information utilized in the chemistry dataset, effects assessment benchmarks, population effects, bioavailability of constituents of potential ecological concerns, receptor organisms and in the risks estimated from surrogate receptors. The conservative assumptions used in the assessment of NGS emissions result in an overestimation of risks (ENVIRON 2011).

E.7 SUMMARY

The purpose of the ecological analysis was to evaluate whether significant risks to aquatic wildlife are occurring due to Hg and Se emissions from NGS. Ecologically significant impacts to wildlife from a regulatory perspective are those that will occur on a scale that could impact populations, communities, and ecosystems of wildlife and the habitat that supports wildlife (USEPA 1994, 1997a, 1998). Special regulatory consideration is given to individual organisms of threatened and endangered species populations since these individuals comprise a greater percentage of the small threatened and endangered populations (USEPA 1997a, 1998).

In larger populations, communities, and ecosystems, *de minimis* impacts can be tolerated without ecologically significant impacts (Suter et al. 1995; USEPA 1994; TNRCC 2000). This means that some impacts can be tolerated without causing adverse (or perhaps even measurable) impacts to the valued ecological entities (i.e., the population, community, and ecosystem). Based on the low modeled concentrations of Hg, MeHg and Se, population, community, and ecosystem level impacts for aquatic species are highly unlikely as a result of NGS emissions. Hazard quotients for Se, Hg and MeHg are well below one representing *de minimis* risk to aquatic receptors.

Overall, the risk to the aquatic and sediment dwelling invertebrate community, fish populations and fish/aquatic invertebrate eating birds and mammals from NGS emissions of mercury and selenium can be summarized as follows:

- Modeled Se, Hg and MeHg concentrations in sediment are below ecological screening levels.
- Modeled Se, Hg and MeHg concentrations in surface water are below ecological screening with the exception of Se(VI) in Lake Segment 4 where concentrations slightly exceeded only the most conservative screening benchmark.
- All calculated critical body residues resulted in HQs well below one suggesting *de minimis* risk to aquatic receptors including fish and piscivorous birds and mammals.

In other words, the analysis of NGS emissions supports a finding that modeled concentrations of Se, Hg^{2+} and MeHg do not pose an unacceptable risk to aquatic receptors in the vicinity of the plant.

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Table E-4 Comparison of Modeled Surface Water Mercury, Methylmercury and Selenium Concentrations against Screening Values

			Ecological Screening Levels				
			Alberta Env.				CT DEP
Area	Chemical	Modeled Concentration ug/L	Commercial / Industrial Groundwater Aquatic Life (Coarse) ug/L	Commercial / Industrial Groundwater Aquatic Life (Fine) ug/L	Residential Groundwater Aquatic Life (Coarse) ug/L	Residential Groundwater Aquatic Life (Fine) ug/L	Surface-Water Protection Criteria ug/L
Lake Segment 1	Mercury	3.23E-07	--	--	--	--	0.4
	Methyl mercury	5.72E-08	--	--	--	--	--
	Selenium IV	2.05E-04	1	1	1	1	--
	Selenium VI	1.14E-03	1	1	1	1	--
Lake Segment 2	Mercury	5.39E-07	--	--	--	--	0.4
	Methyl mercury	9.55E-08	--	--	--	--	--
	Selenium IV	2.71E-04	1	1	1	1	--
	Selenium VI	2.00E-03	1	1	1	1	--
Lake Segment 3	Mercury	5.02E-07	--	--	--	--	0.4
	Methyl mercury	8.90E-08	--	--	--	--	--
	Selenium IV	3.50E-04	1	1	1	1	--
	Selenium VI	3.90E-03	1	1	1	1	--
Lake Segment 4	Mercury	4.00E-07	--	--	--	--	0.4
	Methyl mercury	7.07E-08	--	--	--	--	--
	Selenium IV	4.67E-04	1	1	1	1	--
	Selenium VI	5.81E-01	1	1	1	1	--
Lake Segment 5	Mercury	2.96E-07	--	--	--	--	0.4
	Methyl mercury	5.23E-08	--	--	--	--	--
	Selenium IV	3.32E-04	1	1	1	1	--
	Selenium VI	3.34E-01	1	1	1	1	--
Lake Segment 6	Mercury	7.06E-07	--	--	--	--	0.4
	Methyl mercury	1.25E-07	--	--	--	--	--
	Selenium IV	9.06E-04	1	1	1	1	--
	Selenium VI	1.78E-02	1	1	1	1	--
Lake Segment 7	Mercury	4.38E-07	--	--	--	--	0.4
	Methyl mercury	7.78E-08	--	--	--	--	--
	Selenium IV	7.31E-04	1	1	1	1	--
	Selenium VI	2.81E-02	1	1	1	1	--

NOTES:
--Screening level not available
ug/L Micrograms per liter
(a) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The criterion was calculated by using the previous aquatic life criteria and multiplying it by a conversion factor. (See Reference Document); Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The criterion was calculated by using the previous aquatic life criteria and multiplying it by a conversion factor. (See Reference Document) ; This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective.
(b) Chemical has been designated as a bioaccumulative chemical of concern by the publishing agency.
(c) The recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor used in the GLI to convert this to a value that is expressed as dissolved metal
(d) The CMC=1/[(f1/CMC1)=(f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 ug/l and 12.83 ug/l, respectively. ; This value was announced (61 FR 58444-58449, November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is currently working on this criterion and so this value might change substantially in the near future. ; The recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor used in the GLI to convert this to a value that is expressed as dissolved metal.
(e) Criterion or value is not available or, as is the case for Csat, not applicable.
(f) Aquatic Life Protection Criteria, Acute; Freshwater {Excluding Pinelands and Class 1 (i.e., maintained in their natural state of quality)}.

Table E-4 (continued)

Area	Chemical	Federal							
		Ambient Water Quality Criteria-Fresh Water--Criteria Continuous Concentration		Ambient Water Quality Criteria-Fresh Water--Criteria Maximum Concentration		Ambient Water Quality Criteria-Salt Water--Criteria Continuous Concentration		Ambient Water Quality Criteria-Salt Water--Criteria Maximum Concentration	
		ug/L		ug/L		ug/L		ug/L	
Lake Segment 1	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 2	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 3	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 4	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 5	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 6	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 7	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a

Table E-4 (continued)

Area	Chemical	MI DNRE							
		Ambient Water Quality Criteria-Aquatic Maximum Value for the Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Chronic Water Quality Value for Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Final Acute Value for Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Water Quality Values for Protection of Wildlife	
		ug/L		ug/L		ug/L		ug/L	
Lake Segment 1	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 2	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 3	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 4	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 5	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 6	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 7	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e

Table E-4 (continued)

Area	Chemical	NC DENR		NJDEP		ORNL
		Surface Water Quality Standards-Freshwater Aquatic Life	Surface Water Quality Standards-Saltwater Aquatic Life	Aquatic Life Protection Criteria, Acute; Freshwater (f)	Aquatic Life Protection Criteria, Chronic; Freshwater (f)	Eco PRG
		ug/L	ug/L	ug/L	ug/L	ug/L
Lake Segment 1	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 2	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 3	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 4	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 5	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 6	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 7	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39

Table E-4 (continued)

Area	Chemical	USEPA Region 3 Freshwater Screening Benchmarks for Surface Water ug/L		USEPA Region 5 Ecological Data Quality Level for Surface Water ug/L	AZDEQ Aquatic and wildlife (cold water) (A&Wc) Acute ug/L	AZDEQ Aquatic and wildlife (cold water) (A&Wc) Chronic ug/L		AZDEQ Aquatic and wildlife (warm water) (A&Ww) Acute ug/L		AZDEQ Aquatic and wildlife (warm water) (A&Ww) Chronic ug/L		Selected Ecological Screening Level (ESL)	HQ
Lake Segment 1	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	2.48E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.32E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	5.26E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	2.93E-03
Lake Segment 2	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	4.15E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.88E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	6.96E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	5.13E-03
Lake Segment 3	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.86E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.62E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	8.98E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	9.99E-03
Lake Segment 4	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.08E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.87E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	1.20E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	1.49E+00
Lake Segment 5	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	2.27E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.13E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	8.51E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	8.58E-01
Lake Segment 6	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	5.43E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	5.09E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	2.32E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	4.57E-02
Lake Segment 7	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.37E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.16E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	1.87E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	7.21E-02

Table E-5 Comparison of Modeled Surface Water Mercury, Methylmercury and Selenium Concentrations against Ecological Screening Benchmarks

Area	Chemical	Modeled Concentration ug/L	NJDEP/NOAA Effects Range -- Low mg/kg	NJDEP/NOAA Effects Range -- Median mg/kg	ORNL Eco PRG mg/kg	USEPA Region 3 Freshwater Screening Benchmarks for Sediment mg/kg		USEPA Region 4 Sediment Ecological Effect Level mg/kg	USEPA Region 5 Ecological Data Quality Level for Sediment mg/kg	Selected Ecological Screening Level (ESL)	HQ
Lake Segment 1	Mercury	3.23E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	2.48E-04
	Methylmercury	5.72E-06	--	--	--	--	a	--	0.00001	0.00001	5.72E-01
	Selenium IV	8.16E-04	--	--	--	2	a	--	--	2	4.08E-04
	Selenium VI	4.55E-06	--	--	--	2	a	--	--	2	2.27E-06
Lake Segment 2	Mercury	5.39E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	4.15E-04
	Methylmercury	9.55E-06	--	--	--	--	a	--	0.00001	0.00001	9.55E-01
	Selenium IV	1.08E-03	--	--	--	2	a	--	--	2	5.40E-04
	Selenium VI	7.97E-06	--	--	--	2	a	--	--	2	3.98E-06
Lake Segment 3	Mercury	5.02E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.86E-04
	Methylmercury	8.90E-06	--	--	--	--	a	--	0.00001	0.00001	8.90E-01
	Selenium IV	1.39E-03	--	--	--	2	a	--	--	2	6.97E-04
	Selenium VI	1.55E-05	--	--	--	2	a	--	--	2	7.75E-06
Lake Segment 4	Mercury	4.00E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.08E-04
	Methylmercury	7.07E-06	--	--	--	--	a	--	0.00001	0.00001	7.07E-01
	Selenium IV	1.86E-03	--	--	--	2	a	--	--	2	9.30E-04
	Selenium VI	1.55E-05	--	--	--	2	a	--	--	2	7.75E-06
Lake Segment 5	Mercury	2.96E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	2.27E-04
	Methylmercury	5.23E-06	--	--	--	--	a	--	0.00001	0.00001	5.23E-01
	Selenium IV	1.32E-03	--	--	--	2	a	--	--	2	6.60E-04
	Selenium VI	1.33E-03	--	--	--	2	a	--	--	2	6.66E-04
Lake Segment 6	Mercury	7.06E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	5.43E-04
	Methylmercury	1.25E-05	--	--	--	--	a	--	0.00001	0.00001	1.25E+00
	Selenium IV	3.60E-03	--	--	--	2	a	--	--	2	1.80E-03
	Selenium VI	7.09E-05	--	--	--	2	a	--	--	2	3.55E-05
Lake Segment 7	Mercury	4.38E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.37E-04
	Methylmercury	7.74E-06	--	--	--	--	a	--	0.00001	0.00001	7.74E-01
	Selenium IV	2.79E-03	--	--	--	2	a	--	--	2	1.40E-03
	Selenium VI	1.11E-04	--	--	--	2	a	--	--	2	5.54E-05

NOTES:
Screening level not available
ug/L Micrograms per liter
mg/kg Milligrams per kilogram
(a) Chemical has been designated as a bioaccumulative chemical of concern by the publishing agency.

Table E-6 Total Daily Intake and Food Web Model

Inorganic Mercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	3.58E-10	5.97E-10	5.56E-10	4.43E-10	3.28E-10	7.82E-10	4.49E-10	3.28E-10	5.02E-10	7.27E-10	7.82E-10
Concentration in TL3 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Concentration in TL4 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Total Daily Intake												
Mink	mg/kg BW-d	1.73E-07	2.89E-07	2.69E-07	2.14E-07	1.58E-07	3.78E-07	2.17E-07	1.58E-07	2.43E-07	3.51E-07	3.78E-07
Great Blue Heron	mg/kg BW-d	2.22E-07	3.71E-07	3.45E-07	2.75E-07	2.03E-07	4.85E-07	2.79E-07	2.03E-07	3.11E-07	4.51E-07	4.85E-07
Belted Kingfisher	mg/kg BW-d	6.40E-07	1.07E-06	9.95E-07	7.93E-07	5.86E-07	1.40E-06	8.04E-07	5.86E-07	8.98E-07	1.30E-06	1.40E-06
NOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	5.E-07	8.E-07	8.E-07	6.E-07	5.E-07	1.E-06	6.E-07	5.E-07	7.E-07	1.E-06	1.E-06
Belted Kingfisher	Unitless	1.E-06	2.E-06	2.E-06	2.E-06	1.E-06	3.E-06	2.E-06	1.E-06	2.E-06	3.E-06	3.E-06
LOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	2.E-07	4.E-07	4.E-07	3.E-07	2.E-07	5.E-07	3.E-07	2.E-07	3.E-07	5.E-07	5.E-07
Belted Kingfisher	Unitless	7.E-07	1.E-06	1.E-06	9.E-07	7.E-07	2.E-06	9.E-07	7.E-07	1.E-06	1.E-06	2.E-06

Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	5.76E-11	9.61E-11	8.95E-11	7.12E-11	5.26E-11	1.26E-10	7.79E-11	5.26E-11	8.16E-11	1.17E-10	1.26E-10
Concentration in TL3 Fish (b)	mg/kg WW	3.91E-05	6.54E-05	6.09E-05	4.84E-05	3.58E-05	8.56E-05	5.30E-05	3.58E-05	5.55E-05	7.96E-05	8.56E-05
Concentration in TL4 Fish (b)	mg/kg WW	1.55E-04	2.60E-04	2.42E-04	1.92E-04	1.42E-04	3.40E-04	2.10E-04	1.42E-04	2.20E-04	3.16E-04	3.40E-04
Total Daily Intake												
Mink	mg/kg BW-d	1.33E-05	2.23E-05	2.07E-05	1.65E-05	1.22E-05	2.92E-05	1.80E-05	1.22E-05	1.89E-05	2.71E-05	2.92E-05
Great Blue Heron	mg/kg BW-d	2.22E-05	3.71E-05	3.45E-05	2.75E-05	2.03E-05	4.86E-05	3.00E-05	2.03E-05	3.15E-05	4.51E-05	4.86E-05
Belted Kingfisher	mg/kg BW-d	3.46E-05	5.77E-05	5.38E-05	4.27E-05	3.16E-05	7.56E-05	4.68E-05	3.16E-05	4.90E-05	7.03E-05	7.56E-05
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

NOTES:
(a) Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.
(b) Fish tissue concentrations were calculated on table 4-2. Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.
mg/L milligram per liter
mg/kg milligram per kilogram
HQ Hazard Quotient
EPC Exposure point concentration

Table E-6 (continued)

Mercury + Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

This represents the combined HQ (and is therefore a Hazard Index or HI) for divalent inorganic mercury plus methylmercury.

Selenium		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	1.16E-06	2.03E-06	3.95E-06	5.89E-04	3.39E-04	1.81E-05	2.82E-05	1.16E-06	1.40E-04	5.14E-04	5.89E-04
Concentration in TL3 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Concentration in TL4 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Total Daily Intake												
Mink	mg/kg BW-d	2.06E-05	3.60E-05	7.02E-05	1.05E-02	6.03E-03	3.21E-04	5.02E-04	2.06E-05	2.49E-03	9.13E-03	1.05E-02
Great Blue Heron	mg/kg BW-d	2.63E-05	4.61E-05	8.97E-05	1.34E-02	7.70E-03	4.10E-04	6.41E-04	2.63E-05	3.18E-03	1.17E-02	1.34E-02
Belted Kingfisher	mg/kg BW-d	7.58E-05	1.33E-04	2.59E-04	3.86E-02	2.22E-02	1.18E-03	1.85E-03	7.58E-05	9.18E-03	3.37E-02	3.86E-02
NOAEL HQ												
Mink	Unitless	1.E-04	2.E-04	4.E-04	5.E-02	3.E-02	2.E-03	3.E-03	1.E-04	1.E-02	5.E-02	5.E-02
Great Blue Heron	Unitless	5.E-05	9.E-05	2.E-04	3.E-02	2.E-02	8.E-04	1.E-03	5.E-05	6.E-03	2.E-02	3.E-02
Belted Kingfisher	Unitless	2.E-04	3.E-04	5.E-04	8.E-02	4.E-02	2.E-03	4.E-03	2.E-04	2.E-02	7.E-02	8.E-02
LOAEL HQ												
Mink	Unitless	6.E-05	1.E-04	2.E-04	3.E-02	2.E-02	1.E-03	2.E-03	6.E-05	8.E-03	3.E-02	3.E-02
Great Blue Heron	Unitless	3.E-05	5.E-05	9.E-05	1.E-02	8.E-03	4.E-04	6.E-04	3.E-05	3.E-03	1.E-02	1.E-02
Belted Kingfisher	Unitless	8.E-05	1.E-04	3.E-04	4.E-02	2.E-02	1.E-03	2.E-03	8.E-05	9.E-03	3.E-02	4.E-02

Table E-7 Toxicity Reference Values

Constituent	Toxicity Reference Values (mg/kg-BW/day) Mink NOAEL	Mink LOAEL	Avians NOAEL	Avians LOAEL	Note
Mercury (mercuric chloride)	1	1	0.45	0.9	(a)
Mercury (methyl mercury)	0.015	0.025	0.006	0.064	(a)
Selenium	0.2	0.33	0.5	1	(a)

NOTES:

(a) Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3 Sample, Opresko, and Suter II. Prepared by the Risk Assessment Program Health Sciences Research Division Oak Ridge, Tennessee 37831. ttp://www.hsrd.ornl.gov/ecorisk/tm86r3.pdf NOAEL data from Table 12

Note: that if a constituent lacked a LOAEL, the NOAEL was used for both TRVs

NOAEL No observable adverse effect level
LOAEL Lowest observable adverse effect level
TRV Toxicity reference value
mg/kg-BW/day milligram per killogram - bodyweight per day

Table E-8 Summary of Average HQs

	Inorganic Mercury HQ	Methylmercury HQ	Selenium HQ
TL2 Aquatic Invertebrate	0.0000009	0.000001	0.02
TL3 Threadfin Shad	0.0000009	0.00003	0.02
TL4 Striped Bass	0.0000009	0.00003	0.02
Mink	0.0000002	0.001	0.01
Great Blue Heron	0.0000007	0.005	0.006
Belted Kingfisher	0.000002	0.008	0.02

NOTES:
The HQs are for average sitewide values for NOAELs or low CBRs.
HQ Hazard Quotient
NOAEL No observable adverse effect level
CBR Critical body residue

Table E-9 Total Daily Intake and Food Web Model

Inorganic Mercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	3.58E-10	5.97E-10	5.56E-10	4.43E-10	3.28E-10	7.82E-10	4.49E-10	3.28E-10	5.02E-10	7.27E-10	7.82E-10
Concentration in TL3 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Concentration in TL4 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Total Daily Intake												
Mink	mg/kg BW-d	1.73E-07	2.89E-07	2.69E-07	2.14E-07	1.58E-07	3.78E-07	2.17E-07	1.58E-07	2.43E-07	3.51E-07	3.78E-07
Great Blue Heron	mg/kg BW-d	2.22E-07	3.71E-07	3.45E-07	2.75E-07	2.03E-07	4.85E-07	2.79E-07	2.03E-07	3.11E-07	4.51E-07	4.85E-07
Belted Kingfisher	mg/kg BW-d	6.40E-07	1.07E-06	9.95E-07	7.93E-07	5.86E-07	1.40E-06	8.04E-07	5.86E-07	8.98E-07	1.30E-06	1.40E-06
NOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	5.E-07	8.E-07	8.E-07	6.E-07	5.E-07	1.E-06	6.E-07	5.E-07	7.E-07	1.E-06	1.E-06
Belted Kingfisher	Unitless	1.E-06	2.E-06	2.E-06	2.E-06	1.E-06	3.E-06	2.E-06	1.E-06	2.E-06	3.E-06	3.E-06
LOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	2.E-07	4.E-07	4.E-07	3.E-07	2.E-07	5.E-07	3.E-07	2.E-07	3.E-07	5.E-07	5.E-07
Belted Kingfisher	Unitless	7.E-07	1.E-06	1.E-06	9.E-07	7.E-07	2.E-06	9.E-07	7.E-07	1.E-06	1.E-06	2.E-06

Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	5.76E-11	9.61E-11	8.95E-11	7.12E-11	5.26E-11	1.26E-10	7.79E-11	5.26E-11	8.16E-11	1.17E-10	1.26E-10
Concentration in TL3 Fish (b)	mg/kg WW	3.91E-05	6.54E-05	6.09E-05	4.84E-05	3.58E-05	8.56E-05	5.30E-05	3.58E-05	5.55E-05	7.96E-05	8.56E-05
Concentration in TL4 Fish (b)	mg/kg WW	1.55E-04	2.60E-04	2.42E-04	1.92E-04	1.42E-04	3.40E-04	2.10E-04	1.42E-04	2.20E-04	3.16E-04	3.40E-04
Total Daily Intake												
Mink	mg/kg BW-d	1.33E-05	2.23E-05	2.07E-05	1.65E-05	1.22E-05	2.92E-05	1.80E-05	1.22E-05	1.89E-05	2.71E-05	2.92E-05
Great Blue Heron	mg/kg BW-d	2.22E-05	3.71E-05	3.45E-05	2.75E-05	2.03E-05	4.86E-05	3.00E-05	2.03E-05	3.15E-05	4.51E-05	4.86E-05
Belted Kingfisher	mg/kg BW-d	3.46E-05	5.77E-05	5.38E-05	4.27E-05	3.16E-05	7.56E-05	4.68E-05	3.16E-05	4.90E-05	7.03E-05	7.56E-05
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

NOTES:

(a) Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspendid selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

(b) Fish tissue concentrations were calculated on table 4-2. Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

mg/L milligram per liter
mg/kg milligram per kilogram
HQ Hazard Quotient
EPC Exposure Point Concentration

Table E-9 (continued)

Mercury + Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

This represents the combined HQ (and is therefore a Hazard Index or HI) for divalent inorganic mercury plus methylmercury.

Selenium		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	1.16E-06	2.03E-06	3.95E-06	5.89E-04	3.39E-04	1.81E-05	2.82E-05	1.16E-06	1.40E-04	5.14E-04	5.89E-04
Concentration in TL3 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Concentration in TL4 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Total Daily Intake												
Mink	mg/kg BW-d	2.06E-05	3.60E-05	7.02E-05	1.05E-02	6.03E-03	3.21E-04	5.02E-04	2.06E-05	2.49E-03	9.13E-03	1.05E-02
Great Blue Heron	mg/kg BW-d	2.63E-05	4.61E-05	8.97E-05	1.34E-02	7.70E-03	4.10E-04	6.41E-04	2.63E-05	3.18E-03	1.17E-02	1.34E-02
Belted Kingfisher	mg/kg BW-d	7.58E-05	1.33E-04	2.59E-04	3.86E-02	2.22E-02	1.18E-03	1.85E-03	7.58E-05	9.18E-03	3.37E-02	3.86E-02
NOAEL HQ												
Mink	Unitless	1.E-04	2.E-04	4.E-04	5.E-02	3.E-02	2.E-03	3.E-03	1.E-04	1.E-02	5.E-02	5.E-02
Great Blue Heron	Unitless	5.E-05	9.E-05	2.E-04	3.E-02	2.E-02	8.E-04	1.E-03	5.E-05	6.E-03	2.E-02	3.E-02
Belted Kingfisher	Unitless	2.E-04	3.E-04	5.E-04	8.E-02	4.E-02	2.E-03	4.E-03	2.E-04	2.E-02	7.E-02	8.E-02
LOAEL HQ												
Mink	Unitless	6.E-05	1.E-04	2.E-04	3.E-02	2.E-02	1.E-03	2.E-03	6.E-05	8.E-03	3.E-02	3.E-02
Great Blue Heron	Unitless	3.E-05	5.E-05	9.E-05	1.E-02	8.E-03	4.E-04	6.E-04	3.E-05	3.E-03	1.E-02	1.E-02
Belted Kingfisher	Unitless	8.E-05	1.E-04	3.E-04	4.E-02	2.E-02	1.E-03	2.E-03	8.E-05	9.E-03	3.E-02	4.E-02

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Appendix F
Population and Economic Information

Table F-1 Population in Arizona Counties Residing on Hopi Reservation, Navajo Nation, or Off Reservation [1]

	Total Population	Population, within Hopi Reservation	Population, within Navajo Nation	Population Remainder (off Reservation)
Apache County	69,423	NA	54,521 (78.5%)	14,902 (21.5%)
Coconino County	116,320	1,024 (0.9%)	23,350 (20.1%)	91,946 (79.0%)
Navajo County	97,470	5,812 (6.0%)	26,881 (27.6%)	64,777 (66.5%)
State of Arizona	5,130,632 6,392,017 [2]	6,836 (0.1%)	104,752 (2.0%)	5,019,044 (97.8%)

NOTES: [1] U.S. Census Bureau 2000
[2] U.S. Census Bureau 2010
NA = not applicable

Population statistics from the 2010 U.S. Census are currently available at the statewide level only. The population growth of the State of Arizona from 2000 to 2010 is 24.6 percent. No data are available at the County or Tribal level.

Table F-2 County, Reservation, and Census Place Labor Force Characteristics

	Labor Force	Employment	Unemployment	Percent Unemployment Rate (%)
Apache County, Arizona				
2004	22,577	19,577	3,000	13.3
2003	21,874	18,794	3,079	14.1
Coconino County, Arizona				
2004	68,846	64,655	4,191	6.1
2003	66,940	62,642	4,298	6.4
Navajo County, Arizona				
2004	37,399	66,432	3,967	10.6
2003	35,938	32,055	3,882	10.8
Hopi Reservation				
2005-09	3,611	1,723	448	12.4
2004	3,457	2,828	629	18.2
2003	3,451	2,730	721	20.9
Navajo Nation (Arizona portion)				
2005-2009 [1]	54,714	21,229	7,824	14.3
2004	35,799	28,439	7,360	20.6
2003	35,890	27,449	8,441	23.5
Kayenta Census-designated Place				
2004	2,267	2,050	217	9.6
2003	2,179	1,966	213	9.8
Tuba City Census-designated Place				
2004	3,734	3,130	604	16.2
2003	3,652	3,033	619	16.9

	Labor Force	Employment	Unemployment	Percent Unemployment Rate (%)
State of Arizona				
2009	3,143,000	2,858,000	284,000	9.1
2008	3,133,000	2,960,000	172,000	5.5
2007	3,029,000	2,914,000	115,000	3.8
2006	2,977,000	2,854,000	123,000	4.1
2005	2,844,000	2,710,000	134,000	4.7
2004	2,762,612	2,630,998	131,614	4.8
2003	2,690,294	2,539,359	150,935	5.6

SOURCE: U.S. Census Bureau 1990, 2000, 2004, 2005-2009 American Community Survey; State of Arizona data for 2005-2009 taken from the U.S. Bureau of Labor Statistics website www.bls.gov

NOTES: [1] The 2005-2009 labor statistics for the Navajo Nation include Tribal data from Arizona, New Mexico, and Utah.

Table F-3 Tribal Area and Agency Population

	Population (1990)	Population (2000)	Population (est. 2004)	Households (2000) [1]
Tribal Areas				
Navajo Nation [2, 3]	148,451	155,214	NA	40,933
Hopi Reservation, AZ [3]	7,360	6,815	NA	1,938
Navajo Nation Agencies [4,5,6,7]				
Chinle	5,221	6,212	6,494	1,598
Western	23,787	28,434	29,904	7,143

NOTES: [1] A household includes all the people who occupy a housing unit as their usual place of residence.
[2] Total population for Navajo Nation includes Arizona, New Mexico, and Utah.
[3] U.S. Census Bureau 1990 (STF 1, DP-1), 2000 (SF1, P1 and SF1, P15).
[4] 1990 chapter populations are for the American Indian population only.
[5] 2000 and 2004 chapter populations include all races.
[6] Navajo Nation Division of Community Development, 2005; U.S. Census Bureau 1990, 2000.
[7] The population and household data for the Chinle and Western Agencies include only those chapters within the Area of Influence.

est. = estimated

NA = not applicable

Table F-4 Study Area Employment: Total and Percent Share by Industry Sector

Area	Total Employment	Industry as Percent (%) of Total Employment								
		Agriculture, Forestry, Fishing, and Hunting	Mining [1]	Construction	Manufacturing	Retail and Wholesale Trade	Transportation, Warehousing, and Utilities	Services and Information	FIRE and Rental/Leasing	Public Administration
Tribal Areas										
Hopi Reservation, AZ	2,280	0.3	0.7	10.5	5.5	8.6	1.4	45.2	1.8	26.0
Navajo Nation [2]	51,363	1.2	2.7	12.4	4.4	9.5	6.0	51.1	2.0	10.6
Navajo Nation Chapters										
Black Mesa	60	0.0	0.0	21.7	0.0	0.0	0.0	78.3	0.0	0.0
Chilchinbito	147	0.0	18.4	0.0	0.0	15.6	12.2	38.1	0.0	15.6
Dennehotso	269	0.0	13.0	9.7	0.0	9.7	1.9	50.9	1.5	13.4
Forest Lake	27	0.0	0.0	29.6	0.0	0.0	33.3	37.0	0.0	0.0
Hard Rock	187	2.1	0.0	21.9	0.0	1.6	10.2	48.1	0.0	16.0
Inscription House	257	0.0	11.7	30.7	5.1	17.1	3.5	30.4	0.0	1.6
Kaibito	400	0.0	0.8	18.5	6.8	14.0	6.5	44.3	1.3	8.0
Kayenta	1,524	0.9	12.3	8.9	1.2	10.0	4.0	57.9	0.0	4.7
Oljato	515	0.0	5.0	13.8	4.7	12.0	8.3	52.0	0.0	4.1
Piñon	615	0.8	3.7	4.4	2.6	12.4	12.4	57.7	1.3	4.7
Rough Rock	135	0.0	3.7	15.6	0.0	0.0	0.0	70.4	0.0	10.4
Shonto	511	1.2	12.5	16.2	5.7	2.7	5.3	51.5	1.6	3.3
Tonalea	434	0.0	0.0	24.0	2.3	6.0	10.1	47.2	3.9	6.5
Tuba City	2,908	0.5	1.6	8.8	2.1	8.6	4.3	61.1	2.7	10.4

SOURCE: U.S. Census Bureau 2000 (SF3, QT-P24 and SF3, QT-P30)

NOTES: [1] While the Tonalea Chapter reported no mining employment in the Census 2000, PWCC has supplied employee residence location figures for 2010 that indicate there are currently miners from that community.

[2] Total population for Navajo Nation includes Arizona, New Mexico, and Utah.

FIRE = Finance, Insurance, and Real Estate

Table F-5 State of Arizona and Navajo County Taxes Paid by PWCC

Year	Property Tax ($ million)	Sales Tax ($ million)	Total ($ million)
2001	1.7	12.0	13.7
2002	1.5	18.4	19.9
2003	1.7	14.3	15.9
2004	1.7	16.4	18.1
2005	2.0	18.7	20.6
2006	1.2	12.9	14.1
2007	0.7	13.4	14.1
2008	1.6	17.0	18.6
2009	1.7	14.8	16.5
Average	1.53	15.32	16.83

SOURCES: Peabody Western Coal Company 2010; SWCA Environmental Consultants 2005

Table F-6 AML Reclamation Fund Fees and Black Lung Excise Tax (2001 to 2010)

Year	Reclamation (AML) Fees ($ million)	Black Lung Excise Tax ($ million)	Total ($ million) [1]
2001	3.6	5.5	9.1
2002	4.6	7.1	11.7
2003	4.3	6.7	10.9
2004	4.6	7.2	11.8
2005	2.9	4.5	7.4
2006	2.8	4.4	7.3
2007	2.8	4.4	7.1
2008	2.5	4.4	6.9
2009	2.4	4.1	6.5
2010 [2]	2.5	4.3	6.7

SOURCE: Peabody Western Coal Company 2010
NOTES: [1] Figures may not add to totals due to rounding.
[2] 2010 data are estimated by PWCC.

Table F-7 Coal Royalties and Bonuses Paid by PWCC (1987 to 2009)

Year	Coal Royalties				Coal Bonuses [2]		
	Hopi Lease 5743 ($ million)	Navajo Lease 8580 ($ million)	Navajo Lease 9910 ($ million)	Overall Total ($ million) [1]	Hopi ($ million)	Navajo ($ million)	Total ($ million)
1987	4.3	43.1 [3]	4.3	51.7	NA	NA	NA
1988	8.1	13.3	8.1	29.5	NA	NA	NA
1989	8.6	12.9	8.6	30.1	NA	NA	NA
1990	7.9	13.4	7.9	29.2	NA	NA	NA
1991	9.4	14.7	9.4	33.5	NA	NA	NA
1992	8.7	15.6	8.7	33.0	NA	NA	NA
1993	8.9	15.7	8.9	33.5	NA	NA	NA
1994	10.7	11.5	10.8	33.0	NA	NA	NA
1995	11.8	9.4	11.8	33.0	NA	NA	NA
1996	10.0	11.1	9.8	30.9	NA	NA	NA
1997	9.9	12.9	9.9	32.7	NA	NA	NA
1998	10.7	15.2	9.8	35.7	1.8	2.0	3.8
1999	10.0	13.9	9.7	33.6	0.75	4.3	5.0
2000	10.7	14.4	10.6	35.7	0.75	3.5	4.3
2001	10.9	15.1	11.1	37.1	1.75	3.5	5.3
2002	10.7	16.0	10.5	37.2	0.75	3.5	4.3
2003	10.3	16.0	9.8	36.1	0.75	3.5	4.3
2004	12.0	15.0	12.0	39.0	1.75	3.5	5.3
2005	14.7	16.7	14.0	45.4	0.75	3.5	4.3
2006	13.3	4.3	12.9	30.5	10.5 [4]	14.0 [4]	24.4 [4]
2007	10.3	9.0	9.9	29.2	NA	3.5	3.5
2008	10.3	14.4	10.0	34.7	NA	NA	NA
2009[5]	13.1	7.9	12.1	33.1	NA	NA	NA
Total [1]	235.3	331.5	230.6	797.4	19.6	44.8	64.2
Average (year)	10.2	14.4	10.0	34.7	2.2	4.5	6.4
2005-2009 Total [1]	61.7	52.3	58.9	172.9	11.3	21.0	32.2
2005-2009 Average (year)	12.3	10.5	11.8	34.6	5.6	7.0	10.7

SOURCE: Peabody Western Coal Company 2010

NOTES: [1] Figures may not add to totals due to rounding.

[2] Bonuses began in 1998.

[3] The $43.1 million coal-royalty payment included an adjustment for royalty rates back to 1984.

[4] Navajo/Hopi Lease Extension Bonus Payment of $20,921,466 paid in 2006.

5 Coal bonuses for years 2007-2009 are subject to agreements awaiting Tribal and Federal approvals.

NA = not applicable

Table F-8 Water Use Fees Paid by PWCC (1987 to 2009)

Year	Hopi ($ million)	Navajo ($ million)	Total ($ million) [1]
1987	0.02	0.02	0.04
1988	1.5	1.5	3.0
1989	1.6	1.6	3.2
1990	1.3	1.3	2.6
1991	1.4	1.4	2.8
1992	1.7	1.7	3.4
1993	1.6	1.6	3.2
1994	1.6	1.6	3.2
1995	1.8	1.8	3.6
1996	1.9	1.9	3.8
1997	1.9	1.9	3.8
1998	1.9	1.9	3.8
1999	1.9	1.9	3.8
2000	2.1	2.1	4.2
2001	2.2	2.2	4.4
2002	2.3	2.3	4.6
2003	2.3	2.3	4.6
2004	2.2	2.2	4.4
2005	2.2	2.2	4.4
2006	1.5	1.5	3.0
2007	0.5	0.5	1.0
2008	0.5	0.5	1.0
2009	0.6	0.6	1.2
Total [1]	36.5	36.5	73.0
Average (year)	1.6	1.6	3.2
2005-2009 Total [1]	5.3	5.3	10.6
2005-2009 Average (year)	1.1	1.1	2.1

SOURCE: Peabody Western Coal Company 2010

NOTES: [1] Figures may not add to totals due to rounding.

The grand total of all payments made to the tribes from 1987 to 2009 is shown in Table F-9.

Table F-9 Total Annual Payments to Navajo Nation and Hopi Tribe (1987 to 2009) [2,3]

Year	Hopi Tribe ($ million)	Navajo Nation ($ million)
1987	4.3	47.4
1988	9.6	22.9
1989	10.2	23.1
1990	9.2	22.6
1991	10.8	25.5
1992	10.4	26.0
1993	10.5	26.2
1994	12.3	23.9
1995	13.6	23.0
1996	11.9	22.8
1997	11.8	24.7
1998	14.4	28.9
1999	12.7	29.8
2000	13.6	30.6
2001	14.9	31.9
2002	13.8	32.3
2003	13.4	31.6
2004	16.0	32.7
2005	17.7	36.4
2006	25.3	32.7
2007	10.8	22.9
2008	10.8	24.9
2009	13.7	20.6
Total [1]	291.4	643.4
Average (year)	12.7	28.0
2005-2009 Total [1]	78.3	137.5
2005-2009 Average (year)	15.7	27.5

SOURCE: Peabody Western Coal Company 2010

NOTES: [1] Figures may not add to totals due to rounding.

[2] Total of the annual payments detailed in Table D-16 and Table D-17.

[3] Total does not include student scholarships nor grant payments made to the tribes by the Federal government from the Abandoned Mine Land Reclamation Fund.

Table F-10 Electric Payments to NTUA (1987-2010)

Year	Kayenta Mine Payments ($ million)	Total NTUA Electric Revenue ($ million)	NTUA Revenue from PWCC (%) [1]	Total NTUA Revenue ($ million)	Total NTUA Revenue from PWCC (%) [1]
1987	4.5	27.3	16.4	40.5	11.0
1988	5.5	29.4	18.6	42.7	12.8
1989	5.1	27.6	18.3	41.4	12.2
1990	5.2	29.3	17.7	43.8	11.8
1991	5.1	30.0	17.1	47.5	10.8
1992	5.2	31.7	16.5	49.3	10.6
1993	5.8	33.9	17.2	53.4	10.9
1994	6.3	35.4	17.8	53.2	11.9
1995	6.0	37.0	16.3	54.6	11.1
1996	6.1	37.9	16.0	56.7	10.7
1997	6.0	38.9	15.4	63.0	9.5
1998	6.1	39.7	15.2	62.8	9.6
1999	5.7	37.4	15.3	57.4	9.9
2000	5.9	43.8	13.5	67.5	8.8
2001	7.0	49.4	14.2	76.1	9.2
2002	6.0	43.8	13.7	66.5	9.0
2003	5.9	47.2	12.5	70.2	8.4
2004	6.0	47.5	12.6	71.8	8.3
2005	7.0	NA	NA	NA	NA
2006	6.9	NA	NA	NA	NA
2007	7.0	NA	NA	NA	NA
2008	8.4	NA	NA	NA	NA
2009	8.9	NA	NA	NA	NA
2010 [2]	9.9	NA	NA	NA	NA

SOURCES: Peabody Western Coal Company 2010, SWCA Environmental Consultants 2005
NOTES: [1] Figures may not add to totals due to rounding.
[2] 2010 data are estimated by PWCC.
NA = not applicable