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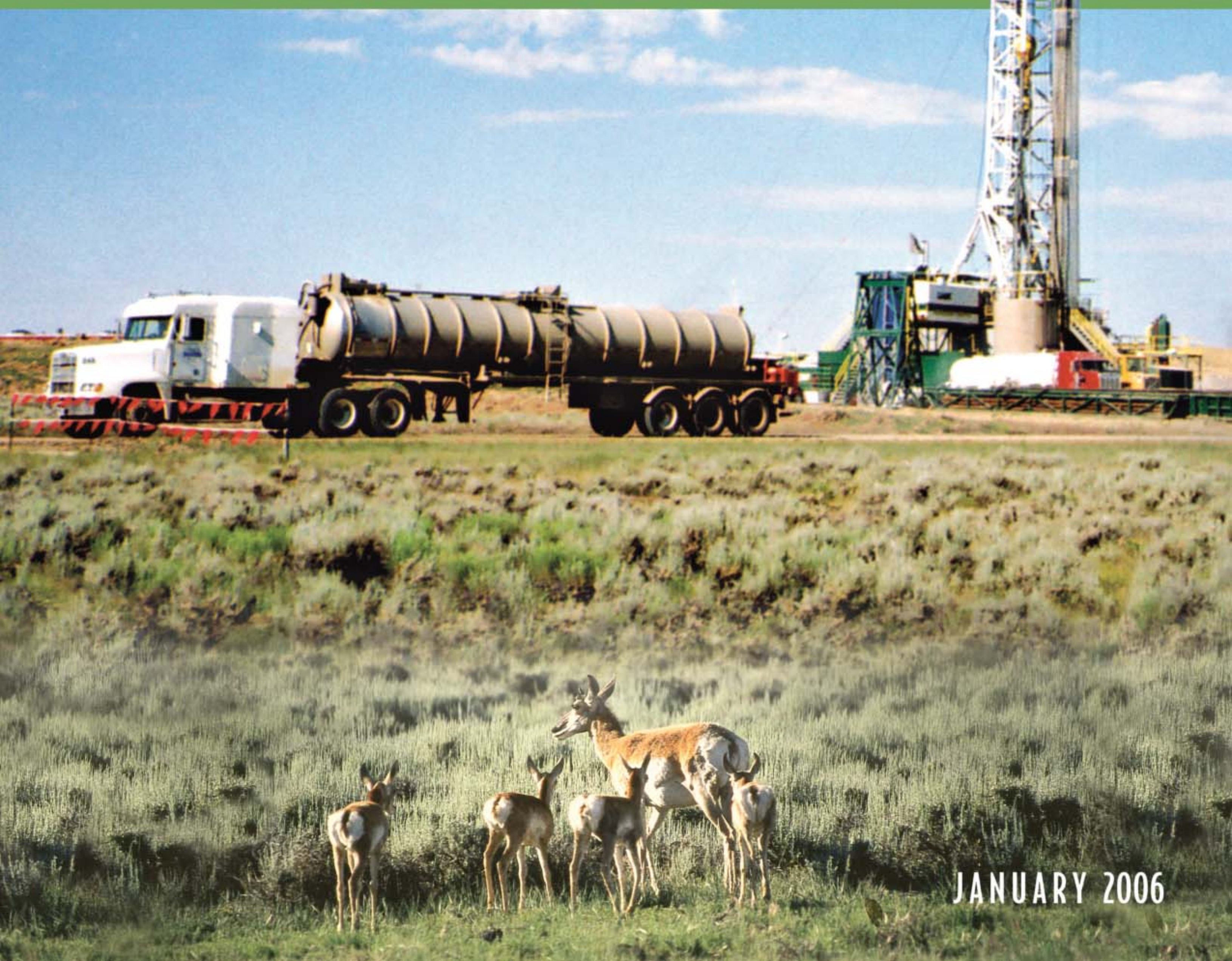
Bureau of Land Management
Pinedale and Rock Springs Field Offices

VOLUME 2 of 2
APPENDIX

FINAL
ENVIRONMENTAL IMPACT STATEMENT

JONAH INFILL DRILLING PROJECT SUBLETTE COUNTY, WYOMING



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FINAL
ENVIRONMENTAL IMPACT STATEMENT
JONAH INFILL DRILLING PROJECT,
SUBLETTE COUNTY, WYOMING

(Volume 2 of 2)

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

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Pinedale, Wyoming

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Rock Springs Field Office
Rock Springs, Wyoming

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Introduction

These guidelines are primarily for the purpose of attaining statewide consistency in how requirements are determined for avoiding and mitigating environmental impacts and resource and land use conflicts. Consistency in this sense does not mean that identical requirements would be applied for all similar types of land use activities that may cause similar types of impacts. Nor does it mean that the requirements or guidelines for a single land use activity would be identical in all areas.

There are two ways the mitigation guidelines are used in the resource management plan (RMP) and environmental impact statement (EIS) process: (1) as part of the planning criteria in developing the RMP alternatives, and (2) in the analytical processes of both developing the alternatives and analyzing the impacts of the alternatives. In the first case, an assumption is made that any one or more of the mitigations will be appropriately included as conditions of relevant actions being proposed or considered in each alternative. In the second case, the mitigations are used (1) to develop a baseline for measuring and comparing impacts among the alternatives; (2) to identify other actions and alternatives that should be considered; and (3) to help determine whether more stringent or less stringent mitigations should be considered.

The EIS for the RMP does not decide or dictate the exact wording or inclusion of these guidelines. Rather, the guidelines are used in the RMP EIS process as a tool to help develop the RMP alternatives and to provide a baseline for comparative impact analysis in arriving at RMP decisions. These guidelines will be used in the same manner in analyzing activity plans and other site-specific proposals. These guidelines and their wording are matters of policy. As such, specific wording is subject to change primarily through administrative review, not through the RMP EIS process. Any further changes that may be made in the continuing refinement of these guidelines and any development of program-specific standard stipulations will be handled in another forum, including appropriate public involvement and input.

Purpose

The purposes of the “Wyoming BLM Mitigation Guidelines” are (1) to reserve, for the BLM, the right to modify the operations of all surface and other human presence disturbance activities as part of the statutory requirements for environmental protection, and (2) to inform a potential lessee, permittee, or operator of the requirements that must be met when using BLM-administered public lands. These guidelines have been written in a format that will allow for (1) their direct use as stipulations, and (2) the addition of specific or specialized mitigation following the submission of a detailed plan of development or other project proposal, and an environmental analysis.

Those resource activities or programs currently without a standardized set of permit or operation stipulations can use the mitigation guidelines as stipulations or as conditions of approval, or as a baseline for developing specific stipulations for a given activity or program.

Because use of the mitigation guidelines was integrated into the RMP EIS process and will be integrated into the site-specific environmental analysis process, the application of stipulations or mitigation requirements derived through the guidelines will provide more consistency with planning decisions and plan implementation than has occurred in the past. Application of the mitigation guidelines to all surface and other human presence disturbance activities concerning BLM-administered public lands and resources will provide more uniformity in mitigation than has occurred in the past.

Mitigation Guidelines

1. Surface Disturbance Mitigation Guideline

Under 43 *Code of Federal Regulations* (CFR) 3101.1-2 and the terms of the lease (BLM Form 3100-11), the Authorized Officer may require reasonable measures to minimize adverse impacts to other resource values, land uses, and users not addressed in lease stipulations at the time operations are proposed. Such reasonable measures may include, but are not limited to, modification of siting or design of facilities, timing of operations, and specification of interim and final reclamation measures, which may require relocating proposed operations up to 200 meters, but not off the leasehold, and prohibiting surface disturbance activities for up to 60 days. Application of reasonable measures beyond 200 meters and longer than 60 days would require additional environmental analysis. The Jonah Infill Drilling Project Area (JIDPA) EIS suffices as the additional analysis for prohibiting surface disturbance for more than 60 days.

Land under lease within the JIDPA may include areas not specifically addressed by lease stipulations that may contain special values, may be needed for special purposes, or may require special attention to prevent damage to surface and/or other resources. Possible special areas are identified below. Any surface use or occupancy within such special areas will be strictly controlled or, if necessary, prohibited. Appropriate modifications to imposed restrictions will be made for the maintenance and operation of producing wells.

a. Slopes in excess of 25 percent.

b. Within important scenic areas (Class I and II Visual Resource Management Areas).

c. Within 500 feet of surface water and/or riparian areas.

d. Within 500 feet of Interstate highways and 200 feet of other existing rights-of-way (i.e., U.S. and State highways, roads, railroads, pipelines, power lines).

e. Within either 0.25 mile or the visual horizon (whichever is closer) of historic trails.

f. Within 0.25 mile of occupied dwellings.

g. Construction with frozen material or during periods when the soil material is saturated or when watershed damage is likely to occur.

Guidance

The intent of the Surface Disturbance Mitigation Guideline is to inform interested parties (potential lessees, permittees, or operators) that when one or more of the seven (a through g) conditions exist, surface-disturbing activities will be prohibited unless or until a permittee or his designated representative and the surface management agency (SMA) arrive at an acceptable plan for mitigation of anticipated impacts. This negotiation will occur prior to development.

Specific criteria (e.g., 500 feet from water) have been established based upon the best information available. However, such items as geographical areas and seasons must be delineated at the field level.

Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, applications for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

2. Wildlife Mitigation Guideline

a. To protect important big game winter habitat, activities or surface use will not be allowed from November 15 to April 30 within certain areas encompassed by the authorization. The same criteria apply to defined big game birthing areas from May 1 to June 30.

- Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects.

- Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the Authorized Officer.

b. To protect important raptor and/or greater sage-grouse and sharp-tailed grouse nesting habitat, activities or surface use will not be allowed from February 1 to July 31 within certain areas encompassed by the authorization. The same criteria apply to defined raptor and game bird winter concentration areas from November 15 to March 14.

- Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects.

- Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the Authorized Officer.

c. No activities or surface use will be allowed on that portion of the authorization area identified within (legal description) for the purpose of protecting (e.g., greater sage-grouse/sharp-tailed grouse breeding grounds, and/or other species/activities) habitat.

- Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the Authorized Officer.

d. Portions of the authorized use area legally described as (legal description), are known or suspected to be essential habitat for (name) which is a threatened or endangered species. Prior to conducting any onsite activities, the lessee/permittee will be required to conduct inventories or studies in accordance with BLM and U.S. Fish and Wildlife Service guidelines to verify the presence or absence of this species. In the event that (name) occurrence is identified, the lessee/permittee will be required to modify operational plans to include the protection requirements of this species and its habitat (e.g., seasonal use restrictions, occupancy limitations, facility design modifications).

Guidance

The Wildlife Mitigation Guideline is intended to provide two basic types of protection: seasonal restriction (2a and 2b) and prohibition of activities or surface use (2c). Item 2d is specific to situations involving threatened or endangered species. Legal descriptions will ultimately be required and should be measurable and legally definable. There are no minimum subdivision requirements at this time. The area delineated can and should be defined as necessary, based upon current biological data, prior to the time of processing an application and issuing the use authorization. The legal description must eventually become a part of the condition for approval of the permit, plan of development, and/or other use authorization.

The seasonal restriction section identifies three example groups of species and delineates three similar time frame restrictions. The big game species including elk, moose, deer, antelope, and bighorn sheep, all require protection of crucial winter range between November 15 and April 30. Elk and bighorn sheep also require protection from disturbance from May 1 to June 30, when they typically occupy distinct calving and lambing areas. Raptors include eagles, accipiters, falcons (peregrine, prairie, and merlin), buteos (ferruginous and Swainson’s hawks), osprey, and burrowing owls. The raptors and greater sage-grouse and sharp-tailed grouse require nesting protection between February 1 and July 31. The same birds often require protection from disturbance from November 15 through April 30 while they occupy winter concentration areas.

Item 2c, the prohibition of activity or surface use, is intended for protection of specific wildlife habitat areas or values within the use area that cannot be protected by using seasonal restrictions. These areas or values must be factors that limit life-cycle activities (e.g., greater sage-grouse strutting grounds, known threatened and endangered species habitat).

Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, applications for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

3. Cultural Resource Mitigation Guideline

When a proposed discretionary land use has potential for affecting the characteristics which qualify a cultural property for the National Register of Historic Places (National Register), mitigation will be considered. In accordance with Section 106 of the National Historic Preservation Act, procedures specified in 36 CFR 800 will be used in consultation with the

Wyoming State Historic Preservation Officer and the Advisory Council on Historic Preservation in arriving at determinations regarding the need and type of mitigation to be required.

Guidance

The preferred strategy for treating potential adverse effects on cultural properties is "avoidance." If avoidance involves project relocation, the new project area may also require cultural resource inventory. If avoidance is imprudent or unfeasible, appropriate mitigation may include excavation (data recovery), stabilization, monitoring, protection barriers and signs, or other physical and administrative measures.

Reports documenting results of cultural resource inventory, evaluation, and the establishment of mitigation alternatives (if necessary) shall be written according to standards contained in BLM Manuals, the cultural resource permit stipulations, and in other policy issued by the BLM. These reports must provide sufficient information for Section 106 consultation. Reports shall be reviewed for adequacy by the appropriate BLM cultural resource specialist. If cultural properties on, or eligible for, the National Register are located within these areas of potential impact and cannot be avoided, the Authorized Officer shall begin the Section 106 consultation process in accordance with the procedures contained in 36 CFR 800.

Mitigation measures shall be implemented according to the mitigation plan approved by the BLM Authorized Officer. Such plans are usually prepared by the land use applicant according to BLM specifications. Mitigation plans will be reviewed as part of Section 106 consultation for National Register eligible or listed properties. The extent and nature of recommended mitigation shall be commensurate with the significance of the cultural resource involved and the anticipated extent of damage. Reasonable costs for mitigation will be borne by the land use applicant. Mitigation must be cost effective and realistic. It must consider project requirements and limitations, input from concerned parties, and be BLM approved or BLM formulated.

Mitigation of natural history sites will be treated on a case-by-case basis. Factors such as site significance, economics, safety, and project urgency must be taken into account when making a decision to mitigate. Authority to protect (through mitigation) such values is provided for in Federal Land Policy and Management Act (FLPMA), Section 102(a)(8). When avoidance is not possible, appropriate mitigation may include excavation (data recovery), stabilization, monitoring, protection barriers and signs, or other physical and administrative protection measures.

4. Special Resource Mitigation Guideline

To protect (resource value), activities or surface use will not be allowed (i.e., within a specific distance of the resource value or between date to date) in (legal description).

Application of this limitation to operation and maintenance of a developed project must be based on environmental analysis of the operational or production aspects.

Exception, waiver, or modification of this limitation in any year may be approved in writing, including documented supporting analysis, by the Authorized Officer.

Example Resource Categories (Select or identify category and specific resource value):

- Recreation areas.
- Special natural history or paleontological features.
- Special management areas.
- Sections of major rivers.
- Prior existing rights-of-way.
- Occupied dwellings.
- Other (specify).

Guidance

The Special Resource Mitigation Guideline is intended for use only in site-specific situations where one of the first three general mitigation guidelines will not adequately address the concern. The resource value, location, and specific restrictions must be clearly identified. A detailed plan addressing specific mitigation and special restrictions will be required prior to disturbance or development and will become a condition for approval of the permit, plan of development, or other use authorization.

Exception, waiver, or modification of requirements developed from this guideline must be based upon environmental analysis of proposals (e.g., activity plans, plans of development, plans of operation, applications for permit to drill) and, if necessary, must allow for other mitigation to be applied on a site-specific basis.

5. No Surface Occupancy Mitigation Guideline

No Surface Occupancy will be allowed on the following described lands (legal description) because of (resource value).

Example Resource Categories (Select or identify category and specific resource value):

- Recreation areas (e.g., campgrounds, historic trails, national monuments).
- Major reservoirs/dams.
- Special management area (e.g., known threatened or endangered species habitat, areas suitable for consideration for wild and scenic rivers designation).
- Other (specify).

Guidance

The No Surface Occupancy (NSO) Mitigation Guideline is intended for use only when other mitigation is determined insufficient to adequately protect the public interest and is the only alternative to "no development" or "no leasing." The legal description and resource value of concern must be identified and be tied to an NSO land use planning decision.

Waiver of, or exception(s) to, the NSO requirement will be subject to the same test used to initially justify its imposition. If, upon evaluation of a site-specific proposal, it is found that less restrictive mitigation would adequately protect the public interest or value of concern, then a waiver or exception to the NSO requirement is possible. The record must show that because conditions or uses have changed, less restrictive requirements will protect the public interest. An environmental analysis must be conducted and documented (e.g., environmental assessment, environmental impact statement, etc., as necessary) in order to provide the basis for a waiver or exception to an NSO planning decision. Modification of the NSO requirement will pertain only to refinement or correction of the location(s) to which it applied. If the waiver, exception, or modification is found to be consistent with the intent of the planning decision, it may be granted. If found inconsistent with the intent of the planning decision, a plan amendment would be required before the waiver, exception, or modification could be granted.

When considering the “no development” or “no leasing” option, a rigorous test must be met and fully documented in the record. This test must be based upon stringent standards described in the land use planning document. Since rejection of all development rights is more severe than the most restrictive mitigation requirement, the record must show that consideration was given to development subject to reasonable mitigation, including “no surface occupancy.” The record must also show that other mitigation was determined to be insufficient to adequately protect the public interest. A “no development” or “no leasing” decision should not be made solely because it appears that conventional methods of development would be unfeasible, especially where an NSO restriction may be acceptable to a potential permittee. In such cases, the potential permittee should have the opportunity to decide whether or not to go ahead with the proposal (or accept the use authorization), recognizing that an NSO restriction is involved.

A.2 STANDARDS FOR HEALTHY RANGELANDS FOR THE PUBLIC LANDS ADMINISTERED BY THE BUREAU OF LAND MANAGEMENT IN THE STATE OF WYOMING

Introduction

According to the Department of the Interior's final rule for grazing administration, effective August 21, 1995, the Wyoming Bureau of Land Management (BLM) State Director is responsible for the development of standards for healthy rangelands on 18 million acres of Wyoming's public rangelands. The development and application of these standards are to achieve the four fundamentals of rangeland health outlined in the grazing regulations (43 CFR 4180.1). Those four fundamentals are: (1) watersheds are functioning properly; (2) water, nutrients, and energy are cycling properly; (3) water quality meets State standards; and (4) habitat for special status species is protected.

Standards address the health, productivity, and sustainability of the BLM administered public rangelands and represent the minimum acceptable conditions for the public rangelands. The standards apply to all resource uses on public lands. Their application will be determined as use-specific guidelines are developed. Standards are synonymous with goals and are observed on a landscape scale. They describe healthy rangelands rather than important rangeland by-products. The achievement of a standard is determined by measuring appropriate indicators. An indicator is a component of a system whose characteristics (e.g., presence, absence, quantity, and distribution) can be measured based on sound scientific principles.

Quantifiable resource objectives and specific management practices to achieve the standards will be developed at the BLM Field Office level and will consider all reasonable and practical options available to achieve desired results on a watershed or grazing allotment scale. The objectives shall be reflected in site-specific activity or implementation plans as well as in livestock grazing permits/leases for the public lands. Interdisciplinary activity or implementation plans will be used to maintain or achieve the Wyoming standards for healthy rangelands. These plans may be developed formally or informally through mechanisms available and suited to local needs (such as Coordinated Resource Management [CRM] efforts).

The development and implementation of standards will enable on-the-ground management of the public rangelands to maintain a clear and responsible focus on both the health of the land and its dependent natural and human communities. This development and implementation will ensure that any mechanisms currently being employed or that may be developed in the future will maintain a consistent focus on these essential concerns.

These standards are compatible with BLM's three-tiered land use planning process. The first tier includes the laws, regulations, and policies governing BLM's administration and management of the public lands and their uses. The previously mentioned fundamentals of rangeland health specified in 43 CFR 4180.1, the requirement for BLM to develop these state (or regional) standards, and the standards themselves, are part of this first tier. Also part of this first tier are the specific requirements of various federal laws and the objectives of 43 CFR 4100.2 that require BLM to consider the social and economic well-being of the local communities in its management process.

These standards will provide for statewide consistency and guidance in the preparation, amendment, and maintenance of BLM land use plans, which represent the second tier of the planning process. The BLM land use plans provide general allocation decisions concerning the kinds of resource and land uses that can occur on the BLM administered public lands, where they can occur, and the types of conditional requirements under which they can occur. In general, the standards will be the basis for development of planning area-specific management objectives concerning rangeland health and productivity.

The third tier of the BLM planning process, activity or implementation planning, is directed by the applicable land use plan and, therefore, by the standards. The standards, as BLM statewide policy, will also directly guide development of the site-specific objectives and the methods and practices used to implement the land use plan decisions.

Activity or implementation plans contain objectives which describe the site-specific conditions desired. Grazing permits/leases for the public lands contain terms and conditions which describe specific actions required to attain or maintain the desired conditions. Through monitoring and evaluation, the BLM, grazing permittees, and other interested parties determine if progress is being made to achieve activity plan objectives.

Wyoming rangelands support a variety of uses which are of significant economic importance to the state and its communities. These uses include oil and gas production, mining, recreation and tourism, fishing, hunting, wildlife viewing, and livestock grazing. Rangelands also provide amenities which contribute to the quality of life in Wyoming such as open spaces, solitude, and opportunities for personal renewal. Wyoming's rangelands should be managed with consideration of the state's historical, cultural, and social development and in a manner which contributes to a diverse, balanced, competitive, and resilient economy in order to provide opportunity for economic development. Healthy rangelands can best sustain these uses.

To varying degrees, BLM management of the public lands and resources plays a role in the social and economic well-being of Wyoming communities. The National Environmental Policy Act (part of the above-mentioned first planning tier) and various other laws and regulations mandate the BLM to analyze the socioeconomic impacts of actions occurring on public rangelands. These analyses occur during the environmental analysis process of land use planning (second planning tier), where resource allocations are made, and during the environmental analysis process of activity or implementation planning (third planning tier). In many situations, factors that affect the social and economic well-being of local communities extend far beyond the scope of BLM management or individual public land users' responsibilities. In addition, since standards relate primarily to physical and biological features of the landscape, it is very difficult to provide measurable socioeconomic indicators that relate to the health of rangelands. It is important that standards be realistic and within the control of the land manager and users to achieve.

Implementation of the Wyoming standards will generally be done in the following manner. Grazing allotments or groups of allotments in a watershed will be reviewed based on the BLM's current allotment categorization and prioritization process. Allotments with existing management plans and high-priority allotments will be reviewed first. Lower priority allotments will then be reviewed as time allows. The permittees and interested publics will be notified when allotments are scheduled for review and encouraged to participate in the review. The review will first determine if an allotment meets each of the six standards. If it does, no further action will be necessary. If any of the standards are not being met, rationale explaining the contributing factors will be prepared. If livestock grazing practices are found to be among the contributing factors, corrective actions will be developed and implemented. If a lack of data prohibits the reviewers from determining if a standard is being met, a strategy will be developed to acquire the data in a timely manner.

Standard 1

Within the potential of the ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.

THIS MEANS THAT:

The hydrologic cycle will be supported by providing for water capture, storage, and sustained release. Adequate energy flow and nutrient cycling through the system will be achieved as optimal plant growth occurs. Plant communities are highly varied within Wyoming.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Water infiltration rates;
- Soil compaction;
- Erosion (rills, gullies, pedestals, capping);
- Soil microorganisms;
- Vegetative cover (gully bottoms and slopes); and
- Bare ground and litter.

Standard 2

Riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge.

THIS MEANS THAT:

Wyoming has highly varied riparian and wetland systems on public lands. These systems vary from large rivers to small streams and from springs to large wet meadows. These systems are in various stages of natural cycles and may also reflect other disturbance that is either localized or widespread throughout the watershed. Riparian vegetation captures sediments and associated materials, thus enhancing the nutrient cycle by capturing and utilizing nutrients that would otherwise move through a system unused.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Erosion and deposition rate;
- Channel morphology and flood plain function;
- Channel succession and erosion cycle;
- Vegetative cover;

- Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.);
- Bank stability;
- Woody debris and instream cover; and
- Bare ground and litter.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 3

Upland vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance.

THIS MEANS THAT:

In order to maintain desirable conditions and/or recover from disturbance within acceptable timeframes, plant communities must have the components present to support the nutrient cycle and adequate energy flow. Plants depend on nutrients in the soil and energy derived from sunlight. Nutrients stored in the soil are used over and over by plants, animals, and microorganisms. The amount of nutrients available and the speed with which they cycle among plants, animals, and the soil is a fundamental component of rangeland health. The amount, timing, and distribution of energy captured through photosynthesis are fundamental to the function of rangeland ecosystems.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Vegetative cover;
- Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.);
- Bare ground and litter;
- Erosion (rills, gullies, pedestals, capping); and
- Water infiltration rates.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 4

Rangelands are capable of sustaining viable populations and a diversity of native plant and animal species appropriate to the habitat. Habitats that support or could support threatened species, endangered species, species of special concern, or sensitive species will be maintained or enhanced.

THIS MEANS THAT:

The management of Wyoming rangelands will achieve or maintain adequate habitat conditions that support diverse plant and animal species. These may include listed threatened or endangered species (U.S. Fish and Wildlife Service-designated), species of special concern (Wyoming Game and Fish Department-designated), and other sensitive species (BLM-designated). The intent of this standard is to allow the listed species to recover and be delisted, and to avoid or prevent additional species becoming listed.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Noxious weeds;
- Species diversity;
- Age class distribution;
- All indicators associated with the upland and riparian standards;
- Population trends; and
- Habitat fragmentation.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 5

Water quality meets State standards.

THIS MEANS THAT:

The State of Wyoming is authorized to administer the Clean Water Act. BLM management actions or use authorizations will comply with all Federal and State water quality laws, rules, and regulations to address water quality issues that originate on public lands. Provisions for the establishment of water quality standards are included in the Clean Water Act, as amended, and the Wyoming Environmental Quality Act, as amended. Regulations are found in Part 40 of the Code of Federal Regulations and in *Wyoming's Water Quality Rules and Regulations*. The latter regulations contain Quality Standards for Wyoming Surface Waters.

Natural processes and human actions influence the chemical, physical, and biological characteristics of water. Water quality varies from place to place with the seasons, the climate, and the kind of substrate through which water moves. Therefore, the assessment of water quality takes these factors into account.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Chemical characteristics (for example, pH, conductivity, dissolved oxygen);
- Physical characteristics (for example, sediment, temperature, color); and
- Biological characteristics (for example, macro- and micro-invertebrates, fecal coliform, and plant and animal species).

Standard 6

Air quality meets State standards.

THIS MEANS THAT:

The State of Wyoming is authorized to administer the Clean Air Act. BLM management actions or use authorizations will comply with all Federal and State air quality laws, rules, regulations, and standards. Provisions for the establishment of air quality standards are included in the Clean Air Act, as amended, and the Wyoming Environmental Quality Act, as amended. Regulations are found in Part 40 of the Code of Federal Regulations and in *Wyoming Air Quality Standards and Regulations*.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Particulate matter;
- Sulfur dioxide;
- Photochemical oxidants (ozone);
- Volatile organic compounds (hydrocarbons);
- Nitrogen oxides;
- Carbon monoxide;
- Odors; and
- Visibility.

Definitions

Activity Plans: Allotment Management Plans (AMPs), Habitat Management Plans (HMPs), Watershed Management Plans (WMPs), Wild Horse Management Plans (WHMPs), and other plans developed at the local level to address specific concerns and accomplish specific objectives.

Coordinated Resource Management (CRM): A group of people working together to develop common resource goals and resolve natural resource concerns. CRM is a people process that strives for win-win situations through consensus-based decision making.

Desired Plant Community: A plant community which produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the land use plan/activity plan objectives established for an ecological site(s). The desired plant community must be consistent with the site's capability to produce the desired vegetation through management, land treatment, or a combination of the two.

Ecological Site: An area of land with specific physical characteristics that differs from other areas both in its ability to produce distinctive kinds and amounts of vegetation and in its response to management.

Erosion: (v.) Detachment and movement of soil or rock fragments by water, wind, ice, or gravity. (n.) The land surface worn away by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

Indicator: An indicator is a component of a system whose characteristics (for example, presence, absence, quantity, and distribution) can be observed, measured, or monitored based on sound scientific principles. An indicator can be evaluated at a site- or species-specific level. Monitoring of an indicator must be able to show change within timeframes acceptable to management and be capable of showing how the health of the ecosystem is changing in response to specific management actions. Selection of the appropriate indicators to be observed, measured, or monitored in a particular allotment is a critical aspect of early communication among the interests involved on-the-ground. The most useful indicators are those for which change or trend can be easily quantified and for which agreement as to the significance of the indicator is broad based.

Litter: The uppermost layer of organic debris on the soil surface, essentially the freshly fallen or slightly decomposed vegetal material.

Management Actions: Management actions are the specific actions prescribed by the BLM to achieve resource objectives, land use allocations, or other program or multiple use goals.

Objective: An objective is a site-specific statement of a desired rangeland condition. It may contain either or both qualitative elements and quantitative elements. Objectives frequently speak to change. They are the focus of monitoring and evaluation activities at the local level. Monitoring of the indicators would show negative changes or positive changes. Objectives should focus on indicators of greatest interest for the area in question.

Rangeland: Land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs. This includes lands revegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows.

Rangeland Health: The degree to which the integrity of the soil and ecological processes of rangeland ecosystems are sustained.

Riparian: An area of land directly influenced by permanent water. It has visible vegetation or physical characteristics reflective of permanent water influence. Lakeshores and stream banks are typical riparian areas. Excluded are such sites as ephemeral streams or washes that do not have vegetation dependent on free water in the soil.

Standards: Standards are synonymous with goals and are observed on a landscape scale. Standards apply to rangeland health and not to the important by-products of healthy rangelands. Standards relate to the current capability or realistic potential of a specific site to produce these by-products, not to the presence or absence of the products themselves. It is the sustainability of the processes, or rangeland health, that produces these by-products.

Terms and Conditions: Terms and conditions are very specific land use requirements that are made a part of the land use authorization in order to assure maintenance or attainment of the standard. Terms and conditions may incorporate or reference the appropriate portions of activity plans (for example, Allotment Management Plans). In other words, where an activity plan exists that contains objectives focused on meeting the standards, compliance with the plan may be the only term and condition necessary in that allotment.

Upland: Those portions of the landscape which do not receive additional moisture for plant growth from run-off, stream flow, etc. Typically these are hills, ridge tops, valley slopes, and rolling plains.

A.3 SUMMARY TABLE BY SPECIES OF STANDARD STIPULATIONS FOR ALL SURFACE-DISTURBING ACTIVITIES THAT APPLY IN THE JONAH INFILL DRILLING PROJECT AREA

Affected Areas/Species	Restriction	Restricted Dates	Restricted Area
Greater Sage-grouse Leks	No surface occupancy	Year-round	Within 0.25 mile of occupied lek boundary
Greater Sage-grouse Leks	No surface-disturbing activity	March 1–May 15	Within 0.25 mile of occupied lek boundary
Greater Sage-grouse Nesting Habitat	No surface-disturbing activity	March 15–July 15	Up to 2-mile radius of active lek **OR** within suitable nesting habitat
Winter Greater Sage-grouse Habitat	No surface-disturbing activity	Nov. 15–March 14	Within identified winter habitat
Greater Sage-grouse Leks/Strutting Grounds	Surface occupancy or use restricted or prohibited	March 1–May 15 between 8pm and 8am	Within 0.25 mile of lek/strutting ground boundary
Mountain Plover	No surface-disturbing activity (including reclamation activities) until two surveys (done no earlier than 4/20 and 5/4) show no nesting activity; activity must begin within 72 hours after surveys completed	April 10–July 10	Within potential mountain plover habitat
Bald Eagle Nest	No surface occupancy	Year-round	Within 0.5 mile of active nest
Bald Eagle Nest	No surface-disturbing activity	February 1–August 15	Within 1-mile radius
Bald Eagle Winter Use Areas	No surface-disturbing activity; disruptive activities restricted	November 15–April 30	Within 1-mile radius
Ferruginous Hawk Nest	No surface occupancy	Year-round	Within 1,000 feet of active nest
Ferruginous Hawk Nest	No surface-disturbing activity	February 1–July 31	Within 1.0-mile radius
Other Raptors	No surface occupancy	Year-round	Within 825 feet of active nest
Other Raptors	No surface-disturbing activity	February 1–July 31	Within 0.5-mile radius
National Register of Historic Places Cultural Resource Sites	No surface occupancy	Year-round	Within site boundaries
Riparian Areas	No surface occupancy	Year-round	Within 500 feet
HUD-designated Zone A (100-yr flood hazard area) on intermittent watercourses	Surface occupancy or use restricted or prohibited	Year-round	Within Zone A boundaries

A.4 INSTRUCTION MEMORANDUM NO. WY-2004-057, STATEMENT OF POLICY REGARDING SAGE-GROUSE DEFINITIONS AND USE OF PROTECTIVE STIPULATIONS AND CONDITIONS OF APPROVAL

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Wyoming State Office
P.O. Box 1828
Cheyenne, Wyoming 82003-1828

In Reply Refer To:

6500 (930) P

August 16, 2004

Instruction Memorandum No. WY-2004- 057
Expires: 9/30/05

To: Field Managers and Deputy State Directors

From: State Director, Wyoming

Subject: Statement of Policy Regarding Sage-Grouse Management Definitions, and Use of Protective Stipulations, and Conditions of Approval (COAs)

The management of the greater sage-grouse (sage-grouse) and its habitat on western rangelands has become a matter of high public interest in recent years. Since much of the sage-grouse's habitat occurs on Public Lands managed by the Bureau of Land Management (BLM), this species' welfare and management is also of significant concern to our agency. The purpose of this Instruction Memorandum is to provide general guidance and consistency for BLM (Wyoming) Field Offices for the conservation of sage-grouse and their habitats on Public Lands administered by the BLM in Wyoming.

BASIC SAGE-GROUSE HABITAT COMPONENTS AND TERMINOLOGY

To effectively manage for sage-grouse and their habitat it is necessary to have a basic, common, understanding of general sage-grouse biology and their habitat needs.

The following seasonal use periods and habitat components have been identified as important to sage-grouse and contribute to their productivity and conservation. The policy described herein relies heavily on these sage-grouse habitat components and definitions. Breeding and wintering habitats have been identified as limiting factors in sage-grouse populations across their range.

BREEDING HABITATS – Breeding habitats are composed of leks, nesting and early broad rearing habitats.

Leks - A lek (also known as a strutting, or breeding ground) is a traditional courtship display area attended by male sage-grouse in, or adjacent to, sagebrush dominated habitat, and is the location where breeding of females occurs. The lek is typically an open area surrounded by potential nesting habitat. The common feature is that leks have less shrub and herbaceous cover than surrounding habitats. The sagebrush cover that surrounds the lek provides important hiding cover from predators for both the male sage-grouse and particularly the hen while attending the lek. Sagebrush cover immediately adjacent to the lek may, or may not, meet the following definition of productive, high quality, nesting habitat. The currently accepted Wyoming lek definitions can be found in Attachment 1.

Nesting/Early Brood-Rearing Habitat - Nesting habitat for sage-grouse in Wyoming is generally described as sagebrush that has canopy cover between 15 and 30 percent and heights between 11 and 32 inches. Herbaceous plant height (6 inches or greater) and canopy cover (>15 percent) provide important cover and food for sage-grouse using these habitats. Early brood-rearing habitat generally has 10 to 25 percent sagebrush canopy cover and has slightly higher canopy cover of grasses and forbs than nesting habitat. Early brood-rearing habitat is generally used by sage-grouse hens with chicks when chicks range in age from 1 to 21 days of age.

WINTER HABITATS – During winter, sage-grouse feed almost exclusively on sagebrush leaves and buds. Suitable winter habitat requires sagebrush above snow. Sage-grouse tend to select wintering sites where sagebrush is 10-14 inches above the snow. Sagebrush canopy cover utilized by sage-grouse above the snow may range from 10 to 30 percent. Foraging areas tend to be on flat to generally southwest facing slopes and windswept ridges.

BACKGROUND

Sage-grouse were once abundant and widespread throughout western North America and are highly dependant upon sagebrush habitats. These populations have decreased significantly range wide, including in Wyoming, during the past 40 years. Land use or habitat management decisions made by BLM directly influence the future of sage-grouse.

Sage-grouse are considered a high priority management species for the Wyoming Game and Fish Department (WGFD) in Wyoming. They are also listed as a sensitive species by BLM (Wyoming). The intent of the BLM (Wyoming) sensitive species designation is to ensure that actions on BLM administered lands consider the welfare of these species and do not contribute to the need to list any sensitive species under the provisions of the Endangered Species Act. This includes avoiding or minimizing adverse impacts and maximizing potential benefits to the species. During the past 5 years, seven petitions have been submitted to the U.S. Fish and Wildlife Service to list sage-grouse as threatened or endangered.

In 1976, the Western Association of Fish and Wildlife Agencies (WAFWA) directed the Sage-Grouse Working Group of this association to establish guidelines for vegetation manipulation of sage-grouse habitat throughout the sage-grouse's range. One of the guidelines promulgated by the group identified the need to protect nesting habitat within 2 miles (3.2 km) of a lek. This assumption was based on studies that indicated between 59 and 87 percent of sage-grouse nests were located within 2 miles (3.2 km) of a lek. These studies were conducted in Montana and Idaho. These guidelines also identified that some sage-grouse nested further than 2 miles from the lek.

Following the development of the 1977 WAFWA Sage Grouse Working Group sage-grouse guidelines, BLM (Wyoming) originally identified a 2-mile radius circle as a flagging device to identify potential sage-grouse nesting habitat that may be impacted by surface disturbance and disruptive activities occurring on public land. This flagging device resulted in the placement of stipulations on oil and gas leases or became part of the COAs of a permit, plan of development, and/or other use authorization that occurred on public lands administered by the BLM in Wyoming. These same use restrictions eventually were incorporated into Land Use Plans (LUPs). This procedure was standardized and directed in BLM (Wyoming) with the adoption of the "*Wyoming BLM Mitigation Guidelines for Surface-Disturbing and Disruptive Activities*" through the development and maintenance of LUPs since 1990. The BLM (Wyoming) mitigation guidelines also allow for other mitigation to be applied for sage-grouse and other species following a site-specific NEPA analysis, if found appropriate.

BLM Field Offices have normally utilized No Surface Occupancy (NSO), Controlled Surface Use (CSU), and Timing Limitation (TLS) lease stipulations, or COAs on specific actions to protect sage-grouse and their habitat within ¼ mile of leks for above ground facilities such as power lines, oil and gas wells, storage tanks, fences, etc. Some disturbances such as low-traffic roads, pipelines, seismic activity, etc., may have been granted exceptions, depending upon site-specific characteristics and type of activity.

Since its inception, many BLM Field Offices in Wyoming have applied conditions of approval to the permit, plan of development, and/or other use authorization for sage-grouse nesting habitat only within the 2-mile radius circle of a lek, regardless of the suitability of nesting habitat both within and outside of that circle. This has usually occurred due to lack of adequate knowledge of sage-grouse nesting habitat requirements, or simply lack of time or manpower to gather onsite information.

Some BLM Field Offices have utilized CSU and TLS lease stipulations or COAs for the protection of winter habitats.

In 1998, the Wyoming Audubon and another individual appealed to the Interior Board of Land Appeals (IBLA) contesting the BLM's use of the ¼ mile NSO or no surface disturbance restrictions for protection of sage-grouse leks. The administrative law judge ruled affirming the BLM's use of the ¼ mile restrictions in the absence of any better compelling science which would warrant other protective measures.

Studies since 1977 indicate that many populations of sage-grouse contained birds nesting much further than 2 miles from the lek of breeding. Studies conducted in Wyoming since 1994 indicate 52 percent of sage-grouse hens nest within 2 miles (3.2 km) of the lek, 67 percent nest within 3 miles (4.8 km), and 78 percent of nests are located within 4 miles (6.4 km) of the lek. Nests are placed independent of lek location, and nest location is based on availability of suitable nesting habitat.

Based on this more recent information, the sage-grouse population and habitat management guidelines were reexamined and revised by the WAFWA in the late 1990s. The newly revised *Guidelines for Management of Sage-grouse Populations and Habitats* (Connelly et al. 2000) also identify the need to determine if sage-grouse populations are migratory or non-migratory in nature. These guidelines also recommend the need to determine if suitable nesting habitat is generally distributed uniformly or irregularly around the lek. As habitats become distributed less uniformly around the lek, sage-grouse hens travel greater distances from the lek to locate nests within suitable nesting habitat. In the event of migratory populations, sage-grouse hens may nest up to 12 to15 miles (18 to 25 km) from the lek.

STATEMENT OF POLICY

Based on the last 4 decades of research, management experience, and legal outcomes and trends, it has become necessary for BLM (Wyoming) to establish some consistent policy and management direction for sage-grouse management on BLM administered Public Lands in the state. For this reason, the following policy is now presented:

1.) Identification and refined mapping of sagebrush ecosystems and sage-grouse seasonal habitats are a high priority for Field Offices to complete. Coordination with the WGFD is critical in the identification of seasonal habitats.

2.) Coordination with WGFD biologists shall be utilized to determine if sage-grouse populations are migratory or non-migratory.

3.) The definitions found in Attachment 1 are adopted by BLM Wyoming to standardize terminology associated with sage-grouse leks in Wyoming. These definitions have also been adopted by the WGFD and should result in improved consistency and communication between the two agencies.

4.) Field Offices shall incorporate recommended management practices from the Wyoming Greater Sage-Grouse Conservation Plan, as appropriate into their LUPs. LUPs should also address the outcome of future local sage-grouse working group plans that are expected to commence this year, to the extent possible. LUPs will develop objectives for maintenance and improvement of sage-grouse habitats and habitats for other BLM (Wyoming) sensitive species. These objectives and associated management practices will be designed to limit loss, degradation, and fragmentation of habitats. Monitoring of sage-grouse habitats and effectiveness of habitat conservation measures will also be addressed in LUPs.

5.) Field offices will continue to utilize the "NSO", "CSU", and "TLS" lease stipulations, where appropriate, as identified in the *Wyoming BLM Mitigation Guidelines for Surface-Disturbing and Disruptive Activities*.

6.) The following distances, and timeframes will hereafter be utilized in all new land use and activity plan development (including revisions), and other resource management implementation actions (authorizations and projects) that involve activities that may impact sage-grouse or their habitats on BLM administered Public Lands in Wyoming. These distances and timeframes are based on current information, and may be subject to change in the future based upon new information.

> **Sage-grouse leks:** 1) Avoid surface disturbance or occupancy within ¼ mile of the perimeter of occupied sage-grouse leks. 2) Avoid human activity between 8 p.m. and 8 a.m. from March 1 – May 15 within ¼ mile of the perimeter of occupied sage-grouse leks.
>
> **Sage-grouse nesting/early brood-rearing habitat:** Avoid surface disturbing and disruptive activities in suitable sage-grouse nesting and early brood-rearing habitat within two miles of an occupied lek, or in identified sage-grouse nesting and early brood-rearing habitat outside the 2-mile buffer from March 15 – July 15.
>
> **Sage-grouse winter habitat:** Avoid disturbance and disruptive activities in sage-grouse winter habitat from November 15 – March 14.

Disruptive activities will include, but not be limited to, the following examples: resource surveys that require that personnel be in nesting habitats for longer than 1 hour (e.g., excavation of cultural sites, land surveys, project construction, geophysical activities, permitted or organized recreational activities, prescribed fires, noise, etc.). Field Offices should determine if these guidelines apply to future maintenance and operation of facilities and clearly address maintenance and operation in their LUPs.

Exceptions to control surface use and timing restrictions will continue to be considered on a case-by-case basis. Exception criteria will be established and included in new LUPs and revisions.

7.) BLM (Wyoming) offices will continue to utilize the 2-mile radius circle as a flagging device for applying stipulations or COAs to all disturbance and disruptive activities, where appropriate. Not all sagebrush habitats within this 2-mile radius circle may be suitable as nesting habitat or other seasonal habitats for sage-grouse. Biologists and resource specialists should make management recommendations on sage-grouse habitat characteristics both inside and outside the 2-mile radius circle that involves these seasonal habitats. Upon identification and mapping of nesting habitat, Field Offices will apply appropriate stipulations or conditions of approval for these habitats beyond the 2-mile radius. Site specific evaluations will be conducted. Field Offices will strive to delineate these seasonal habitats regardless of distances from leks. Upon completion of site specific evaluations of projects affecting nesting and early brood-rearing habitats beyond 2 miles from leks, biologists and other resource specialists shall identify and recommend protective and conservation measures for sage-grouse populations and their habitat. These protective and conservation measures may include timing restrictions and reduction, relocation, or elimination of disturbances. These types of protective measures will also be considered for winter habitats.

8.) Biologists and other resource specialists will also work with the project proponents (including those within BLM) to relocate site-specific activities that may be detrimental to leks, nesting/early brood-rearing and winter habitats. These activities should be located to less sensitive habitats wherever necessary and possible. It should be noted that in some circumstances a project may not be re-locatable due to the uniformity of the habitat. In these situations the project should be located in the least sensitive habitat as possible.

9.) Other mitigation/conservation measures should be developed, if appropriate. This effort should be accomplished in conjunction with the WGFD. These measures should be developed to protect, conserve, improve, or mitigate impacts to productive sage-grouse habitat.

10.) All recommendations/mitigation/conservation measures will be analyzed in a site-specific NEPA document, and be incorporated, as appropriate, into conditions of approval of the permit, plan of development, and/or other use authorizations including distances and timeframes identified in item number 6 above for all resource authorizations and actions.

11.) Rehabilitation of surface disturbance activities in nesting/early brood-rearing habitats and winter habitats will include sagebrush (including locally adapted species and subspecies) for rehabilitation activities. Field Offices will include a minimum of one to two species of appropriate forb species in seed mixtures for nesting and early brood-rearing habitats. Appropriate amounts and species will be determined by site potential.

If you have questions concerning this issue or this memorandum, please contact Tom Rinkes of at (307) 332-8404.

Literature Cited: Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28:1-19.

1 Attachment:
1 – Sage-Grouse Lek Definitions (2 pp.)

Distribution

Director (230), Room 204, LS	1 (w/o atch.)
CF	2 (w/atch.)

Sage-Grouse Lek Definitions

Lek. A traditional courtship display area attended by male sage-grouse in or adjacent to sagebrush dominated habitat. Designation of the site as a lek requires observation of two or more male sage-grouse engaged in courtship displays. In addition new leks must be confirmed by a survey conducted during the appropriate time of day and during the strutting season. Observation of sign of strutting activity can also be used to confirm a suspected lek.

Lek Complex. A group of leks in close proximity between which male sage-grouse may be expected to interchange from one day to the next. A specific distance criteria does not yet exist.

Lek Count. A census technique that documents the actual number of male sage-grouse observed on a particular lek or complex of leks using the methods described below.

Lek Survey. A monitoring technique designed primarily to determine whether leks are active or inactive and obtaining accurate counts of the numbers of males attending is secondary.

Annual status – Each year a lek will be determined to be in one of the following status categories:

Active. Any lek that has been attended by male sage-grouse during the strutting season. Presence can be documented by observation of birds using the site or by signs of strutting activity.

Inactive. Leks where it is known that there was no strutting activity through the course of a strutting season. A single visit, or even several visits, without strutting grouse being seen is not adequate documentation to designate a lek as inactive. This designation requires either an absence of birds on the lek during multiple ground visits under ideal conditions throughout the strutting season or a ground check of the exact lek site late in the strutting season that fails to find any sign (droppings/feathers) of strutting activity.

Unknown. Leks that have not been documented either active or inactive during the course of a strutting season.

Based on annual status a lek may be put into one of the following categories for management purposes:

Occupied Lek. A lek that has been active during at least one strutting season within the last 10 years. Management protection will be afforded to occupied leks.

Unoccupied Lek. (Formerly termed "historical lek"). There are two types of unoccupied leks, "destroyed" or "abandoned". Management protection will not be afforded to unoccupied leks.

Destroyed lek: A formerly active lek site and surrounding sagebrush habitat that has been destroyed and no longer capable of supporting sage-grouse breeding activity. A lek site that has been strip-mined, paved, converted to cropland or undergone other long-term habitat type conversion is considered destroyed. Destroyed leks do not require monitoring unless the site is reclaimed to suitable sage-grouse habitat.

Abandoned lek: A lek in otherwise suitable habitat that has not been active during a consecutive ten-year period. Before a lek is designated "abandoned" it must be confirmed as "inactive" (see above criteria) in at least four non-consecutive strutting seasons spanning the 10 years. Once designated "abandoned," the site should be surveyed at least once every 10 years to determine whether or not the lek has been reoccupied.

Undetermined Lek. Any lek that has not been documented as being active in the last 10 years but does not have sufficient documentation to be designated unoccupied. Management protection will be afforded to undetermined leks until their status has been documented as unoccupied.

A.5 NATIONAL SAGE-GROUSE HABITATION CONSERVATION STRATEGY

Bureau of Land Management
National Sage-Grouse Habitat Conservation Strategy

U.S. Department of the Interior

November 2004

Bureau of Land Management

National Sage-Grouse Habitat Conservation Strategy

Table of Contents

I. Introduction

BLM developed this National Sage-grouse Habitat Conservation Strategy (National Sage-grouse Strategy) to guide future actions for conserving sage-grouse and associated sagebrush habitats and to enhance BLM's ongoing conservation efforts. The National Sage-grouse Strategy provides a framework for future conservation efforts by setting out broad goals and specific actions to meet the goals. For each action that BLM will take, the National Sage-grouse Strategy explains what the action is, when the action will be taken and who will be the responsible official or office for completing the action. Integral to the National Sage-grouse Strategy are various guidance documents that will help BLM ensure that it successfully incorporates sage-grouse conservation measures into all of its ongoing programs and activities, including land use planning, grazing and mineral leasing, and other programs.

BLM designed this National Sage-grouse Strategy around four main goals. Associated with each goal are specific strategies and actions that BLM will undertake to meet the goal. The four goals are:

1) Improve the effectiveness of the management framework for addressing conservation needs of sage-grouse on lands administered by the BLM.

2) Increase understanding of resource conditions in order to prioritize habitat maintenance and restoration.

3) Expand partnerships, available research and information that support effective management of sage-grouse habitat.

4) Ensure leadership and resources are adequate to continue ongoing conservation efforts and implement national and state-level sage-grouse habitat conservation strategies and/or plans.

BLM is not a newcomer to sage-grouse conservation. As the land manager of almost half of the remaining sagebrush habitat, BLM plays a key role in conserving sage-grouse and sagebrush habitat. BLM has been taking actions for years on its own and as an active partner in state and local led efforts that have benefited the species and associated habitats. For example, in July 2000, BLM signed a Memorandum of Understanding (MOU) with the Western Association of Fish and Wildlife Agencies (WAFWA), the U.S. Forest Service (FS), and the U.S. Fish and Wildlife Service (FWS) that provided for state and local cooperation to coordinate planning, habitat and population mapping, and evaluation and restoration of sage-grouse populations. However, conservation of sage-grouse habitat is complex. Effective conservation strategies must occur at a variety of scales, with a variety of partners (state, local and tribal governments), and be integrated into the daily activities of the BLM land management mission. Conservation of sage-grouse requires national level policy, national and local program commitment, and local and regional knowledge and support.

Sections I through IV contain background information about sage-grouse population and life history, habitat requirements, and threats or risks potentially affecting the species. The information comes from a large body of published scientific literature, which is provided in Section IX. Sections V through VII detail the guiding principles, goals, strategies, and actions that provide the fundamental themes and guidance for preparing and implementing national and state-level strategies. Additional information on progress reporting and a list of major authorities used by the BLM in carrying out conservation efforts are provided in Sections VIII-IX.

II. Purpose

The purpose of this comprehensive National Sage-grouse Strategy is to set goals and objectives, assemble guidance and resource materials, and provide a comprehensive management direction for the BLM's contributions to the on-going multi-state sage-grouse conservation effort in cooperation with the WAFWA.

The Federal Land Policy and Management Act (1976) (FLPMA) provides the basic authority for BLM's multiple use management of all resources on the public lands. One of the BLM's many responsibilities under FLPMA is to manage public lands for the benefit of wildlife species and the ecosystems upon which they depend. However, habitat management is one of many provisions of the multiple-use mandate outlined in FLPMA. Because conserving sagebrush habitats involves managing many other public land uses, this National Sage-grouse Strategy includes guidance and existing regulations for a variety of BLM-administered programs. FLPMA gave BLM the legal authority and mandate to manage and regulate the uses on the public lands "so that their various resource values are utilized in a combination that will best meet the present and future needs of the American people" (Section 103 (c)). Consistency and coordination in identifying and addressing threats to sage-grouse and sagebrush habitat in context of the multitude of programs that BLM manages is required. Addressing these threats throughout the range of the sage-grouse is critical to achieving the mandate of FLPMA and threat reduction, mitigation, and elimination to sage-grouse and sagebrush habitats.

In July 2000, WAFWA, FS, FWS and BLM signed an MOU that provides for Federal, state and local cooperation to coordinate planning, habitat and population mapping, and evaluation and restoration of sage-grouse populations. In July 2002, WAFWA agreed to develop a Conservation Assessment (CA) for sage-grouse and sage-grouse habitat to be completed in two distinct phases. Phase 1 is a range-wide assessment of sage-grouse populations and habitat status, trends and threats across eleven Western states. It was completed in June 2004. Phase 2, a range-wide implementation plan, will outline specific actions for the conservation of sage-grouse and sage-grouse habitats. Phase 2 is scheduled for completion in mid to late 2005.

As an active partner in Federal, state and local sage-grouse conservation planning efforts and as the primary Federal manager of sage-grouse habitat, the BLM is in a key position to contribute to sage-grouse habitat conservation from the range-wide geographic scale to the local level. This National Sage-grouse Strategy will strengthen Federal, state and local efforts by addressing habitat needs and trends on the BLM–managed lands and by ensuring that sage-grouse habitat needs are addressed in BLM land use plans and through actions carried out at the site specific level. Implementation of BLM's National Sage-grouse Strategy and the state-level Sage-grouse Habitat Conservation Strategies will complement and expand the ongoing efforts to conserve sagebrush ecosystems on public lands administered by the BLM for the benefit of sage-grouse and other wildlife species.

III. Other Sage-Grouse Related Programs, Initiatives and Efforts

BLM program actions described in this National Sage-grouse Strategy focus on achieving coordinated conservation efforts on BLM-administered public land and are consistent with and support the following on-going efforts:

1) Conservation Planning Framework Team: The 2000 MOU between BLM, FWS, FS and WAFWA established a Conservation Planning Framework Team consisting of four (4) representatives from WAFWA member agencies (U.S. only) and one (1) each from BLM, FS, and FWS. The Team is responsible for developing the range-wide conservation planning framework, making recommendations and providing guidance to working groups on the contents of state and local conservation plans.

2) Nevada Ad Hoc Working Group: In 1999, the BLM, FS, FWS, and the Nevada Department of Wildlife formed an ad hoc working group to coordinate the development of planning tools and other resources to facilitate conservation of species of concern throughout the sagebrush biome.

   The working group adopted a regional, multi-scale approach to conservation and restoration in the sagebrush biome in an attempt to manage overall efforts more effectively. Prototype processes and projects of regional importance are being developed or planned for the Great Basin, Columbia Plateau, Wyoming Basin, Northern Great Plains, and the Utah/Colorado Plateau. This approach will provide better information about sage-grouse and sagebrush habitats and improve conservation planning by prioritizing areas where conservation activities are most likely to be successful using existing and projected resources.

3) SageMap: Regional Science Based Assessments: As a result of the ad-hoc working group's efforts, in 2002 the BLM, in cooperation with the FS, Pacific Northwest Research Station, and the U.S. Geological Survey (USGS), Biological Resources Division, Snake River Field Station (SRFS), developed science-based procedures that use existing information to conduct regional sagebrush habitat assessments for species of concern. The procedures are made available to the public through the USGS SageMap website and were used to develop the prototype Great Basin assessment. Information from that assessment is being used in support of sage-grouse conservation planning and the Great Basin Restoration Initiative (GBRI). These procedures are also being used to conduct or support prototype assessments in the Wyoming Basin.

4) SageMap Query and Data Analysis Modeling: The SageMap project, conducted by SRFS, is identifying and collecting spatial data layers needed to research and manage sage-grouse and shrubsteppe systems. The data sets, which can be queried, viewed, and downloaded from an FTP site, are important for understanding and managing shrubsteppe lands and associated wildlife. SageMap was created to share and disseminate information on sagebrush management, especially among resource managers and researchers interested in available literature and data from research within the sagebrush biome. SageMap contains over 3,000 data sets and currently is the most comprehensive source of spatial data related to sagebrush and associated studies in North America.

5) Great Basin Restoration Initiative: The GBRI was initiated by BLM in response to widespread habitat losses in the Great Basin from wildfires and other causes. Concern over the loss of habitats for sage-grouse and other sagebrush-dependent species was a significant and important factor in how GBRI evolved.

6) Plant Conservation Alliance: The Plant Conservation Alliance (PCA) is a public/private partnership among 10 Federal agencies and more than 200 non-Federal cooperators. In accord with Congressional direction, the PCA (through BLM) is leading an interagency native-plant material-development program for use in restoration and rehabilitation efforts on Federal lands. Funds have been provided for development of appropriate native plant materials within sagebrush ecosystems. This is critical to the development of seed sources for restoring native plant communities within sagebrush ecosystems.

7) Supportive BLM Programs: Numerous BLM programs, plans or initiatives provide additional guidance and resources to conserve and/or restore sagebrush and sage-grouse habitats as described in this National Sage-grouse Strategy. These include:

- Department of the Interior (DOI) and BLM Strategic Plans
- 95 BLM Land Use Plans covering the current occupied range of sage-grouse
- Healthy Forests Initiative
- BLM Special Status Species – Manual 6840
- BLM 1601 Handbook Appendix C – *Land Use Planning, Special Status Species*
- National Fire Plan – 10-year Implementation Plan
- BLM Standards for Rangeland Health Handbook (H-4180-1)

IV. Overview of Sage-Grouse; Population and Life History and Threats to Sage-Grouse Habitat

Sage-grouse historically inhabited much of the sagebrush-dominated ecosystems of North America. Today, sage-grouse population abundance and extent have declined throughout most of their historical range. Population dynamics of sage-grouse are marked by strong cyclic behavior; however, in the last 30 years, the peak in the cycle of bird numbers has declined. Adult survival is high but is offset by low juvenile survival, resulting in low productivity. Habitat requirements for sage-grouse vary greatly depending on the season and life-history stage. Key habitat components include adequate canopy cover of tall grasses and medium height shrubs for nesting, abundant forbs and insects for brood rearing, and availability of herbaceous riparian species for late growing-season foraging.

No single factor can be identified as the cause of declines in sage-grouse populations. Since settlement of the West began, numerous activities have adversely affected the number of birds and the amount, distribution, and quality of sagebrush habitats. Historically, sagebrush-dominated vegetation was one of the most widespread habitats in the country. However, the majority of sagebrush ecosystems were lost or altered in some way by human activities and naturally occurring events. Some examples are large-scale conversions to cultivated croplands or pastures, altered fire frequencies resulting in conifer invasion at higher elevations and annual grass invasion at lower elevations, livestock grazing, herbicide use, mineral and energy development, and recreational activities related to urban growth and increased human populations. In many cases, the extent and significance of these effects or how sage-grouse populations will respond over time to cumulative effects caused by historical uses coupled with new activities is still unknown. Currently, the risk to sage-grouse comes from multiple sources across multiple scales. Thus, the BLM National Sage-grouse Strategy is comprehensive in its approach and address the risk to sage-grouse and habitat at appropriate scales.

A more detailed treatment of life history, threats and risks to sage-grouse is contained in the *Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats* (Connelly, et al.

2004) produced by WAFWA and available at http://sagemap.wr.usgs.gov/.

V. Guiding Principles

The National Sage-grouse Strategy is the framework for conserving and managing sage-grouse habitats on lands administered by the BLM. In addition, this National Sage-grouse Strategy serves as the umbrella for BLM state-level strategies, which have been or are being developed in cooperation with state wildlife agencies and partners.

The following principles are the foundation of the National Sage-grouse Strategy.

- Cooperative Integrated Approach: The BLM recognizes the states' role in sage-grouse conservation planning as described in the 2000 MOU. The BLM National Sage-grouse Strategy complements state-led sage-grouse conservation planning efforts and provides consistent guidance for integration of range-wide, state and local-level conservation actions into existing BLM programs. This cooperation and coordination will ensure appropriate actions are identified at the appropriate scale for conserving sage-grouse and sagebrush habitat.

- BLM's Roles as the Key Federal Sagebrush Habitat Manager: Approximately half of the remaining sage-grouse habitat is under BLM jurisdiction and management; therefore, BLM land plays a significant role in the conservation of sage-grouse and other sagebrush-dependent wildlife species.

- Best Available Science: The BLM will use the best available science and other relevant information to develop conservation efforts for sage-grouse and sagebrush habitats.

- Comprehensive Strategy: Planned actions carried out under this National Sage-grouse Strategy will be fully consistent with laws, regulations, and policies.

- Interdisciplinary Integrated Approach: The use of interdisciplinary teams and specific analysis at the local and regional levels are key to the success of sage-grouse and sagebrush conservation.

- National Goals, Local Solutions: This National Sage-grouse Strategy contains clearly defined goals and measurable tasks. BLM land use plans will be an essential component in implementing local solutions and sage-grouse and sagebrush conservation. These plans will use science and information at the local and state level with input from agency partners, scientists and other planning participants to develop appropriate solutions at the appropriate scale.

- Strategic Implementation: Development and implementation of this National Sage-grouse Strategy is consistent with, and supports implementation of the Department of the Interior (DOI) Strategic Plans Resource Protection mission under the pillars of partnerships and management.

- Land Use Plan Based: BLM land use plans and associated implementation plans are the principal mechanisms for making decisions and conducting on the ground actions to conserve and restore sage-grouse habitats for lands administered by the BLM. Land use plans will be updated and amended when and where appropriate, to adequately address sage-grouse and sagebrush conservation needs through full public participation.

- Rangeland Health Program Based: BLM Standards for Rangeland Health are the primary tool for evaluating the condition of sage-grouse and sagebrush habitats. BLM Resource Advisory Councils (RACs) will be consulted as additional program guidelines are developed.

- Cooperative Conservation: Communication, cooperation, and consultation among state and Federal agencies, tribes, stakeholders, BLM RAC's within states, and the conservation community are essential for achieving successful conservation results. Partnerships both inside and outside the BLM will be fostered at every opportunity and every organizational level.

- Supportive to Current Initiatives: The BLM will capitalize on existing national or regional initiatives, such as the GBRI, Seeds of Success, Partnership Against Weeds, and the Plant Conservation Alliance, that benefit sage-grouse and sagebrush habitat.

- Open Collaborative Approach: The BLM will collaborate and share, as appropriate and authorized all information that is pertinent and useful in conserving sage-grouse and sage-grouse habitat.

- Adaptive: The Bureau is committed to sage-grouse and sagebrush conservation and will continue to adjust and adapt our National Sage-grouse Strategy as new information, science and monitoring results evaluate effectiveness over time.

- Implementation Commitment: Successful implementation of this National Sage-grouse Strategy requires a long-term commitment from BLM managers and staff across all programs and at every level of the organization.

VI. Vision, Goals, Strategies, and Actions

Vision: Manage BLM-administered public land to maintain, enhance and restore sagebrush habitats while ensuring multiple use and sustained yield goals of FLPMA.

The following table identifies the Goals, Strategies, Actions, Responsible Party, and Deadline for each Action.

Goal 1: Set forth the management framework for addressing conservation of sage-grouse on lands administered by the BLM.

Strategy 1.1: Provide needed coordinated policies and program direction at the National and the BLM State and Field Office levels.

Actions	Responsibilities	Deadline
1.1.1 Issue direction on completion of state-level strategies and BLM plans.	Director, WO-230 (Lead), WO-210 (Co-lead)	November 2004
1.1.2 Complete BLM coordination on State agency led strategies and/or plans.	State Directors	Ongoing, with final state submissions July 2005.
1.1.3 Issue off-site habitat mitigation policy. Identify limitations and opportunities for funding and implementation across programs.	WO-300 (Lead); WO-200 (Co-lead)	March 2005
1.1.4 Develop a resource guide to enhance partnership involvement in sage-grouse conservation efforts.	Director, WO-200, WO-300, WO-800	October 2004, Completed
1.1.5 Revise or develop fire management plans for each state to include sage-grouse habitat management guidance.	State Directors	October 2004
1.1.6 Report to the Director on progress towards implementation of this strategy.	WO-200 (Lead) (National Sage-grouse Strategy) State Directors (State-level strategies)	September 1, 2005, 2006, 2007

Strategy 1.2: Establish and maintain a data base to describe and track conservation efforts in sagebrush habitats.

Actions	Responsibilities	Deadline
1.2.1 Gather initial information on conservation effort from all states with current sage-grouse populations.	WO-200 (Lead), WO-300, WO-880	July 2004, Completed
1.2.2 Support the information gathered with a data base that allows assemblage across state lines and queries.	WO-200 (Lead), WO-300, WO-880, NSTC	July 2004, Completed
1.2.3 Expand the data base to include sagebrush habitat in states without current sage-grouse populations.	WO-880 (Lead), WO-200, WO-300	December 2005

Strategy 1.3: Provide guidance to ensure integration of sage-grouse habitat conservation measures for actions provided through the management in land use planning process.

Actions	Responsibilities	Deadline
1.3.1 Issue guidance to ensure land use plans and plan amendments adequately address sage-grouse habitat conservation needs.	Director, WO-200 (Lead)	October 2004, Completed
1.3.2 Develop standard terminology for sage-grouse habitats (e.g., stronghold areas, breeding, etc.) for consistent future use.	WO-200 (Lead), NSTC	January 2005
1.3.3 Complete preparation of Southeast Oregon RMP case history for applying multi-scale information.	WO-230 (Lead), DSDs, NSTC	March 2005
1.3.4 Develop a process and schedule to update deficient land use plans to address sage-grouse needs.	State Directors, WO-210	April 2005
1.3.5 Develop process for use of broad-, mid- and fine-scale assessments in land use planning efforts and incorporate into planning guidance.	WO-200 (Lead), NSTC	October 2005

Strategy 1.4: Issue mandatory guidance on management of sagebrush habitat for sage-grouse conservation.

Actions	Responsibilities	Deadline
1.4.1 Develop and issue "Guidance for the Management of Sagebrush Plant Communities for Sage-Grouse Conservation." National guidance must be adaptable to local variability provided sage-grouse conservation goals are maintained or enhanced by the local adaptations.	Director, WO-230 (lead)	October 2004, Completed
1.4.2 Develop additional management guidance as needed, to address specific future conservation needs.	WO-200 (Lead) and Fire	Ongoing
1.4.3 Develop and issue livestock grazing BMPs to restore, maintain or enhance the quality of sage-grouse and sagebrush habitat.	WO-220 (Lead), WO-200	December 2004
1.4.4 Develop and issue BMPs for oil and gas development.	WO-300 (Lead), WO-200	June 2004, Completed, WO-2004-194

Goal 2: Enhance knowledge of resource conditions and priorities in order to support habitat maintenance and restoration efforts.

Strategy 2.1: Complete and maintain eco-regional assessments of sagebrush and sage-grouse habitats across the sagebrush biome.

Actions	Responsibilities	Deadline
2.1.1 Develop national spatial data sets for multi-scale assessments.	WO-200 (Lead),WO-300, State Directors, NSTC	September 2006
2.1.2 Complete ecoregional assessments of the Wyoming Basin, Northern Great Plains, Colorado Plateau, and complete habitat connectivity analysis.	NSTC (Lead), WO-230, State Directors	September 2006 November 2006 for connectivity analysis
2.1.3 Update ecoregional assessments for the Columbia Basin and Great Basin.	WO-230 (Lead), State Directors	September 2008
2.1.4 Complete state-level mapping of sage-grouse/sagebrush habitats and disturbance regimes.	State Directors (Lead), NSTC	May 2004, Completed
2.1.5 Participate in preparation of the WAFWA range-wide sage-grouse conservation assessment phase I and phase II.	WO-230 (Lead), State Directors	June 2004, phase I completed Phase II, 2005

Strategy 2.2: Provide a consistent and scientifically based approach for collection and use of monitoring data for sagebrush habitats, sage-grouse and other components of the sagebrush community.

Actions	Responsibilities	Deadline
2.2.1 Develop, cooperatively with our partners, appropriate monitoring strategies and protocols at the appropriate scale for sage-grouse habitat in conjunction with the development of the range-wide conservation action plan.	WO-200 (Lead)	August 2005
2.2.2 Develop, cooperatively with our partners, a sage-grouse habitat assessment methodology in conjunction with development of the range-wide conservation action plan.	WO-200	November 2005

Actions	Responsibilities	Deadline
2.2.3 Incorporate the sage-grouse habitat assessment framework into the land health assessment process for evaluating indicators of healthy rangelands.	WO-200	December 2006
2.2.4 In conjunction with the development of the range-wide conservation action plan, issue guidance for collecting fine-scale monitoring and assessment information and incorporating requirements into implementation projects and plans.	WO-200 (Lead), NSTC	April 2005

Strategy 2.3: Identify, prioritize and facilitate needed research to develop relevant information for sage-grouse and sagebrush habitat conservation in coordination with WAFWA.

Actions	Responsibilities	Deadline
2.3.1 In cooperation with partners, establish an national interagency, interdisciplinary technical team to: • receive research questions from local and regional managers and working groups; • sort priority information needs and identify sources of research information (e.g. West Nile virus); and • serve as clearinghouse for research funding proposals.	WO-200	July 2005

Goal 3: **Expand partnerships, available research, and information that support effective management of sage-grouse and sagebrush habitats.**

Strategy 3.1: **Maintain, develop and expand partnerships to promote cooperation and support for all activities associated with sage-grouse and sagebrush conservation.**

Actions	Responsibilities	Deadline
3.1.1 Participate in the local, regional and national conservation efforts established under the agreement with Western Association of Fish and Wildlife Agencies.	State Directors; WO-200	Ongoing
3.1.2 Expand partnerships at all levels to support development and implementation of the National Sage-grouse Strategy.	Director, State Directors, Field Managers	Ongoing
3.1.3 Maintain and expand state and local partnerships to implement the tasks outlined in the cooperatively developed state-level strategies and/or plans.	State Directors, Field Managers	Ongoing

Strategy 3.2: **Effectively communicate throughout BLM and with current and prospective partners on steps BLM will take to conserve sage-grouse and sage-grouse and sagebrush habitats.**

Actions	Responsibilities	Deadline
3.2.1 Complete a communications plan for the National Sage-grouse Strategy, including internal and external audiences.	WO-610 (Lead), WO-200, WO-300, WO-880	August 2004, Completed and Ongoing
3.2.2 Complete a communications plan for state-level sage-grouse strategies/plans, including internal and external audiences Ensure that the BLM National, State and Field Office communication strategies support the comprehensive National Sage-grouse Strategy and ensure each level of the BLM organization knows how their strategies implement goals and enhance sage-grouse and sagebrush conservation goals.	State Directors (Lead), Public Affairs, Field Managers	December 2004

Strategy 3.3: Facilitate the collection, transfer and sharing of information among all BLM partners and cooperators, as well as BLM program personnel.

Actions	Responsibilities	Deadline
3.3.1 Continuously improve interagency data and mapping efforts such as SageMap	WO-200 (lead)	Ongoing
3.3.2 Improve web-based tools available to support sagebrush conservation efforts (e.g. links to literature, project and studies maps, decision support models)	WO-200 (lead)	2005; Ongoing
3.3.3 Develop and distribute publications that support field-level conservation efforts	WO-200 (lead)	Ongoing; 2005 and beyond
3.3.4 Develop minimum standards for data collection, data dictionary and reporting at state, regional and national levels that are compatible with data developed by state agencies and other partners	WO-200 (Lead), WO-880	December 2006
3.3.5 Provide training to ensure Bureau-wide understanding of sage-grouse habitat requirements and Best Management Practices (BMPs) across all disciplines	WO-230 (Lead), NTC	December 2005
3.3.6 Host a biennial workshop with partners to share understanding and knowledge of sagebrush ecology and management, including use of BMPs	WO-200	Biennial
3.3.7 Identify cooperative funding and/or other mechanisms for data collection, reporting and dissemination related to sagebrush and sage-grouse habitats	WO-200	November 2004
3.3.8 Enhance and accelerate, through partnerships, technical and scientific support to the field for sagebrush conservation efforts	WO-200/WO-170	June 2005

Goal 4: Ensure leadership and resources are adequate to implement national and state-level sage-grouse and sagebrush habitat conservation strategies and/or plans.

Strategy 4.1: Develop BLM state-level strategies and/or plans for sage-grouse and sagebrush conservation on BLM-administered public lands.

Actions	Responsibilities	Deadline
4.1.1 Establish BLM state-level interdisciplinary teams to prepare strategies.	State Directors (Lead), Field Managers	Ongoing; November 2004
4.1.2 Consult with States, RACs, Councils, tribes, other agencies, stakeholders, and interested publics in preparation of draft BLM state-level strategy/plan.	State Directors (Lead), Field Managers	Ongoing; annual meetings
4.1.3 Incorporate sage-grouse/sagebrush conservation measures into all applicable land use plans.	State Directors (Lead), Field Managers	Ongoing, as scheduled per Action 1.3.4

Strategy 4.2: Formulate budgets necessary to support continued implementation of the National Sage-grouse Strategy.

Actions	Responsibilities	Deadline
4.2.1 Prioritize needs for sage-grouse and sagebrush conservation in Strategic Budget Plan (FY+2).	Director, State Directors, Field Committee and the Budget Strategy Team	Ongoing; annual
4.2.2 Include priority needs for sage-grouse and sagebrush conservation in Budget Justifications (FY+1).	State Directors, Field Managers, WO-200, WO-300, WO-800 (Lead)	Ongoing; annual
4.2.3 Prioritize needs for sage-grouse and sagebrush conservation in Annual Work Plan.	State Directors, Field Managers, WO-200, WO-300, WO-800 (Lead)	Ongoing; annual
4.2.4 Give priority to sage-grouse and sagebrush conservation in CCS, CCI and NFWF funding proposals.	State Directors, Field Managers, WO-200	Ongoing; annual

VII. Progress Reporting

Implementation of the actions outlined in this BLM National Sage-grouse Strategy and the cooperative state agency led sage-grouse habitat conservation strategies will be monitored and progress reported to the Director annually. The effectiveness of implementing actions outlined in both the national and state strategies will require an assessment process that includes 'before and after' project evaluation of habitat conditions. This assessment process is currently being developed (see Action 2.2.2). The assessment process will be incorporated into BLM's land health assessment process for evaluating indicators of healthy rangelands.

VIII. Authorities and Responsibilities

The BLM has broad authority to manage the public lands. BLM management of the public lands is guided by Federal laws, regulations, policies and handbooks. Collectively, these frame BLM's "regulatory mechanisms" for sage-grouse conservation as discussed in Section 4 of the Endangered Species Act. Many of these authorities have a bearing on sage-grouse conservation, but only the most relevant ones are discussed below.

1) Laws

Several major Federal laws provide the authority and framework for this National Sage-grouse Strategy:

Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 *et seq.*), as amended

This is the primary Federal law governing most land uses on BLM-administered lands. It directs BLM to develop and maintain land use plans based on inventories of these lands and the resources they support. Among other things, this Act gave fish and wildlife resources equal standing with the other traditional public uses of BLM-administered lands. Section 102(a)(8) states: "The Congress declares that it is the policy of the United States that the public lands be managed in a manner that will....provide food and habitat for fish and wildlife...."

National Environmental Policy Act (NEPA), 1969, Title II (42 U.S.C. 4321 *et seq.*), as amended

NEPA requires that land-management planning be conducted in the public arena, using an interdisciplinary process for evaluating and disclosing resource information that considers physical, cultural, and biological resources in conjunction with social and economic factors to explore alternatives; consider impacts, including cumulative impacts; mitigate impacts; and decide appropriate public land uses.

Public Rangelands Improvement Act 1978, Title II (43 U.S.C. 1901 *et seq.*), as amended

The Public Rangelands Improvement Act provides that "[e]xcept where the land use planning process required pursuant to Section 202 of [FLPMA] determines otherwise or the Secretary determines, and sets forth his reasons for this determination, that grazing uses should be discontinued (either temporarily or permanently) on certain lands, the goal of ...management shall be to improve the range conditions of the public rangelands so that they become as productive as feasible in accordance with the rangeland management objectives established through the land use planning process, and consistent with the values and objectives listed in sections 2(a) and (b)(2) of this Act."

Sikes Act of 1974, Title II (16 U.S.C. 670 *et seq.*), as amended

This Act directs the Secretaries of Interior and Agriculture to, in cooperation with the State agencies, develop plans to "... develop, maintain, and coordinate programs for the conservation and rehabilitation of wildlife, fish and game. Such conservation and rehabilitation programs shall include, but not be limited to, specific habitat improvement projects, and related activities and adequate protection for species considered threatened or endangered."

Wild Horse and Burro Act of 1971 (16 U.S.C. 1331), as amended

The Wild Horse and Burro Act gives BLM statutory authority for management of wild horses and burros and responsibility to provide for a thriving ecological balance on public rangelands. At 43 CFR 4700.0-6 is the policy of the BLM that: "Wild horses and burros shall be managed as self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat."

2) Regulations

Once a law is enacted, the administering Federal agency promulgates rules and regulations, as appropriate, to guide implementation. These regulations set the framework for national policy and can in some instances provide implementation direction. Regulations are a very important "regulatory mechanism" for administering land uses on public lands. For the BLM, there are several sets of regulations associated with implementing FLPMA and other laws. Most of the regulations that may affect BLM guidance on sage-grouse management are found in 43 CFR, although some, such as the Council on Environmental Quality regulations, are found in other portions of the CFR.

43 CFR Subpart C, Minerals Management 3000 Series,

The Minerals Management regulations contain regulatory authority for BLM operations, enforcement and reclamation of mineral actions on public lands.

43 CFR Subpart 4120, Grazing Management

The Grazing Management regulations contain the regulatory authority for grazing administration, use authorizations, permit terms, and conditions for achieving resource-condition objectives. Subparts 4140-4170 outline prohibited acts, enforcement, and penalties. Subpart 4180 is an example of how regulations provide direction for sage-grouse conservation. Within the scope of these grazing regulations, are included specific direction to the BLM State Directors to develop standards that among other things would address:

(43 CFR 4180.2(d)):

(4) Habitat for endangered, threatened, proposed, candidate, or special status species; and (5) Habitat quality for native plant and animal populations and communities.

In addition, Subpart 4180.2(e) requires development of guidelines to address:

(9) Restoring, maintaining or enhancing habitats of Federal proposed, Federal candidate, and other special status species to promote their conservation.

43 CFR 4180, Fundamentals of Rangeland Health

The Fundamentals of Rangeland Health require the BLM to develop, in consultation with Resource Advisory Councils, rangeland health standards. The Fundamentals of Rangeland Health combine the basic precepts of physical function and biological health with elements of law relating to water quality and plant and animal populations and communities to provide the basis for the standards for land health.

3) BLM National Policy Guidance

National policy guidance further defines or clarifies how laws and regulations will be administered. This direction comes either in the form of a policy statement or as manuals or handbooks. National policy establishes what basic policy is to be achieved. BLM State and local policies can provide more specific guidance on how the national policy objectives are to be accomplished. BLM State and local field offices have discretion to adapt national policy to local situations, but do not have authority to override national policy for local situations.

Policies are particularly useful in avoiding conflicts with laws and regulations. Federal agency policies concerning sensitive species are a good example. The ESA only applies to proposed and listed species and designated or proposed critical habitat, but it is in the interest of the Federal government, consistent with other laws such as FLPMA, to conserve sensitive species with the intent to avoid a need to list. There are no regulations associated with FLPMA that specifically address fish and wildlife management or, more specifically, conservation of sensitive species at risk of being listed in the future. Agency policy provides this direction for sensitive species conservation and fills this regulatory gap. Two main sets of policy guidance currently provide direction for sage-grouse conservation efforts.

BLM Special Status Species Management – Manual 6840

Policy guidance for sage-grouse habitat conservation is summarized in this manual. It provides national-level policy direction, consistent with appropriate laws, for the conservation of special-status species of animals and plants and the ecosystems on which they depend. *Conservation* in this National Sage-grouse Strategy, and consistent with 6840 policy, means the use of all methods and procedures necessary to improve the condition of special status species and their habitats to a point where their special status recognition is no longer warranted.

Land Use Planning Handbook - H-1601-1

All program actions (allocations, authorizations, objectives, standards, conditions and implementation priorities) taken on the public land are guided by land use plans. These plans ensure that the public lands are managed in accordance with the intent of Congress as stated in FLPMA (43 U.S.C. 1701 *et seq.*) under the principles of multiple use and sustained yield. The BLM Land Use Planning Handbook provides more detailed direction for land use planning consistent with planning regulations found in 43 CFR 1600.

The Handbook states that, as required by FLPMA, the public lands must be managed in a manner that protects the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archaeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use by encouraging collaboration and public participation throughout the planning process. In addition, the public lands must be managed in a manner that recognizes the nation's need for domestic sources of minerals, food, timber, and fiber from the public lands.

Land use plans are the primary mechanisms for guiding BLM program activities. Land use plans guide management actions on public lands in the planning area. Land use plan decisions establish goals and objectives for resource management,; measures needed to achieve these desired future conditions, and the parameters for using BLM-administered public land. These plans identify lands that are open or available for certain uses, including any applicable restrictions, and lands that are closed to certain uses.

IX. Literature Relevant to the BLM Sage-Grouse Habitat Conservation Strategy

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APPENDIX B — JONAH INFILL DRILLING PROJECT DEVELOPMENT PROCEDURES TECHNICAL SUPPORT DOCUMENT

SWCA
ENVIRONMENTAL CONSULTANTS

JONAH INFILL DRILLING PROJECT DEVELOPMENT PROCEDURES TECHNICAL SUPPORT DOCUMENT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

and

Jonah Infill Drilling Project Operators

Prepared by

TRC Mariah Associates
Laramie, Wyoming

Revised and updated by

SWCA Environmental Consultants
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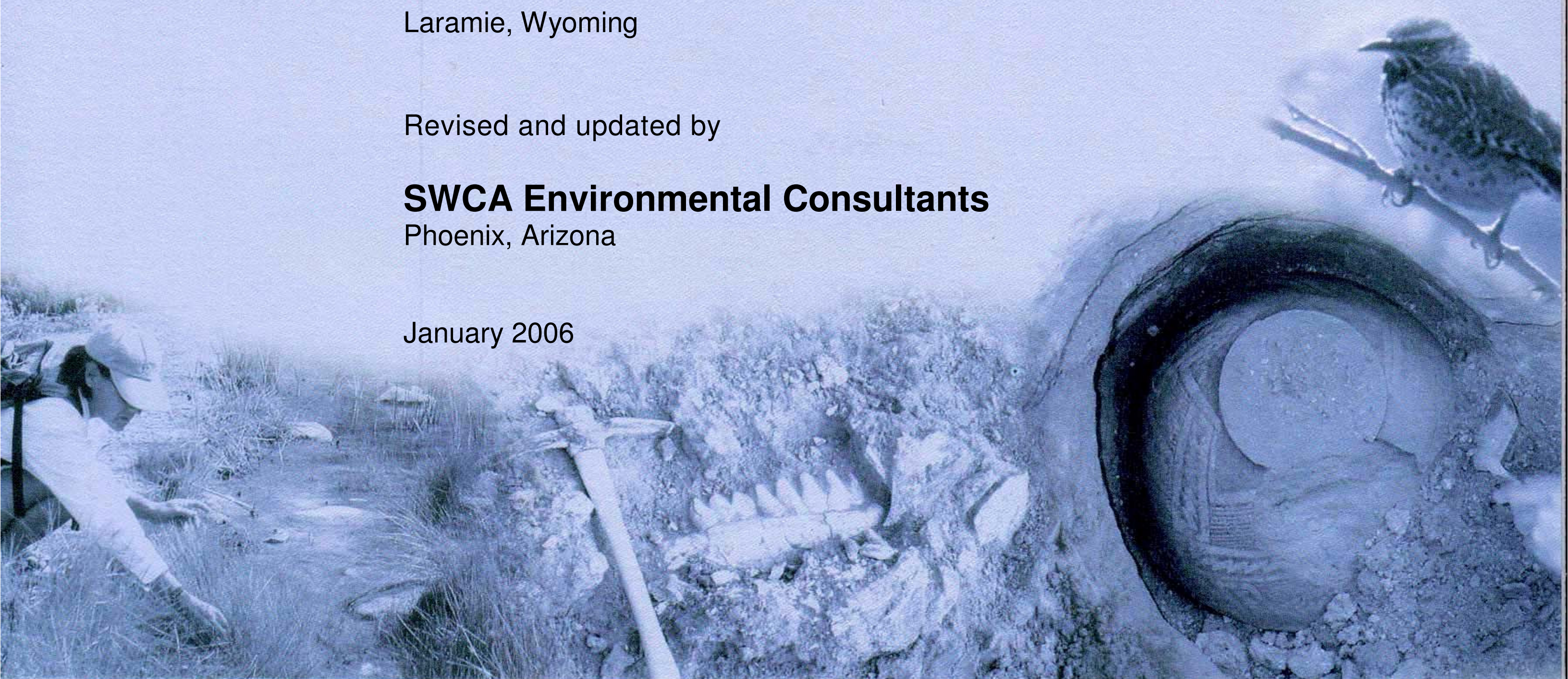
January 2006



JONAH INFILL DRILLING PROJECT
DEVELOPMENT PROCEDURES
TECHNICAL SUPPORT DOCUMENT

Prepared for

Bureau of Land Management
Pinedale Field Office
Pinedale, Wyoming

and

Rock Springs Field Office
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Jonah Infill Drilling Project Operators

Prepared by

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January 2006

PREFACE

The *Jonah Infill Drilling Project Development Procedures Technical Support Document* was originally drafted by TRC Mariah Associates of Laramie, Wyoming, and published as an appendix to the *Jonah Infill Drilling Project Draft Environmental Impact Statement* in February 2005. The document was subsequently revised and updated at the direction of BLM by SWCA Environmental Consultants of Phoenix, Arizona.

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ACRONYMS AND ABBREVIATIONS

APD	Application for Permit to Drill
AQD	Air Quality Division
BACT	Best Available Control Technology
bbl	Barrels
BCF	Billion cubic feet
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COA	Condition of Approval
DR	Decision Records
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
gal	Gallons
JIDPA	Jonah Infill Drilling Project Area
JIO	Jonah Interagency Office
LOP	Life-of-project
LQD	Land Quality Division
mmcf	Million cubic feet
mmcfpd	Million cubic feet per day
NEPA	National Environmental Policy Act of 1969
NTC	Notice to Lessees
Operators	Oil and gas development companies
OSHA	Occupational Safety and Health Administration
OVM	Organic vapor meter
ppm	Parts per million
ROW	Right-of-way
SWPPP	Storm Water Pollution Prevention Plan
SCADA	Supervisory Control and Automated Data Acquisition
TCF	Trillion cubic feet
TDS	Total dissolved solids
TRPH	Total recoverable petroleum hydrocarbons
VOC	Volatile organic compound
WDEQ	Wyoming Department of Environmental Quality
WDOT	Wyoming Department of Transportation
WOGCC	Wyoming Oil and Gas Conservation Commission
WQD	Water Quality Division
WSEO	Wyoming State Engineer's Office

1.0 INTRODUCTION

This technical support document provides a general summary of the primary facets for development of the Jonah Infill Drilling Project (the Project) and includes a Transportation Plan, Reclamation Plan, and Hazardous Materials Summary. These materials are provided in support of the *Jonah Infill Drilling Project Environmental Impact Statement* (EIS) (Bureau of Land Management [BLM] 2005). It is not the intention of this document to establish specific procedures for the implementation of the Project, but rather to assist in the analysis of the various alternatives. Specific conditions of approval, operating procedures, etc., will be established by the Record of Decision when the selected alternative is developed.

Where development actions would likely differ among development alternatives (i.e., Proposed Action, Alternatives A and B, and the Preferred Alternative), these differences are identified. In any instance where this document might seem to conflict with the EIS, the EIS will take precedence.

2.0 PROJECT DEVELOPMENT

Drilling and development operations would continue year-round and may utilize as many as 20 drilling rigs operating in the Jonah Infill Drilling Project Area (JIDPA) simultaneously (the 250-wells/year case). However, BLM will not specifically regulate the pace of development in the JIDPA.

2.1 Traffic and Workforce

Workers, material, and equipment would be transported to the JIDPA over U.S. Highway 191, State Highway 351, and BLM Roads 4206 (Burma Road), 5409 (Luman Road) and the Jonah North Road, and most of these trips would likely originate from Rock Springs, Pinedale, Big Piney, or Marbleton, Wyoming. An estimated 810 round trips would be required to construct, drill, complete, and tie in (pipeline construction) each well (Table 2.1). However, where wells would be directionally drilled, drilling traffic would increase by approximately 20 percent per well (i.e., from 200 trips to 240 trips per well) primarily as a result of increased drilling duration and additional required workforce. During production, an estimated maximum of 1,996 round trips per well would be necessary for condensate and water hauling and maintenance (assumes pumpers visit wells every 3 days and an average of 20 wells would be visited daily) (Table 2.1). Some reduction in production traffic and distance traveled may occur as a result of directionally drilled wells since more wells could be visited daily at fewer well pad locations. Additional detail on traffic requirements is provided in the Transportation Plan included as Appendix DP-A of this document.

Table 2.1. Estimated Traffic Requirements, Jonah Infill Drilling Project, Sublette County, Wyoming

Type of Traffic	Round Trips per Well	Life-of-Project (LOP) Round Trips Maximum Development (Thousands)[1]	Average Daily Traffic[1]
Well Construction and Development			
Well Pad and Access Road Construction (4 days/well site)[2]	20	62	--
Vertical Well Drilling (22 days)[3]	200	620	--
Directional Well Drilling (26 days)[3]	240	744	
Completion/Testing (17 days)	570	1,767	--
Pipeline Construction (4 days)	20	62	--
Total vertical well construction and development (54 days/well site)	810	2,511	529
Total directional well construction and development (58 days/well site)	814	2,635	
New Production Activities[4]	1,996	6,188	424
Existing Production Activities[4]	--	1,064	73
Total[5]	2,569	9,763	505[5]

[1] Assumes 3,100 wells are drilled and completed as producers, wells produce every day, development actions would be completed in 13 years, well life is 40 years, and LOP is 53 years (excludes the final 3 years of reclamation).
[2] Includes gravel hauling.
[3] Vertical wells require 18 days to drill; directional wells require 22 days to drill; 4 additional days included for rig up, rig down, and maintenance.
[4] Assumes one pumper can visit 20 wells/day, one pad is visited every 3 days, and average well life is 40 years.
[5] Some additional low-volume traffic would also be necessary for reclamation activities; average daily traffic volumes are not additive.

Construction workers, rig crews, fracturing/completion crews, and support personnel would be primarily housed in Rock Springs, Pinedale, Boulder, Big Piney, Marbleton, La Barge, and Eden/Farson; therefore, no worker camps or temporary housing in the JIDPA are proposed. Table 2.2 provides the estimated work force requirements associated with the project.

Table 2.2. Estimated Work Force Requirements, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Employment Category	Worker-Days per Well	Worker-Years for 1,250 Wells[2]	Worker-Years for 2,200 Wells[2]	Worker-Years for 3,100 Wells[2]
Well Construction and Development				
Well Pad and Access Road Construction (4 days × 4 workers)	16	77	136	191
Rig Up/Down (5 days × 15 workers)	75	361	635	895
Drilling (22 days × 11 workers × 2 shifts)	484	2,327	4,095	5,770
Directional Drilling (26 days × 11 workers × 2 shifts)	572	2,750	4,840	N/A
Completion Testing (17 days × 11 workers)	187	900	1,583	2,230
Pipeline Construction (4 days × 6 workers)	24	116	203	287
Production and Maintenance Activities				
Production[3,4]	305	1,467	2,581	3,637
Workovers[5] (every 10 to 20 years) (10 days × 7 workers)	210	1,010	1,777	2,504
Abandonment and Reclamation				
(5 days × 10 workers)	50	241	423	597
Vertical Well Total	1,351	6,799	11,733	16,377
Directional Well Total	1,439	7,222	12,478	N/A

1 Assumes all wells are drilled and completed as producers.
2 260 worker-days = 1 worker-year.
3 Assumes 1 pumper can visit 20 wells/day, all pads are visited every 3 days, and wells produce for 40 years.
4 Assumes six full-time production foremen and six full-time field clerks in addition to pumpers.
5 Assumes three workovers per well.

Depending on the number of vertical and directional wells developed per year, project construction, drilling, completion, and production would require up to 105 years to complete (see EIS Table 2.1). The fewer the number of wells, the faster permit approvals are obtained, and the faster the pace of development, the shorter the life-of-project (LOP).

Oil and gas development companies (Operators) would comply with existing federal, state, and county requirements and restrictions developed to protect road networks and the traveling public. Special arrangements would be made with the Wyoming Department of Transportation (WDOT), as required, to transport oversized and/or overweight loads to the JIDPA. The transportation planning process for this project is described in Appendix DP-A.

2.2 Preconstruction Planning and Site Layout

Pursuant to *Onshore Oil and Gas Order No. 1* and BLM regulation 42 *Code of Federal Regulations* (CFR) § 3162.3-1, each proposed well would require an Application for Permit to Drill (APD) approved by BLM prior to any surface disturbance. Each APD would include site-specific information regarding all facets of well development, including environmental concerns. Operators and/or their contractors and subcontractors would conduct all phases of project implementation (e.g., well pad construction, road and pipeline construction, drilling and completion operations, maintenance, reclamation, and abandonment) in full compliance with all applicable federal, state, and county plans, laws, and regulations and according to approved APD specifications, right-of-way (ROW) permits, and potentially site-specific environmental assessments (EAs) and decision records (DRs). Pursuant to section 390 of the Energy Policy Act of 2005, Pub. L. No. 109-58, § 390(b)(3), 119 Stat. 747-48 (2005), the BLM may exclude from NEPA documentation the approval of individual APDs within a developed field when a NEPA document, such as the EIS for the Jonah Infill Drilling Project, has been prepared. Operators would be fully accountable for their contractors' and subcontractors' compliance with the requirements in the approved permits and/or plans.

When development of federal minerals would take place on private surface, Operators would follow *Onshore Oil and Gas Order No. 1* and CFR 43 Subpart 3814, if applicable, with regard to access for natural gas resource development and remuneration to the landowner for potential damage.

2.3 Construction and Drilling Operations

All activities at each well in the JIDPA would follow procedures approved by the BLM in the APD and attached Conditions of Approval (COAs). Well pad, access road, and other construction activities would follow guidelines set forth in the most recent edition of the "Gold Book," *Surface Operating Standards for Oil and Gas Exploration and Development*, and/or *Manual 9113 - Roads* (BLM 1985) concerning road construction standards on projects subject to federal jurisdiction. Sufficient topsoil to facilitate revegetation would be segregated from subsoils during all construction and would be replaced on the surface upon completion of operations as part of the reclamation and revegetation program. Operators would employ appropriate topsoil storage technology and procedures to ensure soil viability and plant rooting potential are maintained. When topsoil piles exceed 3 feet in height and/or will be stored for 2 years or longer, Operators will develop a plan for BLM approval that details methods and/or procedures to maintain or replace soil microbial and nutrient viability for reclamation. Further detail on proposed reclamation activities is provided in the Reclamation Plan, included as Appendix DP-B of this document.

2.4 Well Pads

Major components of each individual well pad include the following:

- a level drilling area for placement and support of the drilling rig and related equipment, production facilities, and storage tanks;
- if approved, an earthen reserve pit to contain drilling fluids, drilled cuttings, and fluids produced during the drilling operation; and
- an earthen flare pit for the safe ignition of flammable gases produced during completion and testing operations.

The entire well pad area would be cleared of all vegetation, and up to 12 inches of topsoil would be removed from all cut, fill, and/or subsoil storage areas. Topsoil would be stockpiled for future use in reclamation. After the topsoil has been removed, the pad would be graded to prepare a level working surface. Each well location would be designed so that the amount of cut and fill material would "balance," where feasible, thereby minimizing the need to stockpile excess subsoil adjacent to the well location until site reclamation. Materials excavated from the reserve pit (if such pit is approved) would be stockpiled adjacent to the reserve pit and used to backfill the pit during reclamation.

The area required for drilling and completion of each well would vary depending upon the type of well being drilled (i.e., vertical or directional), the total number of wells to be developed from the pad, and/or whether new development would occur from an existing pad. In general, new vertical wells would require 3.8-acre pads, and directional well pads with multiple wells would require from 5.0 to 10.0 acres.

Well pad and access road construction would take 4 days per location and would require 4 workers (16 worker days) (see Table 2.2). These services would be provided by local contractors.

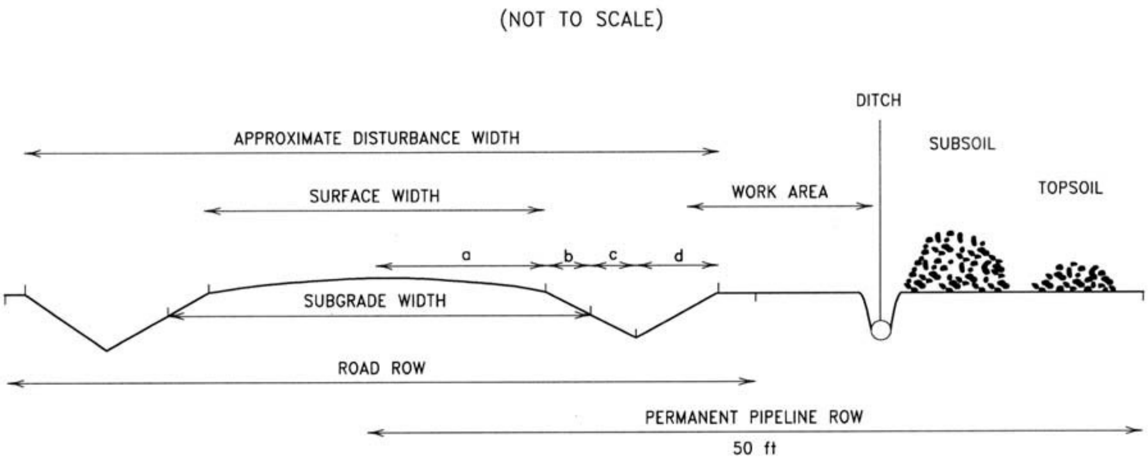
Erosion control would be maintained through prompt revegetation and by constructing surface water drainage controls such as berms, diversion ditches, and sediment ponds as necessary at each well location. All diversion ditches and other surface water and erosion control structures at each location would be shown on topographic relief maps provided with each APD. Storm Water Pollution Prevention Plans (SWPPPs) would be prepared by each Operator for all wells, access roads, and other disturbances of more than 5 acres, in compliance with the Wyoming Department of Environmental Quality (WDEQ) requirements (McMurry Oil Company 2003).

2.5 Roads

New resource road construction would average approximately 0.15 mile for each new well pad. With the inclusion of an adjacent gathering pipeline, 1.3 acres of disturbance would be required initially (73.3-foot initial disturbance width) and 0.5 acre of disturbance would be required for the LOP (29-foot LOP disturbance width). Figure 2.1 provides a typical road with adjacent pipeline schematic.

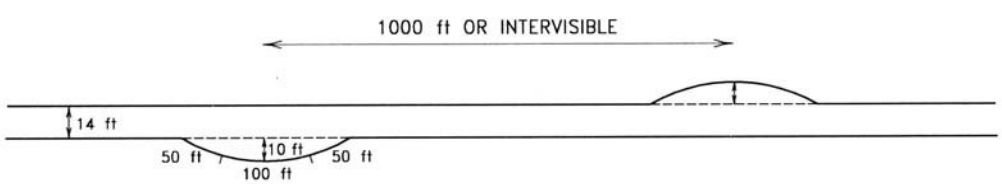
Roads would be designed by a licensed professional engineer if deemed necessary by the BLM (i.e., in problem areas such as steep slopes, unsuitable soils), and all roads would be built in accordance with guidelines established for oil and gas exploration and development activities in *BLM Manual* Section 9113 (BLM 1985, 1991). On completion of construction activities, the engineer would certify that the road was constructed in accordance with the approved road construction design, if deemed necessary by the BLM. Any deficiencies would be corrected to ensure compliance with both the approved Road Construction Plan and the APD. Once resource road construction is complete, all but 29 feet of the ROW (road surface area and portions of borrow ditch) would be reclaimed and revegetated. All road construction, upgrading, maintenance, and road reclamation activities would be implemented in accordance with the Transportation Plan for this project (see Appendix DP-A).

As the existing project has proceeded, various existing lower-volume resource roads have been upgraded to local/collector road conditions (e.g., Jonah North Road), and it is anticipated that



	MINIMUM SUBGRADE WIDTH (ft)	MINIMUM SURFACED TRAVELWAY WIDTH (ft)	a (ft)	b (ft)	c (ft)	d (ft)	APPROXIMATE DISTURBANCE WIDTH (ft)	ROW WIDTH (ft)	DESIGN SPEED (mph)
RESOURCE ROAD	16	12	6	2	4	8	40	50	15–30
LOCAL ROAD	24	20	10	2	4	8	48	55	20–50
COLLECTOR ROAD	28	24	12	2	4	8	52	60	30–50

DIAGRAM OF TYPICAL TURNOUTS ON RESOURCE ROADS



35982\EIS\FIGURE\TYP–ROAD

Figure 2.1. Typical Access Road with Adjacent Pipeline Schematic, Jonah Infill Drilling Program, Sublette County, Wyoming, 2006.

these upgrades would be implemented on approximately 8 miles of existing resource roads in the JIDPA for this proposed project. Additionally, the existing Burma Road from the JIDPA north to Wyoming Highway 351 would be upgraded under the Proposed Action and Alternative A. New or upgraded collector roads in the JIDPA would be developed under all alternatives except No Action. Approximately 73 acres of new disturbance and 37 acres of LOP disturbance would be required for new in-field collector roads, and approximately 75 acres of new disturbance and 20 acres of LOP disturbance would be required for the Burma Road upgrade. Operators would work with the BLM and the WDOT in establishing the appropriate needs for the Burma Road/Highway 351 junction (e.g., turnouts, paving, new fencing, and culverts).

Aggregates used for road and well location construction would be acquired from commercial sources primarily on federal and state lands on and adjacent to the JIDPA. Prior to aggregate extraction, appropriate permits would be obtained from the BLM and/or WDEQ/Land Quality Division (LQD) and WDEQ/Air Quality Division (AQD), as appropriate. Aggregates would be free of noxious weeds.

2.6 Drilling Operations

Gas reserves within the JIDPA are estimated to be 12.8 trillion cubic feet (TCF), and this project is proposed to maximize the recovery of these reserves. Drilling and development activities over the last few years have led to a better understanding of the gas resources beneath the JIDPA, and it has been determined that considerable volumes of gas would be left unrecovered without the development of additional wells (BLM 2002) (Figure 2.2). Without additional drilling in the area, a total of approximately 3,366 billion cubic feet (BCF) would be recovered by existing operations, leaving approximately 9,434 BCF unrecovered. Recovery volumes would vary depending upon the total number and types of wells (vertical or directional) drilled, and, based upon the alternatives analyzed in the EIS, recovery volumes are estimated to range from 3,366 to 8,191 BCF.

Up to 20 drilling rigs rated for drilling to depths of 12,000 feet or more may be employed simultaneously during project development to accommodate development of 250 wells per year. However, if a slower development pace occurs, the number of simultaneously operating rigs would likely be reduced. Drilling is scheduled to begin in 2006, subsequent to the release of the Record of Decision for this project. Operators propose to drill throughout the year utilizing the mitigative measures and environmental considerations outlined in EIS Appendix C. All drilling operations and other well site activities would be conducted in compliance with applicable BLM, Wyoming Oil and Gas Conservation Commission (WOGCC), WDEQ, and other federal, state, and county rules and regulations.

Including rig-up and rig-down activities, drilling each vertical well would take an average of approximately 22 days, with some additional time potentially being required for wells drilled deeper than 12,000 feet. Drilling would require approximately 22 individuals, including two 11-person rig operations crews necessary to conduct drilling 24 hours per day (see Table 2.2). Most project personnel would be hired locally, and construction workers, rig crews, and support personnel likely would live in Pinedale, Rock Springs, Boulder, Big Piney, Marbleton, La Barge, or Eden/Farson. Approximately 200 round trips to each well location would be required during vertical well drilling operations (see Table 2.1).

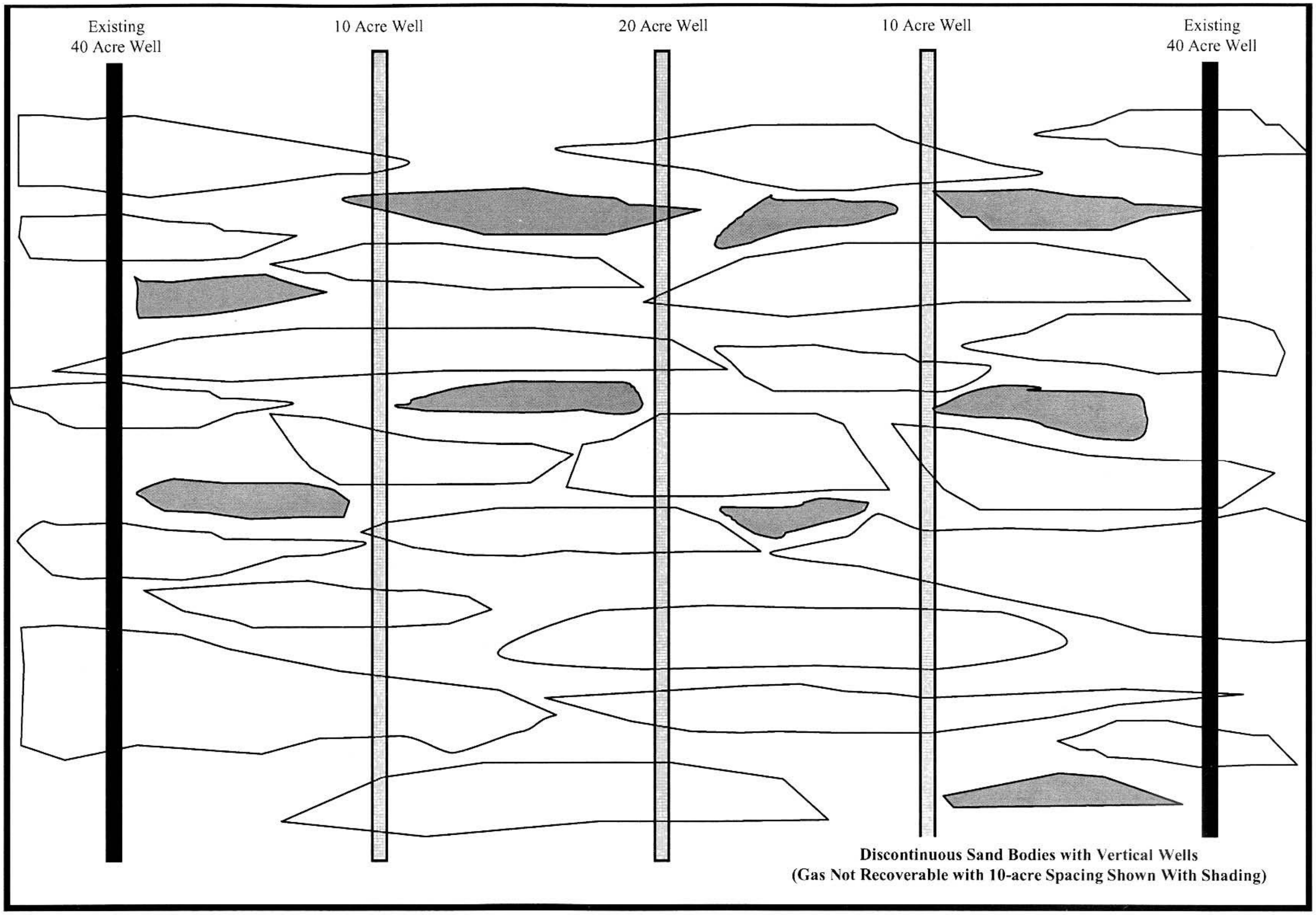


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Figure 2.2. Representation of Gas Traps, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Figure 2.3 presents a schematic representation of a typical vertical well pad layout during drilling.

Whereas vertical drilling is the Operator-preferred method for well development, directional drilling would be used to recover gas beneath sensitive areas (i.e., 0.25-mile greater sage-grouse lek buffers, 825-foot active raptor nest buffers, and the 600-foot Sand Draw buffer) (Map 2.1). To accommodate development of reserves beneath these areas, as many as 422 directionally drilled wells would likely be developed under the Proposed Action; since the aforementioned buffers would not be avoided under Alternative A, fewer directionally drilled wells would likely be developed. Additional directionally drilled wells would also likely be developed under all alternatives to access reserves beneath areas with steep slopes and other topographic features. Additional directional wells would likely be developed under Alternative B due to surface disturbance limitations. However, directional wells have a greater risk of total failure, require additional time and costs to develop, may be uneconomic in some cases, and may result in unrecovered reserves.

Directional drilling provides for the construction of a single well pad that may accommodate as many as 13 wells. Figure 2.4 provides a summary schematic of a multi-well pad developed at an existing vertical well pad site. Drilling directional wells would require an average of 26 days to drill, including rig-up and rig-down operations. With multiple well pads, the initial and LOP disturbance required for each pad is increased. Initial disturbance may be 10 acres per pad and LOP disturbance 3 acres per pad. However, these multiple well pads may be serviced by one access road and gathering system pipeline, as well as a single separation, dehydration, and storage facility. Where new directional wells are developed at an existing well site, separate separation, dehydration, and storage facilities may be used. Use of directional drilling techniques would be contingent upon economic and technical feasibility, potential resource recovery issues, and environmental considerations. An evaluation of directional drilling in the Jonah Field can be found in EnCana Oil and Gas (USA) Inc. (EnCana) (2004).

Most wells would be completed in the Lance Formation (Lance Pool); however, secondary reserves may be encountered in other formations, and approximately 100 acres of new and LOP disturbance are anticipated for exploration activities. Drilling would occur commensurate with new discoveries coupled with anticipated developmental costs and gas prices.

Drilling operations primarily would utilize a water-based mud system with additives to minimize downhole problems; however, oil-based mud systems (closed/tank-controlled) may be employed at some wells (more likely with directionally drilled wells). Drilling would require approximately 11,000 barrels (bbl) of water per well (42 gallons [gal]/bbl) (1.4 acre-feet). Total drilling water requirements for a 3,100 well project would be approximately 4,056 acre-feet, or 338 acre-feet per year over a 12-year well development period (250 wells per year case). The rate of water use may decrease if fewer natural gas wells are developed per year, and total water needs may be reduced if fewer natural gas wells are drilled. Additionally, directional drilling requirements would result in increased water use.

While produced water recycling would be maximally employed (see Section 2.8), additional water would be required and would be obtained from the existing 25 water wells developed in the JIDPA for current development operations, and from approximately 16 new water wells. Although the number of water wells utilized is primarily a function of geography and logistics, fewer additional water wells would be developed in the event that development occurs at a pace of less than 250 wells per year. Water wells would be developed on natural gas well pads and would require no new surface disturbance and <0.5 acre of LOP disturbance.

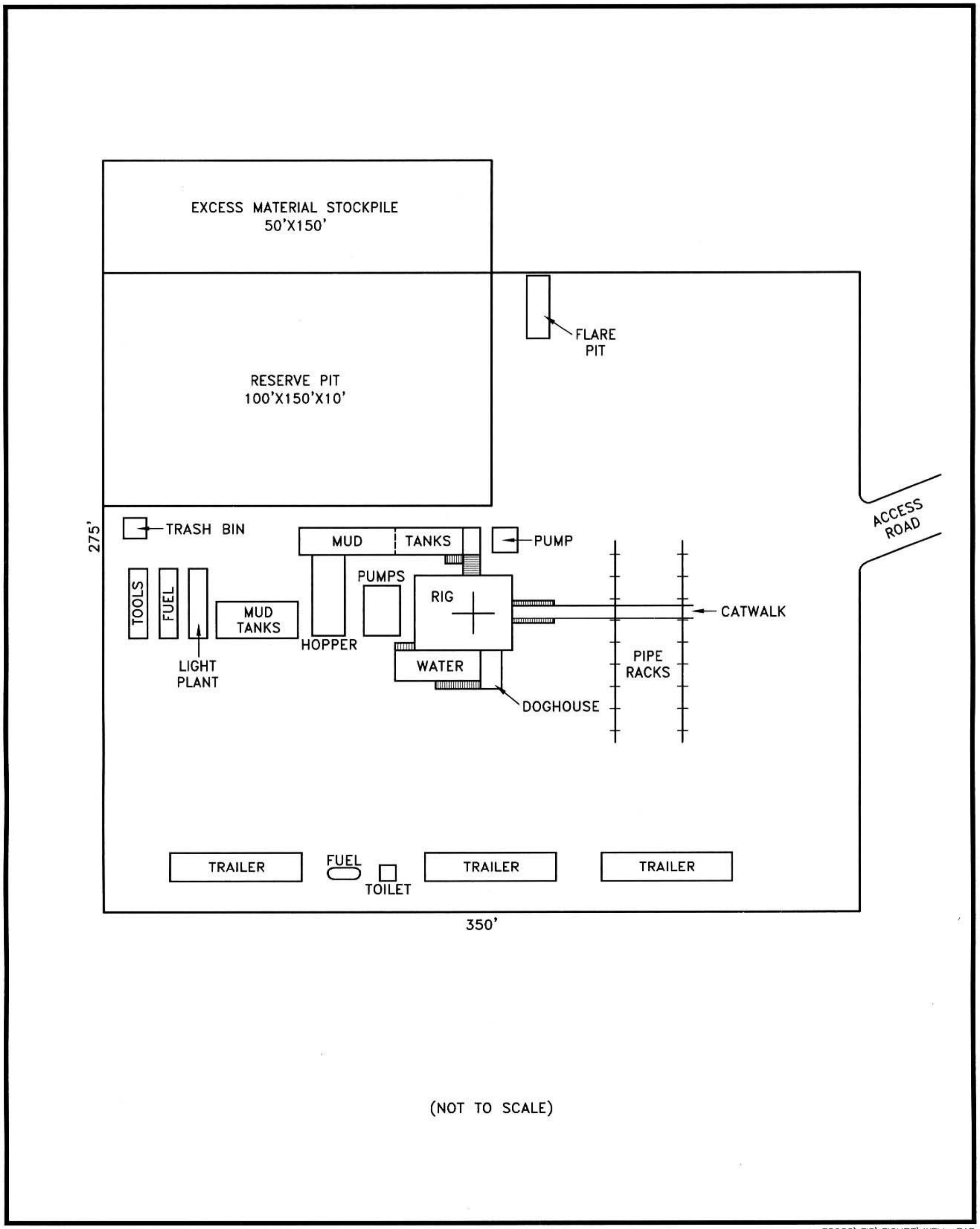
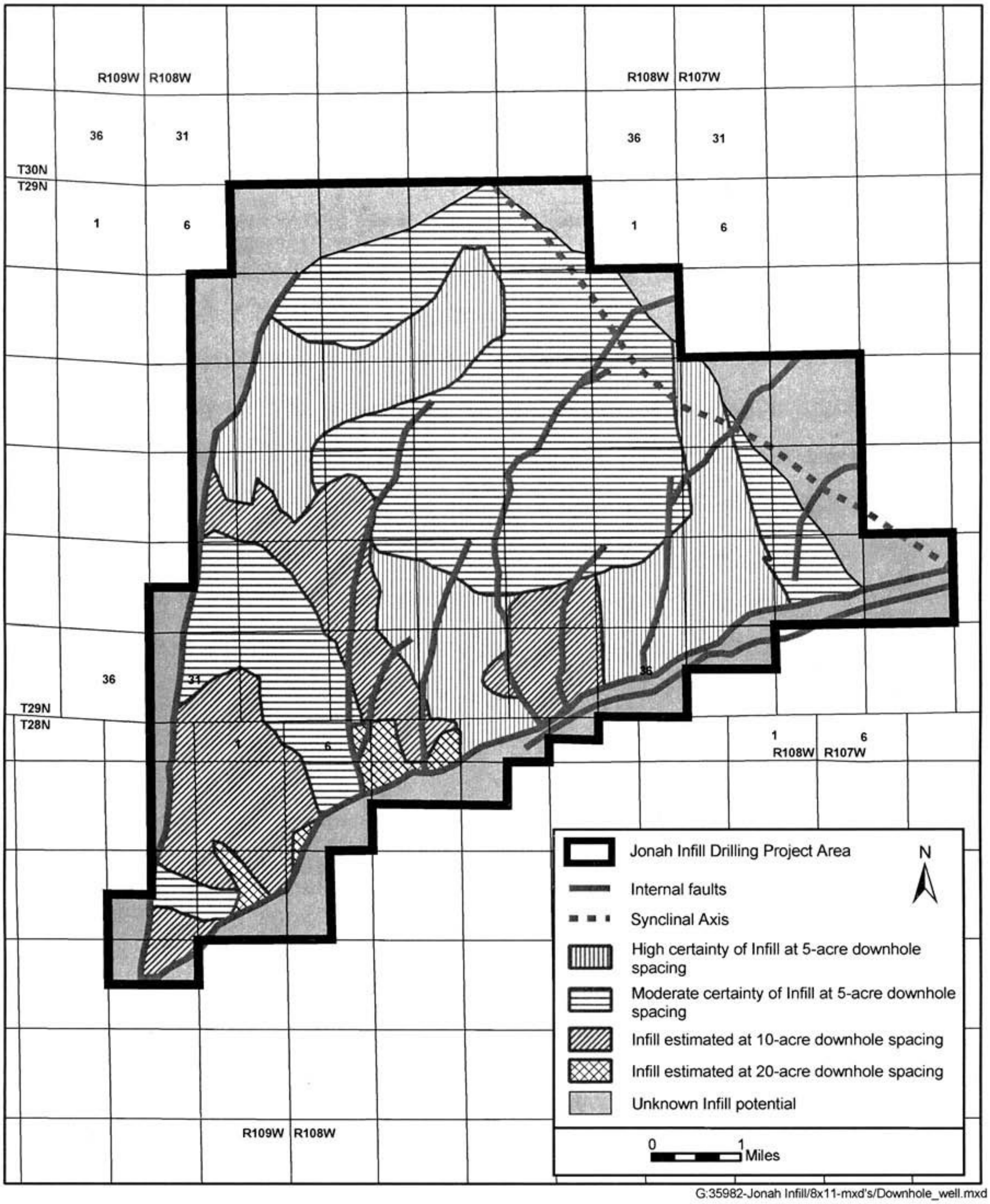


Figure 2.3. Schematic Representation of a Typical Vertical Well Pad Layout During Drilling, Jonah Infill Drilling Project, Sublette County, 2006.



Map 2.1. Surface Disturbance Avoidance Areas, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

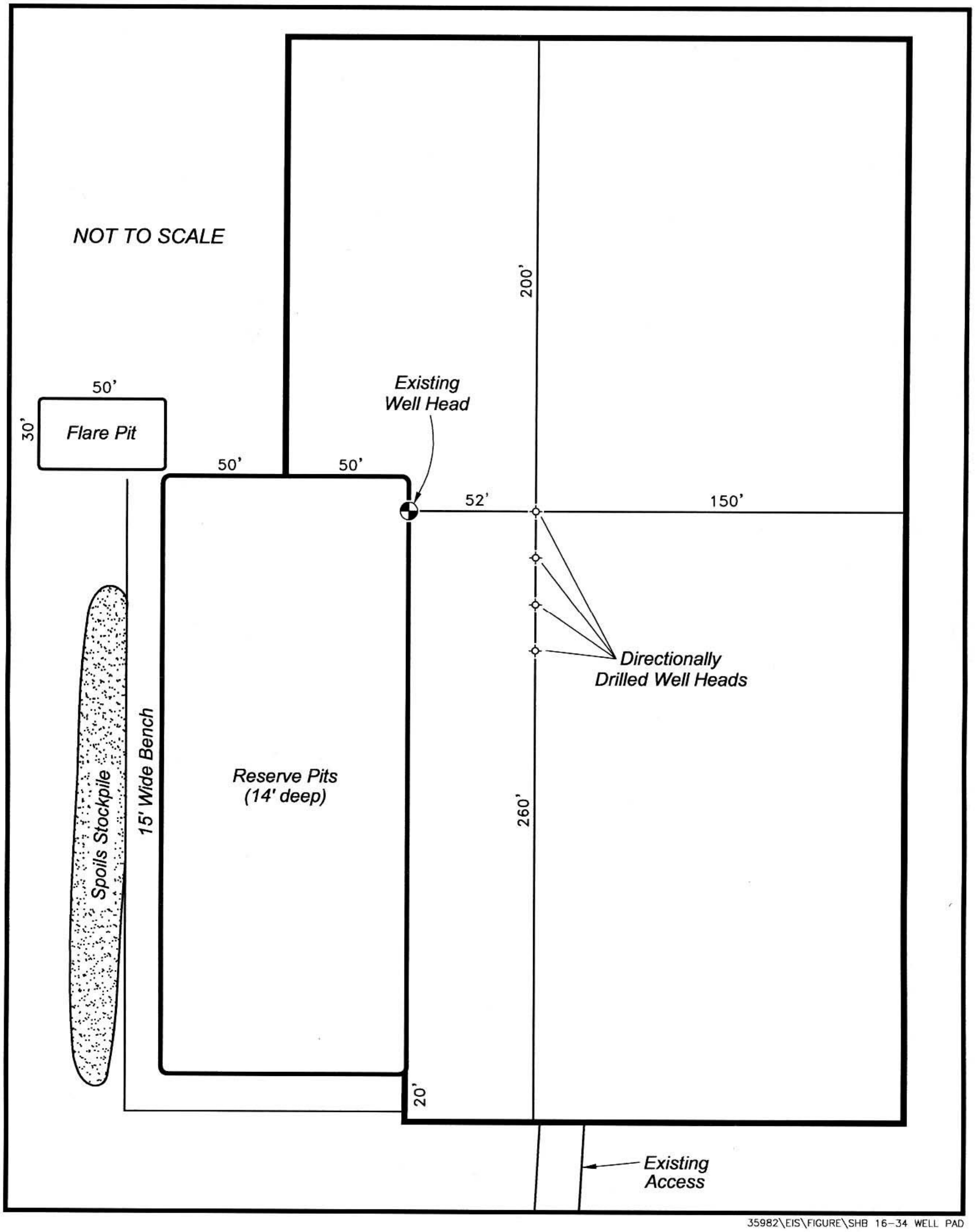


Figure 2.4. Example Directional Drill/Multi-well Pad Layout at an Existing Well Pad, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Water would be trucked or piped from water wells and/or treatment facilities to drilling sites depending on site-specific conditions, disturbance requirements, and time of year. Water pipelines would be temporary and would consist of either standard 3- to 6-inch-diameter aluminum sections or polypipe. These water pipelines would be laid on the ground surface within road ROWs or directly overland and would be removed after completion/testing operations are done. The contracted water hauler would be responsible for obtaining any required permits from the Wyoming State Engineer's Office (WSEO). Water used to drill a well would be reused for drilling subsequent wells to the maximum extent practicable.

Operators would utilize closed drilling systems (no reserve pits) for all wells unless proven to the satisfaction of the Authorized Officer, on a case-by-case basis, that closed drilling systems would not be technologically or economically feasible. If reserve pits are approved, Operators would remove/vacuum fluids from reserve pits within 60 days of all wells on the pad being put into production. If this timeframe is infeasible on a particular site, the Operators would notify the Jonah Interagency Office (JIO) and fluids would be removed as soon as practical. If oil-based fluids are used, they would be recovered in tanks. If any oil enters reserve pits, it would be removed pursuant to WOGCC rules and regulations and the pit would be flagged overhead or covered with netting to prevent waterfowl use in compliance with *BLM Informational Bulletin Number WY-93-054*.

Any shallow water zones encountered during drilling would be reported and adequately protected by installing surface casing and cementing back to the surface. After completion of drilling, the well would be logged and production casing run in accordance with the drilling program approved in the APD. Surface casing would be set to a depth adequate to isolate near-surface freshwater aquifers (approximately 2,500 feet). Production casing would be run and cement circulated to a minimum of 400 feet above the Lance Formation, effectively isolating all geologic formations and eliminating any fluid migration between hydrocarbon-bearing zones and freshwater aquifers (Figure 2.5).

2.7 Completion Operations

Once the well has been drilled and cased, completion operations would begin to clean the wellbore, to conduct pressure testing, and to perforate potentially productive zones. A bond log would be run (a bond log is the process by which the integrity of the cement bond between the casing and the borehole is verified), casing would be perforated in potentially productive zones downhole (e.g., Lance Pool sand lenses), and production tubing run. Multiple sand lenses would be fracture-stimulated. Fracture-stimulation (fracturing) is the process by which sand, nitrogen foam, and other materials are pumped downhole under pressure through the perforations in the casing and subsequently into the formation. As the formation is fractured, the spaces (fractures) are filled with sand to prop open the fractures and facilitate the flow of gas into the wellbore and through tubing to the surface.

Upon completion of fracturing, the well is flowed back to the surface in an attempt to recover as much of the fracture fluid as possible and to clean excess sand out of the perforations. Production tubing would be set, if warranted, prior to installing production equipment and placing the well "on line." All fracture fluid additives would meet BLM and/or U.S. Environmental Protection Agency (EPA) requirements for disposal of oil field wastes. All fluids utilized in the completion procedure would be contained on the well pad in pits or tanks and disposed of in compliance with state and federal rules and regulations.

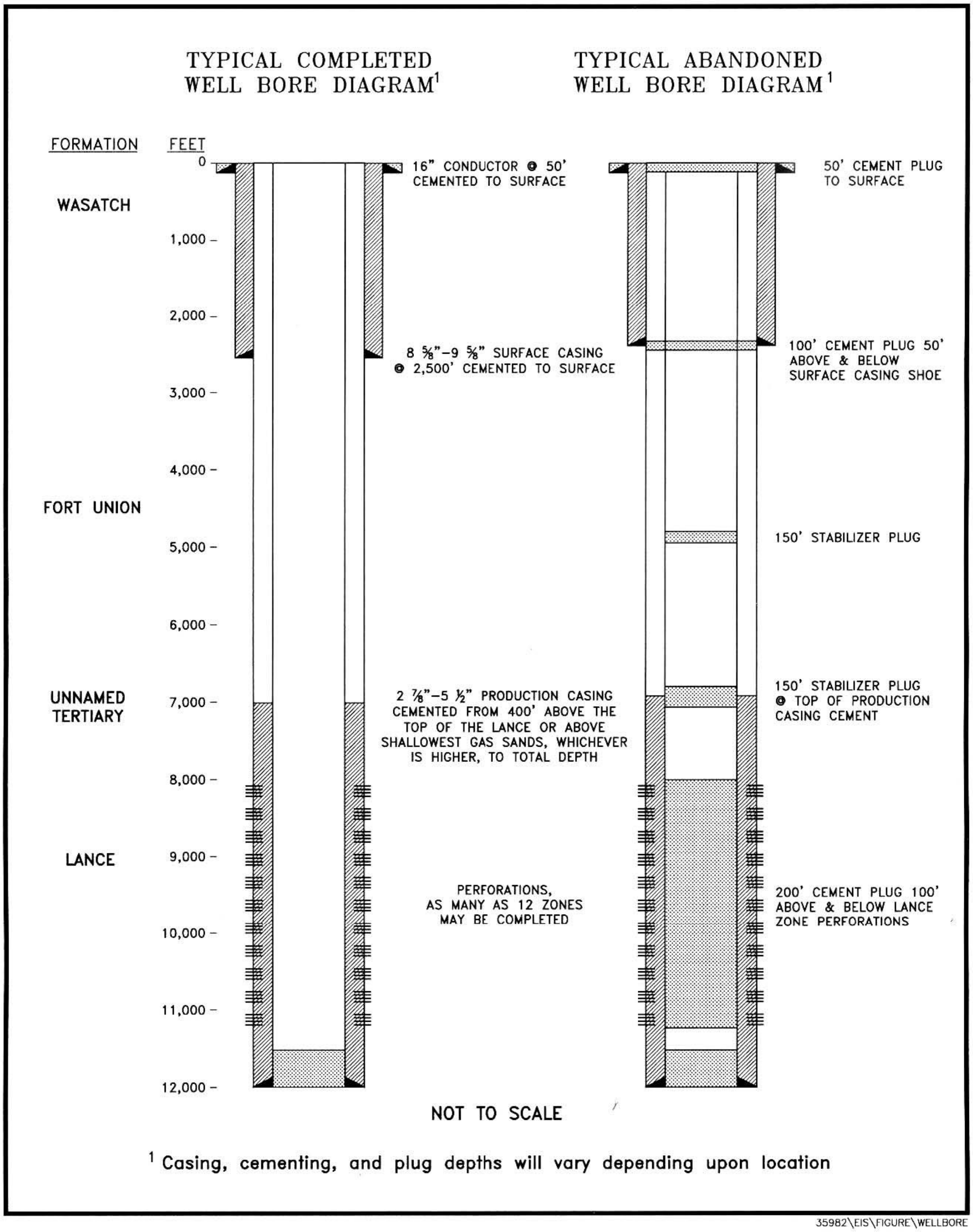


Figure 2.5. Typical Completed and Abandoned Wellbore Diagrams, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

In the past, gases and condensate produced in association with completion and testing have been diverted to an unlined flare pit and ignited (flared); however, this project will employ flareless completions unless proven to the satisfaction of the Authorized Officer, on a case-by-case basis, that flareless completion operations would not be technically or economically feasible, or would be unsafe, and that flaring completion is permitted by WDEQ. To minimize the need for flaring, a high-pressure flow-back unit designed to separate sand, condensate, natural gas, and water would be used. Sand would be piped to the reserve pit (if such pit is approved), water would be captured in a flow-back tank, and gas and condensate would be piped to the normal production unit. This process would result in the capture and sales of approximately 35 million cubic feet (mmcf) of gas and 250 bbl of condensate per well that would otherwise have been lost. Gathering pipelines must be installed prior to the utilization of flareless completions, and the gas flared must be suitable for delivery into an interstate sales pipeline.

Approximately 33,300 bbl of water (4.3 acre-feet) would be needed for completion and testing of each well, and this water would come from the same locations as specified for drilling operations (see Section 2.6). The estimated total water requirement for drilling, completion, and testing operations at each well would be 44,300 bbls (5.7 acre-feet), and 10 percent or more of this water may be from recycling operations (see Section 2.8). Water requirements for 3,100 wells are estimated to be 16,334 acre-feet, approximately 1,362 acre-feet per year over a 12-year development period (250 well/year) case.

Completion and testing would require 11 workers for 35 days (Table 2.2), and workers would likely be from Rock Springs, Big Piney, or LaBarge.

If reserve pits are approved, Operators would remove/vacuum fluids from reserve pits within 60 days of all wells on the pad being put into production. If this timeframe is infeasible on a particular site, the Operators would notify the JIO and fluids would be removed as soon as practical. Off-lease disposal of fluids would be in strict accordance with all appropriate rules and regulations regarding the discharge, transport, and/or disposal of such fluids.

Reclamation of disturbed areas not needed for production would occur as specified in APDs and, upon completion, each vertical well pad would require approximately 0.9 acre of LOP disturbance. From 1.5 to 3.0 acres of LOP disturbance would be required for each multiple well pad.

2.8 Production Operations

After well completion, production equipment would be set, gathering pipelines installed, and the well placed on line, with production continuing as long as the well is capable of commercial production and a demand for the gas exists (estimated at about 40 years per well). Production equipment typically would include a “Christmas tree” at the wellhead (a series of valves designed to control pressures and regulate flows from the well); separators to segregate natural gas, condensate, and water; aboveground tanks for condensate and produced water storage with emission controls to lower volatile organic compounds (VOCs) where required by Wyoming DEQ; a methanol tank and pump; a glycol dehydrator and pump; and a meter run for measurement of gas volumes produced into the pipeline. More tanks or larger tanks would be required at multiple well pads. As gas production declines from wells, so does condensate and water production, and, over time, condensate and water tanks may be removed from well pads and/or smaller tanks may be installed to accommodate reduced storage requirements for condensate and produced water.

All aboveground production facilities would be painted a standard environmental color (e.g., Carlsbad Canyon) that blends with the surrounding landscape, except for structures that require safety coloration to comply with Occupational Safety and Health Administration (OSHA) regulations. A typical production facility layout is shown in Figure 2.6.

Natural gas production from wells in the JIDPA is expected to range from 0.5 to over 5.0 mmcf per day (mmcfpd), with average production field-wide expected to be 2 to 3 mmcfpd per well. As wells age, produced gas volumes would decline. Gas composition data is provided in Table 2.3. No hydrogen sulfide is known to occur in natural gas from the JIDPA, and none is expected to be encountered during project operations.

Condensate production from each well is expected to average from 5 to 45 bbl/day (i.e., approximately 9 to 10 bbl/mmcf of gas produced). Condensate constituents are shown in Table 2.4. Condensates would be stored in tanks at each well location, and all tank batteries would be bermed to contain 110 percent of the volume of the largest tank. Condensates would be removed from storage tanks on a periodic basis as needed and transported by truck for sale. Best available control technologies (BACTs) would be used to reduce VOC emissions from condensate storage tanks pursuant to WDEQ/AQD rules and regulations.

Water production volumes from natural gas wells initially start at about 5 bbl per mmcf of gas for about a 3-month period, then drop to about 2 bbl/mmcf thereafter. Water quality data for various samples, including produced water samples, are provided in Table 2.5. As a reference, WDEQ Class III standards (minimum levels acceptable for livestock use) are provided, but have no bearing on or relationship with produced water quality and content. Water would be removed from the gas stream by the separators and dehydration, would be stored in a tank(s) at each location, and would be periodically removed and recycled or disposed of in accordance with BLM/WOGCC/WDEQ rules and regulations. Produced water would be transported to approved disposal or treatment sites.

A produced water disposal system is currently in operation on state surface in the JIDPA (see EIS Map 1.2). The system consists of an oil separation facility and a series of lined surface pits. During the summer, the primary means of disposal is evaporation, which is enhanced by the use of a spray system to atomize the water. During the winter, water not recycled or injected into disposal wells may be frozen into large mounds of ice. During the freezing process the water is ionically separated into fresh water, and a brine solution that is pumped off for storage and ultimate evaporation at the facility. The fresh water is stored as ice during the winter, and when it thaws in the spring, it is put to beneficial use (e.g., road watering).

Alternative water handling uses are currently being developed that eliminates the need for some water disposal. Because produced water quality has steadily improved as a result of eliminating potassium chloride as a base fluid for fracturing, considerable volumes of water can now be recycled and reused. During the drilling phase of a well, produced water is used by some Operators to drill from the surface casing (below fresh water zones) to the top of the Lance Formation. On average 4,700 bbls of produced water are recycled and used during the drilling of a vertical well; however, this amount may range from 2,000 to 12,000 bbls depending on well depth, time of drilling, and water loss problems. The quantity of water needed is increased with directional drilling due to increased drilling duration, increased total drill bore lengths and volumes, increased drilling mud volume requirements, and other requirements.

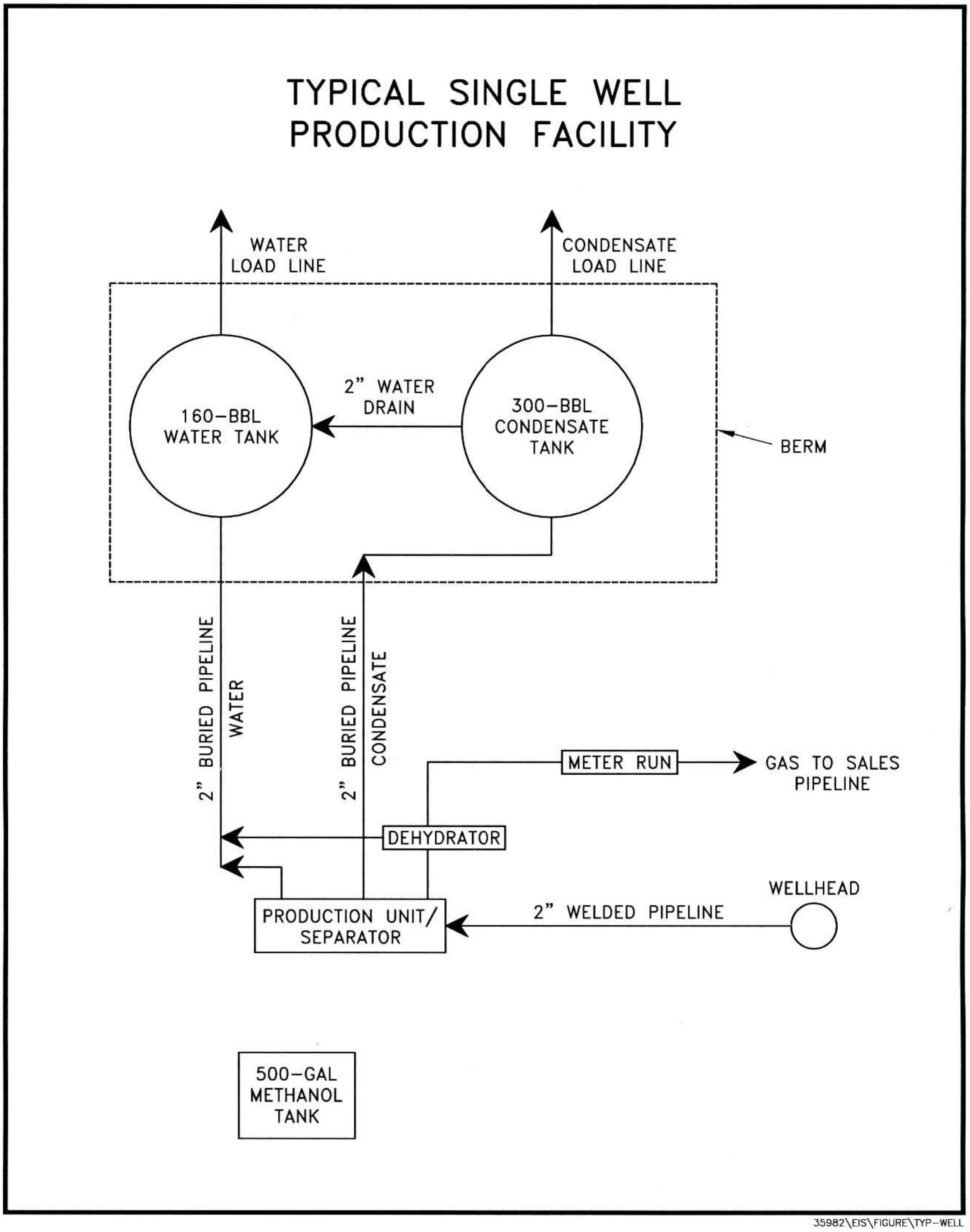


Figure 2.6. Typical Production Facility Layout, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Table 2.3. Natural Gas Composition Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Component	Percentage by Weight
Carbon Dioxide	1.33
Hydrogen Sulfide	0.00
Nitrogen	2.21
Methane	77.90
Ethane	8.66
Propane	4.21
Isobutane	1.26
n-Butane	1.23
Isopentane	0.58
n-Pentane	0.41
Cyclopentane	0.00
n-Hexane	0.18
Cyclohexane	0.11
Other Hexanes	0.31
Heptanes	0.53
Methylcyclohexane	0.19
2,2,4 Trimethylpentane	0.0011
Benzene	0.054
Toluene	0.085
Ethylbenzene	0.0040
Xylenes	0.04
C8+ Heavies	0.70
Total	100.00

[1] Data provided by EnCana.

Table 2.4. Condensate Constituent Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Component	Percentage by Weight
Ethane	0.11
Propane	0.87
Isobutane	1.27
n-Butane	2.04
Neopentane	0.11
Isopentane	2.73
n-Pentane	2.82
2,2-Dimethylbutane	0.24
2,3-Dimethylbutane	0.76
2-Methylpentane	2.35
3-Methylpentane	4.76
n-Hexane	3.64
Heptanes	19.76
Octanes	29.35
Nonanes	18.61
Decanes plus	10.57
Other[2]	0.01
Total[3]	100.00

[1] Data provided by EnCana.
[2] Includes methane, nitrogen, and carbon monoxide.
[3] Includes benzene (1.12%), toluene (4.84%), xylene (5.59%), and 2,2,4-trimethlypentane (0.34%), which are contained within some of the listed components.

Table 2.5. Average Water Quality from Natural Gas Wells, Water Wells, and the Existing Evaporation Pond and Relevant Class III Groundwater Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Water Quality Parameter	WDEQ Class III Underground water Quality Standard[2] (mg/l)	Produced Water[3] (mg/l)	Evaporation Pond[4] (mg/l)	Water Wells[4] (mg/l)
pH[5] (standard pH units)	6.5–8.5	7.49	7.80	9.69
Total Dissolved Solids (TDS)	5,000	4,527	4,752	670
Chloride	2,000	1,853	2,153	107
Sulfate	3,000	38	51	126
Barium	--[6]	<0.1	6.0	--
Boron	5	--	2.7	--
Aluminum[5]	5	4.5	--	--
Cadmium[5]	0.05	<0.001	--	--
Chromium[5]	0.05	<0.004	--	--
Copper[5]	0.5	<0.02	--	--
Iron	--[6]	<17.78	<2.09	0.17
Lead[5]	0.1	<0.34	--	--
Magnesium	--[6]	3.12	6.02	0
Mercury[5]	0.00005	<0.003	--	--
Arsenic[5]	0.2	<0.005	--	--
Selenium[5]	0.05	<0.003	--	--
Zinc[5]	25	1.8	--	--
Calcium	--[6]	292	651	0
Bicarbonate	--[6]	856	747	81
Carbonate	--[6]	355	--	110
Sodium	--[6]	1,042	1,051	245
Potassium	--[6]	--	83	--

[1] Data provided by EnCana, McMurry Oil Company, and Schlumberger.
[2] From WDEQ (1990).
[3] Average produced water concentrations from 30 natural gas wells.
[4] Evaporation pond data are from a single sample; water well data are an average from six water wells.
[5] Produced water data are averaged from four natural gas wells.
[6] -- = no WDEQ standards for Class III groundwater.

Produced water is also being used to drill out frac plugs at the end of the completion phase, using from 2,000 to 4,000 bbls per well, depending upon the conditions of the well during the operation.

Produced water is also being used by some Operators as a component of a gel system for fracture stimulation of new wells. Starting in the fall of 2003, use of produced water for fracturing has resulted in the utilization of up to nearly 100 percent of produced water volumes for some Operators. Currently, almost all of EnCana's produced water is being reused for fracture stimulation and/or drilling operations.

Slick-water fractures are also being employed for some completions. This is fresh water, with a low concentration of friction reducer, and sand without gels or cross-linker systems. The effectiveness of this technique is being evaluated from completion operations at the five wells where it has been employed.

Two water disposal wells are present in the JIDPA (6,500 feet deep/Fort Union Formation) (see EIS Map 2.1), and at least two additional disposal wells are proposed to accommodate produced water and brine disposal needs. All water disposal and underground injection wells would be developed in compliance with *Onshore Oil and Gas Order Nos. 1, 2,* and *7*, as well as WOGCC Underground Injection Control rules and regulations (WOGCC *Rule 405*) governing the subsurface disposal of water.

Supervisory Control and Automated Data Acquisition (SCADA) facilities are being established at all EnCana Oil & Gas (USA) Inc. wells and many other wells in the JIDPA. This system is designed to increase production efficiency by providing real-time operating information to field staff, including well flow rates and pressures, processing equipment operating conditions, tank levels, and emissions control equipment status. Implementation of the SCADA system reduces the number of well pad visits (and associated traffic) by 30 to 40 percent from the number of pad visits necessary without SCADA. SCADA real-time monitoring also reduces the potential for spills (tank-level monitoring) and the reliability of emissions control equipment.

Routine on-site maintenance operations at each producing well (with SCADA) generally would include worker visits every 3 days to monitor the overall operation of the well and make adjustments as required to ensure efficient operation. An average of 20 wells could be visited each day during production. Well workovers would occur every 10 to 20 years; however, workovers would not be undertaken on a set schedule, but rather on an as-needed basis to increase or maintain production from downhole producing zones or to re-complete in new zones.

A well would require a workover for any of several reasons:

- changing or replacing old tubing, rods, or pumps;
- refracturing producing formation(s) using advanced techniques designed to stimulate additional production;
- cleaning out the wellbore and perforations to stimulate/facilitate production; and
- “re-completing” in other potentially productive zones that were not originally completed at the time the well was drilled.

2.9 Pipelines

Industry-standard pipeline equipment, materials, techniques, and procedures in conformance with all applicable regulatory requirements would be employed during construction, testing, operation, and maintenance of pipelines. Depending on the location of acceptable tie-ins, gathering pipeline ROWs would be located within/adjacent to road ROWs to the greatest extent practicable, in order to minimize surface disturbance and to maximize construction and gas transport efficiency. A typical access road with adjacent gathering pipeline is shown in Figure 2.1. Pipeline trenches would generally be 2 to 3 feet wide and located 8 to 10 feet outside of the road outslopes. All trenches would be backfilled and compacted as soon as possible. To facilitate compaction, no vegetation or snow would be present in the trench during backfilling. Pipeline ROW reclamation would be initiated as soon as practical, following disturbance, in accordance with Appendix DP-B (Reclamation Plan).

All newly constructed pipelines would be tested with natural gas or water to ensure their integrity. Testing would consist of filling pipeline segments and pressurizing to levels exceeding operating pressures. If leaks or ruptures occur, they would be repaired and testing would be repeated until successful. Natural gas used for testing either would be returned to the gathering system for sales or vented to the surface in accordance with *Notice to Lessees* (*NTL*)-*4A* and/or WOGCC *Rule 340*. If fresh water would be used for pipeline testing, the water would be discharged (upon completion of the testing) to existing drainages at rates less than the existing capacity of the affected drainages in accordance with requirements of a temporary permit issued by WDEQ/Water Quality Division (WQD).

2.9.1 Gathering System Pipelines

Natural gas would be transported from well pads via buried pipelines, generally from 3 to 12 inches in diameter, to larger existing lines within the field. Pipelines generally would follow roads to minimize surface disturbance; however, where limited by topographic or other constraints, some lines may be built away from roads. The approximate width of gathering system pipeline ROWs would be 35 feet outside of and adjacent to road ROWs (50-foot total pipeline ROW width), and an average 0.15 mile of buried pipeline would be required per well pad. Where multiple wells are developed at a single well pad, only one gathering system pipeline would be necessary.

2.9.2 From-field Transport Pipelines

Two existing pipelines within a single corridor are currently being used to transport natural gas from the JIDPA. No additional pipelines from the field are currently proposed; however, in the event new transport pipelines are proposed, further pipeline-specific National Environmental Policy Act of 1969 (NEPA) analyses would be implemented.

2.10 Compressor Stations

While not specifically proposed for this project, with the anticipated increase in gas production from the JIDPA and other nearby natural gas fields (e.g., Pinedale Anticline), additional pipeline compression needs have been identified. No new compressor stations would be built, but existing stations in the area would be expanded. Table 2.6 provides a listing of the primary stations utilized for JIDPA gas transport, as well as their existing permitted compression horsepower and anticipated expansion requirements. A total of approximately 33,844 horsepower of new compression is anticipated in part as a result of this project.

2.11 Abandonment and Reclamation

At the end of a well's useful life, Operators would obtain all necessary authorizations from the BLM or WOGCC to abandon the well. All aboveground facilities would be removed, and all unsalvageable materials would be disposed of at authorized sites. Wells would be permanently plugged according to BLM and/or WOGCC requirements, including 43 CFR 3162.3-4 and *Onshore Oil and Gas Order No. 1*. Pipelines would be purged of combustible materials and abandoned in place or removed, based on landowner specifications. Abandoned well pads, roads, and other disturbed areas would be restored to near pre-disturbance condition and revegetated according to the specifications of the BLM or private landowner, the Reclamation Plan (Appendix DP-B), and/or as specified in the APD or ROW grant, unless they are determined to be left in place by the BLM or private landowner. All disturbed surfaces would be recontoured to their approximate original contours, with reclamation of the well pad and access road performed as soon as practicable after final abandonment.

Table 2.6. Existing and Anticipated Compression Requirements (Horsepower), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Compression Status	Compressor Stations					Total
	Bird Canyon[1]	Luman[2]	Yellow Point[3]	Jonah Field[4]	Falcon[5]	
Existing Permitted	15,746	18,340	1,121	4,899	11,736	51,842
Anticipated Future	11,004	11,604	0	3,900	7,336	33,844
Total	26,750	29,944	1,121	8,799	19,072	85,686

1 Duke facility at NW¼, Section 34, T27N, R111W, southwest of the JIDPA.
2 Duke facility at NE¼, Section 24, T28N, R109W, just south of the JIDPA.
3 Duke facility at NE¼, Section 13, T28N, R109W, in the JIDPA.
4 Mountain Gas facility at Section 34, T29N, R108W, in the JIDPA.
5 Duke facility at SW¼, Section 36, T29N, R108W, just north of the JIDPA.

2.12 Hazardous Materials

All procedures identified in Appendix DP-C of this document (Hazardous Material Management Summary) would be applied for this Project.

During the course of routine oil and gas production operations, minor leaks, spills, and other accidental releases of crude oil and condensate may occur, thereby creating hydrocarbon-impacted soils. While the surface use lease may allow for the temporary storage and treatment of oil-contaminated soils on well pads, some Operators discourage this practice.

As a Best Management Practice, one Operator plans to transport, accumulate, and treat these contaminated soils at a new bioremediation facility dedicated solely to soils remediation (EnCana 2003). This proposed ancillary facility would be located on state surface in the SW¼ NE¼, Section 36, T29N, R108W. The dimensions of the facility would be 200 by 200 feet. Containment berm walls 2 feet high by 4 feet wide would be located on the east, south, and west perimeters of the pad to contain stormwater runoff. Erosion controls would be installed on the soil berms and pad shoulders to maintain their integrity, and walls and shoulder would be revegetated during operations. All-weather, year-round access to the facility would be maintained, and the facility would be gated and locked.

Point sources for hydrocarbon-impacted soils are wellhead and production battery spills and releases, as well as gas and flow line leaks. The typical range of hydrocarbon contamination, expressed as total recoverable petroleum hydrocarbons (TRPH), ranges from <500 parts per million (ppm) to >20,000 ppm, depending on such factors as spill volume, exposure time, and weather.

Hydrocarbon-impacted soils would be treated at the facility by enhancing hydrocarbon degradation with indigenous bacteria. Impacted soils would be placed in windrows approximately 10 feet wide by 120 feet long and 24 inches deep. On a scheduled basis, the soil mass in each windrow would be turned to continually expose soil mass layers to oxygen, moisture, and sunlight. No tillage of the soils would occur during periods of high winds or when surface conditions would create fugitive dust emissions.

Impacted soils received at the facility that reflect hydrocarbon concentrations in excess of 20,000 ppm TRPH would be blended with soils exhibiting lower hydrocarbon concentrations to avoid pockets of high hydrocarbon concentrations in soil masses.

When an individual windrow is filled to designated dimensions and volumes, hydrocarbon concentrations would be periodically measured using an organic vapor meter (OVM). When OVM readings indicate that hydrocarbon concentrations have dropped to <1,000 ppm, a composite sample of the soil mass would be collected for TRPH analysis. When TRPH concentrations have dropped below WOGCC TRPH concentration limits, the soil mass would be removed from the facility for recycling under a variety of uses approved and stipulated by the WOGCC. The primary use of remediated soils from this facility would be construction-related (e.g., road grades).

Notice of any spill or leakage, as defined in BLM *NTL 3A*, would be immediately reported by the Operator to the BLM and other federal and state officials (e.g., WDEQ) as required by law. Verbal notification would be given as soon as possible but no later than 24 hours after the discovery of the incident. Verbal notification would be confirmed in writing within 15 days or other such time required by the appropriate regulatory agency. Any release of hazardous substances (leaks, spills, etc.) in excess of the reportable quantity, as established by 40 CFR 117, would be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended (42 *United States Code* [USC] 9601 et seq.). If the release of a hazardous substance in a reportable quantity does occur, a copy of the report would be furnished to the BLM and all other appropriate federal and state agencies.

Additionally, all work sites and work activities in the JIDPA would be in compliance with OSHA rules and regulations, including OSHA regulation 49 CFR 1910.1028 (benzene).

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APPENDIX DP-A

TRANSPORTATION PLAN, JONAH INFILL DRILLING PROJECT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

and

Rock Springs Field Office
Rock Springs, Wyoming

Prepared by

TRC Mariah Associates, Inc.
Laramie, Wyoming

Revised and Updated by

SWCA Environmental Consultants
Phoenix, Arizona

January 2006

PREFACE

The Transportation Plan for the Jonah Infill Drilling Project was originally drafted by TRC Mariah Associates Inc. of Laramie, Wyoming, and published as an appendix to the *Jonah Infill Drilling Project Draft Environmental Impact Statement* in February 2005. The plan was subsequently revised and updated at the direction of BLM by SWCA Environmental Consultants of Phoenix, Arizona.

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ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
APD	Application for Permit to Drill
BLM	Bureau of Land Management
EIS	Environmental impact statement
HS-20	Refers to the AASHTO truck type and axle load rating
I-80	Interstate 80
JIDPA	Jonah Infill Drilling Project Area
LOP	Life-of-Project
Operators	Oil and gas and pipeline companies
ORV	Off-road vehicle
PFO	Pinedale Field Office
RMP	Resource Management Plan
ROW	Right-of-way
RSFO	Rock Springs Field Office
TP	Transportation Plan
TPA	Transportation planning area
TRC Mariah	TRC Mariah Associates Inc.
WDOT	Wyoming Department of Transportation

DP-A-1.0 INTRODUCTION

DP-A-1.1 Objectives

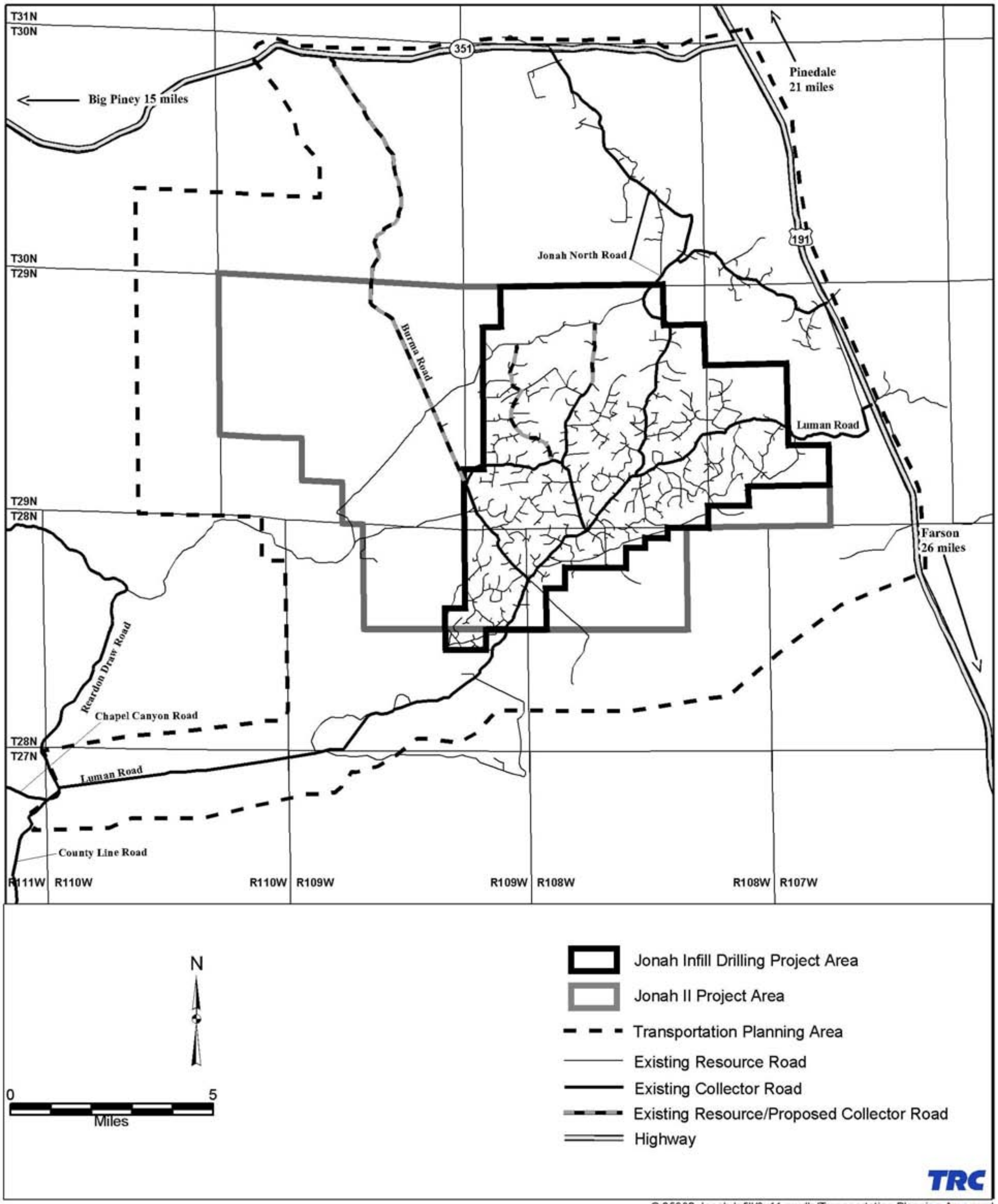
This Transportation Plan (TP) was prepared to supplement a proposal by oil and gas companies (Operators) to drill new wells in the Jonah Infill Drilling Project Area (JIDPA), as described in the JIDPA environmental impact statement (EIS). This TP provides an assessment of future road development and use in and around the JIDPA and of potential impacts to the existing transportation system, and provides a basis for future oil- and gas-related exploration and production transportation planning within the area.

The transportation planning area (TPA) includes the JIDPA plus adjacent areas that include roads that may be used to access the JIDPA (Map DP-A-1.1). The TPA includes U.S. Highway 191 (1.5 to 10.0 miles east of the JIDPA) and State Highway 351 (6 miles north of the area). More detailed maps of the TPA are available for review at the Bureau of Land Management (BLM) Pinedale Field Office (PFO) and Rock Springs Field Office (RSFO).

This TP deals primarily with corridors for proposed local and collector roads on and adjacent to the JIDPA. The EIS discusses the projected well development within the area and associated impacts due to the development. Localized planning for each new well location would be necessary, and this document and applicable transportation codes and standards would be used in localized planning efforts. Operational updates would be made during project development to detail specific localized transportation networks, if deemed necessary by the BLM. All new or upgraded roads in the TPA would incorporate the general provisions of this planning document.

The objectives and content of this TP are listed and discussed below.

- The annual operational update process is described, including scheduling and responsibilities.
- Existing roads in the JIDPA are described, and primary routes (i.e., project-required collector and local roads) are identified on maps. High-traffic-volume roads (i.e., local or collector roads) and resource, two-track, and other unimproved roads are also discussed.
- Existing roads and road corridors that may be used as collector or local roads for the proposed project are identified.
- Existing natural gas pipelines in the JIDPA are shown, and pipeline development actions are presented.
- Natural transportation obstacles (e.g., steep terrain, drainages) and environmentally sensitive areas (e.g., sage grouse leks, raptor nests) are identified. These areas would be avoided, where practical, when determining the location of future high-traffic-volume transportation routes.
- Soils in the JIDPA are identified, and their limitations for project operations are presented. A brief description of field evaluation and observation methods for determining if a soil may have erosion, stability, or other problems is also presented.
- Road types are discussed by functional classification. Standard road surface, construction-related disturbance, and right-of-way (ROW) widths are provided in the EIS.
- Maintenance and other agreements are discussed.



Map DP-A-1.1. Transportation Planning Area and Existing Road Network.

This document was originally prepared for the BLM by TRC Mariah Associates Inc. (TRC Mariah) and subsequently revised and updated at the direction of BLM by SWCA Environmental Consultants.

DP-A-1.2 Scope

The scope of this TP includes a description of the existing road network, the general locations of proposed high-traffic-volume roads and corridors, and definitions of the road types. Relevant requirements for road construction or upgrading are identified. A working plan is outlined to help determine the procedures for planning a road to serve a proposed well, or group of wells, and the development of agreements for use and maintenance are outlined.

This plan also applies to the transportation of gas, condensate, or water via pipelines within the area. Pipelines generally would be located adjacent to roads to reduce the total amount of new surface disturbance. However, this design may complicate route selection, and in some instances, lead to increased environmental impacts. If this occurs, pipelines would be located along alternative routes.

Existing and improved access roads to the JIDPA are under the jurisdiction of the BLM, who approves their design and requires their maintenance. Most roads within the JIDPA also are under the jurisdiction of the BLM, and maintenance of these roads is conducted by Operators. This document describes the responsibility for road maintenance, and the type of maintenance is discussed generically (see Section DP-A-7.0). Operators would provide the BLM with copies of road maintenance agreements that include the name of a designated contact person. Non-oil-and-gas roads would be maintained by the BLM or other ROW holder.

DP-A-1.3 Limitations

- The condition (e.g., road design, upgrading requirements) and maintenance status (e.g., plowed) of existing roads and casual routes in the transportation network are identified on detailed maps available at area BLM offices. Many existing roads may not be passable during inclement weather or during winter months. All roads developed for this project would need upgrading, maintenance, and winter snow removal. Specific road upgrading and maintenance responsibilities would be identified annually under the direction of the BLM.
- Due to the sensitivity of paleontological and historic/cultural resources, the known locations of these resources on and adjacent to the JIDPA are not provided. Further detail on paleontological and historic/cultural resources would be collected prior to road development as a component of the Application for Permit to Drill (APD) and/or ROW application process.
- The transportation network described in this document is focused on local and collector roads and potential road corridors; however, existing low-traffic-volume resource roads and unimproved roads also are identified on the detailed maps available for review at the BLM PFO and RSFO.

DP-A-2.0 Public Involvement/Transportation Plan scoping

Transportation issues and concerns were identified during the preparation of this and other regional oil and gas development EISs. The BLM PFO requested public and agency input on the Jonah Infill Drilling Project in April and December of 2003 through scoping letters, press releases, and telephone calls to potentially affected area users and management agencies. Those contacted include Operators; local and regional media sources; federal, state, and local government representatives; state and county transportation departments; the Wyoming Game and Fish Department and other state offices; recreation and conservation groups; livestock permittees; and other potentially affected entities. A complete list of contacts can be obtained from the BLM PFO.

All comments received during the scoping process were considered in developing this TP. Comments included the following.

- Roads should not be overdesigned.
- Pipelines should parallel roads.
- Pipelines and power lines should be buried.
- Unburied pipelines can spook horses and make off-road travel more difficult.
- Undesirable conditions along two-track roads (e.g., poor drainage crossings) should be repaired, and these roads should be eliminated if another road accesses the same area.
- Two-track roads that are not used and which can be reclaimed should be identified.
- Two-track roads should not be eliminated.
- Access to two-track roads from high-traffic-volume, crowned-and-ditched roads should be maintained.
- High-traffic-volume, crowned-and-ditched roads should be constructed such that vehicles with horse trailers can pull off the road at regular intervals and avoid parking in borrow ditches.
- Livestock and wildlife watering areas should be avoided.
- Cattle guards should be cleaned out annually prior to May 1.
- Sand Draw and a 300-foot buffer (either side) should be avoided.
- Greater sage-grouse leks and associated buffers should be avoided.
- Noise impacts to greater sage-grouse should be considered.
- Greater sage-grouse and mountain plover surveys should be conducted to better define desirable road corridors.
- Development impacts to greater sage-grouse should be thoroughly evaluated and the following commitments made: 1) to adopt a policy of no surface disturbance within 3 miles of occupied leks, and 2) to require road closures (permanent or seasonal) where oil and gas production is permitted.
- All off-road motorized travel in areas with threatened, endangered, proposed, candidate, and BLM Wyoming-sensitive species should be prohibited.
- A 1.0-mile disturbance-free buffer should be applied around bald eagle nests and winter roosts, or, if not practical, activity should be conducted outside of February 15–August 15 to protect nesting birds and November 1–April 15 to protect roosting birds.
- Mule deer winter range west of the JIDPA and east of the Green River may be impacted if access to the JIDPA is through Reardon or Chapel canyons.

- The use of north/south-oriented roads should be maximized to accommodate pronghorn antelope movements.
- The impacts of the project on wildlife deaths due to increased traffic and animal/vehicle collisions should be addressed.
- Negative impacts of the road network on wildlife habitat, increased poaching, diminished enjoyment for hunters, visual impacts, and undue stress on wildlife during critical times of the year should be identified.
- To protect migratory animals: 1) no surface occupancy should be allowed in severe winter relief ranges for mule deer and pronghorn; and 2) a minimum buffer zone of 200 meters should be used for wells and roads until ongoing studies are completed and recommendations based on study results can be made.
- Overwinter fawn survival may decrease in response to human activity or other disturbances causing increased energy expenditure.
- Research has consistently documented avoidance by elk of roads open to vehicular traffic during the spring, summer, and fall months. The effects of open roads on mule deer and pronghorn are less understood.
- Animal-vehicle collisions can be a major source of ungulate mortality.
- Under the PFO and RSFO Resource Management Plans (RMPs), wells may be drilled during the summer months in crucial winter ranges and then maintained through the winter. Traffic associated with maintenance and general road traffic may continue to disturb big game in these areas, especially in the spring, when big game energy reserves are typically low.
- Limits on the density of wells and roads within important ungulate habitats as determined through monitoring and research efforts should be set.
- The TPA boundary should be extended westward to the Green River and southward to the Sweetwater County line.
- The use of looped roads should be minimized to avoid increased traffic.
- Turnout lanes and adequate site distances should be considered for existing and future high-traffic-volume road junctions with existing highways.
- All roads developed for this project should be reclaimed when they are no longer required.
- Sublette County has no interest in acquiring any of the roads developed for this project.
- The ultimate road situation (i.e., after the project is completed) should be similar to predevelopment (pre-1990).
- The majority of large trucks currently access the JIDPA using the Luman Road, and the Luman Road should remain as the principal access road for large vehicles.
- The Burma Road currently is seldom used by large vehicles and should remain as such.
- Improvements to the Burma Road should include widening, installation of a new cattle guard and culvert, and appropriate surfacing.
- Close the Burma Road or leave it unimproved if additional access to the JIDPA is provided from the northeast.
- The southwest access to the JIDPA is used primarily by light-duty trucks.
- A road and pipeline corridor southwest of the JIDPA would be required for the Life-of-Project (LOP), and an additional road and pipeline corridor may be required north of the JIDPA.

- No new road construction should be authorized; wells could be built along existing improved roads.
- Limit habitat fragmentation, protect current roadless areas, provide for aggressively closing of unnecessary or ecologically destructive roads, and provide for maintaining needed roads to reduce negative impacts.
- The TP should require adequate design considerations to minimize impacts and provide orderly and safe traffic movement. The plan should include dust mitigation measures and siltation barriers, and the county should use tax revenues obtained from gas production to pave primary field access roads, similar to the policy of paving roads for energy development in Campbell County.
- Ensure that no cross-country vehicle travel is allowed in known habitat or locations of BLM Wyoming-sensitive plant species within the JIDPA.
- New technologies designed to reduce project impacts should be tested during development and implemented as appropriate.

DP-A-3.0 ROAD ROUTE DESCRIPTIONS

Two paved all-weather roads currently provide access to the TPA: U.S. Highway 191 and Wyoming State Highway 351. The remainder of the roads is not paved. Most unpaved project-required roads are now appropriately surfaced (e.g., gravel, aggregate) to be passable when wet and during winter, and improvements and maintenance including snow removal are regularly performed. In addition, some realignment of these routes may occur to minimize impacts to sensitive resources, to ensure safety, and to maximize traffic flow efficiency. Map DP-A-1.1 and the detailed maps available for review at BLM offices show the location of all existing roads including collector and local road routes with the highest traffic volumes on the TPA.

The following sections briefly describe the location and status of the road routes on the TPA used to access the JIDPA and in-field development sites. Any new roads and necessary improvements and realignments to existing routes would be developed in accordance with BLM standards, and all routes would be selected to ensure safety, to maximize transportation efficiency, to avoid sensitive environmental resources, and to minimize road densities.

DP-A-3.1 U.S. Highway 191

U.S. Highway 191 is the primary transportation corridor currently linking the JIDPA (at the Luman Road) to regional communities (e.g., Pinedale, Rock Springs). U.S. Highway 191 has an average of 1,460 vehicles per day from the Sweetwater County line to State Highway 351, and approximately 1,300 vehicles travel north from State Highway 351 to Boulder, Wyoming, each day (personal communication, November 17, 2003, with Sherman Wiseman, Transportation Survey, Wyoming Department of Transportation [WDOT]). U.S. Highway 191 recently has been improved over much of its length between Interstate 80 (I-80) and State Highway 351, and a turnout at the Luman Road junction has been developed. No future JIDPA access points along U.S. Highway 191 are anticipated; however, any potential new access roads junctions would be developed in consideration of sight distances and may require turnout lanes. These actions would be coordinated with the WDOT. Special arrangements would be made with WDOT to place road signs along this road to increase awareness of potential driving hazards and increase employee and public safety. These signs may include, but would not be restricted to, school bus stops, up-coming turn markers (i.e., Luman Road), animal crossings, etc.

DP-A-3.2 Wyoming State Highway 351

Wyoming State Highway 351 runs east/west approximately 6 miles north of the JIDPA. This road provides access to the JIDPA via the Burma and Jonah North roads primarily for the traffic traveling from the Big Piney/Marbleton area. State Highway 351 traffic has increased from 700 vehicles per day in 2002 to 1,200 vehicles per day in 2003 and is scheduled for improvement in 2010 (personal communication, September 9, 2003, with Bob Maxam, Resident Engineer, WDOT, Pinedale). Turnout lanes and sight distances would be considered at the Burma Road and Jonah North Road junctions and at any future access points, and this action would be coordinated with WDOT. Special arrangements would be made with WDOT to place road signs along this road to increase awareness of potential driving hazards and increase employee and public safety. These signs may include, but would not be restricted to, school bus stops, up-coming turnmarkers (i.e., Burma Road and Jonah North Road), animal crossings, etc.

DP-A-3.3 Luman Road

The existing unpaved Luman Road links the JIDPA to U.S. Highway 191 east of the area and is the primary field access route. This road is a local/collector road, is gravel/aggregate-surfaced, and is regularly treated with magnesium chloride from its junction with U.S. Highway 191 through the JIDPA. The Luman Road has been improved through the JIDPA and continues to the southwest to its junction with the existing County Line Road. Access to the JIDPA from the southwest would be restricted to the Whelan Bridge near LaBarge to avoid increased traffic in Reardon and Chapel canyons. Additional improvement and maintenance work on the Luman Road would be performed by operators under the jurisdiction of the BLM. It is anticipated that, at field abandonment, the Luman Road would remain in an upgraded condition. Multiple subsurface gas sales pipelines currently exist along the Luman Road. These pipelines may be replaced with larger pipelines or additional pipelines may be constructed. Since no new pipelines are currently proposed from the JIDPA, further pipeline development would require another environmental analysis.

DP-A-3.4 Burma Road

The Burma Road extends 12 miles south from Wyoming State Highway 351 to the JIDPA. An upgrade to the Burma Road to allow for additional access to the field from the northwest is being considered for this project under some alternatives. Upgrade improvements would likely include straightening, widening, and surfacing. Additionally, the approach to State Highway 351 would be widened and paved, and a new cattle guard and culvert would be installed. Improvements would be planned and built according to BLM standards. At field abandonment, the entire route would be reclaimed to conditions approximating those currently existing in the area unless there is an identified need for the improved road by other area users.

DP-A-3.5 Jonah North Road

The Jonah North Road begins at Wyoming State Highway 351 (approximately 4.7 miles west from the U.S Highway 191 junction) and extends 7 miles south into the JIDPA. This road has collector road status and has been gravel/aggregate-surfaced. No further improvements are currently scheduled, and any additional road upgrades/improvements would be planned and built according to BLM standards under the analyses provided in the *Pinedale Anticline Environmental Impact Statement* (EIS) (BLM 2000). The road is regularly treated with magnesium chloride to control fugitive dust. At field abandonment, the entire route would be reclaimed unless there is an identified need for the improved road by other area users.

DP-A-3.6 Additional Local and Resource Roads and Gathering Pipelines

Additional local and resource roads and gathering pipelines would be constructed in the JIDPA as necessary to accommodate new wells, and these routes would be specified in annual operational updates. Where any new roads are shown to duplicate existing two-track roads, the existing two-track would be reclaimed unless it is deemed necessary for other area activities (e.g., livestock operations). At field abandonment, it is anticipated that most, if not all, newly constructed local and resource roads would be reclaimed unless there is an identified need for the road by other area users.

DP-A-4.0 EXISTING AND PROPOSED TRANSPORTATION NEEDS

DP-A-4.1 The Existing Network

The existing transportation network on the TPA is shown on Map DP-A-1.1. This system includes four primary access roads: the Luman Road, which connects the JIDPA to U.S. Highway 191 east of the JIDPA; the County Line Road southwest of the area; the Burma Road, which runs north from the JIDPA to State Highway 351; and the Jonah North Road, which connects the northeastern edge of the field north to State Highway 351. Historic use of the roads has been limited primarily to livestock operators and recreationists (e.g., hunters, off-road vehicle [ORV] users). The principal current use of these and other roads in the area is for oil- and gas-related traffic. The existing transportation system is generally suitable for all current users.

The Luman Road is utilized by all user groups, receives more use by large vehicles than any other road in the area, and is the most heavily used road in the area. Most use of the Luman Road occurs in the JIDPA and eastward to U.S. Highway 191; however, access from the southwest is suited for all-weather traffic. Vehicles currently traveling the route from the southwest may access the route from Whelan Bridge in LaBarge or from Five Mile Bridge south of Big Piney and east up Reardon or Chapel canyons. Existing traffic primarily uses the Whelan Bridge. Most of the heavy vehicle traffic in the JIDPA travels the Luman Road to U.S. Highway 191 and is for oil- and gas-related activities.

The Burma Road is traversed by all users, but is currently not well suited for all-weather travel or large vehicles. The road receives less use than the Luman Road; however, there is a moderate amount of heavy truck use during dry weather.

The Jonah North Road is traversed by all users as an all-weather travel and large vehicle access route. The road receives less use than the Luman Road; however, there is a moderate amount of heavy truck use during dry weather.

Undesignated two-track roads also may be used for access. These routes are used primarily by grazing permittees and recreationists and are prohibited for use by Operators except in emergencies. Grazing permittees primarily use the two-track roads to access water developments.

DP-A-4.2 Proposed Network Use or Modification

The typical stages of a trip necessary for use of the JIDPA transportation system are listed below:

- main movement (i.e., U.S. and state highway lanes for workers with destinations terminating in the JIDPA);
- transition (i.e., turnout lanes, where there is a change in travel speed);
- distribution/collection (i.e., oil/gas field unit or ranch access roads, collector and local roads); and
- terminal access (i.e., well location access roads, resource roads).

When planning transportation facilities, all of the described traffic stages can be identified within the system, but any stage could be eliminated if not needed (e.g., intermediate stages may not be necessary). Each movement stage is handled by a separate facility designed specifically for its function. Identifying the stages helps to plan traffic flows.

The TPA transportation network may experience problems at traffic stage changes due to the relatively high volume of expected traffic. Estimated traffic requirements for the Jonah Infill Drilling Project are provided in Tables DP-A-4.1 through DP-A-4.3 and are summarized in Table DP-A-4.4. Construction, drilling, and completion activities have the greatest traffic requirements (an estimated 810 to 850 round trips per well over a 90- to 94-day period). For the entire field, average daily traffic during development is expected to range from 172 to 189 vehicles per day primarily on the Luman Road (Table DP-A-4.5). All well development activities are anticipated to require from 13 to 42 years to complete, depending upon the total number of wells developed and the pace of development (Table DP-A-4.6).

Localized construction and drilling activity would temporarily place heavy demands on road servicing. Traffic demands would be high in areas where drilling and completion activities are occurring throughout the development period (5 to 42 years), but would be reduced within other areas of the JIDPA and once development is completed. Once all wells have been developed, traffic requirements would remain high for the remainder of the LOP (i.e., averaging between 492 and 552 vehicles per day) (see Table DP-A-4.5). JIDPA roads would be used continually until all wells in the area are abandoned and disturbed areas reclaimed. For the entire LOP under the various potential development scenarios (i.e., 43 to 85 years) overall traffic requirements are anticipated to range from 312 to 610 vehicles per day (see Table DP-A-4.5).

DP-A-4.3 Ultimate Road Disposition

When the field is ready for abandonment (estimated to be approximately 43 to 85 years from authorization), the transportation network within the TPA would be reclaimed to appear much as it did prior to development. Roads identified as necessary or desirable for other area users (e.g., grazing permittees, recreationists) may be retained with improvements.

Resource roads that may be retained after the LOP would be those that were identified during transportation planning as duplicating an existing two-track or other low-traffic-volume road, for which these two-track or other roads were reclaimed. In addition, resource roads that are deemed necessary by the BLM for other area uses also may be retained.

The Luman and Burma Roads may be retained after project completion in an upgraded status, depending on the alternative selected. All other project-required roads are anticipated to be entirely reclaimed or returned to conditions similar to those occurring on the area prior to development.

Road use following project completion likely would be limited to two of the three existing uses (i.e., grazing management and recreation), and responsibility for maintenance of roads would revert back to the BLM. A determination regarding the extent of post-project road maintenance (e.g., winter snow removal) cannot be determined at this time since the level of future area use is unknown. Decisions would be made during the later years of the project based on public input.

Table DP-A-4.1. Vehicle Characteristics and Number of Trips for a 3,100 Wells on 3,100 New Well Pads Project

Construction Activities/Vehicle	Average Weight × 1000 lbs[1]	No. of Wheels	Average Speed on Collector Road	Average Speed on Resource Road	Round Trips Per Well Pad or Well	Total Project Round Trips[2]
Well Pad/Access Road						
Gravel/Haul Trucks[3]	35	18	20	15	8	24,800
Light Trucks/Pickups[3]	7	4	30	20	12	37,200
Drilling (vertical)						
Semi	44 (28-60)	18	20	15	140	434,000
Logging/Mud Trucks	48	10	20	15	10	31,000
Roustabouts	20	6	30	20	20	62,000
Vendors/Marketers[4]	7	4	30	20	30	93,000
Completion Traffic						
Semi/Transport/Water/ Sand	54 (28-80)	18	20	15	350	1,085,000
Large Haul Trucks	48	10	20	15	50	155,000
Small Haul Trucks	20	6	20	15	30	93,000
Light Trucks/Pickup	7	4	30	20	140	434,000
Pipeline Construction						
Haul Trucks[5]	54 (28-80)	18	20	15	8	24,800
Light Trucks/Pickups[5]	7	4	30	20	12	37,200
Subtotal Development					810	2,511,000
Production Activities						
Workover Rig	90	18	20	15	3	9,300
Haul Trucks[6]	54 (28-80)	10	20	15	1,750	5,425,000
Light Trucks/Pickups[7]	7	4	30	20	243	753,300
Subtotal Production					1,996	6,187,600
Total[8]					2,806	8,698,600

1 Loaded and empty weights provided in parentheses.
2 Based on 3,100 new well pads and 3,100 new wells.
3 Based on 3,100 new well pads and access roads.
4 Based on 300 round trips/well with 10 wells visited/trip.
5 Based on one pipeline/well.
6 Includes water and condensate hauling.
7 Assumes all wells visited every 3 days, approximately 20 wells visited daily, and a 40-year well life.
8 Some additional low-volume traffic would also be necessary for reclamation activities.

Table DP-A-4.2. Vehicle Characteristics and Number of Trips for a 3,100 Wells on No New Well Pads Project

Construction Activities	Average Weight × 1000 lbs[1]	No. of Wheels	Average Speed on Collector Road	Average Speed on Resource Road	Round Trips Per Well Pad or Well	Total Project Round Trips[2]
Well Pad Expansion						
Gravel/Haul Trucks[3]	35	18	20	15	4	2,000
Light Trucks/Pickups[3]	7	4	30	20	6	3,000
Drilling (Directional)						
Semi	44 (28-60)	18	20	15	168	520,800
Logging/Mud Trucks	48	10	20	15	12	37,200
Roustabouts	20	6	30	20	24	74,400
Vendors/Marketers[4]	7	4	30	20	36	111,600
Completion Traffic						
Semi/Transport/Water/Sand	54 (28-80)	18	20	15	350	1,085,000
Large Haul Trucks	48	10	20	15	50	155,000
Small Haul Trucks	20	6	20	15	30	93,000
Light Trucks/Pickup	7	4	30	20	140	434,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	4,000
Light Trucks/Pickups[5]	7	4	30	20	12	6,000
Subtotal Development					840	2,526,000
Production Activities						
Workover Rig	90	18	20	15	3	9,300
Haul Trucks[6]	54 (28-80)	10	20	15	1,750	5,425,000
Light Trucks/Pickups[7]	7	4	30	20	487	242,000
Subtotal Production					2,240	5,676,300
Total[8]					3,080	8,202,300

1 Loaded and empty weights provided in parentheses.
2 Based on 497 existing well pads and 3,100 new wells.
3 Based on expansion of 497 existing well pads.
4 Based on 300 round trips/well with 10 wells visited/trip.
5 Based on one new pipeline/existing well pad.
6 Includes water and condensate hauling.
7 Assumes all wells visited every 3 days, approximately 10 well pads (about 6 wells/pad) can be visited daily, and a 40-year well life.
8 Some additional low-volume traffic would also be necessary for reclamation activities.

Table DP-A-4.3. Vehicle Characteristics and Number of Trips for a 533 Wells on 497 Well Pads Project (No New Wells)

Construction Activities	Average Weight × 1000 lbs[1]	No. of Wheels	Average Speed on Collector Road	Average Speed on Resource Road	Round Trips Per Well	Total Project Round Trips[2]
Production Activities						
Workover Rig	90	18	20	15	3	1,600
Haul Trucks[3]	54 (28-80)	10	20	15	1,750	932,800
Light Trucks/Pickups[4]	7	4	30	20	243	129,500
Total[5]					1,996	1,063,900

1 Loaded and empty weights provided in parentheses.
2 Based on the existing authorization for 497 well pads and 533 wells.
3 Includes water and condensate hauling.
4 Assumes all wells visited every 3 days, approximately 20 wells visited daily, and a 40-year well life.
5 Some additional low-volume traffic would also be necessary for reclamation activities.

Table DP-A-4.4. Estimated Traffic Requirements Summary, All Development Scenarios, Jonah Infill Drilling Project, Sublette County, Wyoming

Type of Traffic	Round Trips per Well	LOP Round Trips (Thousands)[1]	Average Daily Traffic[1]
Well Construction and Development			
Well Pad and Access Road Construction (4 days/well site)[2]	10–20	5–62	--
Drilling (22–26 day average)[3]	200–240	250–744	--
Completion/Testing (60 days)	570	713–1,767	--
Pipeline Construction (4 days)	20	10–62	--
Total well construction and development (90–94 days/well site; 5–42 years for the project)	810–850	978–2,635	32–172
New Production Activities[4]	1,996–2,240	2,495–6,188	171–424
Existing Production Activities[4]	--	1,064	73
Total[5]	2,806–3,090	4,537–9,887	146–564

1 Assumes 1,250 to 3,100 new wells are drilled and completed as producers, wells produce every day, development actions would be completed in 5 to 42 years, well life is 40 years, and LOP is 48 to 85 years (includes the final 3 years of reclamation).
2 Includes gravel hauling.
3 Includes rig move; average varies from 22 days for a vertical well to 26 days for a directional well.
4 Assumes one pumper can visit 20 wells/day, one pad every 3 days, and average well life is 40 years.
5 Average daily traffic volumes are not additive.

Table DP-A-4.5. Approximate Traffic Volumes for Selected Roads, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Road Type (Number of Wells)	Approximate Number of Round Trips[2]			Approximate Average Daily Traffic[3]		
	Development	Production	Total	Development	Production	Total
Resource Road (1 well)[2]	810-850	1,996-2,240	2,806-3,090	9-10	0.1-0.2	0.1-0.2
Resource Road (10 wells)	8,100-8,500	19,960-22,400	28,060-30,900	86-94	1.4-1.5	0.9-1.8
Collector/Local Roads (50 wells)	40,500-42,500	99,800-112,000	140,300-154,500	172-189	6.8-7.7	4.5-8.8
Collector/Local Roads (100 wells)	81,000-85,000	199,600-224,000	280,600-309,000	172-189	13.7-15.3	9.0-17.6
Collector/Local Roads (500 wells)	405,000-423,000	998,000-1,120,000	1,403,000-1,545,000	172-189	68.4-76.7	45.2-88.2
Luman Road (3,597 wells)[4]	2,511,000-2,635,000	7,179,600-8,057,300	9,690,600-10,692,300	172-189	492-552	312-610

[1] Summarized for all development alternatives.
[2] See Tables DP-A-4.1 through DP-A-4.4.
[3] Assumes a development period of 90 to 94 days per well and 20 simultaneous development operations, a productive well life of 40 years, and an LOP of 63 to 105 years (see Table DP-A-4.6).
[4] 3,100 new and 497 existing wells; no development actions would occur for the 497 existing wells. Approximates maximum project traffic.

Table DP-A-4.6. Estimated Life-of-Project (Years), Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

	Alternative				
	No Action	Proposed Action	A	B	BLM Preferred Alternative
Wells Developed per year	0	250	250	75	250
Development Phase (years)	0	13	13	42	13
Production Phase (years)	40	40	40	40	40
Post-Production Reclamation (years)	23	23	23	23	23
Life-of-Project (years)	63	76	76	105	76

DP-A-5.0 ROAD CLASSIFICATIONS

DP-A-5.1 Functional Road Classification, General

The general functional road classification used in this document classifies roads according to a hierarchy of traffic movement within a traffic system. This classification is described in *BLM Manual* Section 9113 (BLM 1985) and does not necessarily depend on road condition.

DP-A-5.2 Functional Road Classification

The road classification system used in this document is based on the one currently used by the BLM. The special attributes of the roads within the TPA require the use of multiple collector roads.

The road classification described below is derived from the *BLM Manual* Section 9113 (BLM 1985, 1991).

- Local/Collector Roads. These roads normally provide primary access to large blocks of land and connect with or are extensions of a public road system. They also usually provide the internal access network within an oil and gas field. Local/collector roads usually require application of the highest standards used by the BLM. The road design speed is 20–50 mph. The Luman, Burma, Jonah North, South Anticline, and three additional in-field roads are identified as local/collector roads for this project (see Map DP-A-1.1).
- Resource Roads. These normally are spur roads that provide point access. Roads servicing individual oil and gas well locations usually fall within this classification. These roads have a design speed of 15–30 mph and are often constructed with intervisible turnouts.
- Casual Use Routes. Casual use routes are those that have not been constructed or maintained. They are usually created by repeated travel along the same route over time and are often called two-tracks.

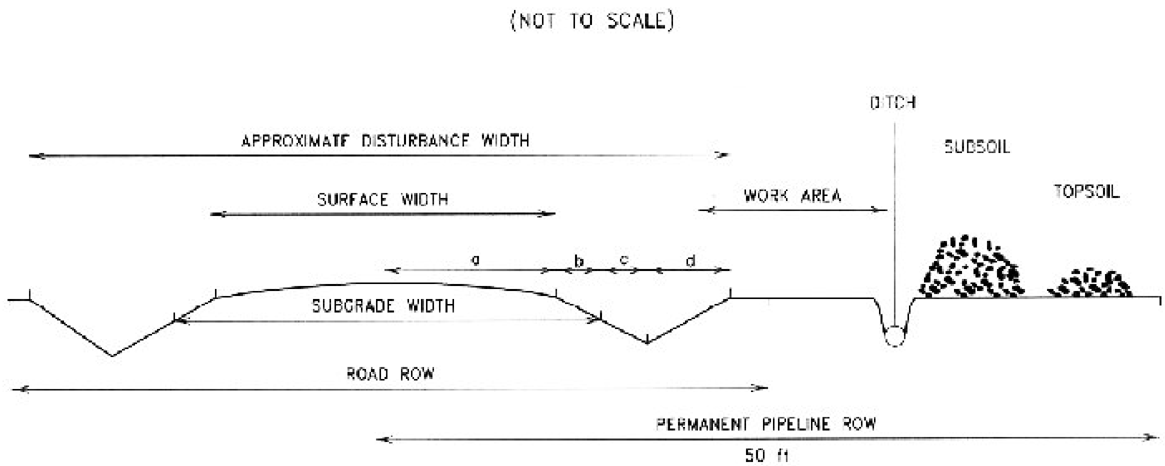
The public local/collector roads in the JIDPA include the four main BLM roads: the Luman, Burma, South Anticline, and Jonah North roads. There are also numerous undesignated casual routes (unimproved/two-track roads) on the area and Operator-maintained well access (resource) roads (see Map DP-A-1.1).

Some of the existing casual routes within the JIDPA may be upgraded and used as resource or local roads for natural gas development activities. Future resource roads (i.e., low-traffic-volume roads) are not specifically identified in this document due to the lack of site-specific details for the proposed project. Resource roads and future local roads would be identified during localized area transportation planning and would be specified in annual operational updates.

Proposed high-traffic-volume roads and/or road corridors (collector and local roads) are identified within this document (see Map DP-A-1.1) and on maps available for review at area BLM offices. Resource roads that currently provide access to one or more existing wells or other facilities are also shown on the maps.

Operational updates would be used to determine the type of road standard and design parameters for new and/or upgraded roads. Design parameters for the road types proposed for this project (i.e., local/collector, and resource roads) are shown in Figure DP-A-5.1 and would be commensurate with *BLM Manual* 9113 specifications (BLM 1985, 1991). No roads required for this project would have travel surface widths of less than 29 feet.

All roads upgraded or developed for this project would be designed, constructed, and surfaced to provide all-weather access. However, some local and resource roads initially may be constructed without appropriate surfacing material and, therefore, may become impassable during inclement weather. Operators would assume the risk of denied access to facility sites during inclement weather on roads that become impassable, since the BLM may deny access to avoid resource damage during periods when roads are unsuitable for travel.



	MINIMUM SUBGRADE WIDTH (ft)	MINIMUM SURFACED TRAVELWAY WIDTH (ft)	a (ft)	b (ft)	c (ft)	d (ft)	APPROXIMATE DISTURBANCE WIDTH (ft)	ROW WIDTH (ft)	DESIGN SPEED (mph)
RESOURCE ROAD	16	12	6	2	4	8	40	50	15–30
LOCAL ROAD	24	20	10	2	4	8	48	55	20–50
COLLECTOR ROAD	28	24	17	7	4	8	52	60	30–50

DIAGRAM OF TYPICAL TURNOUTS ON RESOURCE ROADS

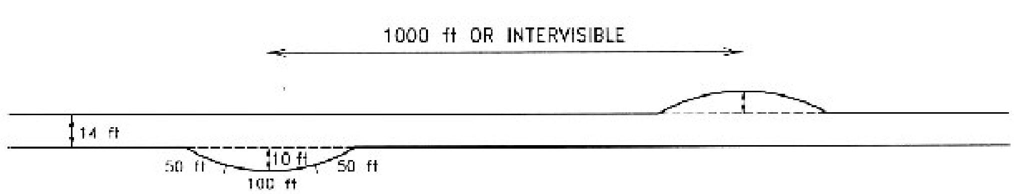


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Figure DP-A-5.1. Typical Access Road (Local/Collector and Resource) with Adjacent Pipeline Schematic, Jonah Infill Drilling Program, Sublette County, Wyoming, 2006.

DP-A-6.0 ENVIRONMENTAL CONSTRAINTS

There are many natural obstacles (e.g., steep slopes, poor soils for road construction, sensitive resources) throughout the TPA that pose problems for road construction and development. This section discusses several of the more formidable obstacles. Additional areas of concern may be identified during transportation planning and during APD or ROW application review processes. Although roads could be constructed through many of the obstacles, these areas would be avoided, where possible, to avoid resource conflicts and augmented construction costs. The maps available for review at area BLM offices show the locations of the following natural and/or physical obstacles.

DP-A-6.1 Topographic Constraints

In addition to the topographic obstacles listed below, there are many small dry lake beds and low-lying areas, small drainage channels, rock outcroppings, steep slopes, etc., that would be considered when choosing transportation routes within and adjacent to the TPA.

DP-A-6.1.1 Steep Slope Areas

Steep slope areas occur throughout the TPA, and these areas would be avoided where possible to minimize erosion, visual resource, and biological resource impacts. Notable steep slope areas present in the TPA include Blue Rim, Stud Horse and Teakettle buttes, and Ross and Yellow Point ridges (see maps available at area BLM offices).

DP-A-6.1.2 Playas

Two playas are known to occur on the TPA. Playas would be avoided where possible during construction to protect these special landscape features.

DP-A-6.1.3 Large Drainages

Crossing drainages is expensive and can cause adverse impacts if crossings are not appropriately designed and constructed. When it is necessary to cross a large drainage, an appropriate bridge, culvert, or low water crossing would be selected and designed to handle at least a 10-year flood. In addition, drainages and adjacent areas often contain significant cultural resource sites. The number of drainage crossings would be scrupulously limited; to the extent practicable, no new crossings would be constructed. Large drainages within the TPA include Sand Draw, North Alkaline Draw, Granite Wash, East and West Buckhorn Draws, and Long Draw.

DP-A-6.2 Soil Constraints

Site investigations and soil evaluations provide valuable information on soil types and limitations of the materials encountered on a road project. The extent of sampling and testing work required depends on the type and size of the road and soils characteristics. Lower-standard roads (e.g., some resource roads) generally would not require soil investigations. Visual examination is generally sufficient for low-traffic-volume roads that would not carry frequent heavy loadings and for roads that appear to have soil types well suited to road construction. Soils that generally cause problems are loose windblown sand, silt, and clay (fine-grained materials without the presence of gravel or rocky material). Fine-grained silts or clays are particularly troublesome when saturated. Sands cause problems when dry.

Sands, silts, and clays may be difficult to distinguish when in combination, and intermediate silts have some characteristics of both sands and clays. Roads constructed on poor soils may perform well immediately after construction but may lose stability by bearing failure (sand) or become too slippery or unable to support loads (clay) when wet. Road surfacing (e.g., gravel, pavement, etc.) can mitigate road placement on poor soils.

Classifying soil types at proposed construction sites is valuable in predicting potential surface damage and in determining the need for and type of surfacing material (Tables DP-A-6.1 to DP-A-6.4). Laboratory testing to determine the structural values of the soil may be advisable on roads requiring high traffic volumes and/or repeated heavy loads. Soils would be classified prior to road construction and specified with appropriate construction criteria in operational updates and/or APD and ROW applications.

Soils present on the JIDPA are shown on Map DP-A-6.1 and the detailed maps available at area BLM offices. Most soils within the TPA have limitations for road construction, shallow excavations associated with pipeline construction, pond/reservoir areas (reserve pits), and reclamation. Limitations were identified using criteria obtained from the U.S. Soil Conservation Service *National Soils Handbook, 603.15* (Soil Survey Staff 1983) (Tables DP-A-6.1 through DP-A-6.4).

Major soils within the JIDPA include the Vermillion Variant-Seedskadee-Fraddle complex on 0–3 percent slopes (Unit 127); Monte-Leckman complex on 1–6 percent slopes (Unit 106); the Fraddle-Ouard-San Arcacio Variant complex on 3–8 percent slopes (Unit 124); the Ouard-Ouard Variant-Boltus complex on 1–8 percent slopes (Unit 114); the Garsid-Monte Association on 1–6 percent slopes (Unit 119); the San Arcacio-Saguache association on 0–3 percent slopes (Unit 125); the Huguston-Horsley-Terada complex on 6–30 percent slopes (Unit 116); and the Haterton-Garsid complex on 1–8 percent slopes (Unit 113) (Table DP-A-6.5). These mapping units collectively cover approximately 78 percent of the JIDPA. Primary limitations associated with these soils include thin soils, shallow depth to rock, low strength, sandiness, and stoniness (Tables DP-A-6.5 and DP-A-6.6). Steep slopes may limit development and reclamation potential in localized areas, but most soils are typically located on gently sloping, undulating uplands. The Cowestglen sand loam on 0–2 percent slopes (Unit 951/106) and the Monte-Leckman complex (Unit 106) on 1–6 percent slopes occur adjacent to drainage channels and on terraces and alluvial fans. These soils are limited by frost action, flooding, excess sand, and/or small stones.

Several associations (i.e., the Monte-Leckman, Fraddle-Tresano, Huguston-Horsely-Terada, Garsid-Monte, Kandaly-Terada-Huguston, and Baston-Boltus-Chrisman complexes/ associations) may be good sources for topsoil (see Tables DP-A-6.5 and DP-A-6.6). The Spool Variant-Ouard Variant-San Arcacio Variant, Fraddle-Ouard-Sand Arcacio Variant, and San Arcacio-Saguache complexes/associations may be good gravel sources (see Tables DP-A-6.5 and DP-A-6.6).

DP-A-6.3 Biological Constraints

Known sensitive biological resources present in the TPA include greater sage-grouse leks and nesting areas, raptor nests, pronghorn antelope migration corridors, and various habitats suitable for threatened, endangered, and other sensitive species. As with other environmental constraints, these resource locations and their associated buffers would be avoided, where practical, to minimize disturbance. In addition, inventories and monitoring of these resources would be conducted as specified in annual wildlife monitoring reports (TRC Mariah 2004). The locations of these resources are shown on maps available for review at area BLM offices.

Table DP-A-6.1 Criteria to Establish Soil Suitability for Drastically Disturbed Areas.[1]

Parameter	Rating[2]			
	Good	Fair	Poor	Restrictive Feature
Soil reaction (pH)	5.6–7.8	5.0–5.5 8.5–9.0	<5.0 >9.0	Too acid Too alkaline
Salinity (mmhos/cm)	0–8	8–16	>16 >8	Excess salt
Depth to cemented pan (inches)	>40	20–40	<20	Reclamation problems
Texture[3]	SL, L, SIL, SCL, VFSL, FSL, CL, SICL (<35% C)	CL, SICL, SC LS, LFS, LVFS	C, SIC, S, FS, VFS	Too clayey Too sandy
Sodium absorption ratio	0–5	5–12	>12	Excess sodium
Depth to bedrock (inches)	>40	20–40	<20	Reclamation problems
Erosion factor	<0.35	>0.35	>0.35	Erodes easily
Wind erodability group			1, 2	Soil blowing
Coarse fragments (% wt)				
3–10 inches	0–15	15–35	>35	Small stones
>10 inches	0–3	3–10	>10	Large stones, reclamation problems

[1] Adapted from Soil Survey Staff (1983).
[2] A rating of 'good' means vegetation is relatively easy to establish and maintain, the surface is stable and resists erosion, and the reconstructed soil has good potential productivity. Material rated 'fair' can be vegetated and stabilized by modifying one or more properties. Topdressing with better material or application of soil amendments may be necessary for satisfactory performance. Material rated 'poor' has such severe problems that revegetation and stabilization are very difficult and costly. Topdressing with better material is necessary to establish and maintain vegetation.
[3] U.S. Department of Agriculture Texture.

C	Clay	LS	Loamy sand	SICL	Silty clay loam
CL	Clay loam	LVFS	Loamy very fine sand	SIL	Silt loam
FS	Fine sand	S	Sand	SL	Sandy loam
FSL	Fine sandy loam	SC	Sandy clay	VFS	Very fine sand
L	Loam	SCL	Sandy clay loam	VFSL	Very fine sandy loam
LFS	Loamy fine sand	SIC	Silty clay		

DP-A-6.4 Other Environmental Constraints

Numerous paleontologic and cultural resource sites are known to exist on the JIDPA. These sites would be avoided where possible during road improvement and construction activities. In addition, surveys for these resources would be conducted prior to construction, and monitoring of construction sites would be implemented as appropriate during development to avoid unnecessary disturbance.

Water developments (i.e., reservoirs, wells, and pipelines) occur throughout the area, and these locations are important for livestock and wildlife on the area. Roads developed and/or improvements for this project would avoid these locations, where possible, to minimize adverse effects to livestock and wildlife resources.

Table DP-A-6.2. Criteria Used to Establish Suitability for Pond/Reservoir Areas[1]

Property	Limits			
	Slight	Moderate	Severe	Restrictive Feature
Texture[2]	SIC, C, SICL, CL, SC, SCL	L, SICL, CL, SIL, FSL, VFSL	SL, FSL, LS, S, LFS, gypsum	Seepage, piping
Permeability (inches/hr) (20–60 inches)	<0.6	0.6–2.0	>2.0	Seepage
Depth to bedrock (inches)	>60	20–60	<20	Depth to rock
Depth to cemented pan (inches)	>60	20–60	<20	Cemented pan
Slope (%)	0–3	3–8	>8	Slope

1 Adapted from Soil Survey Staff (1983). Pond/reservoir areas are areas that hold water behind a dam or embankment and, for this project, include reserve pits. Soils best suited to this use have a low seepage potential, which is determined by permeability and depth to fractured or permeable bedrock, cemented pan, or other permeable material. The soil is rated on its properties in the upper 60 inches as a natural barrier against seepage into deeper layers, without regard to cutoff trenches or other features that may be installed under the reserve pit. Excessive slope in the direction perpendicular to the axis of the pond embankment seriously reduces the storage capacity of the reservoir area. Furthermore, suitable sites may be difficult to find on slopes steeper than about 10%.

2 U.S. Department of Agriculture Texture.

C	Clay	LS	Loamy sand	SICL	Silty clay loam
CL	Clay loam	S	Sand	SIL	Silt loam
FSL	Fine sandy loam	SC	Sandy clay	SL	Sandy loam
L	Loam	SCL	Sandy clay loam	VFSL	Very fine sandy loam
LFS	Loamy fine sand	SIC	Silty clay		

Table DP-A-6.3. Criteria Used to Establish Suitability for Roadfill[1]

Property	Limits			
	Slight	Moderate	Severe	Restrictive Feature
Depth to bedrock (inches)	>60	40–60	<40	Area reclaim
Texture[2]	--	L, SIL, FSL, VFSL, SCL, SC, SICL	CL, C, SIC	Low strength
Layer thickness (inches)	>60	30–60	<30	Thin layer
Fracture ≥ 3 inches (wt %)[3]	<25	25–50	>50	Large stones
Depth to high water table (ft)	>3	1–3	<1	Wetness
Slope (%)	0–15	15–25	>25	Slope
Shrink-swell	Low	Moderate	High	Shrink-swell

1 Adapted from Soil Survey Staff (1983). Roadfill consists of soil material that is excavated from its original position and used in road embankments elsewhere. The evaluations for roadfill are for low embankments that generally are less than 6 ft in height and are less exacting in design than high embankments such as those along superhighways. The rating is given for the whole soil, from the surface to a depth of about 5 ft, based on the assumption that soil horizons will be mixed in loading, dumping, and spreading. Soils are rated as to the amount of material available for excavation, the ease of excavation, and how well the material performs after it is in place. Soil properties that affect the amount of material available for excavation are thickness of suitable material above bedrock or other material that is not suitable. The percent of coarse fragments more than 3 inches in diameter, the depth to a high water table, and the slope are properties that influence the ease of excavation. A high content of gypsum can cause piping or pitting. Some damage to the borrow area is expected, but if revegetation and erosion control are likely to be difficult, the soil is rated severe.

2 U.S. Department of Agriculture Texture.

C	Clay	SC	Sandy clay	SIL	Silt loam
CL	Clay loam	SCL	Sandy clay loam	VFSL	Very fine sandy loam
FSL	Fine sandy loam	SIC	Silty clay		
L	Loam	SICL	Silty clay loam		

3 Weighted average to 40 inches.

Table DP-A-6.4. Criteria Used to Establish Suitability for Shallow Excavations[1]

Factors Affecting Location and Use	Limits			
	Slight	Moderate	Severe	Restrictive Feature
Texture[2]	L, SIL, CL, SCL, SICL	SL, FSL, SI[3], SC, all gravelly types	C[4], SIC[4], S, LS, organic soils, all very gravelly types	
Soil drainage class	Excessive to well	Moderately well	Somewhat poorly to very poorly	Wetness
Depth to high water table (ft)	>6.0	2.5–6.0	<2.5	Ponding, wetness
Flooding	None, rare	None	Subject to flooding	Floods
Slope	<8%	8–15%	>15%	Slope
Depth to bedrock (inches)[5]	>60	40–60	<40	Depth to rock
Stoniness (classes)	0, 1	2	3, 4, 5	Stones
Rockiness (classes)	0	1	2, 3, 4, 5	Rocks

1 Adapted from Soil Survey Staff (1983).

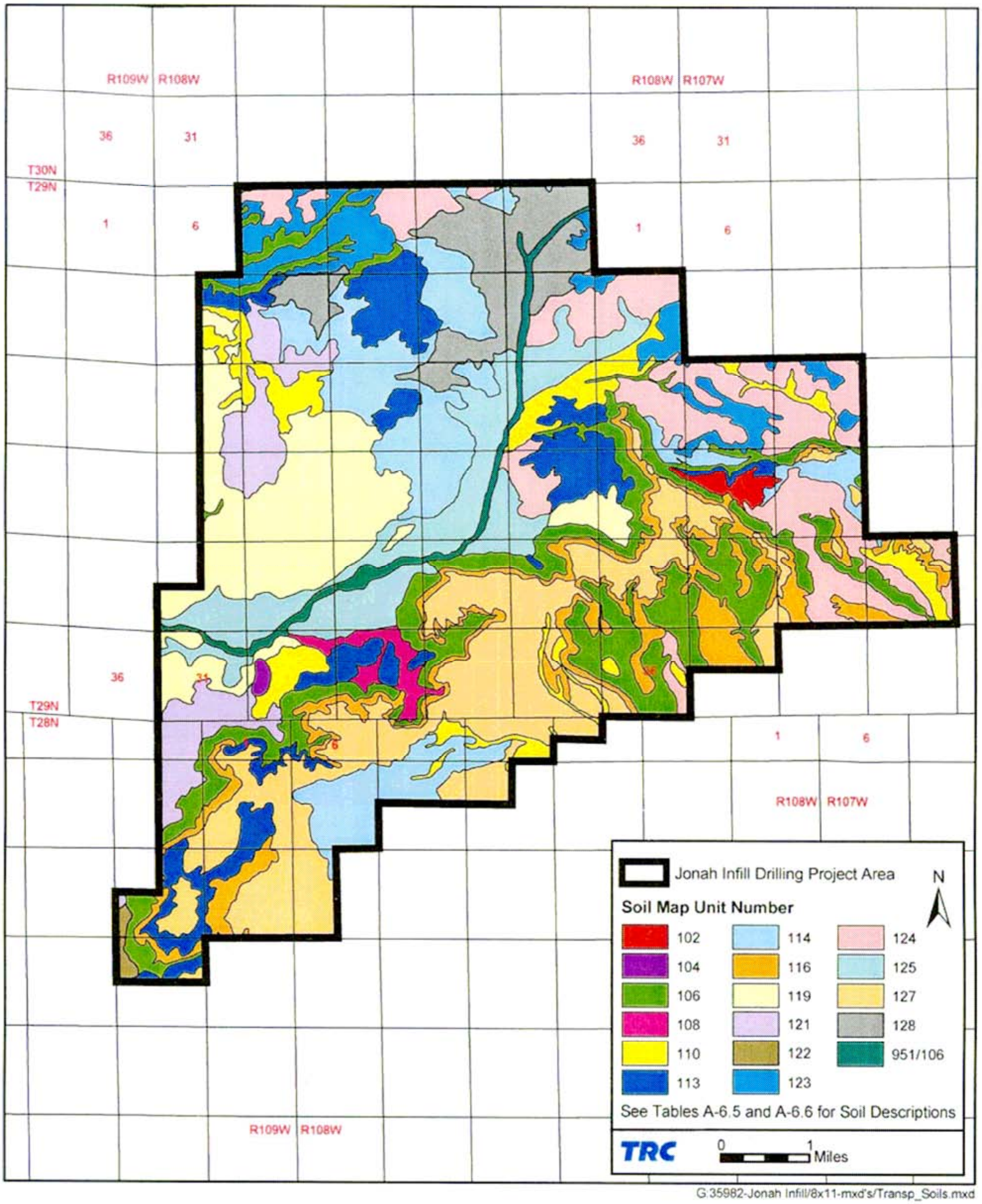
2 U.S. Department of Agriculture Texture. If soil contains a thick fragipan, duripan, or other material difficult (but not impossible) to excavate with handtools, increase the limitation rating by one class unless it already is "severe."

C	Clay	S	Sand	SICL	Silty clay loam
CL	Clay loam	SC	Sandy clay	SIL	Silt loam
FSL	Fine sandy loam	SCL	Sandy clay loam	SL	Sandy loam
L	Loam	SI	Silt		
LS	Loamy sand	SIC	Silty clay		

3 If soil will stand in vertical cuts like loess, reduce rating to "slight."

4 If friable like some kaolinitic clays, reduce rating to "moderate."

5 If bedrock is soft enough to excavate with ordinary handtools or light equipment such as a backhoe, reduce "moderate" and "severe" ratings by one class.



Map DP-A-6.1. Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Table DP-A-6.5. Soil Types, Soil Use, and Management Considerations, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Map Unit Number	Map Unit Name	Use and Management Considerations	Acres
102	Langspring Variant-Langspring complex, 1–10% slopes	Gently sloping to nearly level mesa tops and uplands. Loamy uplands. Generally suitable for road construction. Rehabilitation limited due to excess lime and small stones.	149
104	Chrisman silty clay, 0–2% slopes	Saline upland sites, in closed basins. Construction activities limited due to severe shrink-swell properties. Rehabilitation potential limited by moderately alkaline soils.	42
106	Monte-Leckman complex, 1–6% slopes	Nearly level to gently sloping alluvial fans and drainageways. Loamy, saline uplands. Generally suitable for road construction. Rehabilitation limited by excess sands or small stones.	3,488
108	Dines-Clowers-Quealman complex, 0–3% slopes	Nearly level to gently sloping drainageways and alluvial terraces. Loamy sites, saline uplands. Limited for road construction due to low strength. Rehabilitation potential limited by excess salt, sand, and small stones.	268
110	Fraddle-Tresano complex, 1–8% slopes	Rolling uplands, upper dissected fans, and valley-filling slopes. Loamy uplands. Limited for construction activities and reclamation due to thin soils.	1,541
113	Haterton-Garsid complex, 1–8% slopes	Nearly level to gently sloping uplands and sideslopes. Shallow loamy and loamy sites. Construction limited by shallow depth to bedrock, slope, and low strength. Rehabilitation limited by shallow depth to bedrock and steep slopes.	2,102
114	Ouard-Ouard Variant-Boltus complex, 1–8% slopes	Nearly level to gently sloping uplands. Shallow loamy, shallow clayey, and shaley sites. Limited due to low strength and shallow depth to bedrock. Rehabilitation limited due to thin soils.	3,132
116	Huguston-Horsley-Terada complex, 6–30% slopes	Gently sloping to moderately steep sideslopes and rolling uplands. Shaley and loamy sites. Limited due to shallow depth to bedrock, low strength, and steep slopes. Rehabilitation limited by shallow depths and slopes.	2,109
119	Garsid-Monte association, 1–6% slopes	Gently undulating uplands. Loamy sites. Construction limited by thin soils, low strength, and steep slopes. Rehabilitation limited by steep slopes.	3,087
121	Garsid-Terada-Langspring Variant complex, 1–6% slopes	Undulating uplands. Loamy sites. Construction limited due to thin soils, low strength, and steep slopes. Rehabilitation limited by steep slopes, small stones, and excess lime.	1,261
122	Baston-Boltus-Chrisman association, 0–6% slopes	Undulating and dominantly concave uplands. Clayey, shaley, and saline upland sites. Construction limited by low strength, shrink-swell potential, thin soils, and steep slopes. Rehabilitation limited by thin soils, clayey textures, excess salt, and steep slopes.	85
123	Spool Variant-Ouard Variant-San Arcacio Variant complex, 4–25% slopes	Gently sloping to steep sideslopes and rolling uplands. Shallow sandy, shallow clayey, and loamy sites. Construction limited by shallow depth to bedrock and low strength. Rehabilitation limited by shallow depths, small stones, sandy or clayey textures, or steep slopes.	1,260
124	Fraddle-Ouard-San Arcacio Variant complex, 3–8% slopes	Rolling uplands. Loamy and shallow loamy sites. Construction limited by thin soils and low strength. Rehabilitation limited by thin soils, clayey textures, or small stones.	3,194
125	San Arcacio-Saguache association, 0–3% slopes	Old floodplains, fans, and terraces. Loamy and sandy sites. Generally suitable for road construction. Rehabilitation limited by small stones.	2,304
127	Vermillion Variant-Seedskadee-Fraddle complex, 0–3% slopes	Nearly level uplands and mesas. Shallow loamy and loamy sites. Limited for construction due to shallow depth to bedrock, low strength, and thin soils. Rehabilitation limited by stoniness, excess lime, and thin soils.	4,427
128	Fraddle-Ouard-San Arcacio Variant complex, 0–3% slopes	Nearly level upland surfaces. Loamy and shallow loamy sites. Construction limited by low strength and shallow depth to bedrock. Rehabilitation limited by thin soils and small stones.	1,645
951/106	Cowestglen sandy loam, 0–2% slopes/see also Map Unit 106, above	Nearly level drainage ways. Road construction potentially limited by moderate frost action and flooding. See also Map Unit 106.	406
Total			30,500

Table DP-A-6.6. Soil Salvage Depth and Soil Characteristics for Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
102	12	1–10%	Langspring Variant	Loamy	0–10	L	7.9–8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5–9.0	<2	--
					22–30	SCL, L, SL	7.9–8.4	<2	--
					30+	Sandstone	--	--	--
			Langspring	Loamy	0–9	L	7.9–8.4	<2	Low
					9–26	SCL, L, SL	8.5–9.0	<2	--
					26–40	SCL, L, SL	7.9–8.4	<2	--
104	--	0–2%	Chrisman	Saline upland	0-2	SIC, C, SICL	7.9–9.0	<2	Low
					2-60	SIC, C, SICL	77.8	>4	Low
106	12	1–6%	Monte	Loamy/ saline upland	0–2	L	6.6–9.0	<2	Low
					2–60	CL, L, SL	7.9–9.0	<2	--
			Leckman	Loamy/	0–3	FSL, VFSL	7.9–9.0	<2	Low
				saline upland	3–60	FSL, VFSL	7.9–9.0	<2	--
108	12	0–3%	Dines	Saline upland	0–4	SIL	>7.8	8–16	Low
					4–21	SIL, SICL	>8.4	8–16	--
					21–60	SIL, SICL	>8.4	>16	--
			Clowers	Loamy	0–1	L	7.9–9.0	4–8	Low
					1–60	CL	7.9–9.0	4–8	--
			Quealman	Loamy	0–2	FSL, L, CL	7.4–8.4	<2	Low
					2–60	SR-LS-L-FSL	7.9–9.0	<2	--
110	12	1–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2-4	--
					34+	Soft sandstone	--	--	--
			Tresano	Loamy	0–2	SL	6.6–7.8	<2	Low
					2–16	SCL	6.6–9.0	<2	--
					16–60	SL	7.4–8.4	2–4	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
113	12	1–8%	Haterton	Shallow loamy	0–3	L	7.9–9.0	2–4	Moderate
					3–12	L	7.9–9.0	2–4	--
					12+	Siltstone	--	--	--
			Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Moderate
					22+	Shale	--	--	--
114	4	1–8%	Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Low
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8–16	Moderate
					11+	Shale	--	--	--
116	9	6–30%	Huguston	Shallow loamy	0–9	SL, FSL	7.4–8.4	2–4	Moderate
					9+	Soft sandstone	--	--	--
			Horsley	Shale	0–3	L	7.4–9.0	2–4	Moderate
					3–9	L, CL, SCL	7.4–9.0	<16	--
					9+	Shale	--	--	--
			Terada	Loamy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Moderate
					7–34	VFSL, FSL	7.4–9.0	<2	--
					34+	Sandstone	--	--	--
119	12	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Low
					22+	Shale	--	--	--
			Monte	Loamy	0–2	L	6.6–9.0	<2	Low
					2–60	CL, L, SL	7.9–9.0	<2	--
121	10	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Low
					22+	Shale	--	--	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
121	10	1–6%	Terada	Loamy/sandy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Low
					7–34	VFSL, FSL	7.4–9.0	<2	--
					34+	Sandstone	--	--	--
			Langspring Variant	Loamy	0–10	L	7.9–8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5–9.0	<2	--
					22–30	SCL, L, SL	7.9–8.4	<2	--
					30+	Sandstone	--	--	--
122	0	0–6%	Baston	Clayey	0–3	FSCL	8.0–9.0	<2	Low
					3–28	C	>8.4	<4	--
					28+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8-16	Moderate
					11+	Shale	--	--	--
			Chrisman	Clayey/	0–2	SIC, C, SICL	7.9–9.0	<2	Low
				saline upland	2–60	SIC, C, SICL	>7.8	<4	--
123	4	4–25%	Spool Variant	Shallow sandy	0–6	LFS, GR-SL	6.6–7.3	<2	Moderate to high
					6–12	LFS, CN-LFS,	6.6–7.8	<2	--
						GR-SL, GR-S	--	--	--
					12+	Sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Moderate
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low to moderate
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
124	6	3–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2-4	--
					34+	Soft sandstone	--	--	--
			Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
125	6	0–3%	San Arcacio	Sandy/loamy	0–3	SL, COSL	6.6–8.4	<8	Low
					3–14	SCL, SL	6.6–8.4	<2	--
					14–60	GRV-S, GR-SL, LCOS	7.4–8.4	<4	--
			Saguache	Loamy/sandy	0–6	SL, COSL, GR-SL	6.6–9.0	<2	Low
					6–60	GRV-S, COS, GRV-LS	6.6–9.0	<2	--
127	3	0–3%	Vermillion Variant	Shallow loamy	0–3	L	6.6–8.4	<2	Low
					3–8	CN-L, CN-CL	7.4–8.4	<4	--
					8–27	FLX-L, FLV-CL, FLV-L	7.9–8.4	<4	--
					27+	Hard mudstone	--	--	--
			Seedskadee	Shallow loamy	0–14	SCL, L, SL	7.0–8.5	<2	Low
					14+	Hard sandstone	--	--	--
			Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2-4	--
					34+	Soft sandstone	--	--	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
128	12	0–3%	Fraddle	Loamy	0–4 4–22	SL SCL	6.6–7.8 6.6–7.8	<2 <2	Low --
					22–34	SL, SCL	7.4–8.4	2-4	--
					34+	Soft sandstone	--	--	--
			Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
951[2]/106	--	0–2%/see 106	Cowestglen	Overflow	0–3	CL	7.4–8.4	0	--
					3–8	CL	7.4–8.4	0	--
					8–60	CL	7.4v8.4	0	--
102	12	1–10%	Langspring Variant	Loamy	0–10	L	7.9–8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5–9.0	<2	--
					22–30	SCL, L, SL	7.9–-8.4	<2	--
					30+	Sandstone	--	--	--
			Langspring	Loamy	0–9	L	7.9–8.4	<2	Low
					9–26	SCL, L, SL	8.5–9.0	<2	--
					26–40	SCL, L, SL	7.9–8.4	<2	--
104	--	0–2%	Chrisman	Saline upland	0–2	SIC, C, SICL	7.9–9.0	<2	Low
					2–60	SIC, C, SICL	77.8	>4	Low
106	12	1–6%	Monte	Loamy/ saline upland	0–2 2–60	L CL, L, SL	6.6–9.0 7.9–9.0	<2 <2	Low --
			Leckman	Loamy/	0–3	FSL, VFSL	7.9–9.0	<2	Low
				saline upland	3–60	FSL, VFSL	7.9–9.0	<2	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
108	12	0–3%	Dines	Saline upland	0–4	SIL	>7.8	8–16	Low
					4–21	SIL, SICL	>8.4	8–16	--
					21–60	SIL, SICL	>8.4	>16	--
			Clowers	Loamy	0–1	L	7.9–9.0	4–8	Low
					1–60	CL	7.9–9.0	4–8	--
			Quealman	Loamy	0–2	FSL, L, CL	7.4–8.4	<2	Low
					2–60	SR-LS-L-FSL	7.9–9.0	<2	--
110	12	1–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4-22	SCL	6.6-7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2-4	--
					34+	Soft sandstone	--	--	--
			Tresano	Loamy	0–2	SL	6.6–7.8	<2	Low
					2–16	SCL	6.6–9.0	<2	--
					16–60	SL	7.4–8.4	2-4	--
113	12	1–8%	Haterton	Shallow loamy	0–3	L	7.9–9.0	2-4	Moderate
					3–12	L	7.9–9.0	2-4	--
					12+	Siltstone	--	--	--
			Garsid	Loamy	0–22	L, CL	7.4–9.0	2-4	Moderate
					22+	Shale	--	--	--
114	4	1–8%	Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Low
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8-16	Moderate
					11+	Shale	--	--	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
116	9	6–30%	Huguston	Shallow loamy	0–9	SL, FSL	7.4–8.4	2-4	Moderate
					9+	Soft sandstone	--	--	--
			Horsley	Shale	0–3	L	7.4–9.0	2-4	Moderate
					3–9	L, CL, SCL	7.4–9.0	<16	--
					9+	Shale	--	--	--
			Terada	Loamy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Moderate
					7–34	VFSL, FSL	7.4–9.0	<2	--
					34+	Sandstone	--	--	--
119	12	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2-4	Low
					22+	Shale	--	--	--
			Monte	Loamy	0–2	L	6.6–9.0	<2	Low
					2–60	CL, L, SL	7.9–9.0	<2	--
121	10	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2-4	Low
					22+	Shale	--	--	--
			Terada	Loamy/sandy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Low
					7–34	VFSL, FSL	7.4–9.0	<2	--
					34+	Sandstone	--	--	--
			Langspring Variant	Loamy	0–10	L	7.9–8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5–9.0	<2	--
					22–30	SCL, L, SL	7.9–8.4	<2	--
					30+	Sandstone	--	--	--
122	0	0–6%	Baston	Clayey	0–3	FSCL	8.0–9.0	<2	Low
					3–28	C	>8.4	<4	--
					28+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8–16	Moderate
					11+	Shale	--	--	--
			Chrisman	Clayey/ saline upland	0–2	SIC, C, SICL	7.9–9.0	<2	Low
					2–60	SIC, C, SICL	>7.8	<4	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
123	4	4–25%	Spool Variant	Shallow sandy	0–6	LFS, GR-SL	6.6–7.3	<2	Moderate to high
					6–12	LFS, CN-LFS,	6.6–7.8	<2	--
						GR-SL, GR-S	--	--	--
					12+	Sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Moderate
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low to moderate
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
124	6	3–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--
			Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
125	6	0–3%	San Arcacio	Sandy/loamy	0–3	SL, COSL	6.6–8.4	<8	Low
					3–14	SCL, SL	6.6–8.4	<2	--
					14–60	GRV-S, GR-SL, LCOS	7.4–8.4	<4	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
125	6	0–3%	Saguache	Loamy/sandy	0–6	SL, COSL, GR-SL	6.6–9.0	<2	Low
					6–60	GRV-S, COS, GRV-LS	6.6–9.0	<2	--
127	3	0–3%	Vermillion Variant	Shallow loamy	0–3	L	6.6–8.4	<2	Low
					3–8	CN-L, CN-CL	7.4–8.4	<4	--
					8–27	FLX-L, FLV-CL, FLV-L	7.9-–8.4	<4	--
					27+	Hard mudstone	--	--	--
			Seedskadee	Shallow loamy	0–14	SCL, L, SL	7.0–8.5	<2	Low
					14+	Hard sandstone	--	--	--
			Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--
128	12	0–3%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--
			Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
951[2]/106	--	0–2%/see 106	Cowestglen	Overflow	0–3	CL	7.4–8.4	0	--
					3–8	CL	7.4–8.4	0	--
					8–60	CL	7.4–8.4	0	--

Table DP-A-6.6. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard

[1] Adapted from ERO Resources Corporation (1988).
[2] Criteria used to determine topsoil salvage depth: maximize loamy textures; minimize clayey textures, rock content, and salinity; salvage at least 6 inches if possible; salvage greater depths in better soils to a) provide a deeper seedbed and b) compensate for insufficient soils at other locations.
[3] U.S. Department of Agriculture Texture.

C	Clay	L	Loam	SICL	Silty clay loam
CL	Clay loam	LCOS	Loamy coarse sand	SIL	Silt loam
COS	Coarse sand	LFS	Loamy fine sand	SL	Sandy loam
COSL	Coarse sandy loam	LS	Loamy sand	VFSL	Very fine sandy loam
FS	Fine sand	S	Sand		
FSCL	Fine Sandy clay loam	SCL	Sandy clay loa m		
FSL	Fine sandy loam	SIC	Silty clay		

Texture Modifier:

CN	Channery	GR	Gravelly
FLV	Very flaggy	GRV	Very gravelly
FLX	Extremely flaggy	SR	Stratified

DP-A-7.0 ROAD SPECIFICATIONS, PLANS, AND MAINTENANCE

DP-A-7.1 General Requirements

In general, all new, improved, or rebuilt roads within the TPA would be developed according to the standards stated below for designed roads. Roads on state or private land within the area would be planned and built according to these same standards unless otherwise specified by the state or private landowner. Where roads are not developed in accordance with BLM standards, the potential for adverse impacts to health and safety and sensitive environmental resources is increased.

Newly designed roads on federal lands or those requiring a federal undertaking would comply with the requirements of the BLM District Engineer. The District Engineer requirements draw on the *BLM Manual Section 9113 - Roads* (BLM 1985) and the associated *Wyoming State Supplement* (BLM 1991), as well as other BLM manual sections. Design elements of the roads also would draw on the current American Association of State Highway and Transportation Officials (AASHTO), *Manual on Uniform Traffic Control Devices* (U.S. Department of Transportation Federal Highway Administration 1988), American Society for Testing Materials, and Wyoming State and Sublette County design criteria, where appropriate.

In March of 1992, the Wyoming BLM adopted the *Wyoming State Supplement to the BLM Manual 9113* (BLM 1991). This supplement amplifies several parts of the *BLM Section 9113* (BLM 1985). Some of the information contained within this document is emphasized below:

In Wyoming, BLM roads are designed, constructed, and/or upgraded for long-term use and are to be located, designed, and constructed to provide safety to the user and require the minimum amount of maintenance. Adequate design and construction of drainage structures, cut and fill slopes, and the travel-way will minimize future maintenance needs. The BLM will not accept roads constructed by others which require excessive maintenance expenditures by the BLM.

A standard below the Resource Road classification may only be constructed for short duration use (30–60 days) and should not service traffic during the winter and spring months.

In most cases, flat-bladed roads develop into canals and are a hazard to the user as well as creating environmental problems. Flat-bladed roads will not be authorized in Wyoming. The exception to this rule will be for the lowest class resource road where upgrading of short segments of an existing route is planned (i.e., excavating a hump for better site distance, widening a curve, etc).

Where information in the BLM manual dealing with roads and bridges seems inappropriate, the BLM PFO or RSFO Engineer would be consulted for clarification.

The following standards are the minimum standards for all roads constructed on BLM lands in Wyoming. The standards are found within BLM (1985). These standards are values established to ensure adequate uniformity and quality of all roads constructed on lands administered by the BLM. Average daily traffic, vehicle types, and design speed determine the geometric standards to be applied.

DP-A-7.2 Technical Requirements for Roads

Because each road is unique, it is not the purpose of this document to give all of the technical data that may be necessary for every road. Each road construction project would be evaluated with its own requirements and appropriate technical information obtained during the transportation planning processes and subsequently processed APDs and ROW applications.

BLM Manual Section 9113 (BLM 1985) and its *Wyoming State Supplement* (BLM 1991) contain the comprehensive technical requirements necessary for the design of roads on Wyoming BLM lands. A copy of applicable BLM manual sections can be obtained from the BLM RSFO.

DP-A-7.3 Road Surface Material

Road-surfacing material sources in the area are known from three locations: two sand pits and one gravel quarry. Potential surface material sources on and adjacent to the area are shown on the maps available for review at area BLM offices. The need for additional surface aggregate sources is not anticipated for this project.

Many roads within the TPA are or would be built across sandy or clayey soils and would require surfacing material. Both sandy and clayey soils are subject to special stability problems (see Section DP-A-6.2), which can be remedied with the application of an aggregate surface. When surfacing aggregate is required for roads, it would consist of appropriate material and gradations. Surface material would be applied to the minimum compacted depths that meet current BLM standards.

Given the long-term traffic volumes associated with this project, the BLM may require the paving of selected primary access roads (e.g., Luman, Burma, Jonah North) and/or the use of magnesium chloride or other dust suppressants on more in-field collector, local, and resource roads.

DP-A-7.4 Drainage Crossings

Bridge, culvert, and low-water crossing designs would conform to the *BLM Manual* Section 9112 (BLM 1990), Wyoming state law, and standard engineering practices. Drainage structures can be placed on most of the drainages within the TPA using a U.S. Army Corps of Engineers, Nationwide 404 Permit 14 (Road Crossings Sections 10 and 404). The U.S. Army Corps of Engineers would be consulted to obtain permits for crossing drainages, and it is anticipated that nationwide permit stipulations would be met under most circumstances. If the stipulations in Permit 14 cannot be met, a full standard 404 Permit would be required. The U.S. Army Corps of Engineers would be notified when construction of a road involves a drainage, even if all provisions of Permit 14 are met or flow in the drainage is intermittent. Usually, a simple letter to and a reply from the U.S. Army Corps of Engineers would satisfy the requirement on small drainages. If there is any question about the need to obtain a U.S. Army Corps of Engineers permit or the type of permit necessary, contact with the Wyoming U.S. Army Corps of Engineers would be initiated.

Culverts, bridges, or low-water crossings would be installed wherever a road is constructed across a defined drainage or natural channel. Culverts would be designed to pass no less than a 10-year flood without developing static head at the entrance, as identified by a BLM hydrologist, engineer, or other similarly qualified individual. Calculations would be based on local soil types and other pertinent environmental data. The size and gradient of the culvert would be designed to avoid damage from a 25-year flood. Culverts smaller than 18 inches in diameter would not be used due to problems with cleaning and maintenance.

In addition to installing culverts in defined drainages to provide adequate cross drainage and to minimize erosion, cross culverts would be installed at appropriate spacing for lateral drainage. There are three major factors to consider when determining culvert spacing: gradient, soil type, and rainfall intensity. Other factors that effect drainage are frost and frozen ground, snow depth, groundwater depth, soil permeability, and evaporation rate. Recommended spacing of cross culverts for various gradients and soil types are given in the *BLM Manual* Section 9113 (BLM 1985). This is a good guide for most situations and would be used unless local experience dictates otherwise.

In some relatively flat areas with permeable well-drained soils, a culvert may fill with sand and silt annually, providing no drainage. Culverts in areas with highly erosive soils have a tendency to wash out, leaving an impassable barrier. When past experience or soil and gradient conditions indicate potential problems with culverts, the best option may be to construct the road without cross-drain culverts, except on defined drainages, and to evaluate the drainage performance of the road and adjacent area. Raised roads with flat-bottomed ditches may be useful in poorly drained areas. If unacceptable amounts of water accumulate and do not dissipate within a reasonable period of time, corrective action would be taken. Such action may include installing a dip or low-water crossing or installing a culvert and evaluating its performance.

DP-A-7.4.1 Culverts

Culverts are to be aligned with the natural drainage and would comply with *BLM Manual* Sections 9112 (BLM 1990) and 9113 (BLM 1985) and the Wyoming State Supplement (BLM 1991). Culverts would be installed as needed at all road intersections except when an intersection occurs at the crest of a ridge. The minimum allowable culvert diameter is 18 inches. Culverts and structures would be strong enough to support a minimum of HS-20 loading (AASHTO specification) as required by BLM (1985).

DP-A-7.4.2 Low-water Crossings

Low-water crossings may be used with BLM approval, when necessary, as a type of drainage crossing where a 10-year runoff design produces more runoff than can be reasonably handled with a drainage structure or when the cost of a structure is unreasonable. Cost analysis, terrain and drainage features, structure stability, and necessary drainage diversions must be considered when determining the best alternative for crossing a drainage.

Environmental disturbance also must be considered. Drainage structures may not be the best environmental choice. Low-water crossings, if constructed properly, may cause less short- and long-term environmental damage than a large structure with road approach fills, water backup, and downstream bed scouring. Low-water crossings require continued maintenance to minimize erosion and to allow vehicles to cross. Low-water crossings should not be considered when there is a fishery or a water flow for more than just runoff periods. Low-water crossings in drainages with flow tend to become impassable during winter months due to the freeze and thaw cycles. Trucks attempting to cross ice crusts over water may break through and may high-center on the ice.

DP-A-7.4.3 Bridges or Structures

Bridges and major culverts constructed on public lands must conform to standards as outlined in *BLM Manual* Section 9112 (BLM 1990), including design by or under the direction of a qualified registered professional engineer. These structures are special and would be developed site-specifically. Some structures, such as bridges, may need to be designed to carry heavier loads and would be considered individually at the time of construction. All bridges must have a minimum curb-to-curb or rail-to-rail width (whichever is less) of 14 feet for single-lane roads and 24 feet for double-lane roads but, in all cases, not less than the nominal width of the adjacent travelway as measured at right angles to the travelway centerline. All structures would be designed for a minimum of a HS-20 loading.

DP-A-7.5 Road Layout and Construction Inspection

Surveying and staking necessary for road construction or improvement would be done by or under the direction of proper Wyoming registered professionals (e.g., surveyors, engineers). The complexity of the project would govern the amount of work, design, and inspection necessary.

DP-A-7.5.1 Centerline Staking

Surveyors have many methods used to lay out roads. At a minimum, the BLM requires that stakes be placed on the centerline of the road at a maximum distance of 100 feet, at all fence or utility crossings, and at all abrupt breaks in ground profile of vertical change of 1 foot or more. Stakes would be placed on the centerline of the road at a maximum distance of 50 feet around curves of 4 degrees or sharper. The station or stake number would be written clearly on each stake. Section corner ties would be made and shown on all road design plans, as presented in applications. The BLM may require additional construction staking criteria as determined on an individual basis.

DP-A-7.5.2 Construction Monitoring

Many access roads can be constructed without major inspection efforts. Roads without unusual construction requirements may, in some cases, be monitored by Operators. The extent and type of construction monitoring would be determined by the BLM for roads across BLM land.

Construction inspection ensures the following.

- The route approved for construction is followed with as little environmental disturbance as practical.
- All sensitive environmental, paleontological, or cultural/historic sites are adequately protected.
- Construction methods properly remove organic matter from roadfill areas or fill material.
- Topsoil removal, stockpiling, and replacement and, in some instances, reseeding are conducted commensurate with approved design.
- Embankments meet proper width, slope, and compaction criteria. This may involve the use of water.
- Frost in the ground is not so excessive that it precludes proper construction.
- Reasonable efforts are made to walk equipment on the overall road surface to help with compaction.
- Drainage structure installation includes adequate compaction, rip-rap placement, drainage bowl installation, cover depths, wing ditch slopes and lengths, etc.

- Proper sign placement is used.

In some cases, the inspector may be required to certify that the construction was completed according the design parameters and standards specified in ROW applications. In this case, a Wyoming registered professional would provide to the BLM and relevant Operators a seal and signature on an affidavit of completion, according to the approved plans and specifications.

DP-A-7.6 Other Design Guidelines

The *BLM Manual* Section 9113 - Roads (BLM 1985) and its Wyoming Supplement (BLM 1991), as well as other applicable manual sections, would be the guides for design elements such as horizontal and vertical alignment, curve super elevation, cross-section elements, earthwork design, drainage elements, cattle guards, signs and markers, sight distances, and staking.

The roadway structure that includes the subgrade, the sub-base course (in some cases), and the base course (or the base course used as a surface course in the case of graded earth roads) must be strong enough to support HS-20 loadings (AASHTO specification) as required by BLM specifications or by engineer design where design exceeds BLM minimum requirements.

The special qualities of the particular road and its location govern how the structure is designed and built. In general, road surfacing varies in thickness according to various design factors.

All cattle guards or other structures are to have a minimum curb-to-curb or rail-to-rail width (whichever is less) of 16 feet for single-lane roads and 24 feet for double-lane roads but, in all cases, not less than the nominal width of the adjacent travelway as measured at right angles to the travelway centerline. All structures would be designed for a minimum of a HS-20 loading.

DP-A-7.7 Maintenance

All roads on the project area would be maintained to *BLM Manual* 9113 specifications (BLM 1985, 1991, and the latest edition of the Gold Book [*Surface Operating Standards for Oil and Gas Exploration and Development*]). Maintenance on collector roads is anticipated to occur at least twice per year, whereas local and resource road maintenance may be required only once annually. All roads required for the project would be maintained as necessary to provide all-weather access (e.g., grading, surface material application, snow plowing), and Operators would be responsible for these maintenance actions. Maintenance agreements developed among Operators would be provided to the BLM (see Section DP-A-8.0). Where roads become impassable, the BLM may deny access until the roads are repaired and/or the potential for resource damage is otherwise alleviated.

DP-A-8.0 MAINTENANCE AGREEMENTS

Maintenance agreements are usually binding contracts between companies that deal with road maintenance. The BLM generally does not enter into maintenance agreements with companies. The preferred approach is for companies to work together and adjudicate maintenance agreements amongst themselves. Operators would provide the BLM with copies of all road maintenance agreements, including the name of a designated contact person. Non-project roads would be maintained by the BLM or other ROW holder.

Problems may occur with new Operators in an area. Maintenance agreements must be revised to include new users. If a company is the first to drill in an area, that company may be the sole road maintainer until other companies begin to access the area. Agreements would be reviewed and budgets for maintenance prepared where new Operators or users are identified. Meetings may be held with Operators and other road users to review maintenance agreements. If a company only has a few roads, review may be made over the phone with other participants, and then the contract can be mailed and notarized signatures obtained. When Operators or other area users propose new activity that would utilize part or all of an existing road, maintenance agreements for existing roads must be restructured to include the new users.

Maintenance agreements would contain grading, surfacing, and other maintenance schedules; participant responsibilities; and cost allocation. Agreements would describe response methods and primary and secondary emergency contacts for hazard maintenance.

Operator responsibilities for road maintenance can be divided into at least three types of agreements. The principle maintenance agreement type weights the maintenance cost share of each Operator according to the amount of projected use of the road. The projected use can be based on past use, number of producing wells and facilities down-road, and wet weather access needs. The maintenance contract would have each Operator's tallied amounts and commitments for the upcoming year. This agreement type would be the most commonly used on the JIDPA. Other types of agreements involve Operators taking care of road maintenance on alternate time intervals or dividing a road into segments of near equal maintenance amounts and assigning each Operator maintenance responsibility for their segment of the road.

Snow removal often is considered as a separate item. Some Operators may not need access to sites during the winter months and may not participate in costs associated with snow removal. In some cases, roads may only need maintenance once or twice per year or at some other time interval.

DP-A-9.0 LITERATURE CITED

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APPENDIX DP-B

RECLAMATION PLAN, JONAH INFILL DRILLING PROJECT

Prepared for

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January 2006

PREFACE

The Reclamation Plan for the Jonah Infill Drilling Project was originally drafted by TRC Mariah Associates of Laramie, Wyoming, and published as an appendix to the *Jonah Infill Drilling Project Draft Environmental Impact Statement* in February 2005. The plan was subsequently revised and updated at the direction of BLM by SWCA Environmental Consultants of Phoenix, Arizona.

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ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
EIS	Environmental Impact Statement
JIDP	Jonah Infill Drilling Project
JIDPA	Jonah Infill Drilling Project Area
LOP	Life-of-Project
Operators	Natural gas developers
PFO	Pinedale Field Office
POD	Plan of Development
PLS	Pure Live Seed
RMP	Resource Management Plan
ROW	Right-of-way
RSFO	Rock Springs Field Office
SPCCP	Spill Prevention, Control, and Countermeasure Plan
SUP	Surface Use Plan
SWPPP	Storm Water Pollution Prevention Plan

DP-B-1.0 INTRODUCTION

This reclamation plan will be used by natural gas developers (the Operators) of the Jonah Infill Drilling Project (JIDP) as guidance to achieve successful reclamation on federal lands within the Jonah Infill Drilling Project Area (JIDPA). Alternate reclamation procedures may be implemented on private and state lands or on federal lands as directed by the Bureau of Land Management (BLM). The plan complies with BLM reclamation and management directives specified in the *Pinedale Field Office* (PFO) *Resource Management Plan* (RMP) (BLM 1987a, 1987b, 1988) and the Rock Springs Field Office (RSFO) RMP (BLM 1992, 1996, 1997). This reclamation plan is also based on *Executive Order 13112*, impacts and scoping issues identified for the JIDP Environmental Impact Statement (EIS) (see EIS Section 1.4), and an on-site evaluation of reclamation status on selected areas in the JIDPA.

DP-B-2.0 RECLAMATION REQUIREMENTS AND SUCCESS STANDARDS

DP-B-2.1 Reclamation Requirements

BLM’s reclamation requirements include the following major goals.

- Isolate and/or remove all undesirable materials (e.g., contaminated soils, potentially hazardous materials) to protect the reclaimed landscape from contamination.
- Recontour the land surface and implement other soil conservation, surface manipulation, and water management techniques to establish stable slopes, watercourses, and drainage features to minimize erosion and sedimentation (also protecting surface water and groundwater resources).
- Revegetate regraded areas to establish self-perpetuating native plant communities capable of supporting existing and future land uses.
- Minimize visual contrasts.

The reclamation success standards provided in Section DP-B-2.2 are the measures that will show whether or not these goals are being met.

DP-B-2.2 Reclamation Success Standards

The following reclamation success standards are the measures that would be used to assess whether BLM’s reclamation requirements are being met. The procedures presented below are designed to achieve the success standards and, in doing so, to meet BLM’s requirements. Reclamation would be implemented, managed, and monitored by the Operators with BLM oversight/approval. Alternatives to all or portions of this reclamation plan may be implemented if the following standards would be met.

No contaminated materials would occur at or near the surface, and all buried undesirable materials would be encapsulated in impermeable material (e.g., sealed pit liners, concrete) and covered with at least 4 feet of spoil.

1) The subsurface would be stable—holes would be plugged and no indications of subsidence, slumping, and/or significant downward movement of surface soil materials would be visible.
2) Sites would be free of trash.
3) Reclaimed areas would be stable and would not exhibit evidence of active sheet flow, rills or gullies greater than 2 inches wide or deep or actively eroding, perceptible soil movement or head cutting in drainages, and/or slope instability on or adjacent to the reclaimed area.
4) Soil surfaces would have adequate surface roughness to reduce runoff and to capture rainfall and snow melt.
5) Vegetative canopy cover, production, and species diversity of desirable species would approximate the surrounding undisturbed areas. Vegetation would help stabilize the site, would support post-disturbance land uses, and would be self-sustaining.
6) Revegetated areas would exhibit vegetative reproduction, either spreading by rhizomatous species or seed production, and be free of noxious and non-native/invasive species; non-native species may be present only with BLM approval.

The following specific success standards for revegetation success (item 6 above) would be met. Unless otherwise indicated, these standards apply only to desirable species. Desirable species are generally considered those species present in the seed mix and/or perennial species present in the surrounding undisturbed landscape.

Within 5 years of the initiation of reclamation, the following standards would be met (in addition to standards 1–5).

a) Vegetative basal cover/stock rate would be at least 50 percent of the of indigenous vegetative cover and species composition to maintain soil stability and provide nutritional value, palatability, and vegetative structure (i.e., vegetative habitat function)
b) No single species would account for more than 50 percent of total vegetative cover unless it comprises greater than 50 percent of the total vegetative cover on adjacent undisturbed areas.
c) Invasive, non-native species or other undesirable species (e.g., weeds) would comprise no more than 15 percent of total vegetative cover.

Within 8 years of the initiation of reclamation, the following standards would be met (in addition to standards 1–5).

d) Vegetative basal cover/stock rate would be at least 80 percent of the of indigenous vegetative cover and species composition to maintain soil stability and provide nutritional value, palatability, and vegetative structure (i.e., habitat function).
e) No single species would account for more than 30 percent of total vegetative cover unless it comprises greater than 30 percent of the total vegetative cover on adjacent undisturbed areas.
f) Invasive, non-native species or other undesirable species (e.g., weeds) would comprise no more than 5 percent of total vegetative cover.

7) The reclaimed landscape would have characteristics that approximate the visual quality of adjacent areas with regard to location, scale (e.g., line, form, and texture), contour, color, and orientation of major landscape features and would support post-disturbance land uses.

Permanent revegetation would be considered successful when standards 1–5, 6d, 6e, 6f, and 7 have been achieved.

DP-B-3.0 AFFECTED COMMUNITIES

As described in Section 3.2.1 of the EIS, the JIDPA is dominated by the Wyoming big sagebrush/grassland vegetation type. Saltbush, cushionplant, and basin big sagebrush communities also are present to a limited extent, primarily in the eastern portions of the JIDPA and along Sand Draw.

Potential wetlands occupy approximately 47 acres of the JIDPA (less than 0.1 percent of the area) and occur as inclusions within the dominant vegetation types. One of these potential wetlands is a large playa (23 acres) occurring on private surface in Section 32, T29N, R108W.

One area with stabilized sand dunes occurs in the JIDPA in Sections 2 and 11, T28N, R108W (see Map 3.2 in the EIS).

Reclamation potential within the sagebrush, grassland, and potential wetland communities is good to excellent. In the saltbush, cushionplant, and playa communities, reclamation success would be limited by shallow soils, droughtiness, salinity, and other adverse soil characteristics. Reclamation potential also may be limited by other extant conditions on the JIDPA, including sandy soils (dunal areas), steep slopes, noncohesive soils, weather conditions (high winds, drought), short growing seasons, and livestock and wildlife use.

DP-B-4.0 RECLAMATION PLAN

The reclamation process will consist of the following steps (Figure DP-B-4.1):

- predisturbance planning and site preparation,
- some temporary reclamation,
- permanent reclamation, and
- reclamation success monitoring.

DP-B-4.1 Predisturbance Planning and Site Preparation

Predisturbance planning minimizes the amount of reclamation at a site by reducing land disturbance. In addition, preparing the site for construction while planning for reclamation (e.g., salvaging and stockpiling topsoil and spoil, separately; locating facilities away from cut-and-fill slopes; minimizing the area occupied by facilities) would facilitate achieving reclamation success.

DP-B-4.1.1 Predisturbance Planning

During selection of drill site, road, pipeline, and ancillary facility locations, Operators would avoid the following areas, where practical:

- areas with high erosion potential (e.g., rugged topography, steep slopes [>25 percent], stabilized sand dunes, floodplains);
- areas with saturated soils;
- areas within 500 feet of wetland or riparian areas (e.g., playas and open water areas); and
- areas within 100 feet of ephemeral and intermittent channels.

Prior to disturbance, Operators would conduct on-site inspections with the BLM or other surface owner of each proposed disturbance area to determine the suitability of proposed facility locations and/or corridors with regard to the above-listed avoidance areas. In addition, Operators would submit for BLM approval Surface Use Plans (SUPs) and/or Plans of Development (PODs) for each proposed surface disturbance area or corridor. These plans would include the following components:

- project administration, timeframes, and responsible individuals;
- a commitment to adhere to this reclamation plan;
- detailed descriptions of all deviations from this plan required due to site-specific conditions and the rationale for changes; and
- a commitment to meet the reclamation success standards described above.

In addition to SUPs and PODs, Storm Water Pollution Prevention Plans (SWPPPs) would be prepared for all project activities requiring greater than 5 acres of disturbance to ensure that stormwater runoff would not cause surface water pollution. The SWPPP would include provisions for periodic inspection of stormwater pollution prevention devices and practices. A Notice of Intent would be submitted to the Wyoming Department of Environmental Quality. Copies of the SWPPP and inspection reports would be filed in Operator offices.

Operators will submit interim and long-term reclamation plans for their respective areas of operation to BLM for approval no later than 1 year from the date of the JIDP Record of Decision.

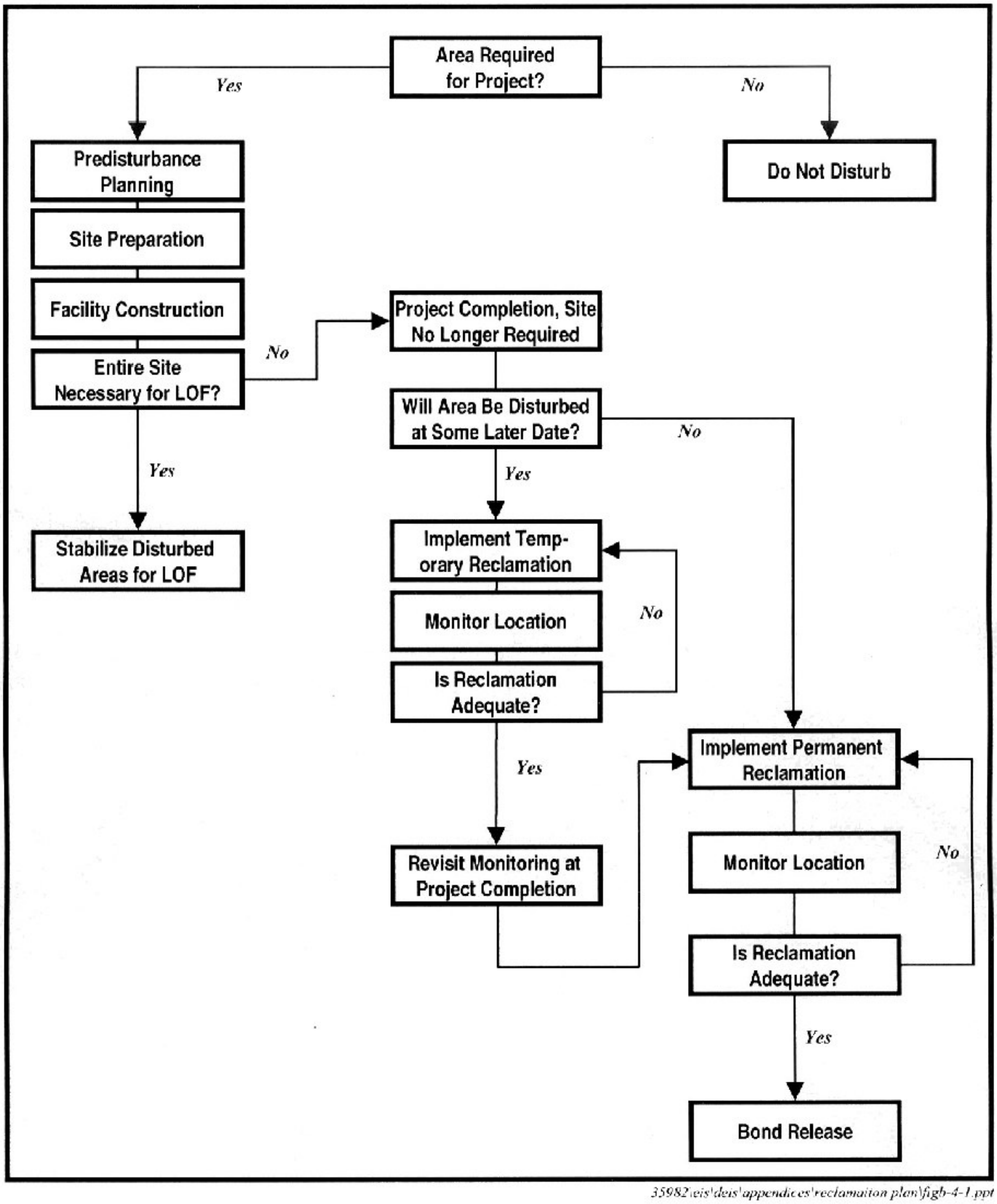

Figure DP-B-4.1. Reclamation Process, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

DP-B-4.1.2 Site Preparation

DP-B-4.1.2.1 Trash and Spills

Trash removal would occur routinely throughout field development and operation. Trash would be picked up by field personnel and disposed of at on-site trash receptacles. These receptacles would be serviced by a licensed solid waste contractor.

Spills would be handled in accordance with Operator-specific Spill Prevention, Control, and Countermeasure Plans (SPCCPs) for the field.

Because trash and spilled materials would be routinely disposed of, removal of these materials is included in the operation plan rather than in the reclamation plan. However, topsoil would not be placed on contaminated materials, and the absence of contaminated materials at or near the ground surface is a reclamation requirement and a reclamation success criterion.

DP-B-4.1.2.2 Topsoil and Spoil Handling

Topsoil would be salvaged from all proposed disturbance areas and stockpiled, unless the BLM deems that leaving topsoil in place would facilitate better reclamation. Vegetation would be salvaged and stockpiled with topsoil to incorporate native seeds and organic matter.

Addendum B-A provides a table of typical soil salvage depths for the various soil types occurring within the JIDPA. At each location to be disturbed, Operators would use the soils map and soil salvage depths table to determine appropriate surface soil material salvage depths. Alternatively, a qualified soil scientist or reclamation specialist may make a field-based determination on appropriate salvage depth(s). This may require soil testing to determine fertility and overall suitability of materials as a plant growth medium. Soil and spoil testing would be required (see Section DP-B-4.4.3) if the Year 4 reclamation success standards (see Section DP-B-2.2) are not met. The volume of topsoil or other suitable plant growth material to be salvaged, proposed topsoil replacement depth, and topsoil storage areas would be specified in the SUP or POD. If less than 6 inches of topsoil are available, topsoil could be mixed with suitable spoil, with BLM approval, so that a minimum of 6 inches of plant growth material is available for use during reclamation. Spoil to be mixed with topsoil would be tested, and amendments would be added so that it meets fair and above suitability criteria for topsoil (Table DP-B-4.1). No unsuitable materials would be used. Alternatively, Operators would identify other topsoil stockpile(s) from which topsoil would be obtained for reclamation. For example, if Location A has less than 6 inches of topsoil but 24 inches were salvaged from neighboring Location B, Operators may identify the neighboring location as the source of additional surface soil material. The SUP or POD for both locations would note that a specific volume of topsoil from Location B is slated for use at Location A.

Where cut-and-fill construction is required, Operators would, to the extent possible, balance the volumes of cut versus fill material to minimize the volume of spoil stockpiled. Spoil would be salvaged and stockpiled separately from topsoil.

For pipelines and access roads constructed on slopes of less than 15 percent, topsoil would be salvaged from all areas to be disturbed and stockpiled in windrows within the construction right-of-way (ROW) by sidecasting with a grader. Where pipelines and roads are to be constructed on slopes greater than 15 percent, topsoil would be transported to more level terrain for storage.

Table DP-B-4.1. Criteria to Establish Suitability as Topsoil (or Topsoil Substitutes)[1]

Parameter	Suitability			
	Good	Fair	Poor	Unsuitable
pH	6.0–8.4	5.5–6.0 8.4–8.8	5.0–5.5 8.8–9.0	<5.0 >9.0
EC (conductivity) mmhos/cm	0–4	4–8	8–16[2]	>16[2]
Saturation Percentage	25–80		>80 <25	-- --
Texture[3]	SL, L, SIL, SCL, VFSL, FSL	CL, SICL, SC, LS, LFS	C, SIC, S	--
SAR	<6	6–10	10–15 10–12[4]	>15 >12[4]
Selenium	<2.0 ppm			>2.0 ppm
Boron	<5.0 ppm			>5.0 ppm
Calcium Carbonate	0–15%	15–30%	>30%	--
Coarse Frag. (% volume)				
3–10 inches	0–15	15–25	25–35	>35
>10 inches	0–3	3–7	7–10	>10
Consistency[5]				
Moist	VFR, FR	LO, FI	VFI, EXFI	--
Dry	LO, SO	SH, H	VH	--

1 Adapted from Wyoming Department of Environmental Quality Land Quality Division (1981).
2 EC (conductivity) of >8 may prove difficult to revegetate.
3 Soil Conservation Service (1978):

C	=	Clay	SC	=	Sandy clay
CL	=	Clay loam	SCL	=	Sandy clay loam
FSL	=	Fine sandy loam	SIC	=	Silty clay
L	=	Loam	SICL	=	Silty clay loam
LFS	=	Loamy fine sand	SIL	=	Silt loam
LS	=	Loamy sand	SL	=	Sandy loam
S	=	Sand	VFSL	=	Very fine sandy loam

4 For fine-textured soils (clay >40%) (Gee et al. 1978).
5 Consistency:

EXFI	=	Extremely firm	SH	=	Semi-hard
FI	=	Firm	SO	=	Soft
FR	=	Friable	VFI	=	Very firm
H	=	Hard	VFR	=	Very friable
LO	=	Loose	VH	=	Very hard

Topsoil and spoil stockpiles would be designed to minimize the surface area occupied and would be constructed to remain stable until they are used for reclamation. Whenever possible, topsoil would be used immediately. When topsoil piles exceed 3 feet in height and/or will be stored for 2 years or longer, Operators will develop a plan for BLM approval that details methods and/or procedures to maintain or replace soil microbial and nutrient viability for reclamation. Stockpile slopes will be 5:1 or less. If a topsoil stockpile is located on or adjacent to ground that slopes 3:1 or more, runoff would be diverted around the stockpile via interceptor ditches. Interceptor ditches would be V-shaped—1 foot deep and 3 feet wide with gently sloping sides—and would empty onto native, undisturbed vegetation. Alternatively, energy dispersing devices (e.g., rock aprons) would be placed at each end of the interceptor ditch. All stockpiles will be located so as not to affect existing drainages. Temporary reclamation (see Section DP-B-4.3) would be implemented immediately on all topsoil and spoil stockpiles.

Topsoil and spoil stockpiles would be clearly marked and noted on site maps and may be identified with signs.

DP-B-4.1.2.3 Additional Procedures for Wetlands

Well pads would not be located in wetlands. Where roads and pipelines must cross wetlands, construction would occur when the area is dry, if possible. In work areas that would not be excavated but would be driven on (e.g., scalped pipeline corridors adjacent to pipeline trenches), vegetation would be cut to ground level, leaving existing root systems intact; these areas would not be graded. At least 12 inches of topsoil would be salvaged and replaced from wetland areas except in areas with standing water or saturated soils, where no topsoil would be salvaged. If standing water or saturated soils are present, either wide-track/balloon-tire construction equipment or typical construction equipment operated on equipment pads would be used. Equipment pads would be removed immediately upon completion of construction.

DP-B-4.2 Reclamation Timing

Temporary and permanent reclamation would occur in the first fall (September 15 to freeze-up) or spring (prior to May 15 and only if fall seeding is not feasible) following completion of required activities (e.g., road or pipeline construction, reserve pit fluid evaporation).

DP-B-4.3 Temporary Reclamation

The objectives of temporary reclamation are to meet success standards 1–6 above (see Section DP-B-2.2). Additionally, vegetation on temporary reclamation would help stabilize soils.

Temporary reclamation would be conducted on areas that would be redisturbed (e.g., topsoil and spoil stockpiles) prior to project abandonment. For operating well pad cut-and-fill slopes, Operators may elect to conduct either temporary or permanent reclamation. Temporary reclamation would not be used as a means to delay permanent reclamation on areas that would not be redisturbed.

Temporary reclamation areas would be graded and contoured to slopes of 3:1 or less. Topsoil and spoil stockpiles would be constructed with side slopes of 5:1 or less. Graded surfaces would be ripped, if necessary, to eliminate soil compaction. Surfaces would then be disced to loosen surface material.

Topsoil would not be replaced on all temporary reclamation areas for the following reasons. First, much of the temporary reclamation would occur on topsoil stockpiles. Second, topsoil should not be mixed with spoil except as described in Section DP-B-4.1.2.2), so placing topsoil on spoil stockpiles would not occur. Finally, replacing and then re-disturbing topsoil on temporary reclamation areas would increase the potential for topsoil loss while it is being handled, stockpiled, and replaced a second time; topsoil handling would be minimized.

After discing, the area would be seeded using the seed mixture for temporary reclamation (Table DP-B-4.2) or one of the seed mixtures for permanent reclamation (see Tables DP-B-4.3 through DP-B-4.7 below). Operators would determine which mixture to use based on seed availability, cost, or other operational considerations.

Table DP-B-4.2. Seed Mixture for Temporary Reclamation[1]

Species	Approximate Seeding Rate (PLS/acre)[2]
Western wheatgrass (*Elymus smithii*)	2.0
Slender wheatgrass (*Elymus trachycaulus*)	2.0
Streambank wheatgrass (*Elymus lanceolatus* var. *riparius*)	2.0
Winter wheat (*Triticum aestivum*)[3]	10.0
Total	16.0

[1] It is anticipated that this seed mixture primarily would be used on topsoil and subsoil stockpiles designated for long-term storage.
[2] PLS/acre = pounds of pure live seed per acre; alternate seeding rates may be applied in some areas as deemed appropriately by BLM and specified in approved SUPs and/or PODs.
[3] A sterile hybrid would be seeded as a cover crop; cover crops would be used only in areas where rapid site stabilization is desired and where further disturbance and reseeding efforts likely would be conducted.

Table DP-B-4.3. Suggested Permanent Reclamation Seed Mixture for Sagebrush-dominated Communities with Sandy Soils[1]

Species	Drill Seeding Rate (PLS/acre)[2]
Grasses	
Thickspike wheatgrass (*Elymus lanceolatus* var. *lanceolatus*)	2.00
Western wheatgrass (*Elymus smithii*)	2.00
Bluebunch wheatgrass (*Elymus spicatum*)	2.00
Indian ricegrass (*Oryzopsis hymenoides*)	3.00
Needle-and-thread (*Stipa comata*)	3.00
Forbs (select one or more of the following forb species)	
Desert Indian paintbrush (*Castilleja chromosa*)	1.00
Scarlet globemallow (*Sphaeralcea coccinea*)	1.00
Shrubs (select 2 or more of the following shrub species)	
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	0.25
Common winterfat (*Krascheninnikovia lanata*)[3]	1.00
Four-wing saltbush (*Atriplex canescens*)	3.00
Antelope bitterbrush (*Purshia tridentata*)	1.00

[1] Operators may submit for approval alternative site-specific seed mixtures.
[2] PLS/acre = pounds of pure live seed per acre. Seeding rates would be doubled if seed is to be broadcast.
[3] Winterfat seed would be broadcast simultaneously with drill-seeding other species.

Table DP-B-4.4. Suggested Permanent Reclamation Seed Mixture for Sagebrush-dominated Communities with Alkaline Soils[1]

Species	Approximate Seeding Rate (PLS/acre)[2]
Grasses	
Western wheatgrass (*Elymus smithii*)	3.00
Thickspike wheatgrass (*Elymus lanceolatus* var. *lanceolatus*)	3.00
Alkaligrass (*Puccinellia distans*)	3.00
Alkali sacaton (*Sporobolus airoides*)	3.00
Forbs (select one or more of the following forb species)	
Scarlet globemallow (*Sphaeralcea coccinea*)	1.00
Evening primrose (*Oenothera* sp.)	1.00
Shrubs (select two or more of the following shrub species)	
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	0.25
Common winterfat (*Krascheninnikovia lanata*)[3]	1.00
Four-wing saltbush (*Atriplex canescens*)	3.00
Gardner saltbush (*Atriplex gardneri*)	1.00

1 Operators may submit for approval alternative site-specific seed mixtures.
2 PLS/acre = pounds of pure live seed per acre. Seeding rates would be doubled if seed is to be broadcast.
3 Winterfat seed would be broadcast simultaneously with drill-seeding other species.

Table DP-B-4.5. Suggested Permanent Reclamation Seed Mixture for Saltbush Communities[1]

Species	Approximate Seeding Rate (PLS/acre)[2]
Grasses	
Sandberg bluegrass (*Poa sandbergii*)	1.0
Western wheatgrass (*Elymus smithii*)	2.0
Thickspike wheatgrass (*Elymus lanceolatus* var. *lanceolatus*)	2.0
Alkaligrass (*Puccinellia distans*)	3.0
Alkali sacaton (*Sporobolus airoides*)	3.0
Forbs (select one or more of the following forb species)	
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	1.0
Northern sweetvetch (*Hedysarum boreale*)	1.0
Evening primrose (*Oenothera* sp.)	1.0
Shrubs (select two or more of the following shrub species)	
Four-wing saltbush (*Atriplex canescens*)	3.0
Shadscale (*Atriplex confertifolia*)	1.0
Gardner saltbush (*Atriplex gardneri*)	1.0
Common winterfat (*Krascheninnikovia lanata*)[3]	1.0

1 Operators may submit for approval alternative site-specific seed mixtures.
2 PLS/acre = pounds of pure live seed per acre. Seeding rates would be doubled if seed is to be broadcast.
3 Winterfat seed would be broadcast simultaneously with drill-seeding other species.

Table DP-B-4.6. Suggested Permanent Reclamation Seed Mixture for Playas and Other Alkaline Areas[1]

Species	Approximate Seeding Rate (PLS/acre)[2]
Grasses	
Muhly (*Muhlenbergia* spp.)	2.0
Alkaligrass (*Puccinellia distans*)	3.0
Alkali sacaton (*Sporobolus airoides*)	3.0
Western wheatgrass (*Elymus smithii*)	3.0
Forbs (select one or more of the following forb species)	
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	1.0
Northern sweetvetch (*Hedysarum boreale*)	2.0
Shrubs	
Four-wing saltbush (*Atriplex canescens*)	3.0
Gardner saltbush (*Atriplex gardneri*)	1.0

1 Operators may submit for approval alternative site-specific seed mixtures.
2 PLS/acre = pounds of pure live seed per acre. Seeding rates would be doubled if seed is to be broadcast.

Table DP-B-4.7. Suggested Permanent Reclamation Seed Mixture for Stabilized Sand Dune Communities[1]

Species	Approximate Seeding Rate (PLS/acre)[2]
Grasses	
Prairie sandreed (*Calamovilfa longifolia*)	3.00
Bluebunch wheatgrass (*Elymus spicatum*)	2.00
Sand dropseed (*Sporobolus cryptandrus*)	2.00
Indian ricegrass (*Oryzopsis hymenoides*)	2.00
Needle-and-thread (*Stipa comata*)	2.00
Basin wildrye (*Elymus cinerus*)	1.00
Forbs (select one or more of the following forb species)	
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	1.00
Desert Indian paintbrush (*Castilleja chromosa*)	1.00
Northern sweetvetch (*Hedysarum boreale*)	1.00
Shrubs	
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	0.25
Spiny hopsage (*Grayia spinosa*)	1.00

1 Operators may submit for approval alternative site-specific seed mixtures.
2 PLS/acre = pounds of pure live seed per acre. Seeding rates would be doubled if seed is to be broadcast.

Operators may elect to plant a cover crop of winter wheat or other sterile hybrid and then interseed with the other three species in the mixture for temporary reclamation or with a mixture for permanent reclamation. Cover crops provide rapid site stabilization and protect surfaces from wind and water erosion, and plant root structures improve soil permeability.

DP-B-4.4 Permanent Reclamation

Permanent reclamation would be conducted on all disturbed areas no longer required for field operations (e.g., portions or all of well pads, road outslopes, and pipeline corridors). Permanent reclamation would be conducted on pads and roads for non-producing wells and on pads for wells that have reached the end of their productive life (includes facility removal and complete well pad and access road reclamation). Because permanent reclamation would occur throughout the Life-of-Project (LOP), this plan does not differentiate between "interim" and "final" reclamation. All permanent reclamation is considered final unless monitoring shows that it needs to be repeated. Operators would completely reclaim all portions of well pads not required for operations, access road out-slopes, and pipeline corridors in the fall or spring immediately following construction or dry hole abandonment. Reserve pits, if approved, would be completely reclaimed in the first spring or fall after draining. If reclamation involves facility removal (Section DP-B-4.4.1), regrading and reseeding would occur in the first fall or spring following facility removal.

DP-B-4.4.1 Facility Removal

Some facilities would reach the end of their operational life during the LOP, whereas others would remain in use until field production is complete. When the Operators determine that a well or other facility is no longer needed, it would be removed and the area would be permanently reclaimed.

All gas wells and generally all water wells would be abandoned according to BLM and/or Wyoming Oil and Gas Conservation Commission regulations. Some water wells may be retained for other uses after the LOP. Aboveground well pad, pipeline, and water disposal facilities, including buildings, tanks, flare pits, reserve pits, evaporation pits, and associated hardware, would be dismantled, removed from BLM lands, and salvaged and re-used or disposed of at approved sites. Underground pipelines would be purged of gas or liquid, plugged, and abandoned in place.

Liquid or solid wastes remaining at well locations would be tested and properly disposed of according to state and federal regulations. Reserve and evaporation pit liners would be disposed of at state-approved sites or buried on-site. Concrete foundations, pads, or footings would be broken-up and removed or buried on-site. Aggregate used for well pad, road, and other facility construction also would be removed or buried on-site. Operators would obtain BLM approval for all on-site burial proposals.

Road reclamation would include the removal of bridges, culverts, cattleguards, sediment control structures, and signs. Drainage-crossing sideslopes would be reduced to no more than 4:1 to reduce bank erosion and produce stable sideslopes. Barriers would be used to discourage travel on the reclaimed roads and pipelines until permanent reclamation is deemed successful.

DP-B-4.4.2 Surface Preparation

DP-B-4.4.2.1 Backfilling and Grading

Backfilling would occur prior to grading. Areas to be backfilled include flare pits, reserve pits, cut slopes, pipeline trenches, borrow ditches, and facility foundations. Pipeline trenches would be backfilled so that the soil berm is less than 3 inches high. Spoil for backfill would be obtained from fill material and spoil stockpiles.

Areas to be reclaimed would be graded to approximate original contours and to blend in with adjacent topography. Area-wide drainage would be restored so that surface runoff flows and gradients are returned to the conditions present prior to development. Graded surfaces would be suitable for the replacement of a uniform depth of topsoil, would promote cohesion between subsoil and topsoil layers, would reduce wind erosion, and would facilitate moisture capture.

Specialized grading techniques would be applied at the Operators' discretion and may include slope rounding, bench grading, stair-step grading, and/or contour furrowing.

Dozers, loaders, scrapers, and motor graders are typically used for backfilling and grading.

DP-B-4.4.2.2 Ripping and Discing

Compacted areas such as roads and well pads would be ripped to a depth of approximately 2 feet to improve soil aeration, water infiltration, and root penetration. Ripped areas would be disced, if necessary, to fill in deep furrows (where topsoil would be lost) and break up large clods (to which topsoil would not adhere).

Motor graders or tractors equipped with ripping shanks are typically used for ripping. Ripper shanks would be set approximately 1–2 feet apart. Discing is typically accomplished using a tractor-drawn disc set 2–6 inches deep.

DP-B-4.4.3 Seedbed Preparation

Seedbed preparation maximizes seeding efficiency and improves reclamation success. It includes topsoil replacement (with amendments, where appropriate) and discing. Surface roughening procedures (e.g., pitting, gouging) also may be applied at the discretion of Operators.

DP-B-4.4.3.1 Topsoil Replacement

Waterbars and erosion control devices would be installed on reclaimed areas prior to topsoil replacement, as necessary, to control topsoil erosion (see Section DP-B-4.5.2).

Between 6 and 24 inches of stockpiled topsoil would be redistributed uniformly on areas to be reclaimed. If the stockpile for a given location contains insufficient topsoil to meet the required 6-inch minimum, topsoil would be mixed with suitable spoil or imported from another location as described in Section DP-B-4.1.2.2. Topsoil would not be replaced on contaminated material—all contaminated material would be removed or otherwise handled in accordance with the SPCCPs.

Topsoil is typically replaced using scrapers, dozers, and/or motorgraders.

Once topsoil is replaced, seeding would occur within 2 weeks unless the ground is wet or frozen. In this circumstance, seeding would be delayed until the ground dries or thaws to the point where soils are friable. An early frost would not be used to delay seeding until the following spring if subsequent fall conditions are appropriate for seeding.

Operators have the discretion to conduct soil fertility tests and/or use fertilizers; it is not required for the first attempt at permanent reclamation because fertilizers generally are not effective in semi-arid climates. Fertilizers would not be used near open water. In addition to fertilizer use, Operators have the discretion to use other amendments such as inoculation with soil microorganisms, lime, organic matter, etc.

If Year 4 reclamation success standards are not met, soil tests would be implemented to determine the need for fertilizers or other soil amendments.

DP-B-4.4.3.2 Discing

After topsoil replacement, newly topsoiled areas would be disced or harrowed to reduce soil compaction, to break up soil clods, to improve root and water penetration, and to provide a friable but firm seedbed. The surface would be rough to reduce wind and water erosion and to promote moisture capture.

If the surface is roughened during discing, other moisture-capture techniques are probably not needed. However, Operators have the full discretion to implement techniques such as pitting and gouging to concentrate water in pits and gouges. If Year 4 reclamation success standards are not met, BLM may require implementation of these kinds of techniques.

Discing and harrowing are typically accomplished using a tractor-drawn disc or harrow set 2–6 inches deep.

DP-B-4.4.4 Revegetation

DP-B-4.4.4.1 Seeding

Reclaimed areas would be seeded using the seed mixtures presented in Tables DP-B-4.3 through DP-B-4.7. These mixtures were developed based on the following criteria: general conditions within the analysis area, species adaptations to site conditions, usefulness of the species for rapid site stabilization, species success in past revegetation efforts, seed costs and availability, and compliance with *Executive Order 11987* and *BLM Manual* Section 1745 (i.e., use of native species).

Alternative species and seeding rates may be used at Operator discretion, if warranted by site-specific conditions or seed availability, provided that the alternative species/seeding rates facilitate achieving reclamation success and all modifications are documented as described in Section DP-B-2.2.

Seed mixtures would be certified weed-free.

Operators would determine which seed mixture to use and which substitute species may be appropriate to include in the mixture in consultation with BLM. Operators may also elect to use interseeding techniques (BLM may require this if Year 4 reclamation is not successful).

Operators have the discretion to inoculate selected seed mixtures with soil microorganisms to facilitate germination and growth. If Year 4 reclamation success standards are not met, BLM may require seed mixture inoculation.

Seeding would be conducted in the fall between September 15 and freeze-up. If fall seeding is not feasible, seeding may occur between spring thaw and May 15. Seeds would be planted along contour using a rangeland drill equipped with an agitator and depth bands to mix seed and ensure proper seeding depths. Seeds would be planted 0.25 to 0.50 inch deep. Fluffy seeds (e.g., winterfat) would be broadcast simultaneously with drilled seeding. Broadcast seeding may be used, at the Operators' discretion, for other shrub and forb species, utilizing either hand or specialized broadcast seeders.

When drill-seeding is not practical due to steep slopes, rocky surfaces, or wet soil conditions, seeding rates would be doubled, seeds would be broadcast, and the area would be raked or chained to cover seeds. Operators may elect to broadcast seed after applying and crimping 2 tons/acre of certified weed-free mulch.

Operators may elect to hand-plant bare-root or containerized shrub stock to facilitate shrub establishment. It is not required for the first-time attempt at permanent reclamation but may be required at a later date by BLM if reclamation success is not achieved.

DP-B-4.4.4.2 Mulching

Where mulching is deemed necessary, the reclaimed area would be uniformly mulched (75 percent minimum cover) with certified weed-free native grass, hay, small grain straw, wood fiber, and/or live mulch, at a rate of 2 tons/acre. Alternatively, cotton, jute, or synthetic netting would be applied. Mulch would be crimped into the soil, tackified, or incorporated into erosion control blankets to prevent it from blowing or washing away and from entering waterways. Mulch would protect the soil from wind and water erosion, raindrop impact, and surface runoff and would help hold seeds in place. Mulching may occur prior to or after broadcast seeding but must occur after drill seeding.

On steep slopes where it is unsafe to operate equipment, at sites where soils have 35 percent or more surface rock content, or on notably unstable areas, hydromulch, biodegradable erosion control netting, or matting would be firmly attached to the soil surface.

DP-B-4.5 Erosion Control

DP-B-4.5.1 Construction- and Operation-Phase Erosion Control

Chapter 2.0 in the EIS provides construction procedures, and erosion control practices have been designed into these procedures. Operators would also adhere to the following additional erosion control measures during construction and operation.

Standard culverts, road ditches, and road design would be used in accordance with typical engineering practices to minimize erosion along active roads. Culverts would be sized to pass expected flows without causing erosion above, below, or around the culvert. Culvert entrances and exits would be protected with energy dissipaters such as riprap or rock aprons as necessary. Road ditches would be sized to collect runoff from roads and surrounding areas; energy dissipating structures such as straw bales anchored with rebar would be used to prevent ditch erosion. Roads would be designed to enable head-on traffic to pass without leaving the surfaced travelway. If turnouts are used for this purpose, Operators would instruct field personnel to use turnouts to avoid traveling on roadside ditches. Water discharged from culverts, roadside ditches, and turnouts would be directed either into undisturbed vegetation or natural drainages.

Interceptor ditches would be installed above all cut slopes. Interceptor ditches would be V-shaped—1 foot deep and 3 feet wide with gently sloping sides—and would empty onto native, undisturbed vegetation. Alternatively, energy-dispersing devices (e.g., rock aprons) would be placed at each end of the interceptor ditch.

Sediment control devices would be placed at the base of all fill slopes and stockpiles.

Where road or pipeline construction occurs on slopes of 3:1 or more, temporary sediment barriers such as silt fences and/or staked weed-free straw bales would be installed along contour below the road/pipeline corridor. Silt fences or other sediment filtering devices would also be installed wherever road or pipeline construction occurs within 100 feet of a drainage or wetland.

Temporary sediment barriers would remain in place until the surfaces are stable and reclamation success standards are met (see Section DP-B-2.2). Sediment filtering devices would be cleaned out and maintained in functional condition throughout the LOP.

Trench plugs would be used during pipeline construction at nonflumed drainage crossings to prevent diversion of flows into upland portions of pipeline trenches. Instream protection devices (e.g., drop structures) also may be used to prevent erosion in drainages crossed by pipelines. In drainages, clean gravel would be used for the upper 1 foot of backfill in pipeline trenches. Application of riprap to channel banks would be limited to areas where flow conditions prevent stabilization by vegetation. Riprap installation would comply with U.S. Army Corps of Engineers' permit requirements. Pipeline trenches would be dewatered so no construction-related silty water flows into drainage channels.

Where roads and pipelines cross a waterbody (i.e., wetlands or drainages), topsoil and spoil would be placed at least 10 feet from the edge of the waterbody, and sediment control structures would be placed between the topsoil/spoil and the waterbody. Dirt, rock, and brush riprap would not be used to stabilize the ROWs at waterbody crossings.

DP-B-4.5.2 Reclamation-Phase Erosion Control

All reclaimed surfaces would be left rough and would be mulched, if recommended by the BLM, as described in Section DP-B-4.4.4.2, to reduce wind and water erosion. Erosion and sediment control structures would be installed on reclaimed areas wherever slope gradients exceed 3:1 and where monitoring demonstrates that erosion control structures are needed.

Runoff from reclaimed areas where slopes exceed 3:1 (and where monitoring suggests that it is warranted) would be controlled using standard structures including, but not necessarily limited to, waterbars, silt fences, geotextile, and energy dissipaters. Areas with concentrated development with closely spaced pads (more than 1/40 acres) would be subject to reclamation efforts that address cumulative runoff, regardless of slope. Waterbars would be installed in accordance with standard BLM specifications and would drain into undisturbed vegetation. Waterbars generally will be 12–18 inches in height with a 2 percent grade. Waterbars would be installed after ripping and prior to topsoil placement. Silt fences would be placed downhill from reclaimed areas where erosion may impact a waterbody and would be installed according to manufacturers' instructions. Energy dissipaters would be used wherever water is channelized (e.g., by a waterbar or an interceptor ditch) to slow flows.

All runoff and erosion control structures would be inspected, maintained, and cleaned-out by Operators on a regular basis throughout the LOP. Inspections would occur after runoff events (e.g., spring runoff, storm events). Sites and sources of soil movement would be addressed in a timely manner and recorded in a way that would allow for erosion pattern tracking. These reports would be provided to BLM annually.

DP-B-4.6 Weed Control

Operators would be responsible for noxious, non-native, and invasive weed control from all project activities for the LOP. If use of herbicides is deemed necessary by Operators or BLM, a Pesticide Use Permit would need to be submitted for approval to the BLM. All herbicides would be used only in the season or growth stage during which they are most effective. Herbicides would be applied only by certified personnel using approved precautions and application procedures in compliance with all applicable federal, state, and local regulations. Herbicides would not be used within 100 feet of open water or during extremely windy conditions. Aerial application of herbicides would be prohibited within 0.25 mile of known special status plant species locations (i.e., federally listed or BLM-sensitive species) and hand application of herbicides would not occur within 500 feet of such occurrences. Certified weed-free seed mixtures and mulches would be used, thereby minimizing the potential for noxious weed introduction.

DP-B-5.0 RECLAMATION SUCCESS MONITORING

This monitoring plan was developed with two primary objectives: 1) to document the condition of reclaimed areas relative to the revegetation success criteria provided in Section DP-B-2.2, and 2) to provide an expeditious means for monitoring all reclamation sites to document reclamation progress.

DP-B-5.1 Monitoring Responsibilities

Operators would be responsible for the following:

- monitoring,
- determining if reclamation success standards are being met,
- developing and implementing remedial actions if success standards are not being met,
- reporting monitoring results to BLM annually, and
- requesting concurrence from BLM that success standards have been met and monitoring is no longer required.

BLM would be responsible for the following:

- evaluating annual monitoring reports,
- providing concurrence (or not) with the reclamation assessments as to whether or not success standards are being met and the rationale for the determination, and
- providing input on remedial actions to facilitate reclamation success (which may include requiring certain actions such as soil testing, soil amendments, irrigation, etc. that are not required by this plan).

Operators would submit annual reclamation evaluation reports to BLM by December 31 of each year and BLM would complete its above-referenced responsibilities by March 31 of the following year. This would enable Operators to make adjustments, if needed, prior to the next field season (summer) and reclamation season (fall).

DP-B-5.2 Monitoring Approach

Monitoring would be largely qualitative because it is reasonably accurate to document the condition of a site in the field with a few basic notes and color photographs. The Monitoring Form provided as Table DP-B-5.1 is designed to collect the appropriate data. The approach described herein is designed to allow reclamation inspectors a tool for evaluating reclamation status throughout the Jonah Field during a short period in the growing season, which would enable Operators to obtain a field-wide record on the status of reclamation. This record, then, would be used to make informed decisions on what actions are needed to obtain field-wide reclamation success, decisions that might range from a high-level action such as revising this Reclamation Plan to a simple remedial action such as installing a silt fence. The record would be key to tracking reclamation progress and initiating appropriate remedial actions for the LOP.

Field-wide monitoring would include existing and proposed facilities authorized under previous National Environmental Policy Act of 1969 documents for the Jonah Field, as well as all infill operations that may be authorized in the future.

Table DP-B-5.1. Monitoring Form

JONAH INFILL DRILLING PROJECT
RECLAMATION MONITORING FORM

Well Name/Number ____________________ **Monitoring Date** ________________________

Well Spud Date ________________________ **Inspector** ________________________________

Circle 1 – Well Pad, Access Road, Pipeline, Other Facility

Reclamation Data

Date Backfilled ____

Date Topsoiled ____

Topsoil Depth Replaced ____

Date Seeded ____

Seed Mixture ____

____

____

____

____

Other Reclamation Techniques Used ____

____

____

____

____

____

____

____

____

Table DP-B-5.1 (Continued)

Monitoring Data

Answer Questions 1 - 6 to evaluate temporary reclamation
Answer Questions 1 - 11 to evaluate reclamation on sites that were reclaimed 4 or more years ago.
Answer Questions 1 - 6 and 12 - 18 to evaluate reclamation on sites that were reclaimed 10 or more years ago or where permanent reclamation success is to be documented.

Questions		Data		
		Yes	No	Comments (include photograph information)
1	Is the area free of undesirable materials (construction materials, trash, potentially hazardous materials)?			
2	Is the subsurface apparently stable, with no indications of subsidence, slumping, and/or significant downward movement of surface soil materials?			
3	Does the area appear stable (absence of rills or gullies that are actively eroding or greater than 2 inches wide/deep, perceptible soil movement, sheet flow, or head cutting in drainages and/or slope instability on or adjacent to reclaimed area)?			
4	Are soil surfaces adequately rough to reduce runoff and capture rainfall and snowmelt?			
5	Is vegetation helping to stabilize the site?			
6	Are weeds or other undesirable species adequately controlled?			
7	Is vegetative canopy cover at least 60% of the adjacent native undisturbed vegetative cover?			
8	Is there evidence of vegetative reproduction (either spreading by rhizomatous species or seed production)?			
9	Is vegetative cover at least 50% by species contained in the seed mix and/or present on adjacent areas?			
10	Does no single species account for more that 50% of total vegetative cover, or if so, does it make up more than 50% of total vegetative cover in adjacent undisturbed areas?			
11	Invasive, non-native species (weeds) or other undesirable species do not comprise more than 15% of total vegetative cover?			

Table DP-B-5.1 (Continued)

Questions		Data		
		Yes	No	Comments (include photograph information)
12	Is vegetative canopy cover at least 80% of cover on adjacent native undisturbed vegetation?			
13	Is there evidence of vegetative reproduction (either spreading by rhizomatous species or seed production)?			
14	Is vegetative cover at least 90% by species contained in the seed mix, present on surrounding native vegetation, and/or by other desirable species?			
15	Does no single species account for more than 25% of total vegetative cover, or if so, does it make up more than 25% of total vegetative cover in adjacent undisturbed vegetation?			
16	Invasive, non-native species (weeds) or other undesirable species do not comprise more than 5% of total vegetative cover?			
17	Does the reclaimed landscape have characteristics that approximate the visual quality of the adjacent area?			
18	Does the reclaimed landscape support desired post-disturbance land uses?			

Use this worksheet to obtain data to answer questions 7-16.

Attribute	Reclaimed Area	Native Undisturbed Vegetation
Vegetative cover (%) by desirable species (note any species that comprises more than 25–50% of cover).		
Vegetative cover (%) by undesirable species		
Species list		
Description of evidence of reproduction by desirable species		Not Applicable

Table DP-B-5.1 (Continued)

Additional Field Notes ______________________________

Table DP-B-5.1 (Continued)

Photographs of Reclaimed Area (attach additional sheets if needed).

Photograph 1

Photograph 2

The qualitative evaluation may be supported by quantitative sampling such as the use of quadrats or transects to estimate vegetative cover. Quantitative or statistical sampling would only be conducted if it is deemed appropriate by the Operators or BLM or to settle any disagreements in the interpretation of the qualitative evaluation. The small sizes of the reclaim areas (especially on operating well pads and along the narrow linear corridors occupied by access roads and pipelines) do not lend themselves to the types of reclamation success studies conducted at the coalmines, so these types of studies are not recommended for the Jonah Field. Using a more qualitative approach will enable monitoring to be conducted at all reclamation areas within a reasonable time frame and at a reasonable cost, while providing valuable data on the status of reclamation at each location. Thus, the determination of success, or lack thereof, would be based largely on the judgment of a suitable professional and would be supported by monitoring forms and color photographs.

The form presented in Table DP-B-5.1 requires the revegetation success inspector to answer a series of questions about the site. The form provides for the monitoring of temporary reclamation, of sites where reclamation is 4 or more years old where only partial reclamation success is anticipated, and of sites where reclamation is 10 or more years old or for which permanent reclamation success is to be documented and monitoring discontinued. Monitoring permanent revegetation would commence during Year 2 because the desirable perennials typically would begin to dominate these reclaimed areas 1–3 years following reclamation, and any erosion problems would be detected early. Monitoring Form questions are derived from the revegetation success standards described in Section DP-B-2.2.

DP-B-5.3 Monitoring Temporary Reclamation

Temporary reclamation would be monitored annually and after large rain storms or snow melt runoff events.

Temporary reclamation monitoring would include visual inspection for undesirable materials, soil stability, the effectiveness of erosion control practices, vegetation establishment, and weed invasion. Monitoring results would be documented on the Monitoring Form (Table DP-B-5.1) and color photographs would be taken. Where success Criteria 1–6 (see Section DP-B-2.2) are not met (i.e., if any of Table DP-B-5.1 questions 1–6 are answered “no”), Operators would correct the problem within 3 weeks of discovery.

DP-B-5.4 Monitoring Permanent Reclamation

For permanent reclamation, reclamation success standards 1–6 (see Section DP-B-2.2) would be monitored qualitatively (annually and after large rain storms or snow melt runoff events). Monitoring would include visual inspection for undesirable materials, soil stability, effectiveness of erosion control practices, and weed invasion. Monitoring results would be documented on the Monitoring Form (Table DP-B-5.1) and color photographs would be taken. Where success criteria 1–6 are not met (i.e., if any of Table DP-B-5.1 questions 1–6 are answered “no”), Operators would correct the problem within 3 weeks of discovery.

Permanent revegetation monitoring (success standards 6a–6i; see Section DP-B-2.2) would occur in Year 2 and annually thereafter until permanent reclamation success standards are achieved (standards 1–5, 6d, 6e, 6f, and 7). Operators may elect to conduct additional monitoring, and BLM may require additional monitoring if it is deemed warranted.

Permanent revegetation monitoring would include a visual inspection of the site to estimate percent cover by desirable and undesirable species and to compare vegetative canopy cover on the reclaimed area with that present on adjacent native vegetation. Quadrats or transects may be used to assist with cover estimates; if so, representative, rather than random, samples should be obtained. The inspector would note whether the desirable plants on the site appear to be reproducing. A list of the species present on reclaimed and adjacent vegetation would be developed and compared. These data would be recorded on the Monitoring Data Form (see Table DP-B-5.1), and color photographs would be taken.

If any Monitoring Data Form questions 7–11 or 12–18 are answered “no” (i.e., revegetated areas do not meet all standards), additional treatments (e.g., discing and reseeding, addition of soil amendments, irrigation, herbicide application) and a treatment schedule would be developed in consultation with BLM and implemented as scheduled. All treatments would be applied within 1 year of determining that treatment is required.

This process will be reiterated as shown in Figure DP-B-4.1.

DP-B-6.0 REFERENCES

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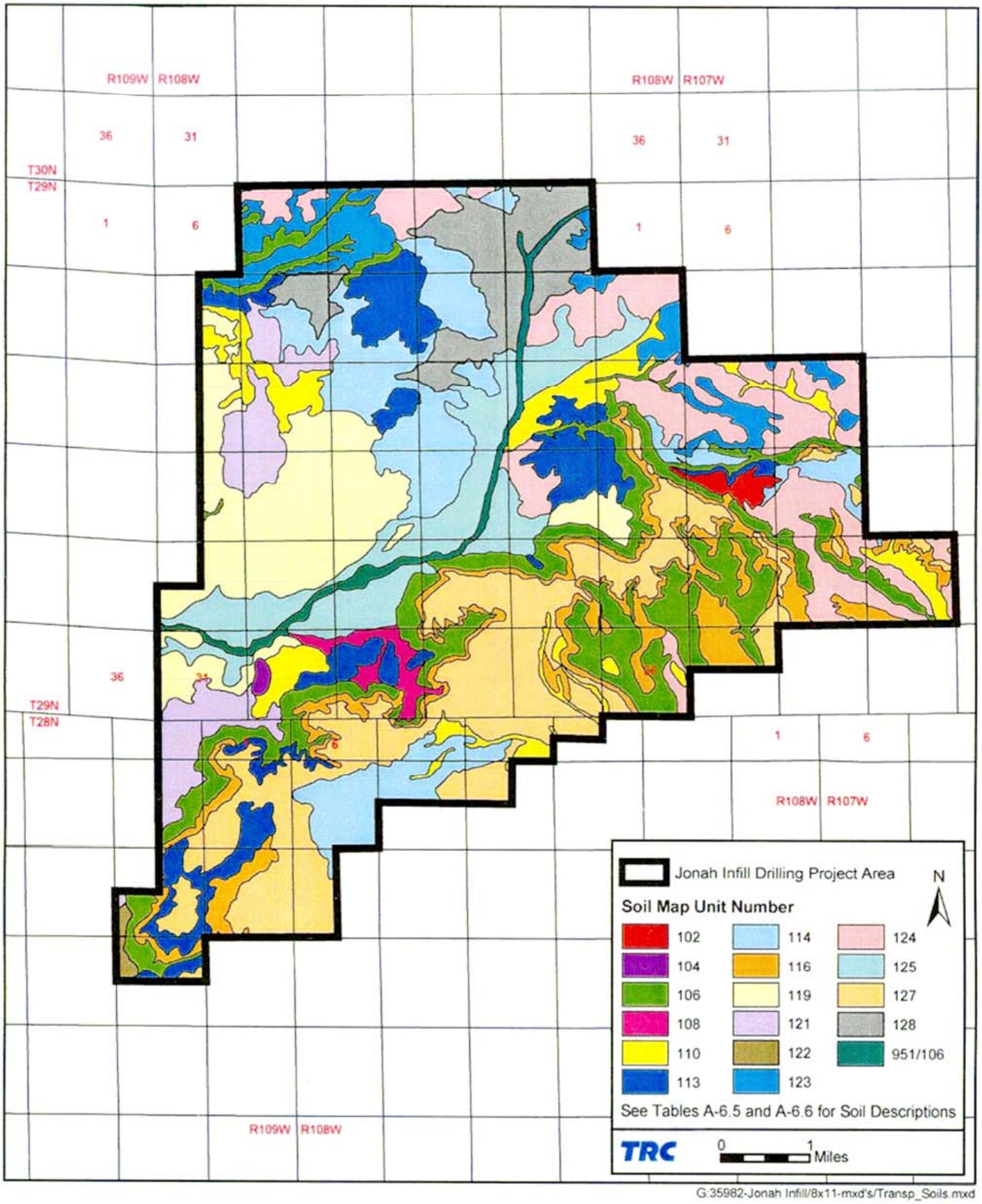
ADDENDUM DP-B-A:

SOILS MAP AND TOPSOIL SALVAGE DEPTHS TABLE



Map DP-B-A.1. Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Table DP-B-A.1. Soil Salvage Depth and Soil Characteristics for Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
102	12	1–10%	Langspring Variant	Loamy	0–10	L	7.9-8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5-9.0	<2	--
					22–30	SCL, L, SL	7.9-8.4	<2	--
					30+	Sandstone	--	--	--
			Langspring	Loamy	0–9	L	7.9-8.4	<2	Low
					9–26	SCL, L, SL	8.5-9.0	<2	--
					26–40	SCL, L, SL	7.9-8.4	<2	--
104	--	0–2%	Chrisman	Saline upland	0–2	SIC, C, SICL	7.9-9.0	<2	Low
					2–60	SIC, C, SICL	77.8	>4	Low
106	12	1–6%	Monte	Loamy/	0–2	L	6.6–9.0	<2	Low
				saline upland	2–60	CL, L, SL	7.9–9.0	<2	--
			Leckman	Loamy/	0–3	FSL, VFSL	7.9–9.0	<2	Low
				saline upland	3–60	FSL, VFSL	7.9–9.0	<2	--
108	12	0–3%	Dines	Saline upland	0–4	SIL	>7.8	8–16	Low
					4–21	SIL, SICL	>8.4	8–16	--
					21–60	SIL, SICL	>8.4	>16	--
			Clowers	Loamy	0–1	L	7.9–9.0	4–8	Low
					1–60	CL	7.9–9.0	4–8	--
			Quealman	Loamy	0–2	FSL, L, CL	7.4–8.4	<2	Low
					2–60	SR-LS-L-FSL	7.9–9.0	<2	--
110	12	1–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--
			Tresano	Loamy	0–2	SL	6.6–7.8	<2	Low
					2–16	SCL	6.6–9.0	<2	--
					16–60	SL	7.4–8.4	2–4	--

Table DP-B-A.1. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
113	12	1–8%	Haterton	Shallow loamy	0–3	L	7.9–9.0	2–4	Moderate
					3–12	L	7.9–9.0	2–4	--
					12+	Siltstone	--	--	--
			Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Moderate
					22+	Shale	--	--	--
114	4	1–8%	Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Low
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8–16	Moderate
					11+	Shale	--	--	--
116	9	6–30%	Huguston	Shallow loamy	0–9	SL, FSL	7.4–8.4	2–4	Moderate
					9+	Soft sandstone	--	--	--
			Horsley	Shale	0–3	L	7.4–9.0	2–4	Moderate
					3–9	L, CL, SCL	7.4–9.0	<16	--
					9+	Shale	--	--	--
			Terada	Loamy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Moderate
					7–34	VFSL, FSL	7.4–9.0	<2	--
					34+	Sandstone	--	--	--
119	12	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Low
					22+	Shale	--	--	--
			Monte	Loamy	0–2	L	6.6–9.0	<2	Low
					2–60	CL, L, SL	7.9–9.0	<2	--
121	10	1–6%	Garsid	Loamy	0–22	L, CL	7.4–9.0	2–4	Low
					22+	Shale	--	--	--
			Terada	Loamy/sandy	0–7	VFSL, FSL, LS	7.4–8.4	<2	Low
					7–34	VFSL, FSL	7.4–9.0	<2	--

Table DP-B-A.1. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
121	10	1–6%	Terada	Loamy/sandy	34+	Sandstone	--	--	--
			Langspring Variant	Loamy	0–10	L	7.9–8.4	<2	Low
					10–22	CL, SCL, L, SL	8.5–9.0	<2	--
					22–30	SCL, L, SL	7.9–8.4	<2	--
					30+	Sandstone	--	--	--
122	0	0–6%	Baston	Clayey	0–3	FSCL	8.0–9.0	<2	Low
					3–28	C	>8.4	<4	--
					28+	Shale	--	--	--
			Boltus	Shale	0–11	C, CL	7.9–9.0	8–16	Moderate
					11+	Shale	--	--	--
			Chrisman	Clayey/	0–2	SIC, C, SICL	7.9–9.0	<2	Low
				saline upland	2–60	SIC, C, SICL	>7.8	<4	--
123	4	4–25%	Spool Variant	Shallow sandy	0–6	LFS, GR-SL	6.6–7.3	<2	Moderate to high
					6–12	LFS, CN-LFS,	6.6–7.8	<2	--
						GR-SL, GR-S	--	--	--
					12+	Sandstone	--	--	--
			Ouard Variant	Shallow clayey	0–4	CL, L	6.6–7.8	<2	Moderate
					4–16	CL, C	7.4–9.0	<2	--
					16+	Shale	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low to moderate
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
124	6	3–8%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--

Table DP-B-A.1. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
124	6	3–8%	Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
125	6	0–3%	San Arcacio	Sandy/loamy	0–3	SL, COSL	6.6–8.4	<8	Low
					3–14	SCL, SL	6.6–8.4	<2	--
					14–60	GRV-S, GR-SL, LCOS	7.4–8.4	<4	--
			Saguache	Loamy/sandy	0–6	SL, COSL, GR-SL	6.6–9.0	<2	Low
					6–60	GRV-S, COS, GRV-LS	6.6–9.0	<2	--
127	3	0–3%	Vermillion Variant	Shallow loamy	0–3	L	6.6–8.4	<2	Low
					3–8	CN-L, CN-CL	7.4–8.4	<4	--
					8–27	FLX-L, FLV-CL, FLV-L	7.9–8.4	<4	--
					27+	Hard mudstone	--	--	--
			Seedskadee	Shallow loamy	0–14	SCL, L, SL	7.0–8.5	<2	Low
					14+	Hard sandstone	--	--	--
			Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--
128	12	0–3%	Fraddle	Loamy	0–4	SL	6.6–7.8	<2	Low
					4–22	SCL	6.6–7.8	<2	--
					22–34	SL, SCL	7.4–8.4	2–4	--
					34+	Soft sandstone	--	--	--

Table DP-B-A.1. (Continued)

Map Unit No.	Topsoil Salvage Depth[2] (inches)	Slope	Map Unit Component	Range Site	Depth (inches)	Texture[3]	Reaction pH	Salinity (mmhos/cm)	Erosion Hazard
128	12	0–3%	Ouard	Shallow loamy	0–1	SL, SCL	6.6–7.8	<2	Low
					1–19	SCL	6.6–7.8	<4	--
					19+	Shale-sandstone	--	--	--
			San Arcacio Variant	Loamy	0–4	SL	6.6–8.4	<8	Low
					4–14	SCL, SL	6.1–8.4	<2	--
					14–25	LCOS, COS, GRV-S	6.6–8.4	<4	--
					25+	Soft sandstone	--	--	--
951[2]/106	--	0–2%/see 106	Cowestglen	Overflow	0–3	CL	7.4–8.4	0	--
					3–8	CL	7.4–8.4	0	--
					8–60	CL	7.4–8.4	0	--

[1] Adapted from ERO Resources Corporation (1988).
[2] Criteria used to determine topsoil salvage depth: maximize loamy textures; minimize clayey textures, rock content, and salinity; salvage at least 6 inches if possible; salvage greater depths in better soils to a) provide a deeper seedbed and b) compensate for insufficient soils at other locations.
[3] U.S. Department of Agriculture Texture.

C	Clay	FSL	Fine sandy loam	SCL	Sandy clay loam
CL	Clay loam	L	Loam	SIC	Silty clay
COS	Coarse sand	LCOS	Loamy coarse sand	SICL	Silty clay loam
COSL	Coarse sandy loam	LFS	Loamy fine sand	SIL	Silt loam
FS	Fine sand	LS	Loamy sand	SL	Sandy loam
FSCL	Fine Sandy clay loam	S	Sand	VFSL	Very fine sandy loam

Texture Modifier:

CN	Channery	GR	Gravelly
FLV	Very flaggy	GRV	Very gravelly
FLX	Extremely flaggy	SR	Stratified

APPENDIX DP-C

HAZARDOUS MATERIALS MANAGEMENT SUMMARY, JONAH INFILL DRILLING PROJECT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

and

Rock Springs Field Office
Rock Springs, Wyoming

Prepared by

TRC Mariah Associates, Inc.
Laramie, Wyoming

Revised and Updated by

SWCA Environmental Consultants
Phoenix, Arizona

January 2006

PREFACE

The Hazardous Materials Management Summary for the Jonah Infill Drilling Project was originally drafted by TRC Mariah Associates of Laramie, Wyoming, and published as an appendix to the *Jonah Infill Drilling Project Draft Environmental Impact Statement* in February 2005. The document was subsequently revised and updated at the direction of BLM by SWCA Environmental Consultants of Phoenix, Arizona.

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DP-C-1.0 INTRODUCTION

This Hazardous Materials Management Summary is provided pursuant to Bureau of Land Management (BLM) Instruction Memoranda Nos. WO-93-344 and WY-94-059, which require that all National Environmental Policy Act (NEPA) documents list and describe any hazardous and/or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project. The summary serves as a supplement to the Jonah Infill Drilling Project Environmental Impact Statement (EIS).

Materials are considered hazardous if they contain chemicals or substances listed in the Environmental Protection Agency's (EPA's) Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Extremely hazardous materials are those identified in the EPA's List of Extremely Hazardous Substances (*40 Code of Federal Regulations* [CFR] 355).

Project proponents, EnCana Oil & Gas (USA) Inc. (EnCana) and BP America Production Company (BP America), (referred to as "Operators") have reviewed the EPA's Consolidated List of Chemicals Subject to Reporting Under Title III of SARA (as amended) to identify any hazardous substances proposed for production, use, storage, transport, or disposal by this project, as well as the EPA's List of Extremely Hazardous Substances as defined in 40 CFR 355 (as amended) and have determined that various materials listed as hazardous and/or extremely hazardous would be used or generated by this project. All known hazardous and extremely hazardous materials potentially produced, used, stored, transported, and/or disposed of as a result of the project are presented in Table DP-C-1.1.

Hazardous materials anticipated to be used or produced during implementation of the proposed project generally can be included in the following categories: drilling materials, cementing and plugging materials, fracturing materials, production products, fuels, pipeline materials, emissions, compressor station materials, and miscellaneous materials. Where possible, the quantities of these products or materials have been estimated on a per-well basis (Table DP-C-1.1).

Table DP-C-1.1. Hazardous and Extremely Hazardous Materials Potentially Utilized or Produced During Construction, Drilling, Production, and Reclamation Operations by the Jonah Infill Drilling Project, Sublette County, Wyoming, 2006.

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Drilling Materials				
Anionic polyacrylamide	20 lbs		Acrylamide	79-06-1
Barite	16,000 lbs	Barium compounds		--
		Fine mineral fibers		--
Bentonite	45,000 lbs	Fine mineral fibers		--
Caustic soda	750 lbs	Sodium hydroxide		1310-73-2
Glutaraldehyde	20 gal	Isopropyl alcohol		67-63-0
Lime	3,500 lbs	Calcium hydroxide		1305-62-0
Mica	600 lbs	Fine mineral fibers		--
Modified tannin	250 lbs	Ferrous sulfate		7720-78-7
		Fine mineral fibers		--
Phosphate esters	100 gal	Methanol		67-56-1
Polyacrylamides	100 gal		Acrylamide	79-06-1
		PAHs[4]		--
		Petroleum distillates		64742-47-8
		POM[5]		--
Polyanionic cellulose	600 lbs	Fine mineral fibers		
Retarder	400 lbs	Fine mineral fibers		--
Cementing and Plugging Materials				
Bentonite	15,000 lbs	Fine mineral fibers		
Anti-foamer	100 lbs	Glycol ethers		--
Calcium chloride flake	2,500 lbs	Fine mineral fibers		--
Cellophane flake	300 lbs	Fine mineral fibers		--
Cements	77,000 lbs	Aluminum oxide		1344-28-1
		Fine mineral fibers		--
Chemical wash	850 gal	Ammonium hydroxide		1336-21-6
		Glycol ethers		--
Diatomaceous earth	1,000 lbs	Fine mineral fibers		--
Extenders	17,500 lbs	Aluminum oxide		1344-28-1
		Fine mineral fibers		--
Fluid loss additive	900 lbs		Acrylamide	79-06-1
		Fine mineral fibers		--
		Napthalene		91-20-3
Friction reducer	160 lbs	Fine mineral fibers		--
		Napthalene		91-20-3
		PAHs		--
		POM		--
Mud flash	250 lbs	Fine mineral fibers		--
Retarder	100 lbs	Fine mineral fibers		--
Salt	2,570 lbs	Fine mineral fibers		--
Silica flour	4,800 lbs	Fine mineral fibers		--
Fracturing Materials				
Biocides	6 gal	Fine mineral fibers		--
		PAHs		--
		POM		--
Breakers	145 lbs	Ammonium persulphate		7727-54-0
		Ammonium sulphate		7783-20-2
		Copper compounds		--
		Ethylene glycol		107-21-1
		Fine mineral fibers		--
		Glycol ethers		--

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Clay stabilizer	50 gal	Fine mineral fibers		--
		Glycol ethers		--
		Isopropyl alcohol		67-63-0
		Methanol		67-56-1
		PAHs		--
		POM		--
Crosslinkers	60 gal	Ammonium chloride		12125-02-9
		Methanol		67-56-1
		Potassium hydroxide		1310-58-3
		Zirconium nitrate		13746-89-9
		Zirconium sulfate		14644-61-2
Foaming agent	120 gal	Glycol ethers		--
Gelling agent	950 gal	Benzene		71-43-2
		Ethylbenzene		100-41-4
		Methyl tert-butyl ether		1634-04-4
		Napthalene		91-20-3
		PAHs		--
		POM		--
		Sodium hydroxide		1310-73-2
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
pH buffers	60 gal	Acetic acid		64-19-7
		Benzoic acid		65-85-0
		Fumaric acid		110-17-8
		Hydrochloric acid		7647-01-0
		Sodium hydroxide		1310-73-2
Sands	2,000,000 lbs	Fine mineral fibers		--
Solvents	50 gal	Glycol ethers		--
Surfactants	15 gal	Glycol ethers		--
		Isopropyl alcohol		67-63-0
		Methanol		67-56-1
		PAHs		--
		POM		--
Production Products				
Liquid hydrocarbons	<5–36 bpd	Benzene		71-43-2
		Ethyl benzene		100-41-4
		n-Hexane		110-54-3
		PAHs		--
		POM		--
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
Natural gas	0.5–>4.0 mmcfd	n-Hexane		110-54-3
		PAHs		--
		POM		--
Produced water/cuttings	1.0–20.0 bpd water and an unknown quantity of cuttings	Arsenic		7440-38-2
		Barium		7440-39-3
		Cadmium		7440-43-9
		Chromium		7440-47-3
		Lead		7439-92-1
		Manganese		7439-96-5
		Mercury		7439-97-6
		Radium 226		--
		Selenium		7782-49-2
		Uranium		--
		Other radionuclides		--

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Fuels				
Diesel fuel	>36,300 gal	Benzene		71-43-2
		Cumene		98-82-8
		Ethylbenzene		100-41-4
		Methyl tert-butyl ether		1634-04-4
		Naphthalene		91-20-3
		PAHs		--
		POM		--
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
Gasoline	Unk	Benzene		71-43-2
		Cumene		98-82-8
		Cyclohexane		110-82-7
		Ethylbenzene		100-41-4
		n-Hexane		110-54-3
		Methyl tert-butyl ether		1634-04-4
		Naphthalene		91-20-3
		PAHs		--
		POM		--
			Tetraethyl lead	78-00-2
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
Natural gas	Unk	n-Hexane		110-54-3
		PAHs		--
		POM		--
Propane	Unk	Propylene		115-07-1
Pipeline Materials				
Coating	Unk	Aluminum oxide		1334-28-1
Cupric sulfate solution	Unk	Cupric sulfate		7758-98-7
		Sulfuric acid		7664-93-9
Diethanolamine	Unk	Diethanolamine		111-42-2
LP Gas	Unk	Benzene		71-43-2
		n-Hexane		110-54-3
		Propylene		115-07-1
Molecular sieves	Unk	Aluminum oxide		1344-28-1
Pipeline primer	Unk	Naphthalene		91-20-3
		Toluene		108-88-3
Potassium hydroxide solution	Unk	Potassium hydroxide		1310-58-3
Rubber resin coatings	Unk	Acetone		67-64-1
		Coal tar pitch		68187-57-5
		Ethyl acetate		141-78-6
		Methyl ethyl ketone		78-93-3
		Toluene		108-88-3
		Xylene		1330-20-7
Emissions				
Gases	Unk	Formaldehyde		50-00-0
			Nitrogen dioxide	10102-44-0
			Ozone	10028-15-6
			Sulfur dioxide	7446-09-5
			Sulfur trioxide	7446-11-9

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Hydrocarbons	Unk	Benzene		71-43-2
		Ethylbenzene		100-41-4
		n-Hexane		100-54-3
		PAHs		--
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
Particulate matter	Unk	Barium		7440-39-3
		Cadmium		7440-43-9
		Copper		7440-50-8
		Fine mineral fibers		--
		Lead		7439-92-1
		Manganese		7439-96-5
		Nickel		7440-02-0
		POM		--
		Zinc		7440-66-6
Compressor Station Materials				
Coolants	Unk	Ethylene glycol		107-21-1
Crude Oil	Unk	Benzene		71-43-2
		PAHs		--
		POM		--
Grease	Unk	Zinc compounds		--
Heat Transfer Fluid	Unk	Benzene		71-43-2
Lubricants	Unk	1,2,4-trimethylbenzene		95-63-6
		Barium		7440-39-3
		Cadmium		7440-43-9
		Copper		7440-50-8
		n-Hexane		110-54-3
		Lead		7439-92-1
		Manganese		7439-96-5
		Nickel		7440-02-0
		PAHs		--
		POM		--
		Zinc		7440-66-6
Methanol	Unk	Methanol		67-56-1
Natural Gas Liquids	Unk	Benzene		71-43-2
		Hexane		110-54-3
			Hydrogen Sulfide[6]	7783-06-4
Marking Paints	Unk	Hexane		110-54-3
		Naphthalene		91-20-3
		Toluene		108-88-3
		Xylene		1330-20-7
		Acetone		67-64-1
		Cyclohexane		110-82-7
Primers	Unk	Acetone		67-64-1
		Methanol		67-56-1
		Methyl Ethyl Ketone		78-93-3
		Napthalene		91-20-3
		Toluene		108-88-3
		Xylene		1330-20-7
		Zinc		7440-66-6

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Plant Condensate	Unk	Benzene		71-43-2
		Ethyl benzene		100-41-4
		n-Hexane		110-54-3
		PAHs		--
		POM		--
		Toluene		108-88-3
		m-Xylene		108-38-3
		o-Xylene		95-47-6
		p-Xylene		106-42-3
Silicone Seal	Unk	Silane		3037-72-7
Miscellaneous Materials				
Acids	Unk	Acetic anhydride		108-24-7
		Formic acid		64-18-6
		Sodium chromate		777-11-3
		Sulfuric acid		7664-93-9
Antifreeze, heat control, and dehydration agents	300 gal	Acrolein		107-02-8
		Cupric sulfate		7758-38-7
		Ethylene glycol		107-21-1
		Freon		76-13-1
		Phosphoric acid		766-38-2
		Potassium hydroxide		1310-58-3
		Sodium hydroxide		1310-73-2
		Triethylene glycol		112-27-6
Batteries	Unk	Cadmium		7440-43-9
		Cadmium oxide		1306-19-0
		Lead		7439-92-1
		Nickel hydroxide		7440-02-0
		Potassium hydroxide		1310-58-3
		Sulfuric acid		7664-93-9
Biocides	Unk	Formaldehyde		50-00-0
		Isopropyl alcohol		67-63-0
		Methanol		67-56-1
Cleaners	Unk	Hydrochloric acid		7647-01-0
Corrosion inhibitors	Unk	4-4' methylene dianiline		101-77-9
		Acetic acid		64-19-7
		Ammonium bisulfite		10192-30-0
		Basic zinc carbonate		3486-35-9
		Diethylamine		109-89-7
		Dodecylbenzenesulfonic acid		27176-87-0
		Ethylene glycol		107-21-1
		Isobutyl alcohol		78-83-1
		Isopropyl alcohol		67-63-0
		Methanol		67-56-1
		Napthalene		91-20-3
		Sodium nitrite		7632-00-0
		Toluene		108-88-3
		Xylene		1330-20-7
Emulsion breakers	Unk	Acetic acid		64-19-7
		Acetone		67-64-1
		Ammonium chloride		12125-02-9
		Benzoic acid		65-85-0
		Isopropyl alcohol		67-63-0
		Methanol		67-56-1
		Napthalene		91-20-3
		Toluene		108-88-3
		Xylene		1330-20-7
		Zinc chloride		7646-85-7

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Fertilizers	Unk	Unk		--
Herbicides	Unk	Unk		--
Lead-free thread compound	25 gal	Copper		7440-50-8
		Zinc		7440-66-6
Lubricants	Unk	1,2,4-trimethylbenzene		95-63-6
		Barium		7440-39-3
		Cadmium		7440-43-9
		Copper		7440-50-8
		n-Hexane		110-54-3
		Lead		7439-92-1
		Manganese		7439-96-5
		Nickel		7440-02-0
		PAHs		--
		POM		--
		Zinc		7440-66-6
Methanol	200 gal	Methanol		67-56-1
Motor oil	220 gal	Zinc compounds		--
Paints	Unk	Aluminum		7429-90-5
		Barium		7440-39-3
		n-Butyl alcohol		71-36-3
		Cobalt		7440-48-4
		Lead		7439-92-1
		Manganese		7439-96-5
		PAHs		--
		POM		--
		Sulfuric acid		7664-93-9
		Toluene		108-88-3
		Triethylamine		121-44-8
		Xylene		1330-20-7
Paraffin control	Unk	Carbon disulfide		75-15-0
		Ethylbenzene		100-41-4
		Methanol		67-56-1
		Toluene		108-88-3
		Xylene		1330-20-7
Photoreceptors	Unk	Selenium		7782-49-2
Scale inhibitors	Unk	Acetic acid		64-19-7
		Ethylene diamine tetra		60-00-4
		Ethylene glycol		107-21-1
		Formaldehyde		50-00-0
		Hydrochloric acid		7647-01-0
		Isopropyl alcohol		67-63-1
		Methanol		67-56-1
		Nitrilotriacetic acid		139-13-9
Sealants	Unk	1,1,1-trichloroethane		71-55-6
		n-Hexane		110-54-3
		PAHs		--
		POM		--
Solvents	Unk	1,1,1-trichloroethane		71-55-6
		Acetone		67-64-1
		t-Butyl alcohol		75-65-0
		Carbontetrachloride		56-23-5
		Isopropyl alcohol		67-63-0
		Methyl ethyl ketone		108-10-1
		Methanol		67-56-1
		PAHs		--
		POM		--
		Toluene		108-88-3
		Xylene		1330-20-7

Table DP-C-1.1. (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Starting fluid	Unk	Ethyl ether		60-29-7
Surfactants	Unk	Ethylene diamine		107-15-3
		Isopropyl alcohol		67-56-1
		Petroleum naphtha		8030-30-6

1 lbs = pounds; gal = gallons; bpd = barrels per day; mmcfd = million cubic feet per day; Unk = quantity unknown.
2 Hazardous substances are those constituents listed under the Consolidated List of Chemicals Subject to Reporting Under Title III of the S*uperfund Amendments and Reauthorization Act of 1986* (SARA), as amended.
3 Extremely hazardous substances are those defined in 40 CFR 355.
4 PAHs = polynuclear aromatic hydrocarbons.
5 POM = polycyclic organic matter.
6 If hydrogen sulfide is present, it occurs at 5% or less of liquid gas component.

DP-C-2.0 DRILLING MATERIALS

Water-based drilling fluids consisting of clays and other additives would be utilized by drilling companies for drilling each well; however, although not currently proposed for use, oil-based drilling fluids may be proposed for use at some wells. Drilling fluid additives potentially containing hazardous materials are listed in Table DP-C-1.1. The polyacrilamides used in drilling may contain the extremely hazardous substance acrylamide. Drilling fluid additives would be transported to well pads during drilling operations in appropriate sacks and containers. Water-based drilling fluids, cuttings, and water would be stored in reserve pits located on-site (if such pits are approved), and reserve pits would be lined as directed by BLM to conserve water and to protect near-surface aquifers. Operators would remove/vacuum fluids from reserve pits within 60 days of all wells on the pad being put into production. If this timeframe is infeasible on a particular site, the Operators would notify the JIO and fluids would be removed as soon as practical. The pit would then be backfilled and reclaimed as described in Section DP-B-4.4 of the Reclamation Plan. If oil-based fluids are used, appropriate environmental protection will be addressed in site-specific Environmental Assessments (EAs). These may include, but are not limited to, closed systems, pit liners, netting, and monitor wells. Oil-based drilling fluids would be reused for drilling other wells or, as for other potentially hazardous materials, removed from the field for disposal at an authorized off-site facility (e.g., the R&G Oil Field Waste Disposal-Shute Creek Site and/or the R&G Piney Co. Field Waste Disposal Facility).

DP-C-3.0 CEMENTING AND PLUGGING MATERIALS

Well completion and abandonment operations include cementing and plugging various segments of the wellbore to protect freshwater aquifers and other down-hole resources. Wells would be cased and cemented as approved by BLM (for federal minerals) and Wyoming Oil and Gas Conservation Commission (WOGCC) (for state minerals). Cementing and plugging materials potentially containing hazardous materials are listed in Table DP-C-1.1. The extremely hazardous material acrylamide may be present in fluid loss additives. All casing and plugging materials would be transported in bulk to each well site. Small quantities may be transported and stored on-site in appropriate containers.

DP-C-4.0 FRACTURING MATERIALS

Hydraulic fracturing would be performed at all proposed wells to enhance gas flow rates. Fracturing fluids consist primarily of fresh water but would contain some additives with hazardous constituents as shown in Table DP-C-1.1. Fracturing materials would be transported to well locations in bulk or in manufacturer's containers. Waste fracturing fluids would be collected in aboveground tanks and/or reserve pits and evaporated, hauled away from the well pad and reused at another well, or disposed of at an authorized facility.

DP-C-5.0 PRODUCTION PRODUCTS

DP-C-5.1 Natural Gas

Produced natural gas primarily would contain methane, ethane, and carbon dioxide. Hazardous substances potentially present in the gas stream are listed in Table DP-C-1.1. No extremely hazardous materials are anticipated to be present. Small quantities of natural gas may be flared into a flare pit during well testing operations, pursuant to BLM/WOGCC rules and regulations (*Notice to Lessees* [NTL]-4A); however, with the use of high-pressure separators, these emissions would be dramatically reduced from levels previously released at the Jonah Field. BLM and WOGCC approval would be necessary prior to flaring operations. No natural gas would be stored on-site.

DP-C-5.2 Liquid Hydrocarbons

Condensates would be produced in association with the gas stream from productive wells. Hazardous materials potentially present in the liquid hydrocarbons are listed in Table DP-C-1.1. No extremely hazardous materials are known to be present in these liquid hydrocarbons.

Liquid hydrocarbons would be stored in tanks at well pads, and all tanks would be bermed to contain 110 percent of the entire storage capacity of the largest tank. Liquid hydrocarbons periodically would be removed from storage tanks and transported by truck off the project area for sale to refineries. All necessary authorizing actions for the production, storage, and transport of liquid hydrocarbons would be addressed prior to the initiation of production activities.

DP-C-5.3 Produced Water

Hazardous materials potentially present in trace amounts in produced water are listed in Table DP-C-1.1. No extremely hazardous materials are expected in the produced water.

Produced water would be stored in tanks at well locations and periodically would be removed and transported to Wyoming Department of Environmental Quality (WDEQ)- or WOGCC-permitted water disposal facilities (e.g., treatment/evaporation facilities, underground injection wells). Produced water quality from wells and in-field treatment facilities would be monitored periodically, and water that meets applicable standards would be discharged to the surface at appropriate locations. Further detail on existing and proposed produced water disposal methodologies is provided in EIS Section 2.6.8 (Production Operations).

Necessary authorizing actions that must be met prior to the disposal of produced water include the following:

- BLM approval of disposal methodologies;
- *Resource Conservation and Recovery Act* compliance, as necessary;
- WDEQ Water Quality Division approval of wastewater disposal (e.g., National Pollution Discharge Elimination System permits);
- WOGCC evaporation pond permits; and
- Wyoming State Engineer’s Office dewatering permits (Form U.W. 5).

DP-C-6.0 FUELS

Diesel fuel, gasoline, natural gas, and propane would be used for the project. All contain hazardous materials (see Table DP-C-1.1). Gasoline and diesel would be used by vehicles providing transport to and from the project area. Diesel fuel also be used in drilling operations and construction equipment and as a minor component of fracturing fluids and may be used in oil-based drilling fluids. Natural gas produced by the proposed project would be used to power production equipment burners, gas-activated valves, pipeline compressor stations, and other ancillary facilities. Propane would be utilized for miscellaneous heating purposes.

DP-C-6.1 Gasoline

Gasoline is known to contain hazardous materials (see Table DP-C-1.1). Gasoline for this project would be purchased from regional vendors and primarily would be stored and transported in vehicle gas tanks. Some additional gasoline storage may be provided in appropriately designed and labeled 1- to 5-gal containers for supplemental use as vehicle fuel. No large-scale storage of gasoline is anticipated. Tetraethyl lead, an extremely hazardous material, is present in leaded gasoline (regular).

DP-C-6.2 Diesel Fuel

Diesel fuel for use as a fuel would be similar to that described for gasoline. Each well location would have aboveground storage tanks containing diesel fuel during drilling operations. Tanks would be filled by a local fuel supplier. The use, transport, and storage of diesel fuel would be conducted in accordance with all relevant state and/or federal rules, regulations, and guidelines.

DP-C-6.3 Natural Gas

Natural gas produced on-site would be burned to provide power for compressor stations and other ancillary facilities. Hazardous materials are known to be present in natural gas (see Table DP-C-1.1). No extremely hazardous materials are known to exist in the natural gas from the project area.

DP-C-6.4 Propane

The only hazardous material known to be present in propane is propylene. No extremely hazardous materials are known to be present. Propane would be purchased from regional vendors and would be stored and transported in appropriate propane tanks. No large-scale storage of propane is anticipated.

DP-C-7.0 PIPELINE MATERIALS

Gas produced from wells would be transported from each well through pipelines linking wells with existing natural gas gathering systems. Industry-standard pipeline equipment, materials, techniques, and procedures in conformance with all applicable regulatory requirements would be employed during construction, testing, operation, and maintenance of the project to ensure pipeline safety and efficiency. All necessary authorizing actions for natural gas pipelines would be addressed prior to installation. These actions may include the following:

- Sublette County special use permits;
- BLM right-of-way (ROW) grants;
- BLM Sundry Notices;
- conformance with Department of Transportation pipeline regulations (49 CFR 191-192); and
- Wyoming Public Service Commission Certificates to act as common carrier for natural gas.

Materials utilized for pipeline construction, operation, and maintenance that may contain hazardous materials are listed in Table DP-C-1.1. Hazardous materials associated with pipeline construction, operation, and maintenance would be handled in accordance with applicable state and federal regulations.

DP-C-8.0 EMISSIONS

Emissions from combustion engines and condensate flashing; well construction, completion, and production; and pipeline construction, operation, and maintenance would occur as a result of this project. Hazardous and extremely hazardous materials are known to be released directly or formed secondarily (i.e., ozone) from the construction and operation of natural gas wells and associated pipelines (Table DP-C-1.1). Extremely hazardous emission materials include nitrogen dioxide, ozone, sulfur dioxide, and sulfur trioxide. No releases of these hazardous and extremely hazardous materials are anticipated to exceed quantities allowed for in Prevention of Significant Deterioration Class II areas of the WDEQ-Air Quality Division Implementation Plan, nor are combustion emissions expected to exceed Wyoming Ambient Air Quality Standards or National Ambient Air Quality Standards. Particulate matter emissions and larger unburned hydrocarbons eventually would settle out on the ground surface, whereas gaseous emissions would react with other air constituents as components of the nitrogen, sulfur, and carbon cycles.

DP-C-9.0 COMPRESSOR STATIONS

Materials potentially containing hazardous substances that are used at compressor stations are listed in Table DP-C-1.1. Quantities of these materials are unknown but consist of fuels, lubricants, paints, primers, and combustion products. The extremely hazardous material hydrogen sulfide may be present as a minor component in natural gas liquids. Natural gas liquids are burnt as a secondary fuel source at compressor stations.

DP-C-10.0 MISCELLANEOUS MATERIALS

Miscellaneous materials potentially containing hazardous substances that may be used for the proposed project are listed in Table DP-C-1.1. Quantities of these materials are unknown; however, no extremely hazardous substances are known to be present in any of these materials. Miscellaneous materials would be used during well construction and production operations; for well, pipeline, and equipment maintenance; and during reclamation activities.

DP-C-11.0 MANAGEMENT POLICY AND PROCEDURE

Each individual Operator would be responsible for ensuring that all production, use, storage, transport, and disposal of hazardous and extremely hazardous materials as a result of the proposed project would be in accordance with all applicable existing or hereafter promulgated federal, state, and local government rules, regulations, and guidelines. All project-related activities involving the production, use, and/or disposal of hazardous or extremely hazardous materials would be conducted to minimize potential environmental impacts (Amoco Production Company [now BP America] 1993, 1995; EnCana 2002a).

Each Operator would comply with emergency reporting requirements for releases of hazardous materials. Any release of hazardous or extremely hazardous substances (leaks, spills, etc.) in excess of the reportable quantity, as established in 40 CFR 117, would be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended (*42 United States Code* [USC] 9601 et seq.). The materials for which such notification must be given are the extremely hazardous substances listed under the Emergency Planning and Community Right to Know Act, Section 302, and the hazardous substances designated under Section 102 of CERCLA, as amended. If the release of a hazardous/extremely hazardous substance in a reportable quantity does occur, immediate notice and reporting must be given to BLM and to all other appropriate federal and state agencies as defined in BLM NTL-3A. Incidents requiring verbal notification would be given as soon as possible but no later than 24 hours after discovery. Verbal notification would be confirmed in writing within 15 days or other such time required by the appropriate regulatory agency.

Each Operator would prepare and implement, as necessary, the following plans and/or policies (parenthetical references below are to documents BLM considers an appropriate example of each type of plan; Operators may choose to develop their own versions of the following plans):

- pursuant to 40 CFR 112, Spill Prevention, Control, and Countermeasure Plans (SPCCPs) for those sites where SPCCPs are applicable (see EnCana 2002b);
- spill response plans (EnCana 2002b);
- plans and inventories of hazardous chemical categories pursuant to Section 312 of SARA, as amended;
- Emergency Response Plans (see EnCana 2002b); and
- Storm Water Pollution Prevention Plans (SWPPPs) (see McMurry Oil Company 2003).

Copies of the above would be maintained with the Operators, as required by regulation, and would be made available upon request.

During the course of routine oil and gas production operations, minor leaks, spills, and other accidental releases of crude oil and condensate may occur, thereby creating hydrocarbon-impacted soils. While the surface use lease may allow for the temporary storage and treatment of oil-contaminated soils on well pads, some Operators discourage this practice in an effort to maintain environmental integrity. As a Best Management Practice (BMP), one Operator plans to transport, accumulate, and treat these contaminated soils at a new bioremediation facility dedicated solely to the remediation of these soils (EnCana 2003).

This proposed ancillary facility would be located on state surface in the SW¼ NE¼, Section 36, T29N, R108W. The dimensions of the facility would be 200 by 200 feet. Containment berm walls 2 feet high by 4 feet wide would be located on the east, south, and west perimeters of the pad to contain stormwater runoff. Erosion controls would be installed on the soil berms and pad shoulders to maintain their integrity, and walls and shoulders would be revegetated during operations.

All weather year-round access to the facility would be maintained, and the facility would be gated and locked.

Point sources for hydrocarbon-impacted soils are wellhead and production battery spills and releases, as well as gas and flow line leaks. The typical range of hydrocarbon contamination, expressed as total recoverable petroleum hydrocarbons (TRPH), is from <500 parts per million (ppm) to >20,000 ppm depending on such factors as spill volume, exposure time, and weather.

Hydrocarbon-impacted soils would be treated at the facility by enhancing hydrocarbon degradation with indigenous bacteria. Impacted soils would be placed in windrows approximately 10 feet wide by 120 feet long and 24 inches deep. On a scheduled basis, the soil mass in each windrow would be turned to continually expose soil mass layers to oxygen, moisture, and sunlight. No tillage of the soils would occur during periods of high winds or when surface conditions would create fugitive dust emissions.

Impacted soils received at the facility that reflect hydrocarbon concentrations in excess of 20,000 ppm TRPH would be blended with soils exhibiting lower hydrocarbon concentrations to avoid pockets of high hydrocarbon concentrations in soil masses.

When an individual windrow is filled to designated dimensions and volumes, hydrocarbon concentrations would be periodically measured using an organic vapor meter (OVM). When OVM readings indicate that hydrocarbon concentrations have dropped to <1,000 ppm, a composite sample of the soil mass would be collected for TRPH analysis. When TRPH concentrations have dropped below WOGCC TRPH-concentration limits, the soil mass would be removed from the facility for recycling under a variety of beneficial uses approved and stipulated by the WOGCC. The primary use of remediated soils from this facility would be construction related (e.g., road grades).

As necessary, development operations would also be in compliance with regulations promulgated under the Resource Conservation and Recovery Act, Federal Water Pollution Control Act (the Clean Water Act), Safe Drinking Water Act, Toxic Substances Control Act, Occupational Safety and Health Act, and the Federal Clean Air Act. In addition, project operations would comply with all attendant state rules and regulations relating to hazardous material reporting, transportation, management, and disposal.

DP-C-12.0 LITERATURE CITED

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McMurry Oil Company. 2003. Storm Water Pollution Prevention Plan, Jonah Field. Prepared for McMurry Oil Company, an affiliate of EnCana Oil & Gas (U.S.A.) Inc., Denver, Colorado, by Lesair Environmental, Inc., Littleton, Colorado. 7 pp. + append.

APPENDIX C — OPERATOR-COMMITTED PRACTICES

Existing Jonah project National Environmental Policy Act of 1969 (NEPA) documents (Bureau of Land Management [BLM] 1998, 2000a) provide various programs and policies that would be implemented to protect the environment during the development and operation of the proposed Jonah Infill Drilling Project (JIDP). Additionally, Operators would implement the environmental protection measures identified in Appendix A-1, "Wyoming BLM Standard Mitigation Guidelines for Surface-Disturbing Activities," and Appendix A-3, "Standard Practices Applied to Surface-Disturbing Activities," of the *Pinedale Resource Management Plan* (RMP) *Record of Decision* (ROD) (BLM 1988), as applicable. Some of the practices identified below are repeated or summarized from these documents with appropriate modifications for this project, and additional measures have been included. Unless otherwise noted, each of the measures identified in this appendix have been agreed to by all the Operators currently working in the Jonah Infill Drilling Project Area (JIDPA). The 15 air quality-related measures listed at the very end of this document have been committed to by EnCana Oil & Gas (USA) Inc. but not yet agreed to by any of the other Operators.

Many of these environmental protection measures would be included as Conditions of Approval (COAs) in the ROD for this project. However, by additionally including them as Operator-committed practices, the various Operators have made a commitment to implement them throughout the life-of-project (LOP), and the impact analyses provided in the Environmental Impact Statement (EIS) take into consideration the implementation of these measures based on this commitment.

Where Operator-committed practices differ from and are less rigorous than those provided in previous NEPA documents, the reason for the change is identified.

Some of the Operator-committed practices are outside the jurisdiction of BLM. These practices are identified as *italicized text*.

In addition to Operator-committed environmental protection practices, the various JIDPA leases often contain one or more stipulations that obligate the leaseholder. These lease stipulations are mandatory and address a number of issues, including but not limited to seasonal and area restrictions for raptor nests, greater sage-grouse leks and nesting habitat, unstable soils, steep slopes, and controlled surface occupancy (see EIS Appendix A). These lease-specific stipulations may be duplicated by the more general measures listed below.

Exceptions to Operator-committed practices may be granted if a thorough analysis by the BLM determines that the resource(s) for which the measure was developed would not be unacceptably impacted by the proposed project, or if the Operator can demonstrate to the satisfaction of the Authorized Officer on a case-by-case basis that the required mitigation or practice would not be technically or economically feasible, or that another method would create less environmental impact.

To assure compliance with the Operator-committed practices stipulated in this EIS, the project ROD, and in site-specific APDs and ROWs, each Operator would provide qualified individuals to oversee construction and drilling operations and to consult with the BLM on a case-by-case basis, as necessary, during field development.

All of the proposed Operator-committed practices identified in this section would be implemented on all federal lands and minerals within the JIDPA. Development activities on all lands would be conducted in accordance with all appropriate federal, state, and county laws, rules, and regulations.

PRECONSTRUCTION PLANNING AND DESIGN MEASURES

1. Implementation of site-specific projects would be contingent on BLM receiving, for approval/acceptance, the following plans: APD and ROW Surface Use Plans, Plans of Development, and other site-specific plans/reports (e.g., road and well pad design plans, cultural clearances, special status species clearances, etc.); Transportation Plan, Reclamation Plan, and Hazardous Materials Management Summary (see EIS Appendices DP-A, DP-B, and DP-C). The above plans may be prepared by Operators for the JIDPA or may be submitted incrementally with each APD, ROW application, or Sundry Notice.

2. Approval of individual project components (i.e., wells, roads, pipelines, and ancillary facilities) would be contingent on completion and acceptance of a site-specific cultural resource literature search, Class III inventory report, and, as necessary, paleontological inventory; threatened, endangered, proposed, and candidate (TEP&C) and BLM Wyoming sensitive (BWS) species surveys; greater sage-grouse lek and nesting clearance; raptor nest clearance; and any other clearances that are justified for scientific data collection and pertinent to a given project.

3. Operators would include in APD, ROW, or other appropriate permit applications a discussion of site-specific mitigation and environmental protection measures and a map showing specific locations where these measures would be implemented. Final locations for these measures would be confirmed by BLM and the Operators following on-site inspections of project locations.

4. Operators would obtain all necessary federal, state, and county permits, including necessary Spill Prevention and Control Countermeasure Plans (SPCCPs) and Storm Water Pollution Prevention Plans (SWPPPs), to ensure that project development occurs in an environmentally responsible manner.

5. *EnCana Oil & Gas (USA) Inc., BP America Production Company, and potentially other Operators would voluntarily implement an off-site mitigation program in part to offset potential impacts resulting from the project. As currently identified, these projects may entail pronghorn migration corridor protection; greater sage-grouse habitat preservation, protection, and enhancement projects; raptor protection; recreational resource augmentation; conservation easement development; air quality improvement and Air Quality Related Values (AQRV) projects; on-the-ground reclamation research with an emphasis on sagebrush; and cultural resource projects. Potential program projects may be proposed by the public, BLM, state agencies, grazing permittees,*

or other entities. Final approval for projects on BLM-administered lands would rest solely with the BLM. See EnCana Appendix 1, Voluntary Compensatory Mitigation Proposal.

AIR QUALITY

6. *Operators would treat primary access roads (e.g., Luman Road, Windmill Road, Burma Road, and North Jonah Road), and heavily used resource roads as necessary during high use periods, with dust suppressants (e.g., magnesium chloride) and would water construction sites and well pad access roads as necessary to control fugitive dust during the summer.*

7. *No open burning of garbage or refuse would be allowed at the well sites or other facilities. Any open burning would be conducted under the permitting provisions of Chapter 10, Section 2 of the Wyoming Air Quality Standards and Regulations.*

8. *Necessary air quality permits to construct, test, and operate facilities would be obtained from the Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD). All internal combustion equipment would be kept in good working order.*

9. *Operators would comply with all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, including Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS).*

10. *Operators would cooperate with WDEQ in determining regional oxides of nitrogen (NO_x) emission levels.*

11. *Operators would continue to encourage contractors and employees to obey speed limits and support local law enforcement officials in enforcing speed limits (i.e., 35 miles per hour [mph]) to reduce fugitive dust concerns, as well as for human health and safety reasons.*

12. *EnCana Oil & Gas (USA) Inc., BP America Production Company, and potentially other Operators would cooperate with the implementation of any WDEQ-mandated air quality monitoring program or emissions control program.*

TOPOGRAPHY

13. Operators would incorporate in their Surface Use Plans and Plans of Development the procedures contained in Standard Practices, Best Management Practices, and Guidelines for Surface-Disturbing Activities, guidelines for road construction contained in BLM Manual 9113 (BLM 1985, 1991), and project-specific requirements in the Transportation and Reclamation Plans for this project (EIS Appendices DP-A and DP-B).

14. Unnecessary topographic alterations would be mitigated by avoiding, where practical, steep slopes, rugged topography, and ephemeral/intermittent drainages and by minimizing the size of disturbed areas.

15. Upon completion of construction and/or production activities, Operators would restore the topography to near pre-existing contours at well pads, roads, pipelines, and other facility sites. The Operators will comply with the requirements of all WDEQ and U.S. Environmental Protection Agency (EPA) stormwater erosion control permitting practices.

16. No well pads, roads, pipelines, or other facilities would be built within 300 feet of the edge of Sand Draw or within the tall sagebrush areas associated with this drainage, except for crossings that would be done at right angles to the channel, where practical. The number of crossings also would be minimized.

GEOLOGICAL/PALEONTOLOGICAL RESOURCES

17. At the Operator's discretion, wells, pipelines, and ancillary facilities would be designed and constructed such that they would not be damaged by moderate earthquakes. Any facilities defined as critical, according to the Uniform Building Code, would be constructed in accordance with applicable Uniform Building Code Standards for Seismic Risk Zone 2B.

18. In areas of paleontological sensitivity, a determination would be made by the BLM as to whether a survey by a qualified paleontologist is necessary prior to the disturbance. In some cases, construction monitoring, project relocation, data recovery, or other mitigation may be required to ensure that significant paleontological resources are avoided or recovered during construction.

19. If paleontological resources are uncovered during surface-disturbing activities, Operators would suspend all operations that would further disturb such materials and would immediately contact the BLM, who would arrange for a determination of significance and, if necessary, recommend a recovery or avoidance plan. Mitigation of impacts to paleontological resources would be on a case-by-case basis, and Operators would either avoid or protect paleontological resources.

20. Contractors and their workers would be instructed about the potential of encountering fossils and the steps to take if fossils are discovered during project-related activities. The illegality of removing vertebrate fossil materials from federal lands without an appropriate permit would be explained.

SOILS

21. Operators would adhere to the reclamation guidelines presented in BLM 2004. Adverse impacts to soils would be mitigated by minimizing disturbance; avoiding construction with frozen soil materials; avoiding areas with high erosion potential (e.g., unstable soils, dunal areas, slopes greater than 25%, floodplains), where practical; salvaging and selectively handling topsoil from disturbed areas; adequately protecting stockpiled topsoil and replacing it on the surface during reclamation; leaving the soil intact (scalping only) during pipeline construction, where practical; using appropriate erosion and sedimentation control techniques including, but not limited to, diversion terraces, riprap, and matting; and promptly revegetating disturbed areas using native species. Temporary erosion control measures such as temporary vegetation cover; application of mulch,

netting, or soil stabilizers; and/or construction of barriers may be used in some areas to minimize wind and water erosion and sedimentation prior to vegetation establishment. Specific measures and locations would be identified in Surface Use Plans, Plans of Development, or SWPPPs prepared during APD and/or ROW application processes.

22. Pipeline ROWs would be located to minimize soil disturbance. Where practical, mitigation would include locating ROWs adjacent to access roads to minimize ROW disturbance widths or routing pipeline ROWs directly to minimize disturbance lengths; direct-line routes may be preferable in areas with high well pad densities.

23. Appropriate erosion control and revegetation measures would be employed. Grading and landscaping would be used to minimize slopes, and water bars would be installed on disturbed slopes in areas with unstable soils where seeding alone may not adequately control erosion. Erosion control and revegetation efforts would be monitored by the BLM and Operators and augmented, as necessary, to control erosion and ensure successful establishment of native vegetation.

24. Sufficient topsoil or other suitable material to facilitate revegetation would be segregated from subsoils during all construction operations requiring excavation and would be returned to the surface upon completion of operations. Soils compacted during construction would be ripped and tilled as necessary prior to reseeding. Cut-and-fill sections on all roads and along pipelines would be revegetated with native species.

25. To the extent practical and necessary, Operators would plan new ground-disturbing activities for periods when soils are not frozen and would work with the BLM on appropriate construction actions in the event that they are proposed for periods when soil frost depths exceed 6.0 inches.

26. Operators would revegetate all disturbed sites as soon as practical following disturbance.

27. Operators would restrict off-highway vehicle (OHV) activity by employees and contract workers.

28. Project-related travel would be limited to only that necessary for efficient project operation during periods when soils are saturated and excessive rutting could occur.

29. Reviews of erosion control structures, culverts, reclamation, etc., would be made by Operator personnel as required by SWPPPs and WDEQ or EPA regulations.

WATER RESOURCES

30. *Operators would comply with U.S. Army Corps of Engineers (COE) requirements when conducting operations in wetlands, riparian areas, open water areas, and ephemeral or intermittent drainages, where practical.* Where

ephemeral or intermittent channels would be crossed by roads, culverts or low-water crossings would be installed at all appropriate locations as specified in the BLM Manual 9112 – Bridges and Major Culverts (BLM 1990) and Manual 9113 – Roads (BLM 1985, 1991). Channels would be crossed perpendicular (at right angles) to flow, where practical, and all stream crossing structures would be designed to carry the 25-year discharge event or other capacities as directed by BLM.

31. *All non-recycled water used in association with this project would be obtained from Wyoming State Engineer's Office (WSEO)- approved groundwater wells.*

32. *Operators would adhere to guidelines specified in SPCCPs.* Any spill or accidental discharge of hazardous material would be remediated. An orientation would be conducted by Operators to ensure that project personnel are aware of the potential impacts that can result from accidental spills and that they know the appropriate recourse if a spill occurs.

33. Erosion-prone areas (e.g., drainages) or high-salinity areas would be avoided where practical, and necessary construction in these areas would be done in the late summer, fall, and winter (prior to soil freezing) to avoid runoff periods. Proper containment of oil and produced water in tanks, drilling and fracturing fluids in tanks or reserve pits, and the location of staging areas for equipment storage away from drainages would prevent potential contaminants from entering surface waters.

34. Prudent use of erosion control measures, including diversion terraces, riprap, matting, temporary sediment traps, and water bars, would be employed as necessary. Interceptor dikes or waterbars would be used to control surface runoff generated at well pads, where necessary. Erosion control and construction methods would be described in APD and ROW plans, if necessary. If water is discharged into an established drainage channel, the rate of discharge would not exceed the capacity of the channel to convey the increased flow without creating erosion induced channel adjustments. Waters that do not meet applicable state or federal standards would be evaporated, treated, or disposed of at an approved disposal facility.

35. Operators would construct reserve pits with 2 feet of freeboard in cut areas or in compacted and stabilized fill. The subsoil material at proposed pit locations would be inspected to assess soil stability and permeability and whether reinforcement and/or lining are required. Prior to installation of reserve pit liners and/or fluids, reserve pits may be inspected by BLM personnel. Unlined earthen reserve pits would be used only after BLM evaluation of the pit location for distance to surface waters, depth to useable groundwater, soil type and permeability, and containment fluid content indicate no potential adverse effects to water resources.

36. If reserve pit leakage is detected, Operators would apply appropriate mitigation techniques in consultation with the BLM.

37. All wells would be cased and cemented to protect subsurface mineral and freshwater zones. Unproductive wells and wells that have completed their

intended purpose would be properly abandoned and plugged using procedures identified by the Wyoming Oil and Gas Conservation Commission (WOGCC) and the BLM.

38. Channel crossings by pipelines would be constructed so that the pipe is buried at least 4 feet below the channel bottom.

39. Channel crossings by roads and pipelines would be constructed perpendicular to flow.

40. Disturbed channel beds would be reshaped to their approximate original configuration.

41. Disposal of all water (hydrostatic test water, stormwater, produced water) would be done in conformance with WDEQ/Water Quality Division (WQD) (1993), BLM *Onshore Oil and Gas Order No. 7*, and WOGCC rules and regulations.

42. *Operators would prepare SWPPPs for all disturbances greater than 5 acres in size as required by WDEQ National Pollution Discharge Elimination System (NPDES) permit requirements.*

43. *Operators would implement SPCCPs if liquid petroleum products or other hazardous materials are stored on-site in sufficient quantities, in accordance with 40 CFR 112.*

44. *Any disturbances to wetlands and/or waters of the U.S. would be coordinated with the COE, and Section 404 permits would be secured as necessary prior to disturbance.*

45. To mitigate potential impacts caused by flooding during the LOP, construction in flood-prone areas would be limited to late summer, fall, or winter when conditions are generally dry and flows are low or nonexistent. Additional mitigation to lessen any impacts from flooding or high flows during and after construction would include the avoidance of areas with high erosion potential (i.e., steep slopes, floodplains, unstable soils); reestablishment of existing contours where practical; avoidance of areas within 500 feet of wetland edges, riparian areas, and open water, where practical; avoidance of areas within 100 feet of ephemeral drainages, where practical; and implementation of appropriate erosion and sediment control and revegetation procedures.

46. Increased sedimentation impacts to surface waters would be avoided or minimized through construction and erosion control practices approved with each authorization and through the prompt reclamation of disturbances.

47. *EnCana Oil and Gas (USA) Inc., BP America Production Company, and potentially other Operators would conduct complete water quality analyses as described in EnCana's Proposed Groundwater Monitoring Plan (e.g., pH, alkalinity, total dissolved solids [TDS], oil and grease, benzene) on all newly developed water wells less than 300 feet in depth. Additionally, annual water quality testing new and existing project-required water wells would be implemented to detect water quality changes, and in the event adverse changes*

are noted, Operators would work with the BLM and the WDEQ if necessary on developing and implementing appropriate corrective actions. Water well drilling and quality analysis reports would be submitted by October 1 of each year to the BLM Pinedale Field Office (PFO), WSEO, and WDEQ/WQD for review.

NOISE

48. All engines and compressor exhaust stacks would be muffled and maintained according to manufacturers' specifications.

49. Construction, drilling, completion, testing, and production facility installation activities would be seasonally restricted proximal to active raptor nests during the nesting period and in greater sage-grouse breeding and nesting areas, unless this restriction is unnecessary based upon site-specific reviews and the BLM grants a waiver or modification.

50. Road use and travel pattern specifications would be designed, in part, to keep traffic to a minimum and to reduce noise impacts as identified in the Transportation Plan (EIS Appendix DP-A).

VEGETATION

51. Herbicide applications would be kept at least 500 feet from known BWS plant species populations or other distance deemed safe by the BLM.

52. Removal and disturbance of vegetation would be kept to a minimum through construction site management (e.g., using previously disturbed areas and existing easements, limiting equipment/materials storage yard and staging area sizes, etc.). Well pads and associated roads and pipelines would be located to avoid or minimize impacts in areas of high value (e.g., TEP&C or BWS species habitats, wetland/riparian areas).

53. Proper erosion and sediment control structures and techniques would be incorporated by Operators into the design of well pads, roads, pipelines, and other facilities. Revegetation using a BLM-approved, locally adapted seed mixture containing native grasses, forbs, and shrubs would begin in the first appropriate season following disturbance. Vegetation removed would be replaced with plants of similar forage value and growth form using the following procedures:

    - fall reseeding (September 15 to freeze-up), where feasible;
    - spring reseeding (post-thaw and prior to May 15) if fall seeding is not feasible;
    - deep ripping of compacted soils prior to reseeding;
    - surface pitting/roughening prior to reseeding;

- utilization of native cool-season grasses, forbs, and shrubs in the seed mix;
- interseeding of shrubs into an established stand of grasses and forbs at least 1 year after seeding the grasses and forbs;
- appropriate, approved weed control techniques;
- broadcast or drill seeding, depending on site conditions; and
- fencing of certain sensitive reclamation sites (e.g., riparian areas, steep slopes, and areas within 0.5 mile of livestock watering facilities) as determined necessary through monitoring.

54. Operators would implement the resource, mitigation, and monitoring measures found in the Transportation and Reclamation Plans (EIS Appendices DP-A and DP-B).

55. Recontouring and seedbed preparation would occur immediately prior to reseeding on the unused portion of well pads and road ROWs and entire pipeline ROWs outside of road ROWs. In the event of uneconomic wells, Operators would initiate reclamation of the entire well pad, access road, and adjacent disturbed habitat as soon as practical. Reclamation would be monitored by the Operators and the BLM, as specified in the Reclamation Plan (EIS Appendix DP-B), to determine and ensure successful and timely establishment of vegetation.

56. Traffic would be confined to the running surface of roads and well pads as approved in APDs and ROWs. Operators have and will continue to cooperate with the BLM to identify and prohibit use of two-tracks where ROWs have not been obtained.

57. Operators would monitor noxious weed and invasive non-native species of concern occurrence on the JIDPA and implement a noxious weed/non-native species of concern control program in cooperation with the BLM and Sublette County to ensure noxious weed and non-native species of concern invasion does not become a problem. Weed-free certification by county extension agents would be required for grain or straw used for mulching revegetated areas. Gravel and other surfacing materials used for the project would be free of noxious weeds.

58. *Operators would evaluate all project facility sites for occurrence of waters of the U.S., special aquatic sites, and wetlands, per COE requirements. All project activities would be located outside of these areas, where practical.*

59. *Where wetlands, riparian areas, and ephemeral or intermittent stream channels must be disturbed, COE Section 404 permits would be obtained if necessary.*

WILDLIFE AND FISHERIES

The following practices would be applied for general wildlife protection.

60. Well pads, access roads, pipelines, and ancillary facilities would be located and designed to minimize disturbances to areas of high wildlife habitat value, including wetlands and riparian areas.

61. Areas with high erosion potential and/or rugged topography (i.e., steep slopes, dunes, floodplains, unstable soils) would be avoided, where practical.

62. Removal or disturbance of vegetation would be minimized through construction site management (e.g., by utilizing previously disturbed areas, and existing ROWs where practical, designating limited equipment/materials storage yards and staging areas, vegetation scalping), and Operators would adhere to all reclamation guidelines presented in the Reclamation Plan (EIS Appendix DP-B).

63. Operators, in consultation with representatives from BLM, Wyoming Game and Fish Department (WGFD), U.S. Fish and Wildlife Service (USFWS), and other interested groups such as area livestock operators, would adhere to the Wildlife Monitoring/Protection Plan for this project (BLM 1998: Appendix D) as annually updated (TRC Mariah 2004). The plan would be incorporated into the Operator field operations manual or handbook, a copy of which would be kept on-site in the JIDPA or with Operator personnel when on-site.

64. To minimize wildlife mortality due to vehicle collisions, Operators would continue to advise project personnel regarding appropriate speed limits (i.e., 35 mph) in the JIDPA, and roads would be reclaimed as soon as possible after they are no longer required. Some existing roads in the area may be closed and reclaimed by Operators as authorized by BLM. Potential increases in poaching would be minimized through employee and contractor education regarding wildlife laws. If violations are discovered, the offending employee or contractor would be disciplined and may be dismissed by Operators and/or prosecuted by WGFD.

65. Reserve, workover, and evaporation pits and other areas that contain hydrocarbons would be adequately protected to prevent access by migratory birds and other wildlife.

66. Firearms and dogs would not be allowed on-site during working hours. Operators would enforce their existing drug, alcohol, and firearms policies.

67. To protect plant populations and wildlife habitat, project-related travel would be restricted to established project roads; no off-road/ROW travel would be allowed, except in emergencies.

68. Wildlife-proof fencing would be utilized on reclaimed areas if it is determined that wildlife species and/or livestock are impeding successful vegetation establishment.

69. ROW fencing associated with this project would be kept to a minimum, and fences, where necessary, would meet BLM and WGFD specifications for facilitating wildlife movement.

70. Potential impacts to fisheries and wetland or riparian areas would be minimized by using proper erosion control techniques (e.g., water bars, jute netting, rip-rap, mulch). Construction within 500 feet of open water, 300 feet of Sand Draw, and 100 feet of other intermittent or ephemeral channels would be avoided, where practical. Channel crossings for roads and pipelines would be constructed during periods of low or no flow (i.e., late summer or fall). All necessary crossings would be constructed perpendicular to flow. No surface water or shallow groundwater in connection with surface water would be utilized for the project.

71. Operators would implement policies designed to control poaching and littering and would notify all employees (contract and company) that conviction of a major game violation could result in disciplinary action. Contractors would be informed that any intentional poaching or littering within the JIDPA may result in dismissal.

The following practices would be applied for raptors.

72. Operator coordination with BLM, USFWS, and WGFD would be conducted for all mitigation activities related to raptor, TEP&C, and BWS species (and their habitats), and all permits required for relocation, removal, and/or establishment of raptor nests would be obtained.

73. Well pads, pipelines, and associated roads would be selected and designed to avoid disturbance to known active raptor nest sites, where practical.

74. Raptor nest surveys would be conducted within a 1.0-mile radius of proposed surface use or activity areas if such activities are proposed to be conducted between February 1 and July 31.

75. All surface-disturbing activity (e.g., road, pipeline, well pad construction, drilling, completion, workover operations) would be seasonally restricted from February 1 through July 31 within a 0.5-mile radius of all active raptor nests, except ferruginous hawk nests, for which the seasonal buffer would be 1.0 mile. (An active raptor nest is defined as a nest that has been occupied within the past 3 years.) The seasonal buffer distance and applicable exclusion dates may vary, depending on such factors as the activity status of the nest, species involved, prey availability, natural topographic barriers, line-of-site distance(s), and other conflicting issues such as cultural values, steep slopes, etc. Routine maintenance or emergency health and safety activities would be allowed on existing well pads.

76. Well pads, roads, ancillary facilities, and other surface structures requiring repeated human presence would not be constructed within 825 feet of active raptor nests (2,000 feet for bald eagles), where practical. Facility construction in these areas would require specific approval from the BLM.

77. Operators would notify the BLM, USFWS, and WGFD immediately if raptors are found nesting on project facilities and would cooperate with the appropriate agencies as necessary to erect artificial nesting structures.

The following practices would be applied for black-footed ferret.

78. Where practical, surface disturbance in all prairie dog towns would be avoided.

79. Specific requirements for black-footed ferret surveys are no longer specified since the entire JIDPA is included within an area identified by the USFWS as no longer requiring surveys. However, if black-footed ferrets are observed, no further project-specific surface disturbance would occur to the prairie dog complex in which the ferret(s) were observed.

The following measures would be applied for greater sage-grouse, and these measures may be modified, with Operator approval, to facilitate participation in ongoing greater sage-grouse studies.

80. Operators would avoid all surface disturbance (including pipelines) within 0.25 mile of active greater sage-grouse leks.

81. Permanent high-profile structures such as buildings and storage tanks would not be constructed within 0.25 mile of an active lek.

82. Greater sage-grouse nest surveys would be implemented during the nesting season (April 1–July 31) by a qualified biologist prior to the start of construction activities in identified greater sage-grouse nesting habitat within 2.0 miles of active leks, and if an active greater sage-grouse nest is identified, surface-disturbing activities would be delayed until nesting is completed.

83. Operators would avoid optimal greater sage-grouse nesting habitats, where practical. Optimal nesting habitat is defined as areas with sagebrush heights of 20–31 inches and cover of 15–25% and an understory (grasses and forbs) cover of >15%.

84. EnCana Oil and Gas (USA) Inc., BP America Production Company, and potentially other Operators would avoid all drilling and construction activities during the greater sage-grouse strutting period (March 1–May 15) on areas within 1.0 mile of active leks.

85. Operators would utilize directional drilling to access resources beneath the 0.25-mile active greater sage-grouse lek buffers if reserves beneath these locations are deemed economic.

86. Operators would utilize directional drilling to access resources beneath the 600-foot wide (or tall sagebrush-dominated) buffer associated with the Sand Draw protection areas if deemed economic.

87. Operators would cooperate in ongoing greater sage-grouse studies in the area.

88. Operators would cooperate with the WGFD on existing/new greater sage-grouse habitat improvement efforts within Upland Game Bird Management Area 7 (e.g., water developments).

89. To further mitigate potential adverse effects to breeding and nesting greater sage-grouse on the JIDPA, 0.5-mile facility-free buffers would be applied to greater sage-grouse lek 7 south of the JIDPA for as long as Operators continue to hold the leases for these areas. No features requiring repeated human presence would be built within this area.

LIVESTOCK/GRAZING MANAGEMENT

90. Reclamation of nonessential areas disturbed during construction activities would be accomplished in the first appropriate season after well completion. Nonessential areas include portions of the well pads not needed for production operations, the outslope portions of new road ROWs, entire pipeline ROWs outside of road ROWs, and all roads and associated disturbed areas at nonproductive well pads. Operators would repair or replace fences, cattleguards, gates, drift fences, and natural barriers that are damaged by development actions to maintain current BLM standards. Cattleguards would be used instead of gates for livestock control on most road ROWs. Livestock would be protected from pipeline trenches, and livestock access to existing water sources would be maintained.

91. BLM, in coordination with livestock permittees, would monitor livestock movements, especially regarding any impacts to livestock from roads or disturbance from construction and drilling activities. Operators in consultation with the BLM will take appropriate and reasonable measures to correct any adverse impacts, if they occur.

92. All pits containing fluids would be fenced to exclude livestock.

CULTURAL RESOURCES

93. Operators would follow the procedures established by the BLM National Programmatic Agreement/Wyoming State Protocol Agreement (ratified April 1998) for cultural resource management and regulation contained within 36 CFR 800 and would either avoid, protect, or mitigate cultural resource properties.

94. Operators would halt construction activities in the area of concern if previously undetected cultural resource properties are discovered during construction. The BLM would be notified immediately, and consultation with the Wyoming State Historic Preservation Office (SHPO) and/or the Advisory Council on Historic Preservation (ACHP) would be initiated to determine proper mitigation measures pursuant to 36 CFR § 800.13 or other Treatment Plans, Programmatic Agreements, or Discovery Plans that may direct such efforts. Construction would not resume until a Notice to Proceed is issued by the BLM.

95. If areas of religious importance, traditional cultural properties, or other sensitive Native American areas are identified in affected areas, BLM would consult with

affected tribes and, in further consultation with Operators, would identify potential impacts and determine appropriate mitigative treatments on a case-by-case basis.

96. Operators in cooperation with the BLM would conduct an educational program to inform employees and contractors about the regulations concerning cultural resource management and artifact collection.

97. All recognized eligible sites, areas of Native American concern, and other recognized sensitive areas would be avoided as much as practical during development permitting. Impacts that cannot be eliminated by avoidance would be mitigated on a case-by-case basis through BLM-approved and SHPO-approved methods. Mitigation may include data recovery (including excavation) and/or Native American consultation/coordination for development in sensitive cultural resource areas, and costs for these efforts would be borne by Operators.

98. Construction in archaeologically sensitive areas during frozen ground conditions would not normally be implemented; exceptions would be considered by the Authorized Officer on a case-by-case basis.

99. Operators would work with the BLM, SHPO, and ACHP in developing and implementing appropriate Programmatic Agreements, Research Designs/ Unanticipated Discovery Plans, Treatment Plans, and/or Cultural Resource Management Plans for the protection of cultural resources in the JIDPA.

SOCIOECONOMICS

100. Operators would encourage the use of local or regional workers.

101. Where feasible, Operators would schedule concentrations of project traffic, such as truck convoys or heavy traffic flows, to avoid periods of expected heavy traffic flows associated with recreation.

102. Travel and parking would be restricted to access roads and on-site parking areas.

103. Where feasible, Operators would plan proposed development operations so that seasonal restrictions do not create a significant reduction in the level of development causing seasonal workforce layoffs (i.e., work continues at a consistent rate year-round).

LAND STATUS/USE/PRIOR RIGHTS

Mitigation to prior rights would include the following:

104. limiting drilling operations to lands leased or owned by the Operators;

105. locating wells away from known underground cables;

106. regrading and repairing roads, as necessary, in areas damaged by project activities;

107. reestablishing a level compacted surface where pipelines cross existing roads;

108. advance identification and flagging of all existing ROWs that would be crossed by proposed pipelines and roads;

109. backhoe and hand excavating at pipeline crossings until the exact locations of existing underground lines have been determined; and

110. restoring native vegetation as soon as practical.

111. Roads and pipelines would be located adjacent to existing linear facilities wherever practical; direct-line routes may be preferable in areas with high well pad densities.

112. Portions of existing roads not included in the new road ROW and not needed by other users would be reclaimed and revegetated by Operators, following Class III cultural resource surveys.

113. Adequate turnouts on new crowned-and-ditched roads would be built to provide access to existing two-tracks and other undeveloped roads.

RECREATION

114. Operators would inform their employees, contractors, and subcontractors that long-term camping (greater than 14 days) on federal lands or at federal recreation sites is prohibited.

115. Operators would direct their employees, contractors, and subcontractors to abide by all state and federal laws and regulations regarding hunting.

VISUAL RESOURCES

116. EnCana Oil and Gas (USA) Inc., BP America Production Company, and potentially other Operators would utilize existing topography to screen roads, pipeline corridors, drill rigs, wells, and production facilities from view, where practical.

117. Operators would paint all aboveground production facilities with appropriate colors (e.g., Carlsbad Canyon or other environmental color required by BLM) to blend with adjacent terrain, except for structures that require safety coloration in accordance with Occupational Safety and Health Administration (OSHA) requirements.

TRANSPORTATION

118. Operators would implement the resource, mitigation, and monitoring measures found in the Transportation Plan (EIS Appendix DP-A). Annual transportation planning would occur in coordination with efforts required for the Pinedale Anticline Project (BLM 2000b) to identify the minimum road network necessary to support annually proposed project activities; Operator construction and

maintenance responsibilities; and road-specific dust abatement, construction, and surfacing requirements.

119. Existing roads would be used to the maximum extent possible and upgraded as necessary.

120. All new and improved roads not required for routine operation and maintenance of producing wells or ancillary facilities would be reclaimed as directed by the BLM, State Land Board, or private landowner. These roads would be permanently blocked, recontoured, reclaimed, and revegetated by Operators, as would disturbed areas associated with permanently plugged and abandoned wells. Reclamation of existing two-track roads would be considered on a case-by-case basis.

121. On a case-specific basis, centerline survey and construction designs would be submitted to and approved by the BLM prior to road construction.

122. Operators would comply with existing federal, state, and county requirements and restrictions to protect road networks and the traveling public.

123. Special arrangements would be made with the Wyoming Department of Transportation to transport oversize loads to the project area. Otherwise, load limits would be observed at all times to prevent damage to existing road surfaces.

124. All development activities along approved ROWs would be restricted to areas authorized in the approved ROW.

125. Available topsoil would be stripped from all road corridors prior to commencement of construction activities and would be redistributed and reseeded on backslope areas of the borrow ditch after completion of road construction activities. Borrow ditches would be reseeded in the first appropriate season after initial disturbance.

126. When practical and feasible, the Operators would maximize the use of temporary fresh water pipelines during late spring, summer, and early fall from water wells to active drill sites to decrease water hauling needs.

HEALTH AND SAFETY/HAZARDOUS MATERIALS

127. Operators would utilize WDEQ-approved portable sanitation facilities at drill sites.

128. Operators would place warning signs near hazardous areas and along roadways.

129. Operators would place dumpsters at each construction site to collect and store garbage and refuse.

130. Operators would ensure that all refuse and garbage is transported to a state-approved sanitary landfill for disposal.

131. *Operators would institute a Hazard Communication Program for its employees and would require subcontractor programs in accordance with OSHA (29 CFR § 1910.1200).*

132. *In accordance with 29 CFR § 1910.1200, a Material Safety Data Sheet for every chemical or hazardous material brought on-site would be kept on file at the Operator's field office.*

133. *SPCCPs would be written and implemented in accordance with 40 CFR § 112.*

134. *Chemical and hazardous materials would be inventoried and reported in accordance with 40 CFR § 335. If quantities exceeding 10,000 pounds or the threshold planning quality are to be produced or stored, the appropriate Section 311 and 312 forms would be submitted at the required times to the State and County Emergency Management Coordinators and the local fire departments.*

135. *Any hazardous wastes, as defined by the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, would be transported and/or disposed of in accordance with all applicable federal, state, and local regulations.*

136. *Operators would adhere to existing internal health and safety policies and procedures.*

137. *During routine operations, Operators would not release fracturing fluids and condensates into flare pits or surrounding areas; they would be confined in lined pits or tanks.*

ADDITIONAL AIR QUALITY MEASURES

Unlike the measures listed in the preceding sections, the following 16 air quality-related measures have been committed to by EnCana Oil and Gas (USA), but not yet agreed to by any of the other Operators in the JIDPA.

1. *Regular equipment maintenance, including emissions checks, and regular maintenance of roads would be conducted as necessary throughout the LOP.*

2. *Operators would treat primary access roads (e.g., Luman Road, Windmill Road, Burma Road, and North Jonah Road in the JIDPA) and heavily used resource roads as appropriate with dust suppressants (e.g., magnesium chloride) and would water construction sites and well pad access roads as necessary to control fugitive dust during the summer.*

3. *No open burning of garbage or refuse would be allowed at the well sites or other facilities. Any open burning would be conducted under the permitting provisions of Chapter 10, Section 2 of the Wyoming Air Quality Standards and Regulations.*

4. *Necessary air quality permits to construct, test, and operate facilities would be obtained from the Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD). All internal combustion equipment would be kept in good working order.*

5. *Operators would comply with all applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, including Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS).*

6. *Operators would cooperate with BLM and WDEQ in determining regional oxides of nitrogen (NO_x) emission levels.*

7. *Operators would continue to encourage contractors and employees to obey speed limits and support local law enforcement officials in enforcing speed limits (i.e., 35 miles per hour [mph]) to reduce fugitive dust concerns, as well as for human health and safety reasons.*

8. *Operators would cooperate with the implementation of any legally enforceable WDEQ-mandated air quality monitoring program or emissions control program.*

19. *By January 1, 2006, EnCana commits to achieve average drilling rig emissions equivalent to Tier 1 standards or better from 100% of EnCana operated or contracted drilling rigs in the Jonah Field.*

10. *By January 1, 2007, EnCana commits to achieve average drilling rig emissions equivalent to Tier 2 standards or better from 100% of EnCana operated or contracted drilling rigs in the Jonah Field.*

11. *By January 1, 2009, EnCana commits to achieve average drilling rig emissions equivalent to Tier 3 standards or better from 100% of EnCana operated or contracted drilling rigs in the Jonah Field.*

12. *By January 1, 2006, EnCana commits to capture on average through flareless completion techniques, 90% of the hydrocarbon and combustion emissions that would have previously been emitted by flaring during flowback procedures on EnCana operated natural gas wells.*

13. *Where practical and feasible, EnCana commits to reduce traffic and surface disturbance and associated dust and tailpipe emissions by utilizing hub and spoke drilling and completion techniques, centralized fracturing operations, and centralized condensate and water collection.*

14. *Wherever possible, EnCana commits to vertically drill all EnCana operated natural gas wells in the Jonah Field in order to reduce associated NO_x, SO_2, and PM_{10} emissions.*

15. *Where feasible, EnCana commits to establish plant cover for all areas disturbed by EnCana's operations within an agreed time period using accelerated and focused reclamation efforts, stabilized soil stockpiles, using mulch and geotextile fabrics to stabilize soils, if necessary, and watering areas under construction to reduce fugitive dust emissions.*

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APPENDIX D — SCOPING ISSUES AND CONCERNS

GENERAL ISSUES

- Consider Greater Yellowstone Coalition for guidance on future development.
- Oil and gas companies do not pay fair market value for leases: government should not subsidize this industry.
- Increase local awareness of the role of local government in the federal planning process.
- Directionally drilled wells should not be addressed in the National Environmental Policy Act (NEPA) analysis.
- Adhere to the Federal Land Policy and Management Act (FLPMA).
- Ensure adherence with international principals and law using current ecological data.
- Bureau of Land Management (BLM) will be open to lawsuits if the project proceeds.
- No pressing need for the development at this time.
- The project undercuts wildlife protection measures in the original Environmental Impact Statement (EIS).
- Do not renew expired leases.
- Existing oil and gas leases in the area should be bought out and/or traded for leases in areas of less-sensitive natural resources.
- Do not waste taxpayer dollars on an EIS for this detrimental project.
- Do not permit drilling on private lands without surface landowner approval.
- BLM is taking a pro-oil-and-gas stance, as evidenced in the *Heritage Brief* of 2003.
- Include environmental protection as a purpose and need.
- BLM is not considering the Jonah Field for multiple use.
- BLM must abide by requirements to manage public lands for multiple use and sustained yield.
- The current average of 90 days to process and approve an application for permit to drill (APD) is unacceptable and must be addressed to avoid interruption of development.

- Improve communication and include proponents in the NEPA process (including range of alternatives development) whenever possible, and facilitate and improve information exchange as recommended by the Green River Basin Advisory Council to reduce time frames and ensure analyses are objective, factual, and complete.

- BLM must remain on the sideline with respect to down-hole spacing issues, and take the forefront in encouraging efficient and rapid development of the resource to prevent waste.

- BLM must recognize its role as lead agency, must not be swayed by public pressure from "conflict industries," and must base its decisions on sound science and fact.

- Consider the April 3, 2003, Instruction Memorandum issued by the BLM regarding the need to protect surface owners on split estate properties.

- If the BLM has insufficient resources to engage in inspection and enforcement, the backlog of inspection, enforcement, and other related issues must be dealt with satisfactorily prior to allowing further development.

- BLM must inspect operations and enforce policy.

- Violations by oil and gas companies should be addressed and may be resolved by canceling the lease, as well as imposing civil and/or criminal penalties.

- The EIS should identify which stipulations cannot be relaxed and the specific conditions that must be met before a request to exempt, except, or relax a stipulation is allowed. Exemptions and exceptions should never be granted as a matter of convenience.

- The differences in stipulations between environmental documents in the same region should be justified considering the input by experts; any variability in stipulations should be recognized as legitimate by both BLM and Wyoming Game and Fish Department (WGFD) before being implemented.

- Provide the public the opportunity to receive notice of individual APDs and participate in site-specific actions. The notice should be sent to groups/individuals requesting such notice within 3 business days of the day the application is received.

- Sufficient bonds must be provided as a part of each complete APD.

- BLM retains the authority to condition oil and gas development despite issuance of a lease, and they should exercise this mandate to avoid unnecessary and undue degradation of public lands.

- The EIS and Record of Decision (ROD) must ensure that the policies and goals set forth in the NEPA are met.

- The EIS and ROD should consider, analyze, and, where appropriate, facilitate international efforts to prevent environmental decline, as stated in 42 USC Section 4332, 40 CFR Section 1507.2, and BLM Handbook H-1790-1.V.B.2.a(3).

- BLM must disclose how it has, since 1988, inventoried its lands and monitored natural resources and must reveal the data gathered.

- Address the adequacy of the NEPA process, in consideration of authorizations for the Jonah II Project without securing adequate information on environmental impacts of Jonah I.

- In accordance with Memorandum No. 99-149, issued to relevant BLM officials on July 1, 1999, assess whether existing NEPA documents can be relied upon for a current Proposed Action and, if so, assist personnel in recording the rationale for that conclusion.

- NEPA and the Endangered Species Act (ESA) prohibit drilling of additional wells in the Jonah Infill Drilling Project Area (JIDPA) while this EIS is being prepared.

- The aggregate nature of BLM development reviews could adversely affect the State of Wyoming's ability to develop its mineral interests to avoid drainage.

- Interested parties should have available to them any data collected on air quality, habitat impacts, water quality, etc.

- The U.S. Department of Agriculture Forest Service (USFS) should be a cooperator on the Jonah Infill project.

- BLM has the responsibility to ensure that local media report the issues from all perspectives. If media reporting is biased toward one or the other point of view, the BLM should write a letter to the editor to ensure the other side is heard.

- Incorporate EnCana advertisements in the public record and hold them responsible for the promises made in these ads.

- Follow Executive Order (EO) 13212 in development of project-level NEPA analyses; current programs, policies, and rules must be evaluated to reduce barriers to America's energy self-sufficiency.

- Communicate with cooperating agencies to prevent unforeseen delays, acknowledge the responsibilities of the various agencies, and work with them during preparation of the NEPA document.

- Allow continued development of the Jonah Field under the existing NEPA analysis during the preparation of the new EIS at the same pace as has been realized for the past 3–5 years.

RMP ISSUES

- Postpone the environmental analysis of the Jonah Project until the Pinedale Field Office (PFO) Resource Management Plan (RMP) has been revised and an ROD signed.

- Disclose to the public that this analysis will go forward independent from the PFO RMP.

- The existing RMP predates the latest technological advances in natural gas recovery.

- The existing RMP does not address the impacts from coalbed methane development, accelerated gas drilling, the increase in disturbance due to subdivisions, etc., over the past 10+ years and the concomitant decrease in wildlife habitat.
- Preparation of the PFO RMP must not take precedence or hinder the progress of the Jonah EIS.
- The PFO RMP should set forth strict inspection and enforcement guidelines, should require quarterly inspection of well sites, and should require at least one unannounced well site visit annually.
- Evaluating additional major oil and gas development projects while revising the RMP will limit the choice of the reasonable alternatives the agency might otherwise have available in the RMP, thus violating 40 CFR Section 1506.1(a)(1)-(2) and 40 CFR Section 1502.2(f).
- The existing RMP and Jonah NEPA documents are outdated and analyses are, for the most part, inadequate to allow tiering by the new Jonah EIS (e.g., the RMP-projected Reasonably Foreseeable Development [RFD] has been exceeded to the point of nullifying its cumulative impacts analysis).
- Writing the EIS prior to completing the RMP predetermines the final outcome of the RMP, undermining the RMP process.
- The inadequacy of BLM's outdated and aging RMPs has opened the BLM up for litigation and has left the BLM ill-prepared to address areas with vulnerable, sensitive, or at-risk resources.

SCOPING ISSUES

- The scoping notice does not define time frames (e.g., initial disturbance, life of project).
- Explain and define the rules for public comment and the extent of the public's ability to affect the decision-making process.
- There is erroneous information in the scoping statement regarding the time span for exploring and developing the Jonah Field and the number of wells approved.
- A sufficient number of scoping meetings should be held at times and places that facilitate and encourage public participation and information. The meeting place and time should not be changed at the last minute, nor should the scoping meetings ever be held at an industry-sponsored location or event.
- Hold more public meetings before implementing the project.
- Some public concerns were not expressed at the scoping meeting because of intimidation due to the rally environment.
- Form letters and post card scoping comments should carry equal weight with other, more detailed comments.

FIELD DEVELOPMENT ISSUES

- Directional drill from existing pads.
- Upgrade existing non-producing or low-quantity producing wells rather than drill new wells.
- Consider the use of alternative and innovative technologies.
- Wait until existing leases are finished, and return pads and roads to wilderness habitat before allowing new drilling.
- Restrict the pace of energy development and keep reserves for future use.
- Leave gas reserves in place if they cannot be accessed by directional drilling from existing pads.
- Maximize natural gas recovery.
- Maintain a lower density of wells and extend the expected 25-year life of the field.
- Use renewable energy sources whenever possible.
- Provide full NEPA disclosure and review of all industry practices in the EIS, designating a list of best practices for oil and gas development.
- Increased well productivity and the decreased need for roads, pipelines, etc., often compensates for increased directional drilling costs, resulting in more profitable operations.
- Well pad construction areas should be adequate for safe operations but be as small as possible.
- Incorporate suggested practices taken from *Drilling Smarter* (2003).
- Consider removing the limit of 400 multiple well locations.
- Centralized condensate stabilization, storage/treatment, and produced water storage facilities should be promoted to help minimize disturbance acreage, traffic, and well site visits.
- Directional drilling should not be required as a primary reducer of disturbance.
- Require underground flaring.
- The complex area geology requires the denser well spacing pattern to ensure recovery of available gas reserves.
- The pipeline system should be located in road right-of-ways (ROWs).

- The use of pit liners during the drilling of the wells may be unnecessary. The liner material may exist in a buried pit for 50 years or more.

ALTERNATIVES ISSUES

- Analyze the following alternatives: 1) no action; 2) no additional development until full reclamation of existing structures is achieved; 3) no new road construction (wells could be built along existing improved roads); and 4) directionally drill all new wells from existing well pads. If these alternatives are not considered, provide scientifically sound reasons why not.

- Evaluate a full development alternative and disclose how that will facilitate future Proposed Actions or necessary deviations from the approved alternative.

- A full development alternative should be developed to avoid re-analysis and project analysis piecemealing.

- A full development alternative should be included (i.e., nearly 3,000 additional wells on as little as 5-acre surface spacing).

- The EIS should contain objective analyses of feasible alternatives, not just mitigation techniques proposed on the presumption of significant impacts.

- Provide a broader range of alternatives to cover all possible levels of development.

- Include a resource protection alternative that includes mitigation measures (with clear and concise BLM and public enforcement capabilities) similar to, but more stringent than, the alternative adopted in the ROD for the Pinedale Anticline Natural Gas Project.

- Incorporate an alternative that withdraws any split estate lands from leasing if they have not yet been leased.

- BLM must not foreclose certain alternatives at the outset of the analysis; all reasonable alternatives must be rigorously explored and objectively evaluated.

- Use the scoping process to develop alternatives that emphasize the need for environmental protection (even if they limit or strongly regulate oil and gas development), rather than just accepting the highest level of industrialization as proposed by industry.

- Evaluate an alternative that requires use of best available technologies (e.g., recapturing gases rather than flaring) and directional drilling.

- Evaluate alternatives that propose development at several different total well numbers (i.e., include alternatives with lower levels of industrialization).

- Consider a conservation/community alternative with fewer wells (<1,250), a slower development pace (<75 wells/year), and no new well pads.

- Evaluate alternatives that propose several different configurations and well spacing scenarios; BLM has the discretion to depart from the industry-preferred configurations and well spacing.
- Consider alternatives that require off-site mitigation and require such mitigation in the ROD.
- Do not treat non-preferred alternatives as "straw men" whose only function is to provide "extremes" against which to contrast "moderate" alternatives.

IMPACT/CUMULATIVE IMPACT ISSUES

- There is not enough current information on the long-term and cumulative impacts of existing wells in the Jonah Field and throughout the Green River Valley.
- The Jonah Field has already been negatively impacted to an unreasonable degree by existing and ongoing development.
- The Proposed Action constitutes unnecessary and undue degradation under FLPMA.
- BLM lacks knowledge on the level of existing development (i.e., number of wells existing in the PFO and their impacts); thus, they are unable to provide this information to concerned citizens.
- Address only the germane concerns and identify and eliminate from further analysis/discussion issues that are not significant and/or that have been covered by prior environmental review.
- In the context of oil and gas development, "incremental step" consultation is of concern, and the EIS must address this issue. BLM must assist the U.S. Fish and Wildlife Service (USFWS) in developing a fully informed understanding of the effects of the *entire* action, even if incremental step consultation is used.
- An ecosystem-wide impacts study should be completed before allowing any further development to proceed.
- Provide maps and/or tables depicting the extent of oil and gas leases, seismic exploration projects, etc., in the PFO and on adjacent lands as part of the evaluation of RFD.
- Disclose baseline data and conditions for important resources (e.g., air and water quality; wildlife populations, migrations, and habitat assessments) present in the area prior to development, and disclose the current ecological conditions of all resources to evaluate environmental conditions and impacts in an informed manner.
- Given the rate of development in the area, 1.2 million acres of the public lands that link the Greater Yellowstone Ecosystem could be converted to a single, continuous industrial sacrifice zone.
- Consider information in the report *Fragmenting Our Lands, the Ecological Footprint from Oil and Gas Development* (Weller et al. 2002).

- The cumulative effects analysis in the Jonah II documents are outdated (e.g., the Pinedale Anticline and numerous other oil and gas projects have occurred in the area since the analysis was conducted).

- Explicitly address unquantifiable environmental values (e.g., open space, quiet landscapes), defining the impacts of the various alternatives, as well as ways to mitigate for impacts on those values.

- Ground-truth and/or analyze with satellite imagery the true amount of surface disturbance associated with existing well pads, roads, compressor stations, pipelines, and other facilities and use those data (rather than the commonly used acreage assumptions) to estimate surface disturbance associated with the project.

- Gather information and disclose where information is lacking, and use credible, scientific evidence to present reasonably foreseeable adverse impacts (including low-likelihood but catastrophic events) so that impacts can be assessed based on approaches that are generally accepted in the scientific community.

- Disclose how actions on private lands (e.g., subdivisions, urban sprawl, roads, fences, and grazing), in combination with the project, would impact natural resources such as air, water, and wildlife.

- Consider connected actions, cumulative actions, and similar actions (40 CFR Section 1508.25).

- Clarify how significant adverse impacts could be identified for the Pinedale Anticline Project, yet a Finding of No Significant Impact (FONSI) could be reached in the adjacent Jonah II area in 2000.

MITIGATION/MONITORING ISSUES

- Exempt surrounding wilderness from any future drilling.

- Withdraw other areas from oil and gas leasing.

- Set aside or construct a mitigation project of equivalent benefit to resources other than oil and gas.

- Require strong monitoring programs for air and water quality, wildlife, etc.

- Industry should be compensated for mitigation costs above and beyond those required by current law (e.g., directional drilling); provide a cost/benefit analysis of all required mitigation measures.

- NEPA does not require mitigation for a FONSI.

- Take actions to prevent unnecessary or undue degradation of lands as required by FLPMA.

- Consider incorporating principles of adaptive management into the project, including 1) accurate delineation of critical habitats and corridors; 2) development of a relatively low number of wells, followed by an assessment of their effects through monitoring and research; and 3) based on these assessments, modify development and implement new mitigation measures.

- Mitigation discussions must have a prominent place and be a major part of the impact assessment process. BLM must consider a wide array of mitigation measures, including off-site measures, that lessen, and potentially eliminate, the adverse impacts of development on natural resources (e.g., water and air quality, wildlife).

- Provide a follow-up procedure to allow for the adoption of new best management practices, as they become available.

- BLM and Operators are legally mandated to monitor a number of species, but current monitoring has been inadequate to nonexistent, particularly for pronghorn antelope populations, distribution, and response to oil and gas development on the Pinedale Anticline project.

- Currently, the extent of the "reduced levels of development" outside the down-spacing area is not well defined, nor have the Operators relinquished the rights to explore/develop the area outside this area at a later date. The EIS should define a firmer commitment of what will occur outside of the proposed down-spacing area, so that more appropriate mitigation can be planned. At present, no further development is proposed for areas outside the JIDPA but within the formerly defined Jonah Field. In the event new development is proposed in this area, additional NEPA analysis would be conducted.

- The management problem of extending mitigation/protection measures to lands adjacent to the Jonah Project area that are within the Anticline Project area must be addressed.

- Off-site mitigation should not be analyzed since the JIDPA is within an Energy Policy and Conservation Act (EPCA) focus area.

LAND MANAGEMENT/USE ISSUES

- Density of disturbance may negatively impact recreation.

- The lands are more valuable for nonconsumptive (scenery, hunting, photography, camping, hiking, tourism) use than for the ultimately limited oil and gas reserves.

- The area of the project is remote, with a low population, little to no recreational value, and little to no agricultural value; thus, it is a desirable area to develop oil and gas reserves.

- Density of disturbance may negatively impact livestock grazing.

- The BLM is right in including disruption of livestock operations, loss of forage availability (short-term) and increased forage availability (long-term), and potential increased livestock productivity from increased water availability in scoping issues.

- Take a proactive approach to managing travel, roads, and off-road vehicle use within the project area.

- The approach at the Burma Road and Highway 351 junction is substandard and requires rebuilding to include widening, paving, and a new culvert and cattleguard.

- Limit habitat fragmentation, protect current roadless areas, provide for aggressively closing unnecessary or ecologically destructive roads, and provide for maintaining needed roads to reduce negative environmental impacts.

- The transportation plan must require adequate design considerations to minimize impacts (number and miles of roads) and provide orderly and safe traffic movement. The plan should include dust mitigation measures and siltation barriers, and the county should use tax revenues obtained from gas production to pave primary field access roads, similar to the policy of paving roads for energy development in Campbell County.

- If the project is approved, BLM should withdraw the South Piney Front from oil and gas leasing, present leases should be allowed to expire, and mitigation projects of equivalent benefit to other resources (e.g., wildlife habitat) should be constructed and implemented.

- Desired future conditions of the landscape must be addressed.

RECLAMATION/VEGETATION ISSUES

- Publicize locations that have been "successfully reclaimed" so that the public can see what the restored lands may look like.

- Reclaimed lands are often not blended into existing landscapes and, as a result, they are often used by all-terrain vehicles (ATVs), resulting in lands that are not truly reclaimed back to an undisturbed state.

- It is a difficult and long-term prospect to reclaim desert lands after disturbance.

- The spread of non-native species as a result of the project must be addressed.

- The potential to remove 20 percent of the vegetation for the life-of-project (LOP) is a very significant vegetation impact, and noxious weed control, among other issues, must be addressed.

- Land may be damaged beyond its ability to be reclaimed.

- Provide for compliance and enforcement of EO 13112, which establishes federal agency requirements and procedures relative to invasive species and requires agencies to not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species, unless it is determined that the benefits of such actions clearly outweigh the potential harm caused by invasive species.

- To protect native vegetation: 1) prohibit surface disturbance and ROWs in threatened, endangered, or sensitive plant species habitat; 2) ensure no cross-country vehicular travel is allowed in known habitat for sensitive plant species; 3) address how Operators will be trained with respect to noxious weed identification; 4) augment law enforcement personnel and field staff to curb noncompliance activities and to protect sensitive species from irreversible impacts; 5) survey the project area to document all relict or undisturbed plant communities and ensure that those areas are protected; 6) protect and reestablish, where degraded, riparian plant communities; 7) address how all equipment will be properly cleaned prior to arrival in the area; and 8) make every APD contingent on the prevention of weed infestation and include plans to monitor weed infestation over the LOP.

- Ensure that ecosystems are fully protected so as to enhance biological diversity.
- Sufficient bonds (as opposed to the unreasonably low bond amounts currently used) should be required to ensure adequate monies for cleanup/reclamation; this will protect the federal government, as well as landowners on split estates.
- Each APD should fully describe and detail reclamation requirements.
- Develop and implement practices to replace the grass resources lost to field development.
- Reclamation should proceed, as applicable, throughout the LOP so that final reclamation is more easily and quickly accomplished (e.g., controlling noxious weeds from the outset, rather than allowing them to propagate).
- Invite all interested parties to participate in final bond release inspections, and on split estate properties, the landowners should be notified of the opportunity to participate at least 15 days prior to final inspection.

GENERAL WILDLIFE ISSUES

- Obtain better baseline wildlife data and monitoring (animals and habitat).
- The Jonah area is critical winter habitat for wildlife in the Yellowstone Ecosystem.
- Long-term impacts to pronghorn, greater sage-grouse, mountain plover, pygmy rabbit, and other high-profile or sensitive species are unknown and may be unacceptable.
- Prohibit development in environmentally sensitive areas such as big game migration corridors and winter and transitional ranges, greater sage-grouse strutting and nesting habitats, the Green and New Fork River corridors, and the scenic Wind River Front.
- Assess the impact on wildlife that are displaced and may move to less desirable or marginal habitat.
- The project will contribute to increased wildlife habitat fragmentation.
- Address impacts on wildlife deaths due to increased traffic and animal/vehicle collisions.
- Identify negative impacts of the road network on wildlife habitat, increased poaching, diminished enjoyment for hunters, visual impacts, and undue stress on wildlife during critical times of the year.

- Study and disclose the increase in poaching from increased human population size, access, and presence.

- Provide a list of species within and outside the PFO that will be impacted; disclose monitoring, population, and habitat data in regard to each species; and adopt mitigation measures to protect each species from negative impacts caused by the project.

- Discuss the impacts of the human population growth that accompanies oil and gas development on the wildlife species in and near the project area.

- The WGFD Strategic Habitat Plan should be closely followed and included within the project EIS and subsequent ROD.

- Indirect impacts of energy development on wildlife should be more extensively studied and incorporated into a long-term cumulative effects analysis, which also takes into account the subdivision of private lands in the Upper Green River Valley.

- Address the impact of power lines on birds and bats (e.g., strike hazard, electrocution, alteration of the structure of the habitat such as the provision of perches for raptors to the detriment of other species).

- Royalty revenues from natural gas and oil development underwrite the conservation of wildlife and habitat, national parks, refuges, and recreation areas and often fund research and monitoring efforts that assist land managers with managing the many resources found on public lands.

- Carefully analyze the potential impacts to migratory birds and require mitigations or avoidance accordingly.

- WGFD requests an opportunity to review existing wildlife monitoring data and to provide mitigation measures in coordination with BLM personnel.

- Water developments that provide year-round water sources for antelope and other wildlife species should be considered as mitigation; WGFD would provide on-the-ground consultation with Operators and BLM personnel to help implement this mitigation measure.

- Consider as mitigation the rejuvenation of the "wildlife wells" program in the Yellowpoint area.

- The disturbance of an additional 11,000 acres could pose a serious threat to wildlife habitat, causing habitat fragmentation and disruption of migration routes and breeding activity. Give serious thought and attention to cumulative impacts of this and other projects in the Green River Valley, with the importance of this area to many wildlife species, as well as tourism and recreation, weighing in heavily on the ultimate decision.

- Impacts to migratory birds must be addressed, actions that may result in a take of a bird or nest must be coordinated with USFWS, and the appropriate permits must be obtained prior to the actions.

- The field provides wildlife habitat, with facilities providing cover for small mammals, tanks and elevated structures providing nesting areas for birds, and new grass on reclaimed areas providing forage for ungulates. The short-term impact on wildlife should be weighed against the long-term improvement in their habitat.

BIG GAME ISSUES

- Assess the wildlife impacts of winter drilling exceptions.

- Assess the impacts of the project on migration corridors of elk, deer, moose, and pronghorn.

- Impacts to deer and pronghorn may be subtle and not easily quantified but may include negative and incremental physiological responses, resulting in cumulative stress and less resistance to natural stressors (e.g., poor forage, climatic extremes).

- Consider the findings presented in *Potential Effects of Oil and Gas Development on Mule Deer and Pronghorn Populations in Western Wyoming* (Sawyer et al. 2001).

- The project may result in impacts on habitat use by deer and pronghorn, as well as the potential for alteration of use patterns resulting in degradation of winter, crucial, or transition ranges and use of marginal habitat.

- To protect migratory mammals: 1) no surface occupancy should be allowed in severe winter relief ranges for mule deer and pronghorn; 2) a minimum buffer zone of 200 meters should be used for wells and roads until ongoing studies are completed and recommendations based on study results can be made; 3) where possible, directional drilling should be required; and 4) pads should be placed to minimize disturbance to big game.

- Sufficient data should be collected so as to define the ecological and landscape conditions necessary for maintaining big game populations at WGFD target levels.

- Ensure that migration corridors and other ecological linkages are maintained and that management actions protect the ecological integrity of these corridors.

- Require no net loss of big game transitional and winter ranges.

- The Modified Jonah Environmental Assessment (EA) states that approximately 49 percent of the original Jonah II area would have reduced levels of development, and some areas may have no development. However, there were no assurances that these areas would not be further developed in the future. Desirable exploration and development areas may be identified as development proceeds in the area. If this is still true, the upper limit for impacts to migrating wildlife is unknown and cannot be adequately addressed. Impact levels should be identified that would trigger a re-analysis of impacts/alternatives in the future if further development occurs.

- The area provides wintering habitat for pronghorn, and the area west of the proposed down-spacing serves as a migration corridor for the Jackson Hole (and, presumably, other) antelope. Studies show that pronghorn appear to be wintering in areas not classified as winter range. Note that results of research to refine seasonal range boundaries will be provided as it becomes available.

- The reason for the mule deer population decline in the area may be that the deer are in a "down cycle," as has been described for deer in northwestern Wyoming.

- Consider the Western EcoSystems Technology Inc. (WEST) Evaluation of the PFO RMP and the Anticline Final EIS, including all materials referenced within (WEST 2003).

GREATER SAGE-GROUSE ISSUES

- Potential impacts to greater sage-grouse include 1) male and/or female lek attendance and the potential decrease in reproductive success; 2) disturbance of nesting and brooding greater sage-grouse and the resulting potential for decreased reproductive success; and 3) disturbance of wintering greater sage-grouse and the potential of forcing grouse onto less desirable wintering grounds, resulting in the potential for decreased survival and/or spring fitness.

- Thoroughly evaluate project impacts on greater sage-grouse and commit to the following: 1) adopt a policy of no surface disturbance within 3 miles of occupied leks; 2) locate and give special designation as Areas of Critical Environmental Concern (ACECs) to all areas used by greater sage-grouse during both average and severe winters; 3) require standard surveys as soon as possible to estimate changes in numbers of greater sage-grouse in identified winter use areas, to locate active leks, and to map mid- to late-summer brood-rearing areas based on moisture and green forage availability; 4) immediately initiate replicated, long-term studies to understand the effects of habitat fragmentation on predator numbers and greater sage-grouse predation rates; 5) incorporate the habitat guidelines/desired future conditions published by Connelly et al. (2000) into the project EIS/ROD so that greater sage-grouse nest success and chick survival improve; and 6) require road closures (permanent or seasonal), the burial of power lines, modifications of fences and other structures, and elimination of livestock grazing in areas where oil and gas production is permitted.

- The Western Association of Fish and Wildlife Agencies and the Wyoming BLM Statewide Greater Sage-grouse Team management guidelines should be utilized.

- Determine whether the grouse in the JIDPA are migratory.

- The distinction between active and historic greater sage-grouse leks should be addressed, and scientifically based rationale should be provided and other agency personnel (i.e., WGFD) input sought if protective stipulations are removed from historic leks.

- Avoidance of greater sage-grouse wintering areas should be addressed with specific details provided so that a disclosure of the benefits can be identified.

- Allowing down-spacing within the area and creating lower-density areas in the remainder of the Jonah Project Area would not benefit greater sage-grouse leks, as there are no longer any active leks outside of the proposed down-spacing area. To assure adequate protection for at least the nesting and brood-rearing habitat near project area lek sites, a 0.5-mile buffer around the 4-2, 4-6, and Sand Draw Reservoir leks should be provided for any new drilling sites. Additionally, a 0.5-mile buffer from new drilling should be afforded the Rocks, Buckhorn #1, Alkali Draw, and Shelter Cabin leks outside but adjacent to the JIDPA.

- The Jonah and Anticline areas provide fall and wintering range for greater sage-grouse that breed as far as 20–30 miles away. Alkali Draw and Granite Wash areas could be used as mitigation locations for potential impacts to winter range. Suggested mitigation/protection measures could be lower well densities, larger buffer zones for no surface disturbance, or both.

- No project activities that may exacerbate habitat loss or degradation for greater sage-grouse should be permitted in important habitats.

- Long-term monitoring efforts (20–30 years) and research studies to determine and separately quantify impacts of energy development and other multiple use activities are needed. It would also be desirable to establish concurrent long-term monitoring within the Wind River Front area, which is currently prohibited from new leasing.

- Unless site-specific information is available, greater sage-grouse habitat should be managed following the guidelines of Connelly et al. (2000), including: 1) before initiating vegetative treatments, quantitatively evaluate the area proposed for treatment to ensure that it is not suitable breeding habitat (generally, fire should not be used in greater sage-grouse breeding habitats dominated by Wyoming big sagebrush, and fire should be avoided in areas prone to invasion by cheatgrass or other invasive weedy species); 2) include sagebrush, native forbs (especially legumes), and native grasses in reseeding efforts; 3) when restoring habitats dominated by Wyoming big sagebrush, do not treat >20 percent of the breeding habitat within a 30-year period (similarly, in areas dominated by mountain big sage, no more than 20 percent of the breeding habitat should be treated in a 20-year period); 4) avoid land use practices that reduce soil moisture effectiveness, increase erosion, cause invasion of exotic plants, and reduce abundance and diversity of forbs; 5) avoid removing sagebrush within 300 meters of greater sage-grouse foraging areas along riparian zones, meadow, lakebeds, and farmland, unless such removal is necessary to achieve management objectives; 6) avoid use of organophosphorus and carbamate insecticides in greater sage-grouse brood-rearing habitats; 7) avoid developing springs for livestock water, but if water from a spring will be used in a pipeline or trough, design the project to maintain free water and wet meadows in the spring; 8) maintain sagebrush communities on a landscape scale, allowing greater sage-grouse access to sagebrush stands with canopy cover of 10–30 percent and heights of 25–35 centimeters regardless of snow cover; 9) re-seed former winter ranges with the appropriate subspecies of sagebrush and herbaceous species unless the species are recolonizing the area in a density that would allow recovery within 15 years; 10) identify breeding and winter ranges in Wyoming big sagebrush habitats and establish these areas as high priority for wildfire suppression; and 11) greater sage-grouse populations that have thus far survived extensive habitat loss may still face extinction because of a time lag between habitat loss and population collapse.

- Incorporate recommendations in the report *A Review of Sage-Grouse Habitat Needs and Sage-Grouse Management Issues for the Revision of the BLM's Pinedale District Resource Management Plan* (Braun 2002), including: 1) adopt a policy of no surface disturbance within 3 miles of occupied leks, as data clearly show negative impacts to greater sage-grouse at the present distance of 0.25 mile or 0.50 mile; 2) all areas used by greater sage-grouse during both average or "normal" and severe winters should be located, mapped, and given special protection from wildfire, manipulation of sagebrush, and human-induced disturbance (at least 90 percent of the newly mapped areas should be designated as a network of ACECs as part of the RMP revision process); 3) adherence to time of use restrictions for project activities from 6:00 p.m. to 9:00 a.m. during the breeding and nesting periods should be strictly monitored and enforced; 4) management of mid- to late-summer brood-rearing areas should encourage forb regrowth while maintaining at least a 6-inch residual grass height with taller live sagebrush of >15 percent canopy cover in close proximity (<200 yards) for use as escape cover; and 5) mitigation should be emphasized for all activities known to negatively impact greater sage-grouse, including, but not limited to, a) burial or modification of power lines; b) offset drilling; c) road closures and time restrictions; d) removal of livestock grazing; e) nitrogen fertilization of winter and nesting areas; and f) removal or modification of existing fences. Full mitigation would be to replace the exact number of project-impacted grouse by increasing the number of grouse per area that unaffected areas can support.

RAPTOR ISSUES

- Examine existing stipulations and protections to determine their effectiveness and whether they should be modified to protect raptors.
- Evaluate whether habitat that could potentially be occupied by raptors (e.g., previously utilized nests) should receive protection to ensure the continued viability of raptors in the JIDPA.
- Consider all biological needs of raptors and develop suitable protections for all significant life stages of the birds.
- Address BLM means of compliance and enforcement with the Bald Eagle Protection Act and Migratory Bird Treaty Act.

THREATENED, ENDANGERED, PROPOSED, CANDIDATE AND BLM WYOMING SENSITIVE SPECIES

- Address threatened, endangered, proposed, and candidate (TEP&C) and BLM Wyoming sensitive (BWS) species.
- Work toward prairie dog conservation and recovery, and disclose whether any prairie dog towns are found in the JIDPA.
- Require and ensure full compliance with BLM Manual MS-6840, including the following: 1) ensure candidate and BWS species are appropriately considered; 2) develop and implement range-wide or site-specific management plans, conservation strategies, and assessments for TEP&C and BWS species that include specific habitat and population management strategies and objectives; 3) ensure activities affecting the habitat of TEP&C and BWS species are carried out in a manner consistent with management objectives; and 4) monitor populations and habitats of TEP&C and BWS species to determine whether management objectives are being met.

- Ensure full compliance with requirements to engage in early consultation with the USFWS relative to the effects of this action on listed species.

- Identify and provide for the protection of keystone species (e.g., prairie dogs), and recognize and protect keystone resources (e.g., springs, deep pools in streams, salt or mineral licks).

- Comply with the ESA, and proactively implement programs for the conservation of listed species.

- Prepare a Biological Assessment (BA) and involve only credible and reputable scientists to conduct BA and other ESA-related analyses.

- It is inappropriate to merge BAs with EISs, mixing ESA compliance with NEPA compliance.

- Information on the existence of pygmy rabbits in the project area must be collected prior to activity associated with this proposed project, and pygmy rabbit habitat should be considered in APD decisions. BLM should immediately begin collecting pygmy rabbit data for the project, as well as assessing if Jonah Field management requires adjustment.

- Protection of potential TEP&C species habitat should not be given the same protection as that for TEP&C species.

- If the project is approved, BLM and their non-federal representatives must work with the USFWS to develop survey, impact minimization, and conservation measures for all listed species. Consultation with USFWS pursuant to Section 7(a)(2) of the ESA must be undertaken if the proposed project may affect a listed species.

- Species listed by USFWS that may be present in the project area or affected by the project include bald eagle, black-footed ferret, Ute ladies'-tresses, mountain plover, and Colorado River fish.

- Implement a 1.0-mile disturbance-free buffer around bald eagle nests and winter roosts, or, if not practical, conduct activity outside of February 15–August 15 to protect nesting birds and November 1–April 15 to protect roosting birds.

- If white-tailed prairie dog towns or complexes of greater than 200 acres will be disturbed, surveys for ferrets are recommended. These surveys should be conducted even if only a portion of the town or complex will be disturbed.

- Surveys for Ute ladies'-tresses should be conducted by a knowledgeable botanist trained in conducting rare plant surveys.

- Surveys for mountain plover should be conducted in all suitable nesting habitat, and nesting areas should be avoided from April 10–July 10. The current *Mountain Plover Survey Guidelines* provide the necessary information regarding surveys and protection measures. Changes in habitat suitability and/or direct habitat loss should also be addressed.

- Develop protective measures, with an assurance of implementation should mountain plover be found in the JIDPA.

- Formal consultation is required for any project that may lead to depletions of water to the Colorado River System. Depletions include evaporative losses and/or consumptive use of surface water or groundwater within the affected basin. Should depletions be anticipated as a result of the project, include an estimate of the amount and timing (by month) of average annual water depletion (both existing and new depletions) and describe the methods of arriving at such estimates.

- The impacts to TEP&C species on non-federal lands must be considered an interrelated and interdependent effect and must be evaluated and addressed. Notify all lessees of their responsibilities to comply with federal and other applicable regulations, regardless of land or mineral ownership.

AIR QUALITY ISSUES

- Obtain better baseline air quality monitoring data before developing new wells.

- Air quality impacts may result in acidification of lakes, soil damage, and negative impacts to wildlife and human safety.

- The project is likely to result in significant air quality impacts not only in the JIDPA but also in the Class I Bridger and Fitzpatrick Wilderness Areas.

- The project is likely to result in the production and deposition of considerable volumes of oxides of sulfur (SOx), oxides of nitrogen (NOx), and other toxic aerosols; however, this deposition is extremely difficult to monitor due to the narrowness and shifting direction of the plumes.

- Address all reasonably foreseeable direct, indirect, and cumulative impacts on air quality, including global warming as a result of burning the produced gas.

- Air quality analysis for far-field effects should not be necessary, given the analysis completed for the Pinedale Anticline EIS.

- The air quality discussion should include a thorough analysis of the adverse impacts to air quality associated with burning substitute fuel sources, if development is limited, made more costly, or delayed.

- Include a complete increment consumption analysis to identify areas where Prevention of Significant Deterioration (PSD) increments previously have been fully consumed by prior development and/or will be fully consumed by the additional emissions from proposed oil and gas developments.

- Analyze control strategies to identify mitigation measures sufficient to prevent expected exceedances of air quality standards.

- Modeling should include emissions from drilling of 250 wells per year with emissions from the maximum number of producing wells.

- Analyze the recent evidence of adverse health effects associated with exposure to particulate matter less than 10 microns in size (PM10) and less than 2.5 microns in size (PM2.5).

- Address releases of hazardous air pollutants (HAPs) during produced water disposal operations.

- Implement cumulative impacts analysis including all completed, ongoing, and proposed oil and gas projects and other existing activities in the Greater Yellowstone Ecosystem.

- Quantify impacts state-wide.

- Consider mitigation measures sufficient to provide for compliance with state and federal standards and to prevent adverse effects on: 1) public health resulting from large increases in exposure to daily concentrations of fine particles, and 2) acid-sensitive watersheds as a result of emissions.

- Conduct a regulatory analysis to identify the minor source baseline dates for pollutants. If the EIS fails to include a comprehensive increment consumption analysis, the EIS will be rendered inadequate because without such analysis, it is impossible to determine whether increments have been consumed by prior development or whether the project will cause the increments to be exceeded.

- Before proceeding with the project, the RMP EIS must describe the full magnitude of the exceedances of increments that will result from adding emissions from the completed, ongoing, and proposed projects and then identify mitigation measures that will prevent the adverse impacts.

- Expressly address how the BLM will carry out responsibilities to protect visibility in the Class I areas.

- Include provisions to implement EPA's "No Degradations" policy under the Clean Air Act. The information needed to identify the least-impaired days and to provide a meaningful assessment of the extent to which visibility will be degraded on the least-impaired days should be developed and submitted to the public in the EIS. The results of the analysis should be considered for the purpose of identifying the kinds of mitigation measures necessary to achieve the No Degradation standard.

- Identify and mitigate acid rain impacts.

- Identify and mitigate the impacts on public health from fine particle exposures.

- Address the problem of global warming and the steps BLM can take in considering this project to reduce the problem.

- It is contended that 1) the Upper Green River Region has suffered measurable degradation from human-caused visual haze and nonvisible greenhouse gases (air transparency and possible regional microclimate/heating effects) from the trona plants west of Green River and drilling activities in the Jonah field; 2) distinct decreases in average peak ultraviolet radiation have resulted from the Jonah field; 3) haze events now occur in the region; and 4) there is increased traffic dust and engine emissions.

- Conduct investigations to assess microclimate heating prior to further development.

- Development and utilization of natural gas reserves assists in attainment of clean air objectives in conformance with presidential and congressional directives.

- Utilize NOx emissions data collected in recent years to determine whether visibility impacts are occurring or predicted to occur and use this information to make recommendations to EPA regarding air quality and to WDEQ regarding permitting for existing leases and in making decisions regarding future leases on BLM-administered lands.

- In light of the April 24, 2000, letter agreement between BLM, EPA, WDEQ, and the USFS to discontinue the Jonah II ROD levels of concern, the BLM should review the agreement, along with new monitoring information; should review emission sources that WDEQ has been tracking; and should assess current impacts and mitigation for future projects.

- Do not make the assumption that mitigation measures used in 40-, 80-, or 160-acre spacing are appropriate for the project. The proposed spacing will require additional analysis and mitigation practices that have not previously been required.

- EPA requests a meeting be set up as soon as possible, involving WDEQ, USFS, National Park Service (NPS), EPA, and BLM, to determine what has been accomplished (in the area of air and water quality) per past agreements for southwestern Wyoming and what future impact analysis and mitigation might be needed.

- Consider potential increased gas processing emissions associated with increased gas production from the field.

- Investigate options for off-site mitigation that may improve the overall air quality in southwest Wyoming while allowing development to continue (e.g., as when Ultra Petroleum and the Naughton Power Plant added emission reduction equipment to the Naughton Power Plant, reducing levels of NOx emissions).

- Cumulative impacts on air quality from the project combined with ongoing development and RFD, including the Powder River Basin Coalbed Methane Project, should be analyzed. Analysis should include potential impacts to visibility and deposition in the Bridger, Fitzpatrick, Teton, Washakie, and North Absaroka Wilderness Areas (Class I), as well as impacts to the Gros Ventre and Popo Agie Wilderness Areas (Class II).

- Air quality modeling domains should be expanded to incorporate the Powder River Basin study to determine cumulative impacts.

- The installation of vapor-burning stacks and other emissions control equipment in the field has increased the clarity of the air, which previously created a haze at the base of the Wind River Mountains east of the field.

WATER ISSUES

- Obtain better baseline water quality monitoring data before developing new wells.
- Assess present and future water quality, quantity, direction, and flow conditions.
- Pumping water from the Green and New Fork Rivers and their tributaries would magnify drought effects on these waters.
- Comply with WDEQ water quality permits/permitting requirements.
- The project will increase pollution and draining of water resources.
- Assess downstream effects on the Colorado River system.
- Two stock ponds have dried up and six cattle have been poisoned from drinking contaminated water as a result of oil and gas activities in the area.
- Concern over negative effects of aquifer depletion on stock ponds.
- Ensure compliance with the Clean Water Act and 1) manage natural resources on a watershed basis; 2) emphasize assessment of the function and condition of watersheds, incorporating watershed goals in planning, enhancing pollution prevention, monitoring and restoring watersheds, recognizing waters of exceptional value, and expanding collaboration with other agencies, states, tribes, and communities; 3) increase maintenance of roads and trails and aggressively relocate problem roads and trails; and 4) enhance the quality of streams and riparian zones and accelerate restoration.
- The proposed well density may cause problems with sediment in runoff from storm events, thus impacting water quality in the Green River.
- Water quality data should be logged and continually registered at the Sublette County Courthouse Register of Deeds and Documents prior to and during oil and gas development.
- Riparian or streamside habitats should be avoided whenever possible. Plans for mitigating unavoidable impacts to wetland and riparian areas should include mitigation goals and objectives, methodologies, time frames for implementation, success criteria, and monitoring to determine if the mitigation is successful. The plan should also include a contingency plan to be implemented should the mitigation be unsuccessful.
- It may be advantageous for all parties to find a use for the produced water before it is evaporated or injected.
- Water handling equipment is currently being tested to investigate the viability of reusing produced water for base fluid in fracture simulations.

CULTURAL/ARCHAEOLOGICAL/HISTORIC RESOURCE ISSUES

- Assess impacts to Native American issues and cultural/religious sites.
- Assess impacts to National Historical Trails in light of recent legislation protecting those sites.
- Density of disturbance may negatively impact archaeological resources.
- Consider more intensive data collection on archaeological sites of high value in exchange for disturbance of areas with less unique archaeological value.
- Address the implication of the recent Instruction Memorandum authorizing the BLM to do away with the traditional linear approach to surveying for cultural resources on the Jonah area.
- Identify areas where cultural sites are at risk, and employ available administrative measures to protect those resources.
- Provide specific management intent and practices for cultural resources.
- Consult with Native American tribes during the planning process.
- Ensure that cultural resource inventories are prepared and maintained and that historic properties are identified, evaluated, and protected, and, if appropriate, nominated to the National Register of Historic Places (NRHP).
- The effects of the project on the Lander Trail should be addressed.
- Address the cumulative effects of the proposed development on cultural resources.
- BLM has not honored an agreement (Programmatic Agreement between the BLM and SHPO regarding the Jonah II and Pinedale Anticline) to develop a historic context planning document that would synthesize previous ethnohistorical, historical, geophysical, soils, biological, and cultural-historical studies conducted within the fields. This synthesis was to have been used to form the basis for development of a cultural resource research design/management plan, which was to have been completed within one year of ratification of the agreement.
- Given past failures to consult in good faith and to fulfill previous obligations, the BLM has not met its commitment to managing and protecting the important and nationally significant historic properties under their charge. BLM must provide specific management intent and practices with regard to cultural resource considerations and concerns identified by SHPO.

OTHER NATURAL RESOURCE ISSUES

- Soil surveys are needed in the area.
- Given the past several years of drought, recognize and address the potential for soil erosion from all proposed surface disturbance.
- The use of soils analysis is potentially beneficial, but the costs should not be born by Operators alone—tax revenues in the county should be used to finance the expenditure.
- Concern over effects on livestock and wildlife food sources.
- Address impacts to visual resources; density of disturbance may negatively impact visual resources.
- Address impacts from noise, including requirements to minimize noise and plans for monitoring.

HEALTH AND SAFETY ISSUES

- The oil and gas industry leaves behind equipment and contaminated soil and water.
- Address public health issues.
- Require the containment of litter and industrial waste.
- Include provisions to notify the public of health and safety threats.
- Address the use of hydraulic fracturing and the impacts of drilling fluids and chemicals on the environment.
- Drilling operations must be required to comply with any applicable stormwater discharge requirements, including acquiring National Pollutant Discharge Elimination System (NPDES) permits, as required.
- Work with the EPA relative to regulation of hazardous and toxic wastes generated from gas development activities.

SOCIOECONOMIC ISSUES

- Continue drilling at the present or accelerated rate to prevent expensive start up and shut down costs and continue current economic momentum.
- Retain current Operators who have experience in the Jonah Field.
- Provide a thorough socioeconomic analysis for each alternative considered.
- Avoid boom-bust cycles, which create pricing instability.

- The project would generate a large amount of taxes and royalties, much of which would be returned to state and county governments for use in education and other tax-funded programs.

- Consider not only Sublette County but also neighboring counties and communities.

- The amount of tax and royalty revenue generated from the project should be made public and consider distributions to schools, hospitals, roads, convalescent homes, and other infrastructures.

- Present the negative impacts associated with not developing the natural gas resources (e.g., loss of jobs, royalties, taxes, etc.).

- Natural and physical resources should not be given more credence and analysis than human (social and economic) factors.

- Models historically used for socioeconomic analysis do not adequately account for long-term trends associated with community stability.

- The project would help mitigate long-term trends of decreasing school enrollment and aging demographics.

- Development of the project would increase Wyoming's share of new and existing natural gas markets.

- The input-output models historically used in determining socioeconomics must take into account long-term trends associated with education.

- In considering economic factors, include loss of revenue to the WGFD and local outfitters because of declines in wildlife.

- Private industries should not profit from public lands.

- Concerns regarding a foreign (Canadian) company coming in and profiting from our mineral wealth and then leaving after destroying public lands.

- Consider the economic impacts (e.g., loss of tourism, hunting, fishing income) to the state as public lands of high recreational value are developed.

- Consider school enrollment declines/school closures (consolidations) in Sweetwater County.

- Consider long-term trends.

- Implementing the project as described would contribute to boom and bust economic conditions, rather than economic stability, as opposed to a phased approach requiring closure and reclamation prior to granting new permits, which would allow production on a sustainable level.

- In the long run, tourism dollars are more sustainable than oil and gas industry dollars.

- The oil and gas industry has caused skyrocketing property values and property taxes in the area.
- The high pay of transient oil and gas workers has raised the per capita and median income levels to the point where government grants previously available to fund community projects are no longer available.
- Natural gas prices have skyrocketed since local production of the resource was initiated.

MISCELLANEOUS ISSUES

- Work harder to develop alternative energy sources.
- Include provisions that ensure that industry is held accountable for the full liability of conducting business in the Upper Green River Valley.
- Cut demand and use less natural gas.
- Pursue alternate energy sources (e.g., wind power) instead of implementing the project.
- The project is necessary for National Security to develop the gas and keep Operators from moving to foreign countries.
- The project sets the precedent for similar high levels of energy development throughout the Green River Valley.
- Rapid destruction of wild places throughout Wyoming is undesirable.
- Use previously generated data to expedite document preparation.
- Establish a time line and a project deadline if so requested by the Operator.
- The BLM should recognize its increased demand for manpower, and must act accordingly to adequately staff the PFO.
- The ROD should be issued by March 2005.
- The BLM is already 5 months behind the schedule contained in the Memorandum of Understanding (MOU) and must strive to issue the ROD as soon as possible.
- An increase in demand is anticipated for natural gas as a clean, low-cost fuel.
- The BLM Reservoir Management Group (RMG) must provide analysis of the waste of reserves that will occur if all wells are required to be directionally drilled.
- The BLM must not use pace of development assumptions in its NEPA analysis as absolute ceilings on development.
- The WOGCC must be involved as a cooperating agent in the preparation of the EIS.

- Allow the development, but with more input from conservation groups and other federal agencies.

- The project provides a clean, environmentally desirable energy source.

- Regarding areas where the BLM lacks baseline data, describe how BLM intends to deal with this lack of data and how such data will be collected in the future.

- Further exploration prior to preparation of the EIS, as proposed by BLM in the Scoping Notice, would violate NEPA, further exceed the RFD scenario, and potentially violate the ESA; this exploration must not be allowed.

- BLM must not define the purpose and need solely as to allow natural gas production and cater to the oil and gas industry's desire to develop and produce resources; it must also include strong environmental protections as at least a co-equal purpose and need.

- Existing NEPA documents are outdated and must be supplemented before they can be used for tiering purposes and before any further drilling can occur.

- The Pinedale Anticline NEPA documents are outdated and must be supplemented before they can be used for tiering.

- Information should be presented in a manner that the public can easily understand.

- Consider oil and gas projects as long-term that pay over years (not boom and bust).

- The EIS should be based on new and current resource data.

- Provide a map showing the location of the JIDPA relative to other ongoing and proposed oil, gas, and coalbed methane projects. The status and extent of each development should be identified.

- Natural gas is the cleanest, most efficient fossil fuel and is used in many alternative energy sources such as fuel cells.

- Development over such a short time frame has very little environmental consequence in the greater scheme.

- The denser well spacing provides new jobs and creates less impact on the environment than development outside an existing gas field.

- The scope of the EIS should be limited and simple.

- Approximately 90 percent of the PFO is currently under lease and, including the Jonah Field, six major natural gas fields are in operation in the area.

APPENDIX E — EROSION, SEDIMENT TRANSPORT AND SALINITY MODELING TECHNICAL REPORT

HydroGeo, Inc.
Surface & Groundwater Hydrology

EROSION, SEDIMENT TRANSPORT, AND SALINITY MODELING TECHNICAL REPORT

JONAH INFILL DRILLING PROJECT SUBLETTE COUNTY, WYOMING

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1. INTRODUCTION

The potential for environmental impacts associated with sediment transport and salinity has been identified as an issue for further investigation in the environmental impact statement (EIS) for the proposed Jonah Infill Drilling Project (JIDP). The Bureau of Land Management (BLM) is preparing an EIS for the JIDP (BLM 2005). The purpose of this report is to describe the conceptual model of watershed hydrology, to summarize the hydrologic transport modeling methods, and to present modeling results quantifying potential JIDP impacts resulting from sedimentation and salinity.

1.1 Modeling Objectives

The goal of the sediment transport and salinity modeling was to quantify sediment loss and loading at the JIDP area (JIDPA) boundary and the potential for salinity loading in the Green River. The modeling quantified sediment loading under the following four conditions:

- assuming no disturbance in the JIDPA;
- under the EIS-described No Action condition;
- under the EIS-described Proposed Action condition; and
- under the EIS-described Preferred Alternative condition.

The quantitative impacts from alternatives that were not explicitly modeled can be interpolated from the conditions that were modeled. The results of the watershed modeling were expressed in tons of sediment per year per watershed, so those alternatives can be directly compared.

1.2 Modeling Approach

The watershed modeling was performed using the Kinematic Runoff and Erosion Model (KINEROS2), developed by the U.S. Department of Agriculture (USDA) (2005). KINEROS2 is an event-oriented physically based model that describes the processes of interception, infiltration, surface runoff, and erosion from small agricultural and urban watersheds.

Seven sixth-level watersheds were modeled. Each watershed was represented by a cascade of planes and channels, and the partial differential equations describing overland flow, channel flow, erosion, and sediment transport were solved in KINEROS2 using finite-difference techniques. The input of spatial variation in soils, infiltration, runoff, and erosion parameters was accomplished using a Geographic Information System (GIS) interface.

1.3 Impact Analysis Approach

The following conditions/alternatives were modeled:

- an undisturbed condition;
- No Action;
- Proposed Action; and
- Preferred Alternative.

Mitigation measures such as engineered retention structures were not modeled.

2 PROJECT DESCRIPTION

The JIDPA is located in south-central Sublette County approximately 32 miles southeast of Pinedale and 28 miles northwest of Farson, Wyoming (Map 1). Drilling is proposed in Townships 28 and 29 North, Ranges 107 through 109 West, 6th Principal Meridian, on a total project area of approximately 30,500 acres. Natural gas developers (Operators) propose to expand development of natural gas resources in the JIDPA over a period of about 25 years.

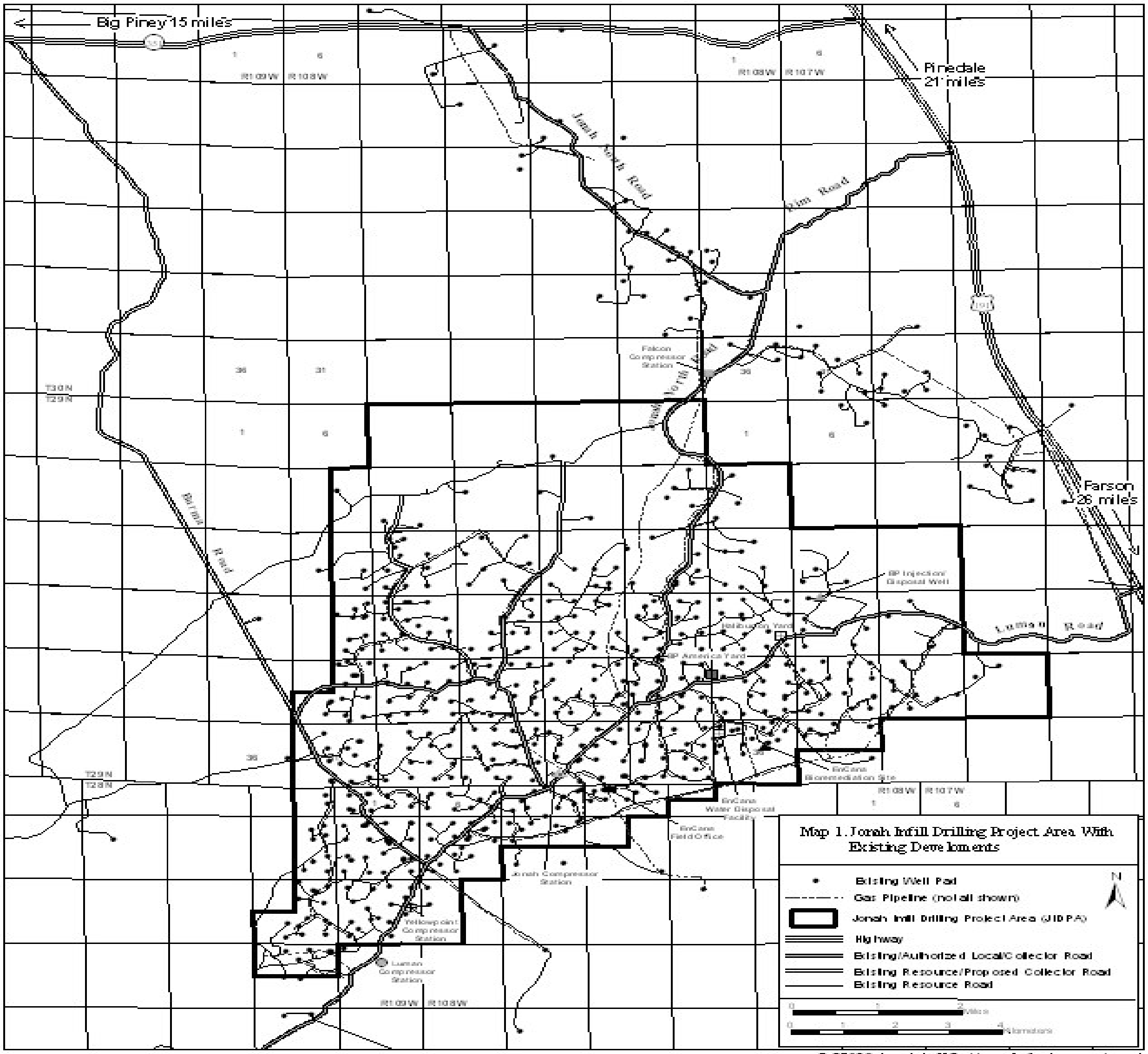
The original development proposal to drill 450 wells in addition to the 47 existing wells was approved by the BLM in the *Environmental Assessment and Finding of No Significant Impact for the Modified Jonah Field II Natural Gas Project* (BLM 2000) (Modified Jonah Field II EA). The Operators now propose to drill up to 3,100 additional wells on a minimum of 64 well pads per section within the JIDPA and to explore further for natural gas in known productive formations, as well as deeper formations beneath the area (Proposed Action).

The planned development would include the following associated structures and facilities in addition to the proposed wells: well pad separators, dehydrators, and storage tanks; collector, local, and resource roads and road improvements; a system of gathering pipelines; compressor station expansions; five additional water wells; and other ancillary facilities (e.g., water disposal facilities, ware yards).

The EIS-described alternatives included for this analysis are as follows:

- No Action – 533 wells from 497 well pads on 4,209 acres of initial surface disturbance. Well pad density = 1 pad/40 acres (16 pads/section). Estimated total initial surface disturbance is approximately 14% of the JIDPA; the estimated Life of Project (LOP) surface disturbance is approximately 5% of the JIDPA.

- Proposed Action – Up to 3,100 new wells on up to 16,200 acres of new initial surface disturbance. Well pad density = a minimum of 64 well pads/section, or 1 pad/10 acres Estimated total initial surface disturbance is approximately 67% of the JIDPA; estimated LOP surface disturbance is approximately 20% of the JIDPA.



Map 1 Jonah Infill Drilling Project Area with Existing Developments.

- Preferred Alternative – Up to 3,100 new wells on approximately 8,316 acres of new initial disturbance. Well pad densities would likely vary across the JIDPA depending upon surface disturbance acreage allowances (Map 2). Estimated total initial surface disturbance is 41% of the JIDPA; estimated LOP surface disturbance is approximately 13% of the JIDPA.

3 CONCEPTUAL MODEL OF SEDIMENT TRANPORT AND SALT LOADING

3.1 Watershed Hydrology

All drainages in the JIDPA are ephemeral, flowing only in response to snowmelt and rain storms. Drainage is predominantly to the west within Sand Draw, Alkali Creek tributaries, and Granite Wash, which flow to the Green River; to the southeast in Long Draw and Bull Draw, which flow to the Big Sandy River, a tributary of the Green River; to the southeast in Jonah Gulch and an unnamed drainage (watershed 140401040603 [104]), which flow to a closed basin; and to the south in Buckhorn Draw, which flows to the Green River (Map 3).

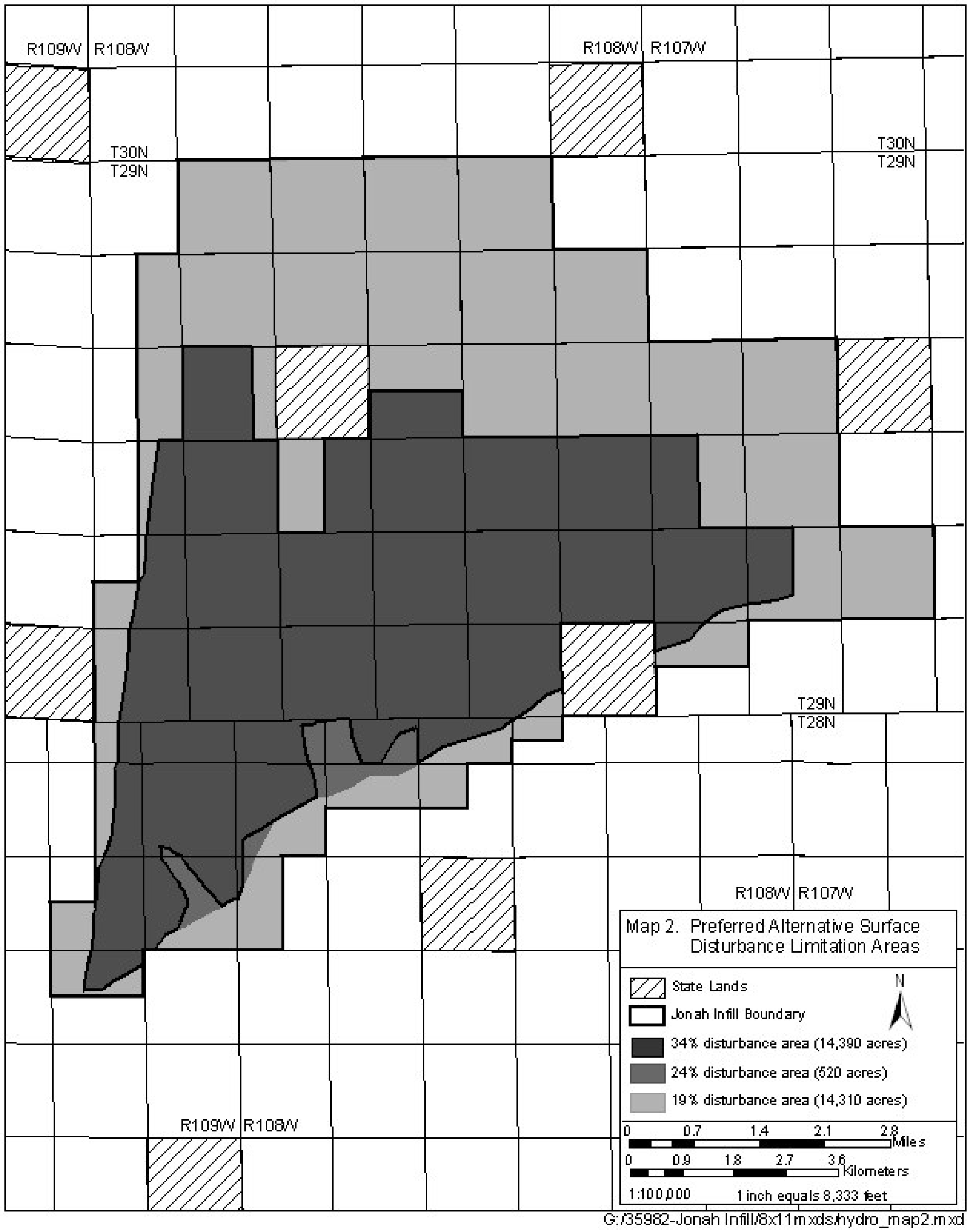
Eight sixth-level watersheds intersect the JIDPA (Table 1, Map 4), and seven of these watersheds were modeled. Not modeled was Jonah Gulch, as it covers only a small part of the JIDPA (318 acres or 1.0%), which would make numeric modeling unreliable. Additionally, Jonah Gulch drains into a closed basin such that overland flow does not reach the Green River system.

Table 1 Watershed Areas

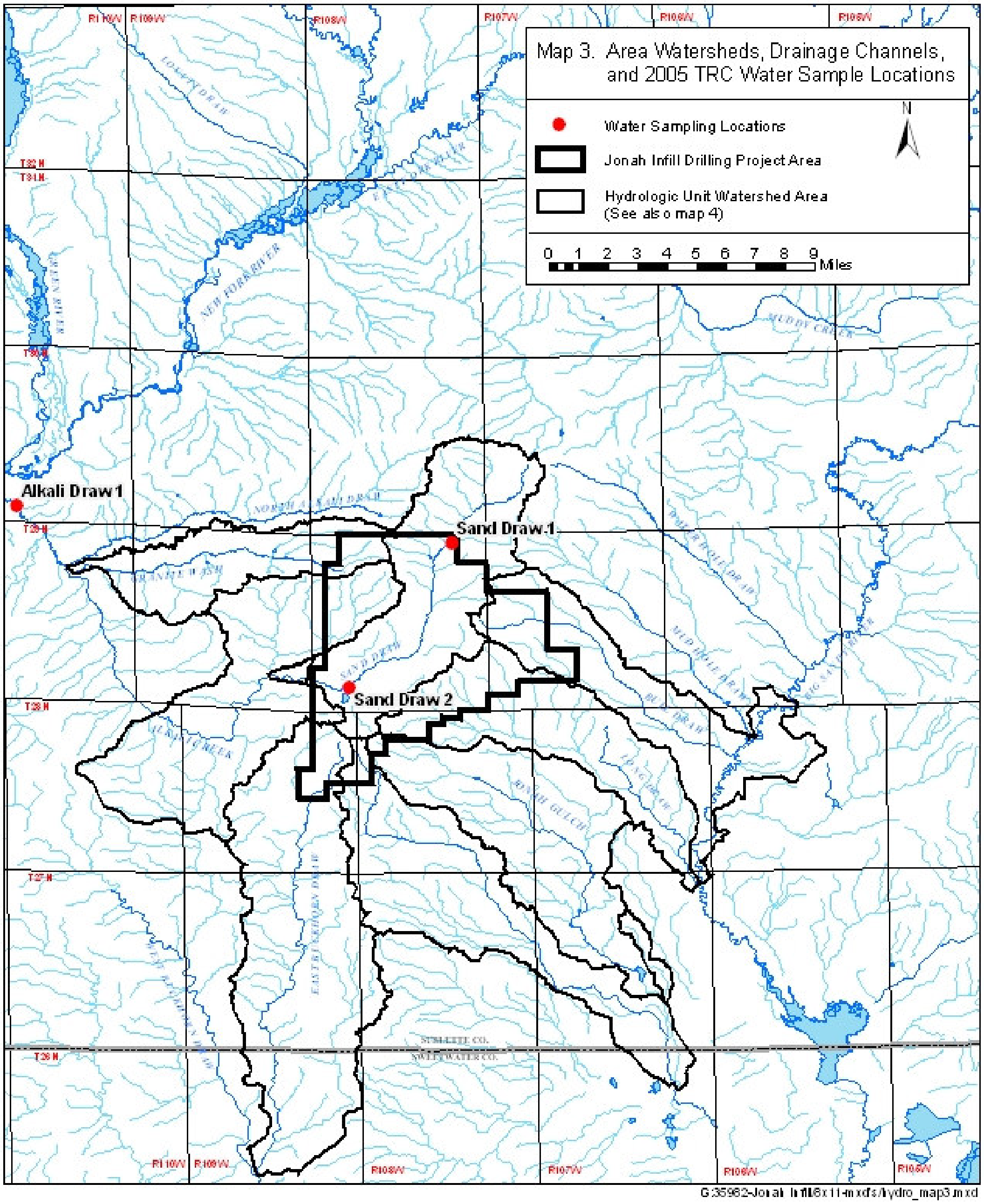
Watershed	Acreage within JIDPA	Total Acreage
Sand Draw	13,724	23,373
Granite Wash	1,312	12,212
Upper Alkali Creek	3,782	26,355
Upper Eighteenmile Canyon	1,958	35,212
Bull Draw	3,630	19,760
Long Draw	5,028	18,521
Jonah Gulch	318	22,652
140401040603 (140)	748	24,558

3.2 Erosion, Sediment Transport, and Salt Loading

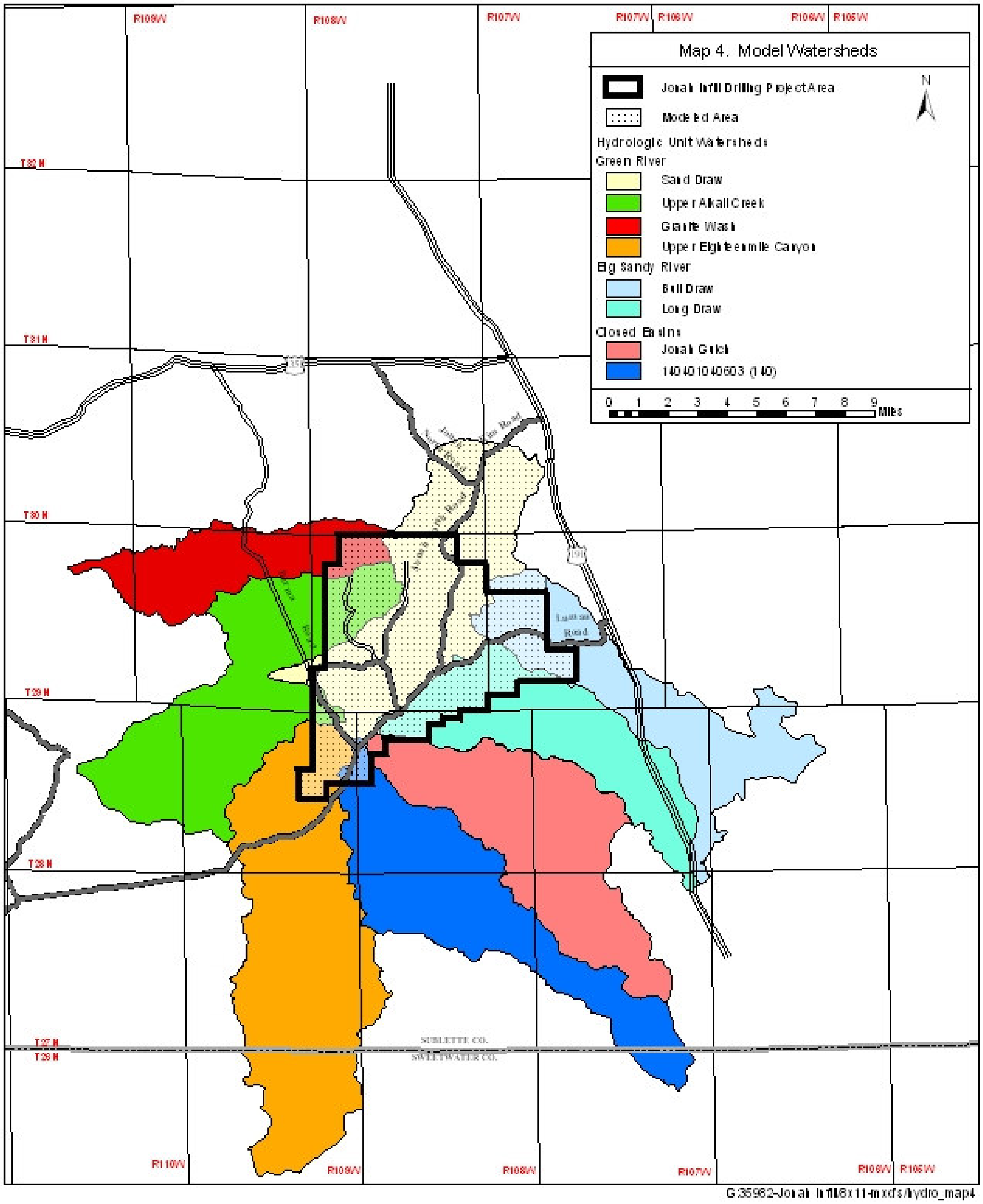
Much of the JIDPA has shallow soils, lime- or salt-affected soils, and sandy soils that are subject to water erosion and difficult to reclaim. Project activities may increase the potential erosion of these soils due to the large amount of proposed surface disturbance. After major storm events, disturbed soils could be eroded and transported into live streams, if unchecked by appropriate erosion control measures (e.g., reclamation, retention structures).



Map 2 Preferred Alternative Surface Disturbance Limitation Areas.



Map 3 Area Watersheds, Drainage Channels, and 2005 TRC Water Sample Locations.



Map 4 Model Watersheds.

Increased erosion and sediment transport could lead to increased salinity in the Green and Big Sandy Rivers; significant precipitation events could move the dissolved salt to these receiving waters. The Green River and the Big Sandy River are Class IIAB waters (Wyoming Department of Environmental Quality [WDEQ] 2001). Salt loading is an issue in the Colorado/Green River system; therefore, any salt loading associated with this project could have implications concerning the *Colorado River Basin Salinity Control Act*.

4 MODEL SETUP

4.1 KINEROS2

The watershed modeling was performed using KINEROS2, which is an event-oriented, physically based model describing the processes of interception, infiltration, surface runoff, and erosion from small agricultural and urban watersheds. Watersheds are represented by a cascade of planes and channels; the partial differential equations describing overland flow, channel flow, erosion, and sediment transport are solved by finite difference techniques. The spatial variation of rainfall, infiltration, runoff, and erosion parameters can be accommodated within the program. KINEROS2 may be used to determine the effects of various artificial features--such as urban developments, small detention reservoirs, or lined channels--on flood hydrographs and sediment yield.

The KINEROS2 model was operated using a public-domain GIS interface, called Automated Geospatial Watershed Assessment or AGWA. AGWA was developed by the USDA, Agricultural Research Service, Southwest Watershed Research Center, in cooperation with the U.S. Environmental Protection Agency Office of Research and Development (Burns et al. 2004). AGWA operates in ArcView 3.x GIS and was used to perform the automated parameterization of KINEROS2 for a specified watershed.

KINEROS2 uses a version of the Universal Soil Loss Equation (USLE) to compute erosion (USDA 2005). The USLE (Wischmeier and Smith 1965, 1978) and the Modified Universal Soil Loss Equation (MUSLE) (Williams 1975) are the most commonly used methods for computing erosion caused by rainfall and runoff. USLE predicts average annual gross erosion as a function of rainfall energy. In MUSLE, the rainfall energy factor is replaced with a runoff factor. MUSLE is documented in Neitsch et al. (2002). Although several models exist to simulate erosion using the USLE or MUSLE, KINEROS2 was selected because it is a public domain code that interfaces easily with the ArcView GIS data compiled for the JIDP EIS.

USLE is implemented in the following manner in KINEROS2 (USDA 2005). For upland surfaces, Erosion e is assumed to be composed of two major components: 1) production of eroded soil by splash of rainfall on bare soil and 2) hydraulic erosion (or deposition) due to the interplay between the shearing force of water on the loose soil bed and the tendency of soil particles to settle under the force of gravity. Thus e may be positive (increasing concentration in the water) or negative (deposition). Net erosion is a sum of splash erosion rate as e_s and hydraulic erosion rate as e_h.

Splash Erosion. Based on limited experimental evidence, the splash erosion rate can be approximated as a function of the square of the rainfall rate (r) (Meyer and Wischmeier 1969). This relationship in KINEROS estimates the splash erosion rate as follows:

$$e_s = c_f\, k(h)\, r^2$$

in which c_f is a constant related to soil and surface properties, and $k(h)$ is a reduction factor representing the reduction in splash erosion caused by increasing depth of water.

Hydraulic Erosion. The hydraulic erosion rate e_h represents the rate of exchange of sediment between the flowing water and the soil over which it flows and may be either positive or negative. KINEROS assumes that, for any given surface water flow condition (velocity, depth, slope, etc.), there is an equilibrium concentration of sediment that can be carried if that flow continues steadily. Hydraulic erosion rate (e_h) is estimated as being linearly dependent on the difference between the equilibrium concentration and the current sediment concentration. In other words, hydraulic erosion/deposition is modeled as a kinetic transfer process:

$$e_h = c_g\, (C_m - C_s)\, A$$

in which C_m is the concentration at equilibrium transport capacity, C_s is the current local sediment concentration, c_g is a transfer rate coefficient, and A is the cross-sectional area of flow.

Clearly, the transport capacity is important in determining hydraulic erosion, as is the selection of transfer rate coefficient. Conceptually, when deposition is occurring, c_g is theoretically equal to the particle settling velocity divided by the hydraulic depth, h. For erosion conditions on cohesive soils, the value of c_g must be reduced.

4.2 Storm Events

Most runoff, sedimentation, and loading occur during major storm events. Storm runoff events were modeled for 24-hour storms having the following recurrence intervals:

- 5-year,
- 10-year,
- 20-year,
- 50-year,
- 100-year, and
- 150-year.

Modeled but not presented were 2-year storm events, as these storms did not generate enough precipitation for flow to occur in most ephemeral channels in the JIDPA. Precipitation depth for the 2-year through 100-year storm events were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas for Western Precipitation Frequency Maps (NOAA 1973). Precipitation depth for the 150-year storm event was extrapolated from the NOAA data using a semi-log plot (Figure 1). Precipitation depths for all storm events are given in Table 2.

Figure 1 Storm Magnitude

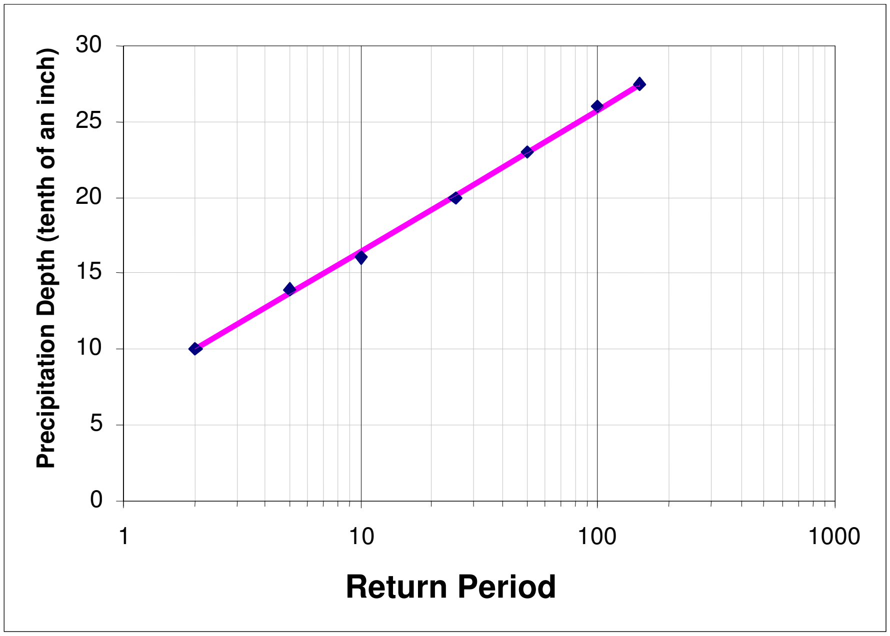


Table 2 Recurrence Interval and Magnitude of 24-hour Precipitation Event

Recurrence Interval T (Years)	Annual Probability	Storm Magnitude x_T (inches)
2	0.5	1.0
5	0.2	1.4
10	0.1	1.6
20	0.04	2.0
50	0.02	2.3
100	0.01	2.6
150	0.0067	2.7

Using AGWA, the precipitation depth is converted to a hyetograph using the Soil Conservation Service (SCS) methodology (SCS 1973) and a type II storm distribution. The precipitation input files for KINEROS2 give the rainfall depth over time, and a sample is shown in Appendix A.

4.3 Elevation Data and Watershed Delineation

KINEROS2 calculates flow and erosion in a watershed by assuming each watershed is a connected series of planes and channels. AGWA calculates the planes and channels necessary for KINEROS2 input from digital elevation data. Elevation data from the National Elevation Dataset were downloaded from the U.S. Geological Survey (USGS) EROS Data Center (USGS 2005a).

The following elevation data were used: National Elevation Dataset (NED) 1/3 Arc Second, downloaded in ArcGrid NAD 83 Geographic format (vertical datum is GRS 80), for the area bounded by the latitudes 42.6249 to 42.375, and the longitudes 109.875 to 109.501. This area covers six USGS quadrangle maps: Gobblers Knob, Olsen Ranch, Sugar Loaf NE, Stud Horse Butte, Square Top, and Bull Draw. For this dataset, the cell size is 0.00009 degrees or 10 m. The elevation data were converted to NAD 1983, UTM Zone 12, in meters.

AGWA was then used to delineate the watersheds covering the JIDPA and to divide the watersheds into planes and channels for KINEROS2 input. This process is described in the AGWA manual (Burns et al. 2004). First, any sinks in the NED data are filled. Sinks are isolated depressions in the elevation surface that can cause flow routing problems. Next, a flow direction grid is created for the entire topographic surface. Then a flow accumulation grid is created. The user then selects a watershed outlet, and the watershed is delineated according to the elevations in the NED file. Ponds or internal gages can be created but were not used for this project. Lastly, a size for the contributing source area (CSA) of 2.5% of the watershed size was selected for all watersheds. CSA is the area that is required before flow becomes channelized. Smaller numbers result in a larger number of smaller planes and vice versa, so the CSA is a measure of the geometric complexity at which the watershed is delineated. The default value is 2.5% of the watershed area and is recommended in the AGWA manual, as it provides the best results in a preliminary analysis. The watersheds delineated and used in the model are shown in Maps 3 and 4. The Jonah Gulch watershed was not modeled because the stream lengths in that watershed in the JIDPA was too short to be modeled numerically. Channel reaches upstream but outside of the JIDPA in the Sand Draw and Bull Draw drainages were included in the modeling, as they produce water inflow into the JIDPA and thus can influence sediment transport in the area.

Discrete channels were created within AGWA, and AGWA-created model channels were generally consistent with the mapped drainage channels shown on Map 3. Channel geometry was defined by using the model-default hydraulic geometry relationship options for the channel geometries. These relationships are known as bankfull hydraulic geometry relationships, and they define the bankfull channel width and depth based on watershed size. Bankfull hydraulic geometry relationships are useful in that they define channel topography with minimal input from the user and when actual channel topography is not known or known only for a small portion of actual channels in the watershed (Burns et al. 2004). The channels defined for the JIDPA varied in width from 2 to 34 meters, with an average width of 10 meters. Channel lengths varied from 13 to 4,600 meters, with an average length of 1,000 meters. Channel slopes varied from 0.001 to 0.05, with an average of 0.01, and channel depth varied from 0.25 to 0.82 meters, with an average of 0.45 meters. Detailed channel geometries were generated for the KINEROS2 input files, and an example is provided in Appendix A.

4.4 Soils

Properties of the soils in the watersheds can provide estimated input parameters, such as infiltration, water flow, and sediment routing, for KINEROS2. The following parameters are estimated for each channel and plane element of each watershed from the soil properties:

- Ks - saturated hydraulic conductivity, in mm/hr or inches/hr;
- CV - Coefficient of variation of Ks;
- G - mean capillary drive, in mm or inches (a zero value sets the infiltration rate to a constant value of Ks);
- Distribution - pore size distribution index (or Brooks and Corey Lambda) (This is a parameter used for redistribution of soil moisture during intervals of no flow.);
- Porosity;
- Rock - volumetric rock fraction, if any;
- Splash - rain splash coefficient (for plane elements only);
- Cohesion - cohesion coefficient of bed material; and
- Fractions - list of particle class fractions that must sum to one.

AGWA estimates these parameters from the State Soil Geographic (Statsgo) database (Burns et al. 2004). However, more detailed soil data are available for the JIDPA from the Burma Road Soil Survey (ERO Resources Corporation 1988; BLM 2005). In consultation with Professor Scott Miller, Ph.D. from the University of Wyoming, Laramie, who is one of the authors of AGWA (Burns et al. 2004), JIDPA-specific soil data were put in a database format equivalent to the Statsgo data format. Statsgo soils data were added to the new database for areas not covered by the Burma Road Soil Survey. The Statsgo data were for Region 14, Upper Colorado, and downloaded from the USGS website (USGS 2005b). The database tables created from JIDPA soils and surrounding Statsgo soils are shown in Appendix B. The newly created database tables were then used within AGWA to estimate the parameters listed above, and an example input file is provided in Appendix A. The range and average of the parameters estimated from the soils data are shown in Table 3.

Table 3 KINEROS2 Input Parameters Derived from Soil Properties

	Channel (Constant)	Plane Average	Plane Minimum	Plane Maximum
Ks (mm/hr)	210	13.3	1.6	27.0
CV	0	1.1	0.4	1.5
G (mm)	101	160	108	293
Distribution	0.545	0.34	0.25	0.43
Porosity	0.44	0.45	0.42	0.47
Rock	0	0.12	0.03	0.24
Splash	--	100	69	124
Cohesion	0.005	0.006	0.004	0.008
Sand Fraction	0.9	0.54	0.38	0.67
Silt Fraction	0.05	0.26	0.15	0.39
Clay Fraction	0.05	0.20	0.15	0.36

4.5 Landcover

Landcover and vegetation can be used to estimate infiltration parameters and Manning roughness for KINEROS2. The following parameters have to be estimated for each plane element of each watershed:

- Canopy - cover fraction of surface covered by intercepting cover (rainfall intensity is reduced by this fraction until the specified interception depth has accumulated);
- Interception - interception depth in mm or inches; and
- Manning - Manning roughness coefficient (for plane and channel elements).

AGWA estimates these parameters from the Multi-Resolution Land Characteristics (MRLC) Consortium National Land Cover Data (NLCD). To use AGWA routine, the detailed JIDPA-specific vegetation data (BLM 2005) were developed as grid files. NLCD vegetation data were added to the grid for areas not covered by the detailed JIDPA vegetation data. JIDPA vegetation types were added to the AGWA lookup table and used within AGWA to estimate the above parameters. The NLCD data were downloaded from the same site as the elevation data (see Section 4.3). The AGWA look-up table for vegetation data is shown in Appendix C.

The range and average of the parameters estimated from landcover data are shown in Table 4.

Table 4 KINEROS2 Input Parameters Derived from Landcover Properties

	Channel (Constant)	Plane Average	Plane Minimum	Plane Maximum
Canopy (no disturbance case)	--	0.2500	0.2475	0.2525
Interception (no disturbance case)	--	3.00	2.97	3.03
Manning (no disturbance case)	0.035	0.055	0.054	0.056
Canopy (disturbance cases)	--	0.150	0.087	0.2525
Interception (disturbance cases)	--	1.69	0.87	3.03
Manning (disturbance cases)	0.035	0.035	0.023	0.056

Detailed parameters for each channel and plane were developed for the KINEROS2 input files; an example is provided in Appendix A.

4.6 Disturbance

Disturbance from JIDP developments was simulated for modeling purposes by changing the land cover to equal bare ground. The AGWA Land-Cover Modification Tool was used to create a random pattern grid with different amounts of bare soil and pre-existing vegetation types in the JIDPA. The following amount of bare soil occurs in the modeled alternatives (BLM 2005):

- No Disturbance case - 0% disturbed ground;
- No Action - 14% disturbed ground;
- Proposed Action - 67% disturbed ground; and
- Preferred Alternative - three zones, with 33%, 38%, and 48% disturbance.

Disturbance zones for the Preferred Alternative can be seen on Map 2. The disturbance estimates identified in Map 2 for the Preferred Alternative are for new disturbances only and do not include the 14% disturbance of the No Action Alternative. However, the No Action disturbance was combined with the new disturbance in the model runs for the Preferred Alternative.

4.7 Salt Loading

In the Burma Road soil survey (ERO Resources Corporation 1988), chemical analyses of seven soil profiles were performed. Six of the soil profiles were performed in soils present in the JIDPA. The chemical properties of the top layer of saturated soil are given in Table 5.

Table 5 Soil Profile Chemical Analysis (ERO Resources Corporation 1988)

Soil Name	Depth (inches)	Electric Conductivity (µS/cm)	Ca (meq/l)	Mg (meq/l)	Na (meq/l)	Sodium Adsorption Ration
Fraddle	0-4	300	1.4	0.7	0.3	0.3
Quard Variant	0-4	500	1.2	0.7	3.2	3.3
Dines	0-4	400	1.0	0.4	3.0	3.5
Vermillion Variant	0-3	300	1.4	1.1	0.3	0.3
Baston	0-3	500	0.8	0.5	4.7	6.0
Langspring Variant	0-3	400	4.4	1.1	0.3	0.2

Electric conductivity was measured with the saturation extract method or saturated paste method. In this method, water is added to the soil until the soil is saturated and just reaches the flow point. This condition is referred to as a saturated paste. The saturated paste is allowed to sit for approximately two hours to reach equilibrium. At that time, the water present in the paste is extracted. This extract is referred to as the saturation extract. The electrical conductivity of this extract is then measured. The higher the salt concentration in a specific soil, the higher the conductivity of the saturation extract.

In ERO Resources Corporation (1988), an estimated electric conductivity is given for all soils present in the JIDPA (see also BLM 2005). Estimated average electric conductivity for each soil series and the derived electric conductivity for each soil complex or map unit and for each watershed are shown in Appendix D. The estimated electric conductivities are higher than the measured electric conductivities in the soil profiles.

Electric conductivity for the 1988 analyzed profiles using the saturated paste method averages 400 µS/cm. The estimated electric conductivity for all watersheds except for the closed-basin watersheds is 2,000 µS/cm.

Electric conductivity, which is closely related to total dissolved solids (TDS), can be used as a measure of salinity. A commonly used conversion states that the TDS in mg/l is roughly equal to 0.67 times the electric conductivity in µS/cm (Hem 1989), thus the average salinity as expressed in TDS for soil water extract is about 268 mg/L for the measured profile average and 1,340 mg/L for the estimated salinity average.

5 MODEL RESULTS

5.1 Sediment Transport to Project Boundary

Disturbance of vegetation (conversion to bare ground) notably increases the sediment transport in channels in the JIDPA. When compared to no disturbance, sediment transport increases the most for the Proposed Action and the least for the No Action Alternative (see Table 6 - 12 and Figure 2 - 9). The percentage increase in sediment yield from undisturbed to disturbed soil conditions is greatest for the 5-year storm (Figure 9). In the 150-year storm event, even the no disturbance case produces a large amount of sediment runoff; thus, the percent increase in sediment runoff is proportionally not as large, even though the total amount of sediment transported is largest for the 150-year storm.

Table 6 Sediment Yield Upper Eighteenmile Canyon

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	171.5	405.5	3,153.9	1,766.8
10	2,691.5	3,580.1	18,122.2	11,078.1
25	39,106.3	45,735.2	89,204.6	68,180.1
50	94,900.7	109,592.2	185,947.7	152,678.9
100	183,518.3	204,172.5	299,607.8	258,022.4
150	219,184.7	240,983.8	341,312.8	296,913.0

Table 7 Sediment Yield 140401040603Watershed

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	1,202.8	1,687.7	7,109.8	3,066.3
10	5,966.9	7,628.3	20,251.4	11,594.3
25	35,097.3	42,463.0	78,287.1	57,556.3
50	84,748.2	94,873.2	141,112.1	115,482.5
100	147,692.1	159,872.3	214,009.8	182,395.8
150	170,172.7	182,220.2	238,605.5	205,547.9

Table 8 Sediment Yield Bull Draw

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	1,443.5	2,943.8	36,797.9	10,846.8
10	19,211.8	29,722.2	142,846.4	62,882.5
25	231,075.2	298,784.7	749,269.9	444,537.2
50	681,779.9	811,244.1	1,541,332.7	1,062,556.2
100	1,364,158.6	1,547,113.6	2,523,421.5	1,895,932.0
150	1,638,146.6	1,835,340.0	2,878,763.9	2,210,098.0

Table 9 Sediment Yield Granite Wash

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	19.8	26.9	2,429.7	417.8
10	2,657.0	3,669.5	9,343.7	5,254.1
25	22,712.5	28,101.3	71,558.5	40,477.8
50	76,665.0	92,257.3	188,792.2	119,575.6
100	189,132.3	220,672.8	397,484.5	275,972.8
150	243,820.1	286,727.2	478,231.9	348,078.3

Table 10 Sediment Yield Long Draw

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	7,122.6	15,331.2	175,511.5	73,390.8
10	97,459.6	151,779.2	659,835.4	391,828.4
25	987,919.3	1,225,348.9	2,539,526.5	1,929,420.4
50	2,364,237.9	2,713,609.8	4,526,261.1	3,671,069.7
100	4,093,360.8	4,546,820.0	6,793,543.8	5,711,533.6
150	4,730,072.4	5,181,675.3	7,472,308.5	6,479,504.8

Table 11 Sediment Yield Sand Draw

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	0.0	0.0	0.1	0.0
10	1.3	1.7	5.7	2.7
25	321.7	2,066.0	79,285.7	31,481.8
50	39,925.3	66,290.4	330,637.7	172,380.2
100	195,787.7	283,179.9	1,032,544.6	594,299.3
150	320,822.3	439,567.3	1,433,121.8	848,886.8

Table 12 Sediment Yield Alkali Draw

Storm Return Period (years)	Sediment Yield (kg)			
	No Disturbance	No Action	Proposed Action	Preferred Alternative
5	6,150.1	7,485.3	26,511.7	12,012.8
10	18,762.9	26,826.7	98,332.2	52,452.5
25	173,917.1	218,680.3	473,012.2	308,554.1
50	483,665.8	556,970.3	932,709.2	698,082.8
100	901,809.5	998,242.2	1,437,397.1	1,160,826.0
150	1,052,956.4	1,156,586.4	1,624,999.1	1,326,865.6

Figure 2 Sediment Transport to Project Boundary in Granite Wash

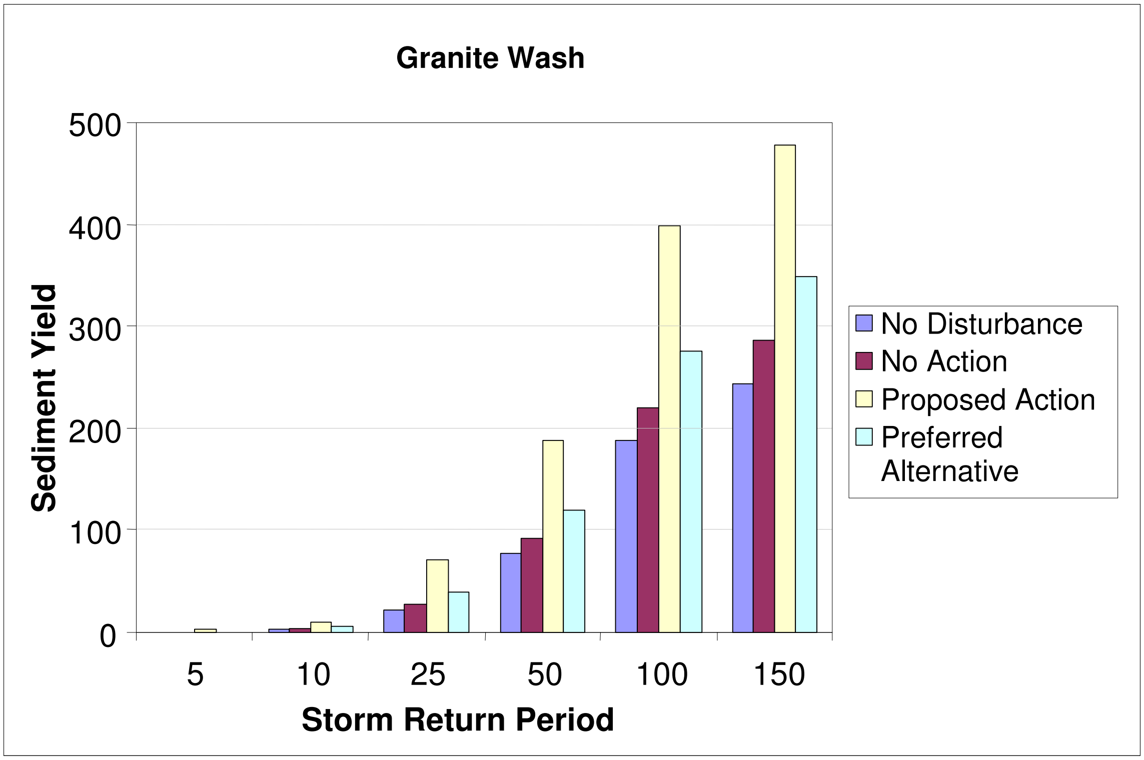


Figure 3 Sediment Transport to Project Boundary in Long Draw

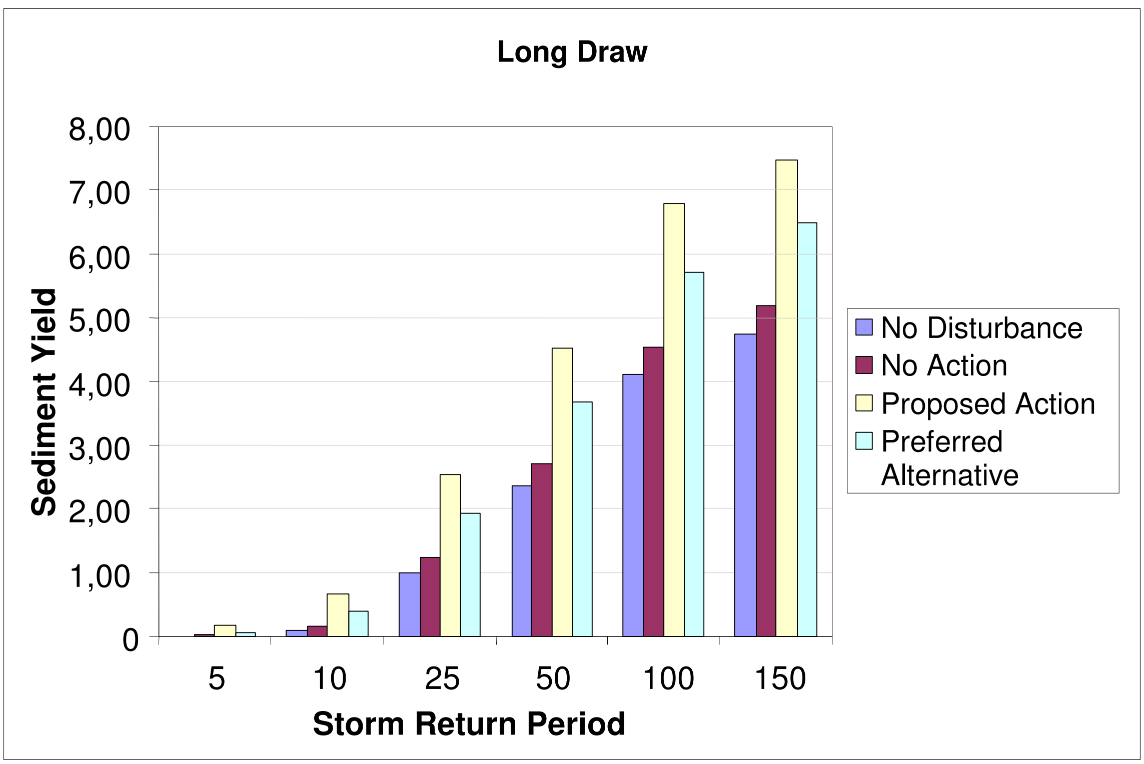


Figure 4 Sediment Transport to Project Boundary in Sand Draw

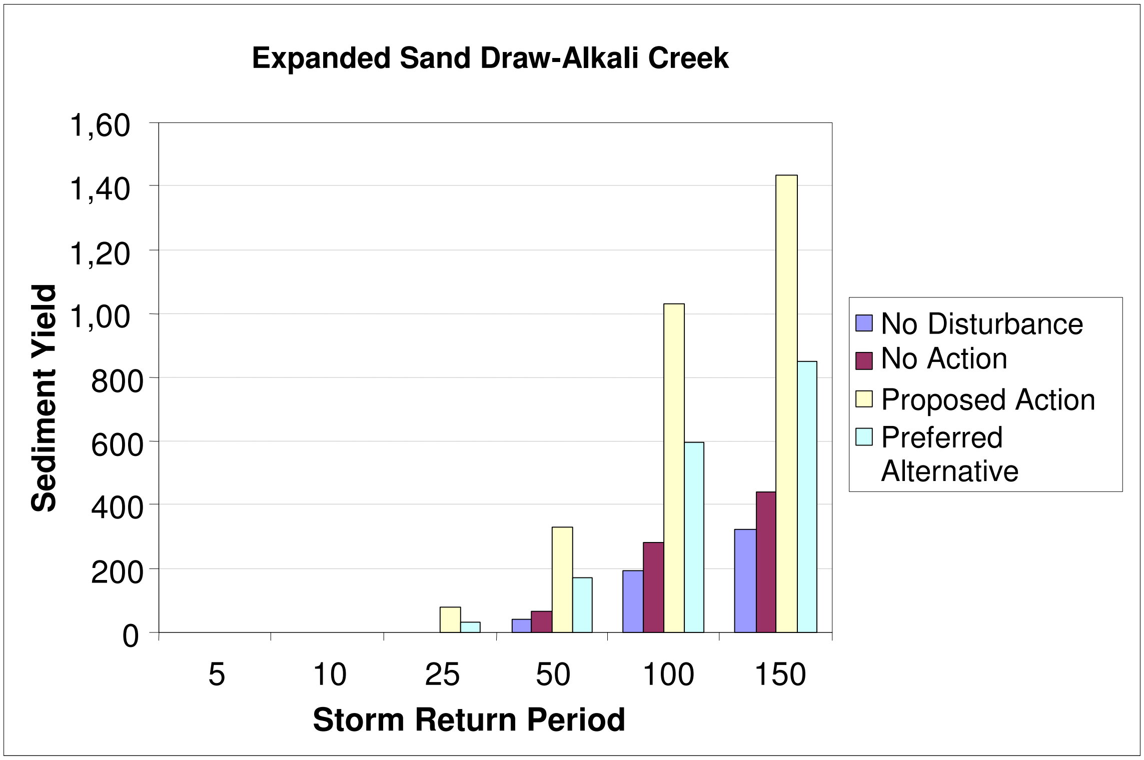


Figure 5 Sediment Transport to Project Boundary in Bull Draw

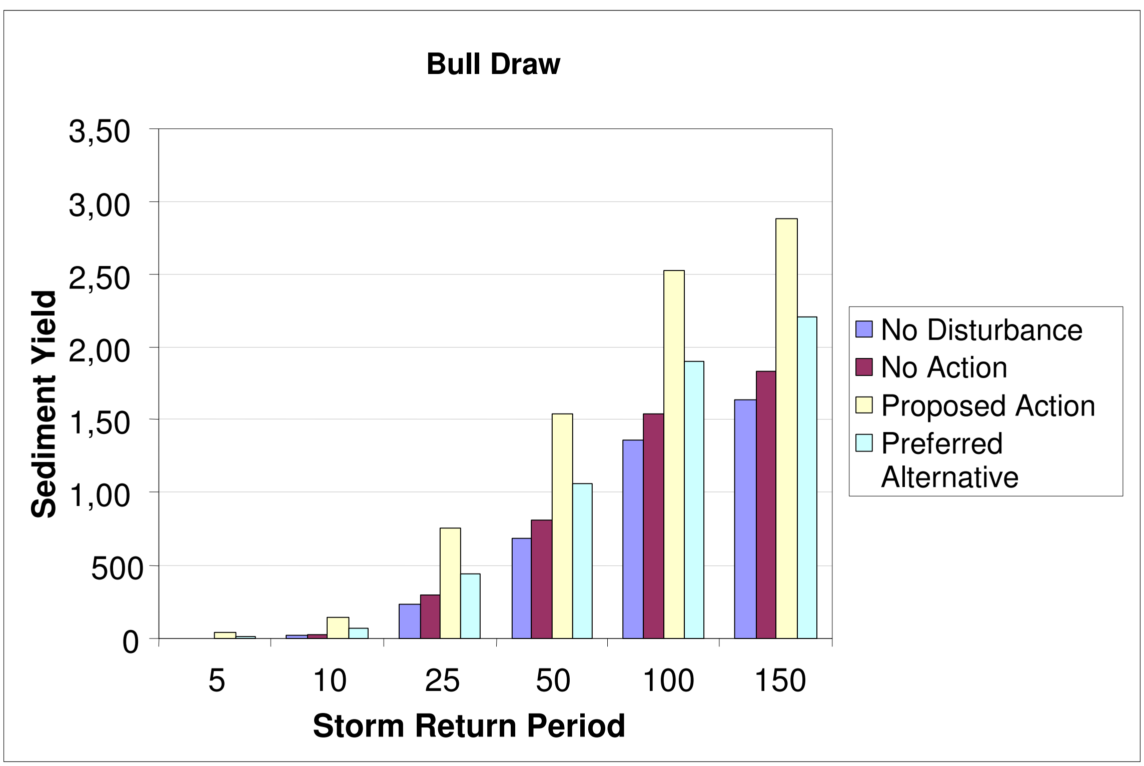


Figure 6 Sediment Transport to Project Boundary in Upper Eighteenmile Canyon

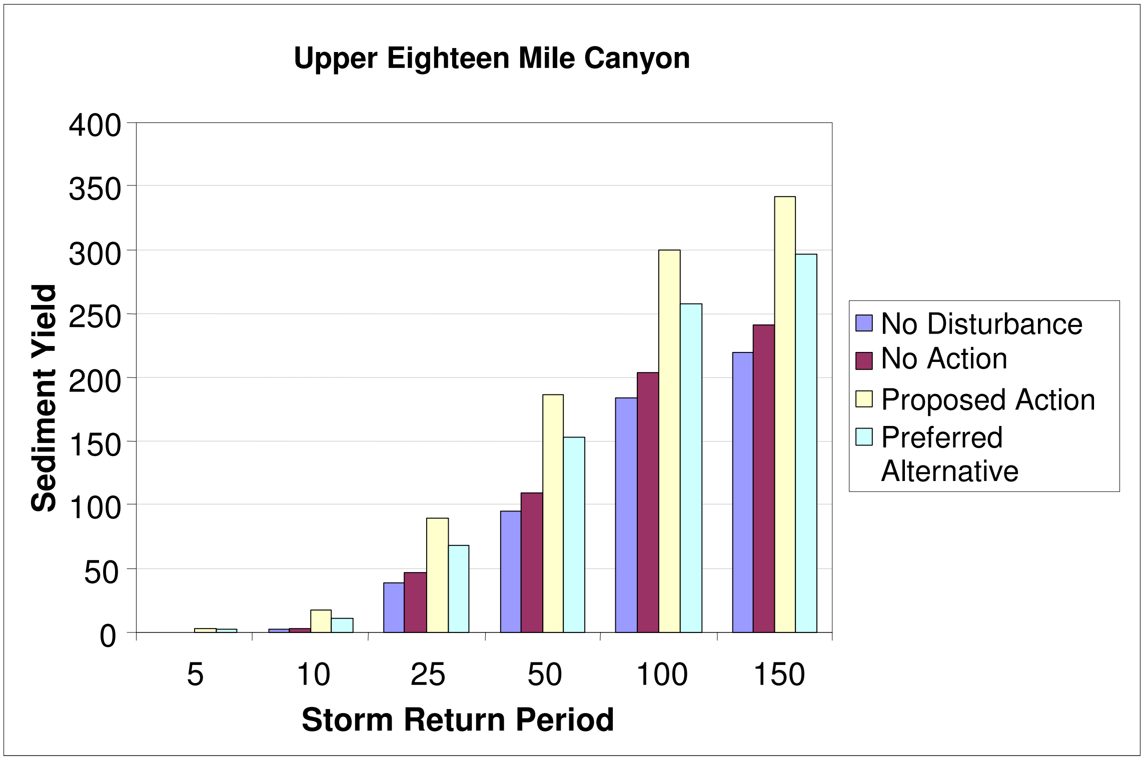


Figure 7 Sediment Transport to Project Boundary in 140401040603 Watershed

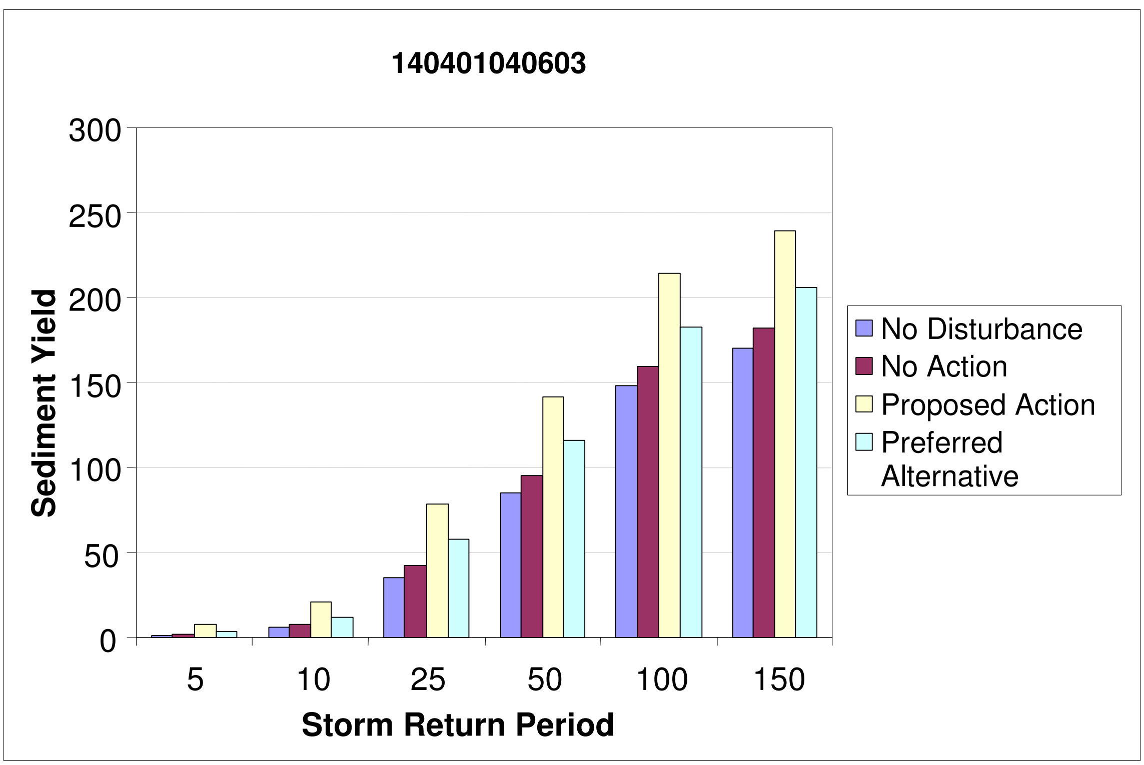


Figure 8 Sediment Transport to Project Boundary in Upper Alkali Creek

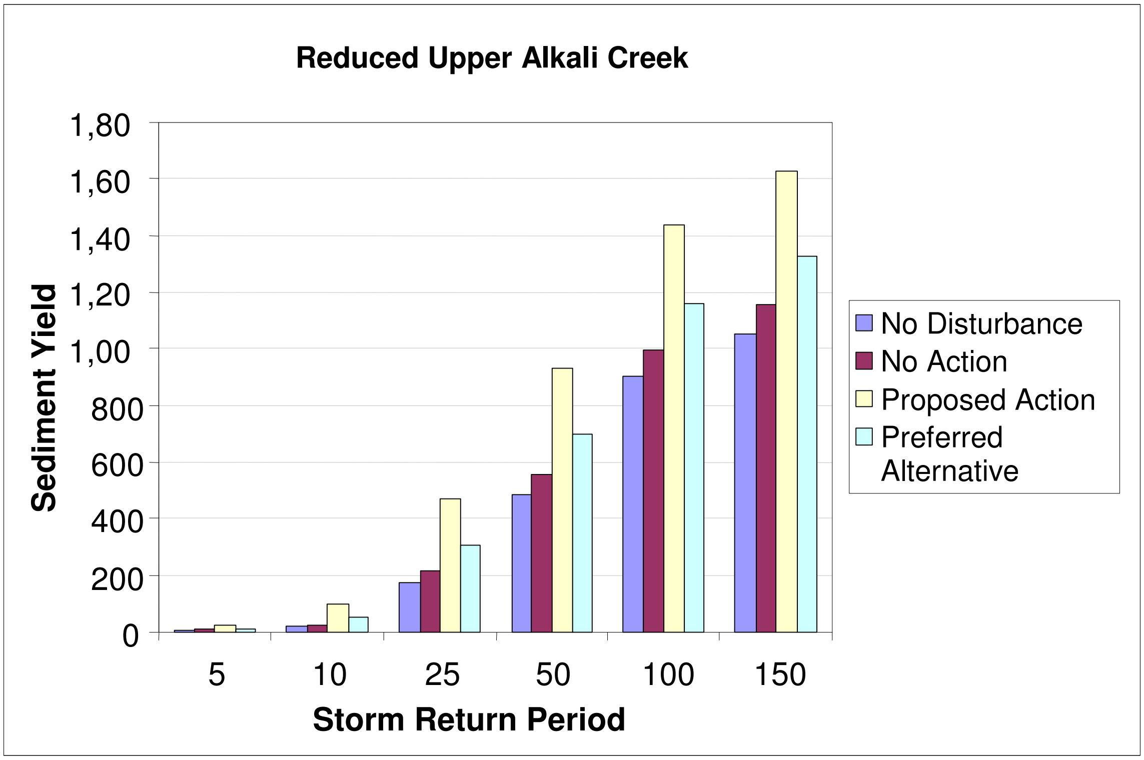
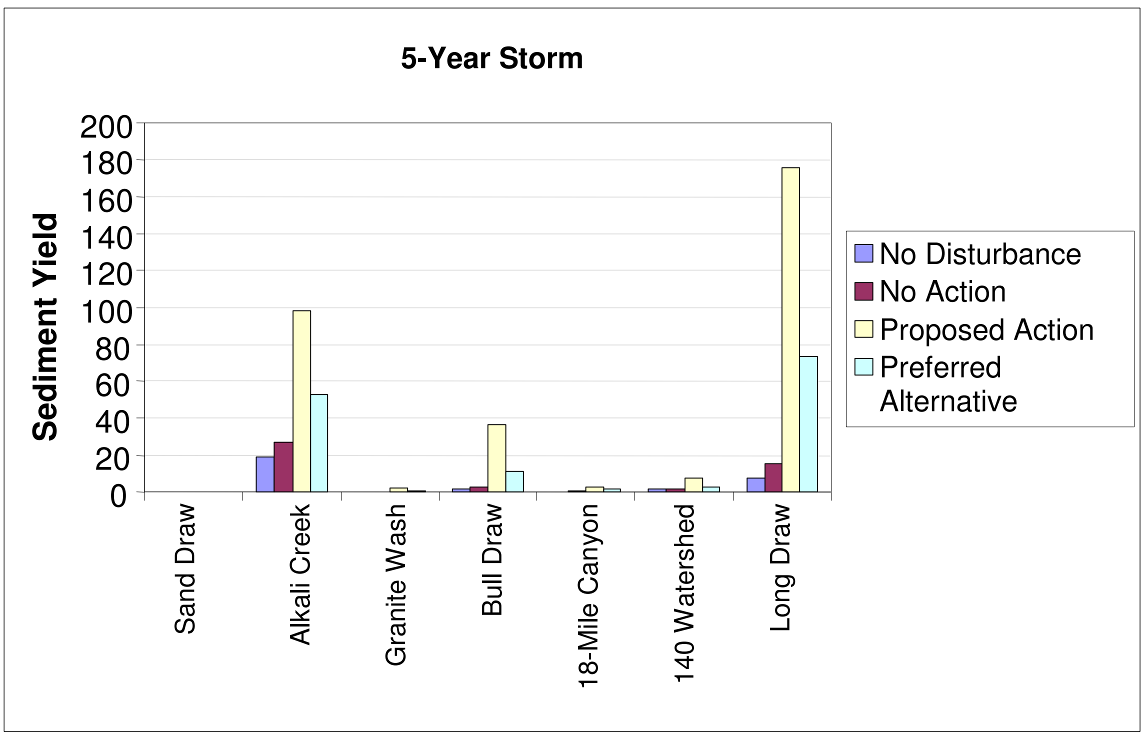


Figure 9 Sediment Transport for 5-Year Storm Event



Sediment yields from all channels reaching the JIDPA boundary were combined; however, large amounts of sediment mobilized inside the JIDPA were re-deposited before leaving the area. Thus, Long Draw shows a much larger sediment yield than Sand Draw. While a large amount of sediment is mobilized in Sand Draw, much of this sediment is re-deposited as tributary drainages come together and before the single drainage leaves the JIDPA. In Long Draw, however, many separate small drainages reach the JIDPA boundary; therefore, considerably less mobilized sediment in the Long Draw Watershed gets deposited while still within the JIDPA. Thus, the modeled volume of sediment at the JIDPA boundary is much larger for Long Draw than for Sand Draw.

All modeling is based on assumptions, and many simplifications are inherent when creating input parameters for KINEROS2. Thus, the actual values of sediment transported should be considered with caution. However, the differences in model-derived sediment transport volumes among the analyzed cases/alternatives and among precipitation events provide an approximate value suitable for comparison. Specific monitoring and sampling in the JIDPA channels would provide more accurate data of environmental conditions, and if conducted these data could be compared with the model results presented herein for verification.

5.2 Salt Loading at Project Boundary

Salinity in all waters leaving the JIDPA was estimated as ranging from approximately 300 to 1,300 mg/L as TDS. Salinity at the project boundary can be estimated from the measured soil saturation extract salinity or electric conductivity. The saturation extract salinity is assumed to be the maximum salinity of water in contact with sediment. Actual salinity may be lower, if the contact time between water and sediment is not long enough to reach equilibrium or if only a portion of the water volume is in contact with the sediment; both conditions are likely during most storm events. Saturation extract salinity has been measured for only six of the roughly 25 identified soil series within the JIDPA and was estimated for the other soil series, so only a rough estimate for the maximum salinity for all watersheds can be provided.

5.3 Salt Loading to Green and Big Sandy Rivers

No salt loading to the Colorado via the Green or Big Sandy Rivers is predicted to occur. KINEROS2 was run to estimate the amount of water leaving the JIDPA through Sand Draw and reaching the Green River for a 150-year storm event. The Sand Draw watershed covers the largest part of the JIDPA, and runoff from a 150-year storm over this watershed was calculated. Runoff from this event was routed along the approximate 32-kilometer length of the Sand Draw and Alkali Creek drainage to the point where Alkali Creek flows into the Green River. No other inflows into Alkali Creek were considered. Under these conditions, all water leaving the JIDPA infiltrates or evaporates along the drainage before it reaches the Green River.

This modeling result is supported by 2005 field observations: snowmelt runoff in Sand Draw was entering the JIDPA from upstream sources at approximately 0.18 cfs; however, no flow was leaving the area (Hart 2005). Water chemistry samples taken from three sampling points indicate low salinity values as TDS (90-150 mg/L) for the snow melt water (Table 13).

Table 13 Water Quality Analysis Sand Draw and Alkali Creek Snow Melt Runoff

	Sand Draw 1	Sand Draw 2	Alkali Draw 1
Boron, diss. (mg/l)	0.02	0.03	0.03
Calcium, diss. (mg/l)	7.3	12.1	15.6
Magnesium, diss. (mg/l)	1.4	1.9	4.4
Potassium, diss. (mg/l)	3.0	3.5	4.4
Sodium, diss. (mg/l)	3.0	3.2	27.4
Acidity as CaCO3 (mg/l)	<2	<2	<2
Alkalinity as CaCO3 (mg/l)	<2	<2	<2
Bicarbonate as CaCO3 (mg/l)	34	46	134
Carbonate as CaCO3 (mg/l)	<2	<2	<2
Hydroxide as CaCO3 (mg/l)	<2	<2	<2
Total Alkalinity (mg/l)	34	46	134
Conductivity (µS/cm)	64	93	247
pH (lab)	7.8	7.8	8.1
Filterable Residue TDS (mg/l)	90	100	150
Non-Filterable Residue TSS (mg/)	56	70	430
Settleable Matter Residue SS (m/L/h)	<0.1	<0.1	<0.1
Turbidity (NTU)	125	136	944

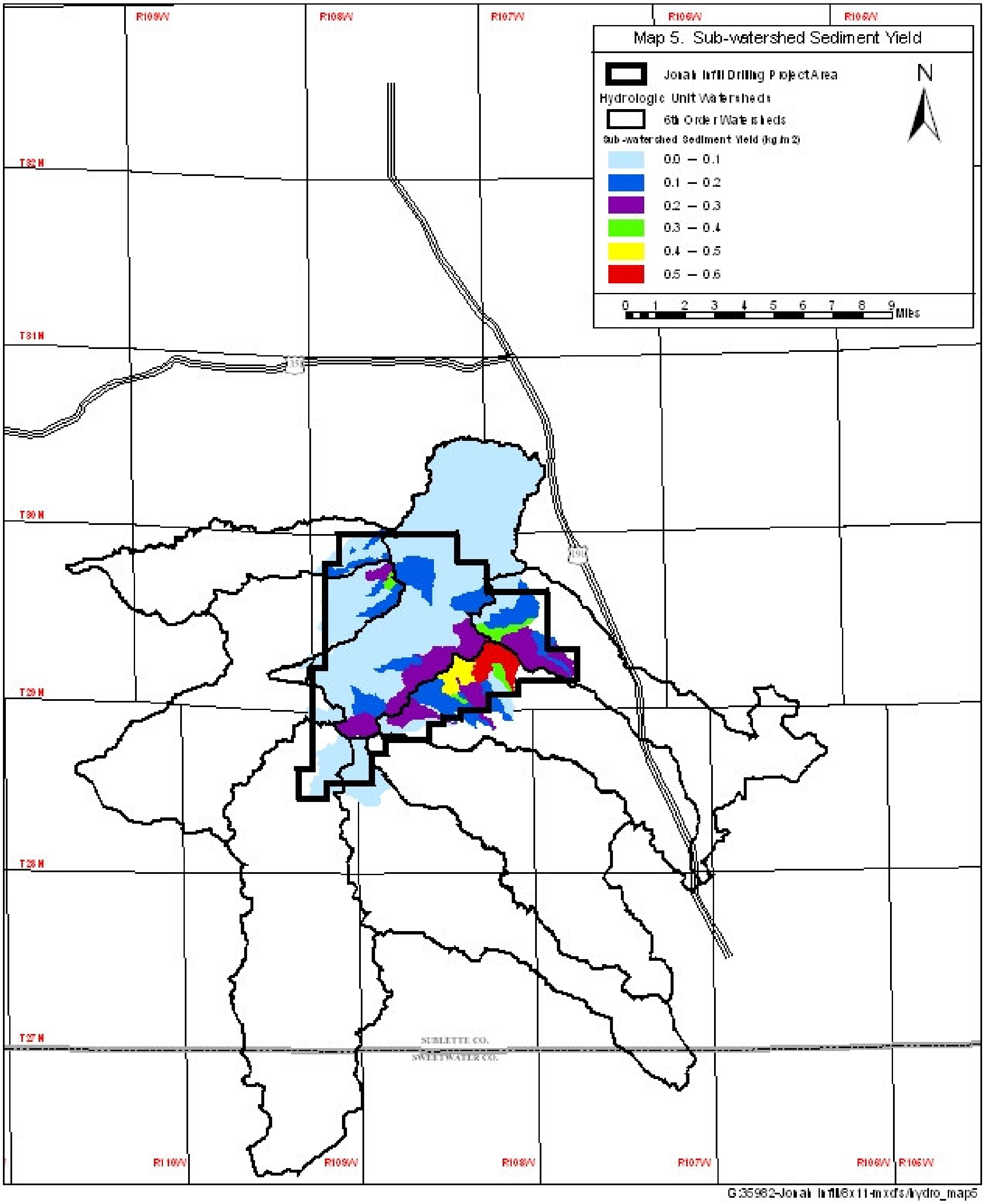
Adapted from Hart (2005).

It can be assumed that none of the other watersheds will create enough flow to reach the Green River either from a 150-year or shorter-duration storm. Water from the JIDPA will only reach the Green River when it mixes with water from other downstream sources, and even then, a large part of the JIDPA runoff water will have infiltrated, while the remainder will be diluted, thus, any salinity transported from the JIDPA would likely be negligible.

5.4 Areas Most Susceptible to Erosion

Erosion potential depends on slope, soil, and vegetation cover. To delineate areas within the JIDPA with the greatest potential for erosion, sub-watersheds were analyzed for their sediment yield under the Proposed Action for a 150-year storm. This analysis provided the worst case scenario with the largest sediment yields for each sub-watershed; however, the ranking of the sub-watersheds across alternatives with respect to erosion potential would not change under any other rainfall scenario. For this analysis, Proposed Action disturbance was distributed over the entire JIDPA.

Areas (sub-watersheds) along the watershed boundaries between Long Draw and Sand Draw, and Long Draw and Bull Draw--draining to the Big Sandy River--have the greatest potential for erosion after disturbance (Map 5). These areas appear to be the most susceptible due to the somewhat steeper gradients found in this area. Map 5 illustrates the potential for erosion in the JIDPA. The areas with the highest sediment yield are the most prone to erosion.



Map 5 Sub-watershed Sediment Yields.

6 CONCLUSIONS

All alternatives increase erosion and sediment transport in and from the JIDPA. Modeled erosion and sediment transport is largest for the Proposed Action and smallest for the no disturbance case. Erosion and sediment transport also increase with rainfall intensity. However, no impacts are expected to occur on the Green and Big Sandy Rivers. There are several reasons for this conclusion:

- The area is dry, and even storm events do not produce large amounts of rainfall.
- The topography of the area is fairly flat, and all ephemeral drainages in the JIDPA have gradual slopes.
- The JIDPA is drained in multiple directions along multiple small channels, without one single major drainage direction.

Thus, only small accumulations of flow occur in the area. Very sandy soils and the presence of playas and catchment structures (livestock watering reservoirs) both in and down channel of the JIDPA drainages also cause water to infiltrate and evaporate rather than flow downstream for small rainfall events. For storms with a precipitation less than a 5-year storm, not enough water flows in channels for any water to leave the JIDPA. Even for larger storms, much of the sediment mobilized is re-deposited in flat areas along the drainages. Nonetheless, given the 40-plus-year life of the project and the identified increase in sediment production resulting from disturbance, multiple repeated runoff events may create an effect on down-channel waterways over time.

The modeling assumed that no measures were taken to prevent erosion and sediment transport. However, Best Management Practices (e.g., revegetation, sediment control structures) are and would continue to be used to prevent erosion and sediment transport; thus, any increase in sediment transport from the JIDPA is likely to be much smaller than that modeled. Areas and sub-watersheds that are most susceptible to erosion, and create the largest amount of sediment have been identified, and these areas are recommended to receive the most aggressive monitoring (e.g., photo-point, vegetation, channel cross section, first flush) and soil erosion control measures/treatments.

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APPENDIX A: KINEROS2 INPUT FILES

Precipitation Input File:

Only a sample input file for 2 year storm is presented here.

```
! Design storm computed from the AGWA database dsgnstrm.dbf using the SCS Methodology with a type II distribution
! Storm generated for the wSan watershed using the design storm for Jonah
! Return Period (frequency) = 2 years, Duration = 24.00 hours.
! ** Return period depth has NOT been reduced for watershed area.
BEGIN RG1
N = 145
    TIME   DEPTH
!   (min)  (mm)
    0     0.00
    10    0.04
    20    0.09
    30    0.14
    40    0.18
    50    0.23
    60    0.27
    70    0.32
    80    0.37
    90    0.42
    100   0.47
    110   0.52
    120   0.57
    130   0.62
    140   0.67
    150   0.72
    160   0.78
    170   0.83
    180   0.89
    190   0.94
    200   1.00
    210   1.05
    220   1.11
    230   1.17
    240   1.23
    250   1.29
    260   1.35
    270   1.42
    280   1.48
    290   1.54
    300   1.61
    310   1.68
    320   1.75
    330   1.82
    340   1.89
    350   1.96
    360   2.03
    370   2.11
    380   2.19
    390   2.27
    400   2.35
    410   2.43
    420   2.51
    430   2.60
    440   2.69
    450   2.78
    460   2.88
    470   2.97
    480   3.07
    490   3.18
    500   3.28
    510   3.40
    520   3.51
```

530	3.63
540	3.75
550	3.88
560	4.02
570	4.16
580	4.31
590	4.47
600	4.64
610	4.81
620	5.01
630	5.21
640	5.44
650	5.69
660	5.97
670	6.29
680	6.66
690	7.12
700	7.73
710	8.69
720	12.70
730	16.71
740	17.67
750	18.28
760	18.74
770	19.11
780	19.43
790	19.71
800	19.96
810	20.19
820	20.39
830	20.59
840	20.76
850	20.93
860	21.09
870	21.24
880	21.38
890	21.52
900	21.65
910	21.77
920	21.89
930	22.00
940	22.12
950	22.22
960	22.33
970	22.43
980	22.52
990	22.62
1000	22.71
1010	22.80
1020	22.89
1030	22.97
1040	23.05
1050	23.13
1060	23.21
1070	23.29
1080	23.37
1090	23.44
1100	23.51
1110	23.58
1120	23.65
1130	23.72
1140	23.79
1150	23.86
1160	23.92
1170	23.98
1180	24.05
1190	24.11
1200	24.17
1210	24.23

```
    1220   24.29
    1230   24.35
    1240   24.40
    1250   24.46
    1260   24.51
    1270   24.57
    1280   24.62
    1290   24.68
    1300   24.73
    1310   24.78
    1320   24.83
    1330   24.88
    1340   24.93
    1350   24.98
    1360   25.03
    1370   25.08
    1380   25.13
    1390   25.17
    1400   25.22
    1410   25.26
    1420   25.31
    1430   25.36
    1440   25.40
SA = 0.2
END
```

Parameter Input File Sand Draw/No Action:

Only the input file for the No Action Alternative for Sand Draw is presented here

```
! File Info
!   Watershed:          wSan
!   Land Cover:         Noactionlc
!   Soils:              Jonah Soils
!   Number of Channels:  25
!   Number of Planes:    63
!   Contrib Source Area: 575 Acres
!   DEM Grid Size:       8.94594 m
!   Total Drainage Area: 22997 Acres (9307 ha)
!   AGWA Version:        ta b
!   Creation date/time:  05/17/2005 10:12
! End of File Info

BEGIN GLOBAL
  CLEN = 10, UNITS = METRIC
  DIAMS = 0.25, 0.033, 0.004 ! mm
  DENSITY = 2.65, 2.65, 2.65 ! g/cc
  TEMP = 33 !deg C
  NELE = 88
END GLOBAL

BEGIN PLANE
  ID = 71, LEN = 582.6, AREA = 2476102.2
  SL = 0.031, MAN = 0.055, X = 611248.7, Y = 4706550.5
  CV = 1.43, PRINT = 1
  KS = 16.59, G = 143.59, DIST = 0.37, POR = 0.449, ROCK = 0.15
  FR = 0.60, 0.24, 0.16, SPLASH = 104.21, COH = 0.006, SMAX = 0.90
  INTER = 2.97, CANOPY = 0.2477, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 72, LEN = 261.8, AREA = 1099471.0
  SL = 0.061, MAN = 0.050, X = 610023.6, Y = 4705494.5
  CV = 1.15, PRINT = 1
  KS = 20.11, G = 171.66, DIST = 0.39, POR = 0.439, ROCK = 0.12
  FR = 0.60, 0.20, 0.20, SPLASH = 96.09, COH = 0.006, SMAX = 0.88
```

```
 INTER = 2.67, CANOPY = 0.2245, PAVE = 0.02
END PLANE

BEGIN PLANE
 ID = 73, LEN = 584.5, AREA = 2464401.8
 SL = 0.029, MAN = 0.049, X = 609228.8, Y = 4705873.5
 CV = 1.11, PRINT = 1
 KS = 13.48, G = 193.87, DIST = 0.40, POR = 0.419, ROCK = 0.12
 FR = 0.63, 0.16, 0.21, SPLASH = 84.30, COH = 0.005, SMAX = 0.86
 INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN CHANNEL
 ID = 74, PRINT = 1
 LAT =  72 73
 UP =  71
 LEN = 2890.51, SLOPE = 0.0060, X = 609496.853, Y = 4705358.142
 WIDTH = 9.50, 13.03, DEPTH = 0.47, 0.54
 MAN = 0.035, SS1 = 1.00, SS2 = 1.00
 WOOL = Yes
 CV = 0.00, KSAT = 210, G = 101
 DIST = 0.5450, POR = 0.4400, ROCK = 0.00
 FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
 ID = 81, LEN = 586.3, AREA = 2346437.6
 SL = 0.048, MAN = 0.049, X = 609739.7, Y = 4704515.5
 CV = 1.05, PRINT = 1
 KS = 12.23, G = 200.20, DIST = 0.37, POR = 0.430, ROCK = 0.08
 FR = 0.58, 0.19, 0.23, SPLASH = 92.54, COH = 0.006, SMAX = 0.87
 INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN PLANE
 ID = 82, LEN = 51.0, AREA = 13969.7
 SL = 0.055, MAN = 0.049, X = 608509.9, Y = 4704652.5
 CV = 1.10, PRINT = 1
 KS = 13.70, G = 211.02, DIST = 0.39, POR = 0.419, ROCK = 0.09
 FR = 0.61, 0.16, 0.23, SPLASH = 89.37, COH = 0.005, SMAX = 0.86
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
 ID = 83, LEN = 67.1, AREA = 34530.5
 SL = 0.035, MAN = 0.049, X = 608460.7, Y = 4704491.0
 CV = 1.10, PRINT = 1
 KS = 13.73, G = 211.02, DIST = 0.39, POR = 0.419, ROCK = 0.09
 FR = 0.61, 0.16, 0.23, SPLASH = 89.37, COH = 0.005, SMAX = 0.86
 INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN CHANNEL
 ID = 84, PRINT = 1
 LAT =  82 83
 UP =  81
 LEN = 210.66, SLOPE = 0.0086, X = 608467.596, Y = 4704605.167
 WIDTH = 9.32, 9.39, DEPTH = 0.47, 0.47
 MAN = 0.035, SS1 = 1.00, SS2 = 1.00
 WOOL = Yes
 CV = 0.00, KSAT = 210, G = 101
 DIST = 0.5450, POR = 0.4400, ROCK = 0.00
 FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
 ID = 192, LEN = 189.6, AREA = 320672.4
 SL = 0.018, MAN = 0.049, X = 608101.3, Y = 4704823.5
 CV = 1.23, PRINT = 1
```

```
  KS = 20.53, G = 168.15, DIST = 0.43, POR = 0.429, ROCK = 0.24
  FR = 0.67, 0.15, 0.18, SPLASH = 68.83, COH = 0.004, SMAX = 0.88
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 193, LEN = 228.1, AREA = 323424.3
  SL = 0.034, MAN = 0.049, X = 608140.9, Y = 4704296.0
  CV = 0.90, PRINT = 1
  KS = 13.50, G = 180.69, DIST = 0.35, POR = 0.432, ROCK = 0.10
  FR = 0.56, 0.22, 0.22, SPLASH = 99.23, COH = 0.006, SMAX = 0.88
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 194, PRINT = 1
  LAT =  192 193
  UP =  74 84
  LEN = 992.34, SLOPE = 0.0053, X = 607926.695, Y = 4704492.900
  WIDTH = 14.66, 15.05, DEPTH = 0.57, 0.58
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 11, LEN = 606.3, AREA = 4098891.7
  SL = 0.044, MAN = 0.055, X = 610615.6, Y = 4712615.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 12, LEN = 381.1, AREA = 1222654.8
  SL = 0.040, MAN = 0.055, X = 610875.8, Y = 4711062.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 13, LEN = 691.5, AREA = 2804714.8
  SL = 0.034, MAN = 0.055, X = 609799.6, Y = 4711491.5
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
  ID = 14, PRINT = 1
  LAT =  12 13
  UP =  11
  LEN = 2530.13, SLOPE = 0.0060, X = 610401.384, Y = 4710914.995
  WIDTH = 11.36, 14.47, DEPTH = 0.51, 0.57
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 21, LEN = 734.6, AREA = 2493322.7
```

```
  SL = 0.031, MAN = 0.055, X = 612700.9, Y = 4711388.5
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 22, LEN = 389.2, AREA = 1476337.3
  SL = 0.037, MAN = 0.055, X = 611755.2, Y = 4709817.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 23, LEN = 510.1, AREA = 1591225.4
  SL = 0.024, MAN = 0.055, X = 611453.3, Y = 4710549.5
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
  ID = 24, PRINT = 1
  LAT =  22 23
  UP =  21
  LEN = 2676.92, SLOPE = 0.0048, X = 611469.946, Y = 4709902.664
  WIDTH = 9.52, 12.66, DEPTH = 0.47, 0.53
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 142, LEN = 144.8, AREA = 125612.0
  SL = 0.023, MAN = 0.055, X = 610017.3, Y = 4709732.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 143, LEN = 284.0, AREA = 567544.3
  SL = 0.040, MAN = 0.055, X = 610388.2, Y = 4709359.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
  ID = 144, PRINT = 1
  LAT =  142 143
  UP =  14 24
  LEN = 847.29, SLOPE = 0.0032, X = 610034.004, Y = 4709591.911
  WIDTH = 17.38, 17.68, DEPTH = 0.61, 0.62
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL
```

```
BEGIN PLANE
  ID = 31, LEN = 670.2, AREA = 2327293.2
  SL = 0.051, MAN = 0.055, X = 608118.6, Y = 4712034.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 32, LEN = 297.3, AREA = 955804.1
  SL = 0.036, MAN = 0.055, X = 609463.4, Y = 4710502.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 33, LEN = 525.0, AREA = 2162363.1
  SL = 0.037, MAN = 0.055, X = 608426.0, Y = 4710569.5
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
  ID = 34, PRINT = 1
  LAT =  32 33
  UP =  31
  LEN = 2476.57, SLOPE = 0.0064, X = 609290.928, Y = 4710376.587
  WIDTH = 9.29, 12.56, DEPTH = 0.47, 0.53
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 152, LEN = 387.0, AREA = 909543.5
  SL = 0.036, MAN = 0.055, X = 609668.3, Y = 4708726.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 153, LEN = 698.9, AREA = 3167789.8
  SL = 0.028, MAN = 0.055, X = 608397.6, Y = 4709336.5
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
  ID = 154, PRINT = 1
  LAT =  152 153
  UP =  34 144
  LEN = 2149.99, SLOPE = 0.0035, X = 609185.295, Y = 4708693.185
  WIDTH = 19.79, 21.13, DEPTH = 0.65, 0.67
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
```

END CHANNEL

BEGIN PLANE
ID = 41, LEN = 563.1, AREA = 2409884.5
SL = 0.026, MAN = 0.055, X = 611611.4, Y = 4708277.5
CV = 1.45, PRINT = 1
KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
ID = 42, LEN = 328.1, AREA = 1028592.1
SL = 0.035, MAN = 0.055, X = 610085.6, Y = 4707546.5
CV = 1.45, PRINT = 1
KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
ID = 43, LEN = 501.2, AREA = 1564747.8
SL = 0.033, MAN = 0.055, X = 610403.3, Y = 4708357.0
CV = 1.45, PRINT = 1
KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN CHANNEL
ID = 44, PRINT = 1
LAT = 42 43
UP = 41
LEN = 2103.02, SLOPE = 0.0051, X = 609936.544, Y = 4707873.760
WIDTH = 9.41, 12.19, DEPTH = 0.47, 0.53
MAN = 0.035, SS1 = 1.00, SS2 = 1.00
WOOL = Yes
CV = 0.00, KSAT = 210, G = 101
DIST = 0.5450, POR = 0.4400, ROCK = 0.00
FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
ID = 162, LEN = 165.5, AREA = 167427.9
SL = 0.020, MAN = 0.049, X = 608621.5, Y = 4707910.5
CV = 1.17, PRINT = 1
KS = 12.31, G = 195.50, DIST = 0.38, POR = 0.428, ROCK = 0.08
FR = 0.60, 0.18, 0.22, SPLASH = 92.90, COH = 0.006, SMAX = 0.87
INTER = 2.61, CANOPY = 0.2201, PAVE = 0.01
END PLANE

BEGIN PLANE
ID = 163, LEN = 275.0, AREA = 434481.5
SL = 0.042, MAN = 0.053, X = 608973.1, Y = 4707537.0
CV = 1.36, PRINT = 1
KS = 17.62, G = 147.73, DIST = 0.37, POR = 0.449, ROCK = 0.14
FR = 0.59, 0.24, 0.17, SPLASH = 102.59, COH = 0.006, SMAX = 0.90
INTER = 2.88, CANOPY = 0.2408, PAVE = 0.04
END PLANE

BEGIN CHANNEL
ID = 164, PRINT = 1
LAT = 162 163
UP = 154 44
LEN = 845.34, SLOPE = 0.0049, X = 608667.152, Y = 4707743.863
WIDTH = 22.58, 22.74, DEPTH = 0.69, 0.69
MAN = 0.035, SS1 = 1.00, SS2 = 1.00
WOOL = Yes
CV = 0.00, KSAT = 210, G = 101

```
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 51, LEN = 597.1, AREA = 2400419.4
  SL = 0.039, MAN = 0.055, X = 607041.5, Y = 4709230.0
  CV = 1.45, PRINT = 1
  KS = 16.90, G = 140.47, DIST = 0.37, POR = 0.450, ROCK = 0.16
  FR = 0.60, 0.24, 0.16, SPLASH = 104.79, COH = 0.006, SMAX = 0.91
  INTER = 3.00, CANOPY = 0.25, PAVE = 0.05
END PLANE

BEGIN PLANE
  ID = 52, LEN = 260.5, AREA = 360680.8
  SL = 0.025, MAN = 0.051, X = 608183.3, Y = 4708147.0
  CV = 1.23, PRINT = 1
  KS = 13.51, G = 184.30, DIST = 0.38, POR = 0.433, ROCK = 0.10
  FR = 0.59, 0.20, 0.21, SPLASH = 96.90, COH = 0.006, SMAX = 0.88
  INTER = 2.73, CANOPY = 0.2293, PAVE = 0.02
END PLANE

BEGIN PLANE
  ID = 53, LEN = 192.3, AREA = 769129.1
  SL = 0.031, MAN = 0.053, X = 607057.3, Y = 4708287.0
  CV = 1.33, PRINT = 1
  KS = 15.11, G = 164.97, DIST = 0.38, POR = 0.439, ROCK = 0.12
  FR = 0.61, 0.21, 0.18, SPLASH = 99.60, COH = 0.006, SMAX = 0.89
  INTER = 2.85, CANOPY = 0.2385, PAVE = 0.03
END PLANE

BEGIN CHANNEL
  ID = 54, PRINT = 1
  LAT =  52 53
  UP =  51
  LEN = 974.82, SLOPE = 0.0052, X = 608071.722, Y = 4707949.219
  WIDTH = 9.40, 10.78, DEPTH = 0.47, 0.50
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 172, LEN = 217.9, AREA = 400941.3
  SL = 0.019, MAN = 0.049, X = 607797.4, Y = 4707438.0
  CV = 1.09, PRINT = 1
  KS = 10.94, G = 210.57, DIST = 0.38, POR = 0.422, ROCK = 0.06
  FR = 0.60, 0.17, 0.23, SPLASH = 89.56, COH = 0.006, SMAX = 0.86
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 173, LEN = 285.5, AREA = 566052.6
  SL = 0.037, MAN = 0.048, X = 608257.9, Y = 4707125.5
  CV = 1.08, PRINT = 1
  KS = 13.77, G = 201.12, DIST = 0.38, POR = 0.427, ROCK = 0.07
  FR = 0.59, 0.18, 0.23, SPLASH = 91.02, COH = 0.006, SMAX = 0.87
  INTER = 2.55, CANOPY = 0.2155, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 174, PRINT = 1
  LAT =  172 173
  UP =  54 164
  LEN = 1223.69, SLOPE = 0.0032, X = 607941.251, Y = 4707210.729
  WIDTH = 23.65, 23.89, DEPTH = 0.70, 0.70
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
```

```
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 61, LEN = 600.2, AREA = 2333206.0
  SL = 0.034, MAN = 0.049, X = 605869.6, Y = 4707417.0
  CV = 1.00, PRINT = 1
  KS = 9.84, G = 215.74, DIST = 0.37, POR = 0.425, ROCK = 0.07
  FR = 0.57, 0.18, 0.25, SPLASH = 94.41, COH = 0.006, SMAX = 0.86
  INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 62, LEN = 120.8, AREA = 134880.7
  SL = 0.022, MAN = 0.048, X = 607199.8, Y = 4706923.0
  CV = 1.09, PRINT = 1
  KS = 11.07, G = 210.96, DIST = 0.38, POR = 0.421, ROCK = 0.06
  FR = 0.60, 0.17, 0.23, SPLASH = 89.55, COH = 0.006, SMAX = 0.86
  INTER = 2.55, CANOPY = 0.2155, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 63, LEN = 299.7, AREA = 1460580.5
  SL = 0.032, MAN = 0.051, X = 606591.2, Y = 4707964.0
  CV = 1.12, PRINT = 1
  KS = 10.75, G = 203.58, DIST = 0.36, POR = 0.430, ROCK = 0.09
  FR = 0.57, 0.20, 0.23, SPLASH = 96.90, COH = 0.006, SMAX = 0.86
  INTER = 2.70, CANOPY = 0.227, PAVE = 0.02
END PLANE

BEGIN CHANNEL
  ID = 64, PRINT = 1
  LAT =  62 63
  UP =  61
  LEN = 518.11, SLOPE = 0.0059, X = 607433.920, Y = 4706983.024
  WIDTH = 9.30, 11.19, DEPTH = 0.47, 0.51
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 182, LEN = 439.5, AREA = 2539341.3
  SL = 0.030, MAN = 0.051, X = 608390.8, Y = 4706199.5
  CV = 1.18, PRINT = 1
  KS = 15.43, G = 182.86, DIST = 0.39, POR = 0.431, ROCK = 0.12
  FR = 0.61, 0.18, 0.21, SPLASH = 89.79, COH = 0.006, SMAX = 0.88
  INTER = 2.70, CANOPY = 0.227, PAVE = 0.01
END PLANE

BEGIN PLANE
  ID = 183, LEN = 860.9, AREA = 3723140.7
  SL = 0.032, MAN = 0.049, X = 606672.9, Y = 4705924.5
  CV = 0.91, PRINT = 1
  KS = 8.04, G = 227.21, DIST = 0.33, POR = 0.432, ROCK = 0.08
  FR = 0.52, 0.21, 0.27, SPLASH = 95.98, COH = 0.006, SMAX = 0.85
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 184, PRINT = 1
  LAT =  182 183
  UP =  64 174
  LEN = 3046.35, SLOPE = 0.0039, X = 607588.378, Y = 4705547.990
```

```
  WIDTH = 24.82, 26.18, DEPTH = 0.72, 0.73
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 202, LEN = 493.2, AREA = 3086306.0
  SL = 0.015, MAN = 0.049, X = 606640.7, Y = 4703529.0
  CV = 1.13, PRINT = 1
  KS = 14.45, G = 201.29, DIST = 0.39, POR = 0.438, ROCK = 0.17
  FR = 0.59, 0.18, 0.23, SPLASH = 80.80, COH = 0.005, SMAX = 0.88
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 203, LEN = 713.7, AREA = 3409428.9
  SL = 0.033, MAN = 0.049, X = 607923.6, Y = 4703111.0
  CV = 0.86, PRINT = 1
  KS = 13.22, G = 162.89, DIST = 0.34, POR = 0.446, ROCK = 0.13
  FR = 0.53, 0.26, 0.21, SPLASH = 99.56, COH = 0.006, SMAX = 0.91
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 204, PRINT = 1
  LAT =  202 203
  UP =  184 194
  LEN = 3468.84, SLOPE = 0.0028, X = 607101.844, Y = 4702928.341
  WIDTH = 27.94, 29.07, DEPTH = 0.75, 0.77
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 91, LEN = 606.0, AREA = 2611850.9
  SL = 0.049, MAN = 0.049, X = 609494.1, Y = 4702355.5
  CV = 0.86, PRINT = 1
  KS = 9.59, G = 159.52, DIST = 0.30, POR = 0.459, ROCK = 0.11
  FR = 0.47, 0.32, 0.22, SPLASH = 97.41, COH = 0.006, SMAX = 0.91
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 92, LEN = 371.3, AREA = 839227.6
  SL = 0.027, MAN = 0.049, X = 608364.6, Y = 4702288.0
  CV = 0.67, PRINT = 1
  KS = 11.26, G = 157.42, DIST = 0.28, POR = 0.460, ROCK = 0.11
  FR = 0.44, 0.33, 0.23, SPLASH = 99.86, COH = 0.006, SMAX = 0.91
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 93, LEN = 613.1, AREA = 1780986.1
  SL = 0.052, MAN = 0.049, X = 607910.1, Y = 4701411.0
  CV = 1.05, PRINT = 1
  KS = 10.06, G = 167.78, DIST = 0.32, POR = 0.444, ROCK = 0.12
  FR = 0.52, 0.27, 0.21, SPLASH = 86.55, COH = 0.005, SMAX = 0.88
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 94, PRINT = 1
  LAT =  92 93
```

```
  UP =  91
  LEN = 2774.45, SLOPE = 0.0049, X = 607564.248, Y = 4702004.125
  WIDTH = 9.68, 12.39, DEPTH = 0.48, 0.53
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 212, LEN = 333.1, AREA = 944545.6
  SL = 0.013, MAN = 0.049, X = 605498.6, Y = 4701571.0
  CV = 1.17, PRINT = 1
  KS = 15.98, G = 171.90, DIST = 0.38, POR = 0.440, ROCK = 0.19
  FR = 0.59, 0.21, 0.20, SPLASH = 75.06, COH = 0.004, SMAX = 0.89
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 213, LEN = 320.7, AREA = 1228710.5
  SL = 0.054, MAN = 0.049, X = 605771.1, Y = 4701070.5
  CV = 1.16, PRINT = 1
  KS = 12.39, G = 171.88, DIST = 0.35, POR = 0.445, ROCK = 0.14
  FR = 0.55, 0.24, 0.21, SPLASH = 82.07, COH = 0.005, SMAX = 0.89
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 214, PRINT = 1
  LAT =  212 213
  UP =  204 94
  LEN = 2772.00, SLOPE = 0.0028, X = 605368.047, Y = 4701318.175
  WIDTH = 29.93, 30.28, DEPTH = 0.78, 0.78
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 101, LEN = 827.9, AREA = 2721899.2
  SL = 0.020, MAN = 0.049, X = 605720.3, Y = 4703524.0
  CV = 0.74, PRINT = 1
  KS = 3.41, G = 269.39, DIST = 0.28, POR = 0.442, ROCK = 0.07
  FR = 0.42, 0.24, 0.33, SPLASH = 103.36, COH = 0.007, SMAX = 0.84
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 102, LEN = 192.4, AREA = 374926.0
  SL = 0.031, MAN = 0.049, X = 605362.8, Y = 4701989.0
  CV = 0.95, PRINT = 1
  KS = 8.96, G = 232.57, DIST = 0.33, POR = 0.443, ROCK = 0.12
  FR = 0.50, 0.22, 0.28, SPLASH = 90.01, COH = 0.006, SMAX = 0.86
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 103, LEN = 192.3, AREA = 584583.9
  SL = 0.014, MAN = 0.049, X = 604895.3, Y = 4701801.0
  CV = 0.86, PRINT = 1
  KS = 11.38, G = 183.07, DIST = 0.31, POR = 0.450, ROCK = 0.13
  FR = 0.48, 0.28, 0.24, SPLASH = 87.59, COH = 0.005, SMAX = 0.89
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
```

```
  ID = 104, PRINT = 1
  LAT =  102 103
  UP =  101
  LEN = 2570.18, SLOPE = 0.0033, X = 604885.161, Y = 4701795.368
  WIDTH = 9.83, 10.94, DEPTH = 0.48, 0.50
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 232, LEN = 183.4, AREA = 480196.7
  SL = 0.013, MAN = 0.049, X = 604044.5, Y = 4700479.5
  CV = 1.23, PRINT = 1
  KS = 19.72, G = 167.79, DIST = 0.42, POR = 0.432, ROCK = 0.23
  FR = 0.65, 0.16, 0.19, SPLASH = 69.30, COH = 0.004, SMAX = 0.89
  INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 233, LEN = 197.6, AREA = 480293.3
  SL = 0.018, MAN = 0.049, X = 603731.5, Y = 4700763.0
  CV = 1.03, PRINT = 1
  KS = 11.63, G = 174.31, DIST = 0.33, POR = 0.450, ROCK = 0.13
  FR = 0.51, 0.27, 0.22, SPLASH = 83.29, COH = 0.005, SMAX = 0.89
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 234, PRINT = 1
  LAT =  232 233
  UP =  104 214
  LEN = 1979.61, SLOPE = 0.0035, X = 603699.042, Y = 4700543.440
  WIDTH = 30.84, 30.99, DEPTH = 0.79, 0.79
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 121, LEN = 520.0, AREA = 3150196.5
  SL = 0.047, MAN = 0.049, X = 606288.0, Y = 4699860.0
  CV = 0.84, PRINT = 1
  KS = 9.69, G = 165.49, DIST = 0.31, POR = 0.434, ROCK = 0.12
  FR = 0.49, 0.29, 0.22, SPLASH = 89.20, COH = 0.005, SMAX = 0.87
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 122, LEN = 392.3, AREA = 1201784.7
  SL = 0.022, MAN = 0.049, X = 604512.6, Y = 4699623.0
  CV = 0.63, PRINT = 1
  KS = 12.85, G = 150.54, DIST = 0.28, POR = 0.467, ROCK = 0.10
  FR = 0.43, 0.37, 0.20, SPLASH = 123.63, COH = 0.008, SMAX = 0.93
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 123, LEN = 469.1, AREA = 1649449.2
  SL = 0.035, MAN = 0.049, X = 605015.1, Y = 4700152.0
  CV = 1.07, PRINT = 1
  KS = 13.88, G = 173.37, DIST = 0.35, POR = 0.453, ROCK = 0.15
  FR = 0.53, 0.27, 0.20, SPLASH = 92.14, COH = 0.005, SMAX = 0.90
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE
```

```
BEGIN CHANNEL
  ID = 124, PRINT = 1
  LAT =  122 123
  UP =  121
  LEN = 3517.27, SLOPE = 0.0038, X = 604568.475, Y = 4700090.337
  WIDTH = 10.35, 13.00, DEPTH = 0.49, 0.54
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 242, LEN = 51.0, AREA = 27647.4
  SL = 0.037, MAN = 0.049, X = 603077.1, Y = 4699958.0
  CV = 0.82, PRINT = 1
  KS = 7.05, G = 174.81, DIST = 0.26, POR = 0.462, ROCK = 0.07
  FR = 0.41, 0.35, 0.25, SPLASH = 93.23, COH = 0.006, SMAX = 0.89
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 243, LEN = 122.6, AREA = 101308.6
  SL = 0.014, MAN = 0.048, X = 602978.6, Y = 4700104.0
  CV = 1.21, PRINT = 1
  KS = 13.90, G = 176.72, DIST = 0.38, POR = 0.442, ROCK = 0.16
  FR = 0.57, 0.22, 0.21, SPLASH = 76.62, COH = 0.004, SMAX = 0.88
  INTER = 2.52, CANOPY = 0.2132, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 244, PRINT = 1
  LAT =  242 243
  UP =  234 124
  LEN = 414.89, SLOPE = 0.0022, X = 603054.609, Y = 4699985.980
  WIDTH = 31.86, 31.88, DEPTH = 0.80, 0.80
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 131, LEN = 684.7, AREA = 2442666.6
  SL = 0.044, MAN = 0.049, X = 603521.9, Y = 4697664.5
  CV = 0.75, PRINT = 1
  KS = 8.52, G = 186.46, DIST = 0.31, POR = 0.449, ROCK = 0.12
  FR = 0.48, 0.28, 0.24, SPLASH = 93.90, COH = 0.006, SMAX = 0.90
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 132, LEN = 208.7, AREA = 418773.3
  SL = 0.025, MAN = 0.049, X = 603021.2, Y = 4698733.0
  CV = 1.02, PRINT = 1
  KS = 8.79, G = 177.67, DIST = 0.32, POR = 0.446, ROCK = 0.07
  FR = 0.51, 0.27, 0.22, SPLASH = 96.67, COH = 0.006, SMAX = 0.89
  INTER = 2.61, CANOPY = 0.2201, PAVE = 0.00
END PLANE

BEGIN PLANE
  ID = 133, LEN = 524.6, AREA = 2022567.5
  SL = 0.044, MAN = 0.049, X = 603994.4, Y = 4698907.0
  CV = 0.93, PRINT = 1
  KS = 10.24, G = 166.40, DIST = 0.31, POR = 0.448, ROCK = 0.10
  FR = 0.50, 0.29, 0.21, SPLASH = 96.09, COH = 0.006, SMAX = 0.90
```

```
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
 ID = 134, PRINT = 1
 LAT =  132 133
 UP =  131
 LEN = 1976.30, SLOPE = 0.0044, X = 603298.310, Y = 4699129.960
 WIDTH = 9.45, 12.09, DEPTH = 0.47, 0.52
 MAN = 0.035, SS1 = 1.00, SS2 = 1.00
 WOOL = Yes
 CV = 0.00, KSAT = 210, G = 101
 DIST = 0.5450, POR = 0.4400, ROCK = 0.00
 FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
 ID = 252, LEN = 218.6, AREA = 420652.3
 SL = 0.014, MAN = 0.049, X = 602240.4, Y = 4699966.5
 CV = 1.22, PRINT = 1
 KS = 16.91, G = 172.12, DIST = 0.40, POR = 0.437, ROCK = 0.20
 FR = 0.61, 0.19, 0.20, SPLASH = 72.85, COH = 0.004, SMAX = 0.88
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
 ID = 253, LEN = 467.5, AREA = 1519593.7
 SL = 0.028, MAN = 0.049, X = 602362.6, Y = 4699308.5
 CV = 0.91, PRINT = 1
 KS = 10.58, G = 192.05, DIST = 0.30, POR = 0.446, ROCK = 0.11
 FR = 0.45, 0.29, 0.25, SPLASH = 92.58, COH = 0.006, SMAX = 0.88
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
 ID = 254, PRINT = 1
 LAT =  252 253
 UP =  244 134
 LEN = 2452.62, SLOPE = 0.0018, X = 602149.694, Y = 4699738.665
 WIDTH = 32.56, 32.82, DEPTH = 0.81, 0.81
 MAN = 0.035, SS1 = 1.00, SS2 = 1.00
 WOOL = Yes
 CV = 0.00, KSAT = 210, G = 101
 DIST = 0.5450, POR = 0.4400, ROCK = 0.00
 FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
 ID = 111, LEN = 787.8, AREA = 2999924.5
 SL = 0.020, MAN = 0.049, X = 604211.7, Y = 4702392.0
 CV = 0.60, PRINT = 1
 KS = 9.19, G = 164.56, DIST = 0.25, POR = 0.463, ROCK = 0.09
 FR = 0.38, 0.37, 0.25, SPLASH = 95.45, COH = 0.006, SMAX = 0.90
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
 ID = 112, LEN = 504.2, AREA = 1629392.6
 SL = 0.012, MAN = 0.049, X = 602766.6, Y = 4700746.5
 CV = 0.90, PRINT = 1
 KS = 14.84, G = 164.49, DIST = 0.34, POR = 0.447, ROCK = 0.17
 FR = 0.52, 0.27, 0.21, SPLASH = 82.09, COH = 0.005, SMAX = 0.89
 INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN PLANE
 ID = 113, LEN = 421.5, AREA = 1794577.9
 SL = 0.010, MAN = 0.049, X = 602509.0, Y = 4701530.0
 CV = 0.65, PRINT = 1
```

```
  KS = 10.16, G = 163.16, DIST = 0.26, POR = 0.461, ROCK = 0.10
  FR = 0.41, 0.36, 0.24, SPLASH = 93.50, COH = 0.006, SMAX = 0.90
  INTER = 2.58, CANOPY = 0.2178, PAVE = 0.00
END PLANE

BEGIN CHANNEL
  ID = 114, PRINT = 1
  LAT =  112 113
  UP =  111
  LEN = 2732.86, SLOPE = 0.0025, X = 602382.087, Y = 4700990.770
  WIDTH = 10.17, 13.32, DEPTH = 0.49, 0.55
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL

BEGIN PLANE
  ID = 222, LEN = 185.9, AREA = 280617.9
  SL = 0.008, MAN = 0.053, X = 600900.8, Y = 4700068.0
  CV = 1.12, PRINT = 1
  KS = 12.47, G = 155.25, DIST = 0.32, POR = 0.456, ROCK = 0.12
  FR = 0.51, 0.29, 0.20, SPLASH = 99.55, COH = 0.006, SMAX = 0.90
  INTER = 2.85, CANOPY = 0.2385, PAVE = 0.03
END PLANE

BEGIN PLANE
  ID = 223, LEN = 470.6, AREA = 1587202.5
  SL = 0.015, MAN = 0.053, X = 601133.9, Y = 4700946.0
  CV = 1.16, PRINT = 1
  KS = 14.75, G = 150.33, DIST = 0.34, POR = 0.452, ROCK = 0.14
  FR = 0.54, 0.27, 0.19, SPLASH = 98.38, COH = 0.006, SMAX = 0.90
  INTER = 2.85, CANOPY = 0.2385, PAVE = 0.03
END PLANE

BEGIN CHANNEL
  ID = 224, PRINT = 3, FILE = C:\AGWA_PROJ\jonahsan\simulations\kin_sims\noac5yr.sim
  LAT =  222 223
  UP =  114 254
  LEN = 1064.51, SLOPE = 0.0010, X = 600947.551, Y = 4700171.482
  WIDTH = 33.67, 33.90, DEPTH = 0.82, 0.82
  MAN = 0.035, SS1 = 1.00, SS2 = 1.00
  WOOL = Yes
  CV = 0.00, KSAT = 210, G = 101
  DIST = 0.5450, POR = 0.4400, ROCK = 0.00
  FR = 0.9000, 0.0500, 0.0500, SP = 63.00, COH = 0.0050
END CHANNEL
```

APPENDIX B: SOIL DATABASE TABLES

Soil data from the Burma Soil Survey (ERO 1988) were put into Statsgo format, in order to allow AGWA to read the data and use it to estimate the infiltration, runoff, and sediment transport parameters. The first soil database table from the Statsgo data which AGWA reads is called comp.dbf. This file contains the following fields:

STSSAID	State Soil Survey Area ID
MUID	Map Unit Identification
SEQNUM	Sequence Number
MUSYM	Map Unit Symbol
COMPNAME	Component Name
S5ID	Soil Interpretations Record Number
COMPPCT	Component Percent
SLOPEL	Soil Slope (Minimum)
SLOPEH	Soil Slope (Maximum)
SURFTEX	Surface Soil Texture
OTHERPH	Phase Class (other than slope or texture)
COMPKIND	Kind of Component (S=Series, F=Family, V=Variant, M=Miscellaneous)
COMPACRE	Component Acres
CLASCODE	Taxonomic Classification Code
ANFLOOD	Annual Flooding Frequency (Descriptive)
ANFLODUR	Flood Duration Class (Descriptive)
ANFLOBEG	Month in which annual flooding begins in a normal year
ANFLOEND	Month in which annual flooding ends in a normal year
GSFLOOD	Growing Season Flooding (Descriptive)
GSFLODUR	Growing Season Flood Duration (Descriptive)
GSFLOBEG	Month in which annual flooding begins during growing season
GSFLOEND	Month in which annual flooding ends during growing season
WTDEPL	Depth to high Water Table (Minimum)
WTDEPH	Depth to high Water Table (Maximum)
WTKIND	Water Table Kind (Artesian, Perched, Apparent)
WTBEG	Month in which seasonal water table occurs at the depth specified in a normal year
WTEND	Month in which seasonal water table subsides below the normal year depth
PNDDEPL	Ponding Depth (Minimum)
PNDDEPH	Ponding Depth (Maximum)
PNDDUR	Ponding Duration
PNDBEG	
PNDEND	
ROCKDEPL	Depth to Bedrock (Minimum) Inches
ROCKDEPH	Depth to Bedrock (Maximum) Inches
ROCKHARD	Bedrock Hardness (Descriptive)
PANDEPL	Depth to Cemented Pan (Minimum) Inches
PANDEPH	Depth to Cemented Pan (Maximum) Inches
PANHARD	Cemented Pan Thickness (Descriptive)

SUBINITL	Min. value in initial subsidence when drained, in inches (organic soils only)
SUBINITH	Max. value in initial subsidence when drained, in inches (organic soils only)
SUBTOTL	Min. value in total subsidence when drained, in inches (organic soils only)
SUBTOTH	Max. value in total subsidence when drained, in inches (organic soils only)
HYDGRP	Hydrologic Group
FROSTACT	Potential Frost Action (Descriptive)
DRAINAGE	Code identifying the natural soil drainage condition. Example: Well Drained (W); Excessive (E); Moderately Well (MW); Poorly (P); Somewhat Excessively (SE); Somewhat Poorly (SP)
HYDRIC	Hydric Soil Rating
CORCON	A rating of concrete susceptibility to corrosion when in contact with the soil
CORSTEEL	A rating of the uncoated steel susceptibility to corrosion when in contact with soil
CLNIRR	A rating of the soil for nonirrigated agricultural use
CLIRR	Irrigated Capability Class
SCLNIRR	Irrigated Capability Subclass
SCLIRR	Irrigated Capability Subclass
PRIMFML	Prime Farmland Classification

From this table, AGWA reads the composition percentages and surface texture for each soil. Table B-1 presents the part of the comp.dbf table read by AGWA and populated with data from the Burma Soil Survey.

Table B-1: Composition percentages and Textures for Jonah Soils

MUID	SEQNUM	COMPNAME	COMPPCT	SURFTEX	ROCKDEPL	ROCKDEPH
JOW	1	WATER	100		0	0
JO102	1	Langspring Variant	72	L	20	40
JO102	2	Langspring	28	L	40	60
JO104	1	Chrisman	100	SiC	60	60
JO106	1	Monte	67	L	60	60
JO106	2	Leckman	33	L	60	60
JO108	1	Dines	45	L	60	60
JO108	2	Clowers	33	L	60	60
JO108	3	Quealman	22	L	60	60
JO110	1	Fraddle	72	L	20	40
JO110	2	Tresano	28	L	40	60
JO113	1	Haterton	53	L	20	40
JO113	2	Garsid	47	L	20	40
JO114	1	Ouard	35	L	10	20
JO114	2	Ouard Variant	35	C	10	20
JO114	3	Boltus	30	Sh	4	20
JO116	1	Huguston	44	L	4	20
JO116	2	Horsley	39	Sh	3	10
JO116	3	Terada	17	L	20	40
JO119	1	Garsid	53	L	20	40
JO119	2	Monte	47	L	60	60
JO121	1	Garsid	47	L	20	40
JO121	2	Terada	29	L	20	40
JO121	3	Langspring Variant	24	L	20	40

JO122	1	Baston	44	C	20	40
JO122	2	Boltus	31	Sh	4	20
JO122	3	Chrisman	25	C	60	60
JO123	1	Spool Variant	41	S	3	20
JO123	2	Ouard Variant	41	C	10	20
JO123	3	San Arcacio Variant	18	L	20	40
JO124	1	Fraddle	35	L	20	40
JO124	2	Ouard	35	L	10	20
JO124	3	San Arcacio Variant	30	L	20	40
JO125	1	San Arcacio	56	LS	60	60
JO125	2	Saguache	44	SL	60	60
JO127	1	Vermillion Variant	39	L	20	40
JO127	2	Seedskadee	39	L	10	20
JO127	3	Fraddle	22	L	20	40
JO128	1	Fraddle	56	L	20	40
JO128	2	Ouard	22	L	10	20
JO128	3	San Arcacio Variant	22	L	20	40
JO139	1	HUGUSTON	20	FSL	10	20
JO139	2	WINT	10	CN-SL	6	20
JO139	3	HATERTON	10	L	10	20
JO139	4	TASSELMAN	10	SL	10	20
JO139	5	ROCK OUTCROP	5	UWB	0	0
JO139	6	ROGRUBE	10	L	60	60
JO139	7	WESTVACO	10	FSL	20	40
JO139	8	TEAGULF	20	FSL	20	40
JO139	9	KANDALY	5	FS	60	60

The second soil database table from the Statsgo data, which AGWA reads in order to estimate the infiltration, runoff, and sediment transport parameters, is called layer.dbf. This file contains the following fields:

STSSAID State Soil Survey Area ID
MUID Map Unit Identification
SEQNUM Sequence Number
S5ID Soil Interpretations Record Number
LAYERNUM Layer Number
LAYERID convention to identify the original layers on the Number SOI-5 record. Example: layerid 11 for the first surface of a multisurface record, 12 for the second surface layer, 2 through 9 for subsurface layers
LAYDEPL depth to upper boundary of soil layer, inches
LAYDEPH depth to lower boundary of soil layer, inches
TEXTURE1
TEXTURE2
TEXTURE3
KFACT Soil Erodibility Factor, includes adjustment for rock fragments
KFFACT Soil Erodibility Factor, without adjustment for rock fragments Used in SWAT
TFACT Soil loss tolerance factor.
WEG Wind Erodibility Group
INCH10L weight of the rock fragments greater than 10 inches size, in percent (minimum)

INCH10H	weight of the rock fragments greater than 10 inches size, in percent (maximum)
INCH3L	weight of the rock fragments 3 to 10 inches size, in percent (minimum)
INCH3H	weight of the rock fragments 3 to 10 inches size, in percent (maximum)
NO4L	Percent Passing Sieve Number 4 (Minimum)
NO4H	Percent Passing Sieve Number 4 (Maximum)
NO10L	Percent Passing Sieve Number 10 (Minimum)
NO10H	Percent Passing Sieve Number 10 (Maximum)
NO40L	Percent Passing Sieve Number 40 (Minimum)
NO40H	Percent Passing Sieve Number 40 (Maximum)
NO200L	Percent Passing Sieve Number 200 (Minimum)
NO200H	Percent Passing Sieve Number 200 (Maximum)
CLAYL	Clay Content of Material less than 2 mm in size (Minimum)
CLAYH	Clay Content of Material less than 2 mm in size (Maximum)
LLL	Liquid Limit in percent moisture by weight (Minimum)
LLH	Liquid Limit in percent moisture by weight (Minimum)
PIL	Plasticity Index (Minimum)
PIH	Plasticity Index (Maximum)
UNIFIED1	Unified Soil Classification (engineering)
UNIFIED2	Unified Soil Classification (engineering)
UNIFIED3	Unified Soil Classification (engineering)
UNIFIED4	Unified Soil Classification (engineering)
AASHTO1	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO2	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO3	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO4	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHIND	A AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group index
AWCL	Available Water Capacity (Minimum)
AWCH	Available Water Capacity (Maximum)
BDL	Bulk Density (Minimum)
BDH	Bulk Density (Maximum)
OML	Organic Matter, percent by weight (Minimum)
OMH	Organic Matter, percent by weight (Maximum)
PHL	Soil Reaction (pH) (Minimum)
PHH	Soil Reaction (pH) (Maximum)
SALINL	Salinity (Minimum)
SALINH	Salinity (Maximum)
SARL	Sodium Absorption Ratio (Minimum)
SARH	Sodium Absorption Ratio (Maximum)
CECL	Cation Exchange Capacity (Minimum)
CECH	Cation Exchange Capacity (Maximum)
CACO3L	Carbonate as $CaCO_3$, percent (Minimum)

CACO3H Carbonate as CaCO3, percent (Maximum)
GYPSUML Sulfates as CaSO4 (gypsum), percent (Maximum)
GYPSUMH Sulfates as CaSO4 (gypsum), percent (Minimum)
PERML Permeability Rate inches/hour (Minimum)
PERMH Permeability Rate inches/hour (Minimum)
SHRINKSW Shrink-Swell Potential

This file, showing only the populated fields for the soils of the Jonah project, is in shown in Table B-2.

Table B-2: Layer Composition for Jonah Soils

MUID	SE QN UM	LA YE RN UM	LA YE RID	LA YD EP L	LA YD EP H	TEXT URE 1	TEXT URE 2	TEX TUR E3	KFAC T	KFFAC T	INC H10 L	INC H10 H	INC H3L	INC H3 H	NO 4L	NO 4H	NO 10L	NO 10H	NO 40L	NO 40H	NO 200 L	NO 200 H	CL AYL	CL AY H	LLL	LLH	AW CL	AWC H	BDL	BDH
JO102	1	1	11	0	3	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	34	25	30	0.14	0.17	1.30	1.40
JO102	1	2	2	3	22	CL	SCL	L	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	18	34	25	30	0.13	0.16	1.30	1.40
JO102	2	1	11	0	4	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	27	25	30	0.14	0.17	1.30	1.40
JO102	2	2	2	4	9	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	27	25	30	0.14	0.17	1.30	1.40
JO102	2	3	3	9	40	SCL	L	SL	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	15	27	25	30	0.13	0.16	1.30	1.40
JO104	1	1	11	0	2	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	40	60	0.15	0.17	1.30	1.40
JO104	1	2	2	2	60	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	40	60	0.10	0.15	1.30	1.40
JO106	1	1	11	0	2	L			0.24	0.24	0	0	0	10	95	100	90	100	75	95	55	75	15	25	30	40	0.16	0.18	1.30	1.40
JO106	1	2	2	2	60	CL	L	SL	0.24	0.24	0	0	0	10	95	100	90	100	65	95	45	75	15	34	30	40	0.16	0.18	1.30	1.40
JO106	2	1	11	0	3	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	20	25	0.15	0.17	1.30	1.40
JO106	2	2	2	3	60	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	20	25	0.15	0.17	1.30	1.40
JO108	1	1	11	0	4	SIL			0.37	0.37	0	0	0	0	100	100	100	100	95	100	80	100	18	27	25	40	0.09	0.11	1.30	1.40
JO108	1	2	2	4	60	SIL	SICL		0.37	0.37	0	0	0	0	100	100	100	100	95	100	80	100	37	35	25	40	0.09	0.16	1.30	1.40
JO108	2	1	11	0	1	L			0.37	0.37	0	0	0	0	80	100	80	100	80	90	60	75	18	28	25	35	0.12	0.14	1.30	1.40
JO108	2	2	2	1	60	CL			0.49	0.49	0	0	0	0	80	100	75	100	65	90	50	75	20	40	25	35	0.12	0.14	1.30	1.40
JO108	3	1	11	0	2	FSL	L	CL	0.32	0.32	0	0	0	0	75	100	75	100	50	75	25	50	10	34	0	0	0.11	0.15	1.30	1.40
JO108	3	2	2	2	60	SR-LS	L	FSL	0.37	0.37	0	0	0	0	90	100	80	100	40	75	20	35	10	34	15	25	0.10	0.13	1.30	1.40
JO110	1	1	11	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	15	25	0.11	0.13	1.30	1.40
JO110	1	2	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	30	40	0.14	0.16	1.30	1.40
JO110	2	1	11	0	2	SL			0.24	0.24	0	0	0	0	80	100	75	90	50	60	25	35	10	20	20	30	0.11	0.13	1.30	1.40
JO110	2	2	2	2	16	SCL			0.28	0.28	0	0	0	0	80	100	75	90	60	80	35	50	20	30	20	30	0.14	0.16	1.30	1.40
JO113	1	1	11	0	3	L			0.37	0.37	0	0	0	0	75	100	75	100	70	100	50	70	18	27	25	30	0.16	0.18	1.30	1.40
JO113	1	2	2	3	12	L			0.43	0.43	0	0	0	0	75	100	75	100	60	75	50	60	18	27	20	30	0.16	0.18	1.30	1.40
JO113	2	1	11	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO113	2	2	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO114	1	1	11	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0	0	0.11	0.13	1.30	1.40
JO114	1	2	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	25	35	0.14	0.16	1.30	1.40
JO114	2	1	11	0	4	CL	L		0.32	0.32	0	0	0	0	95	100	90	100	75	95	55	80	6	25	35	45	0.17	0.21	1.30	1.40
JO114	2	2	2	4	13	CL	C		0.37	0.37	0	0	0	0	95	100	90	100	90	100	75	95	35	50	35	45	0.19	0.21	1.30	1.40
JO114	3	1	11	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	35	50	0.08	0.10	1.30	1.40
JO114	3	2	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	35	50	0.08	0.10	1.30	1.40
JO116	1	1	11	0	2	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0	0	0.13	0.15	1.30	1.40
JO116	1	2	2	2	9	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0	0	0.13	0.15	1.30	1.40
JO116	1	3	3	9	60	UWB			0.32	0.32	0	0	0	0									5	12	0	0			1.30	1.40
JO116	2	1	11	0	3	L			0.15	0.15	0	0	0	0	50	75	50	75	45	65	35	50	18	27	25	35	0.11	0.15	1.30	1.40

JO116	2	2	2	3	9	L	CL	SCL	0.37	0.37	0	0	0	0	90	100	75	100	60	80	50	60	18	35	25	40	0.15	0.20	1.30	1.40
JO116	2	3	3	9	60	SH			0.37	0.37	0	0	0	0															1.30	1.40
JO116	3	1	11	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	20	25	0.15	0.17	1.30	1.40
JO116	3	2	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	20	25	0.15	0.17	1.30	1.40
JO119	1	1	11	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO119	1	2	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO119	2	1	11	0	2	L			0.24	0.24	0	0	0	10	95	100	90	100	75	95	55	75	15	25	30	40	0.16	0.18	1.30	1.40
JO119	2	2	2	2	60	CL	L	SL	0.24	0.24	0	0	0	10	95	100	90	100	65	95	45	75	15	34	30	40	0.16	0.18	1.30	1.40
JO121	1	1	11	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO121	1	2	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	20	30	0.16	0.18	1.30	1.40
JO121	2	1	11	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	20	25	0.15	0.17	1.30	1.40
JO121	2	2	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	20	25	0.15	0.17	1.30	1.40
JO121	3	1	11	0	3	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	34	25	30	0.14	0.17	1.30	1.40
JO121	3	2	2	3	22	CL	SCL	L	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	18	34	25	30	0.13	0.16	1.30	1.40
JO122	1	1	11	0	3	FSCL			0.37	0.37	0	0	0	0	90	100	90	100	75	85	35	50	20	35	30	40	0.14	0.16	1.30	1.40
JO122	1	2	2	3	28	C			0.37	0.37	0	0	0	0	75	100	75	100	70	90	65	90	35	50	40	60	0.11	0.13	1.30	1.40
JO122	2	1	11	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	35	50	0.08	0.10	1.30	1.40
JO122	2	2	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	35	50	0.08	0.10	1.30	1.40
JO122	3	1	11	0	3	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	40	60	0.15	0.17	1.30	1.40
JO122	3	2	2	3	60	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	40	60	0.10	0.15	1.30	1.40
JO123	1	1	11	0	6	LFS	GR-SL		0.20	0.20	0	0	0	10	85	100	80	100	65	95	15	30	5	12	15	25	0.08	0.11	1.30	1.40
JO123	1	2	2	6	12	LFS	CN-LFS	GR-SL	0.28	0.28	0	0	0	10	70	90	65	90	60	90	10	30	5	12	15	25	0.06	0.11	1.30	1.40
JO123	2	1	11	0	4	CL	L		0.32	0.32	0	0	0	0	95	100	90	100	75	95	55	80	6	25	35	45	0.17	0.21	1.30	1.40
JO123	2	2	2	4	13	CL	C		0.37	0.37	0	0	0	0	95	100	90	100	90	100	75	95	35	50	35	45	0.19	0.21	1.30	1.40
JO123	3	1	11	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	20	30	0.11	0.13	1.30	1.40
JO123	3	2	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	30	40	0.14	0.16	1.30	1.40
JO124	1	1	11	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	15	25	0.11	0.13	1.30	1.40
JO124	1	2	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	30	40	0.14	0.16	1.30	1.40
JO124	2	1	11	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0	0	0.11	0.13	1.30	1.40
JO124	2	2	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	25	35	0.14	0.16	1.30	1.40
JO124	3	1	11	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	20	30	0.11	0.13	1.30	1.40
JO124	3	2	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	30	40	0.14	0.16	1.30	1.40
JO125	1	1	11	0	3	SL	COSL		0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	20	30	0.11	0.13	1.30	1.40
JO125	1	2	2	3	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	30	40	0.14	0.16	1.30	1.40
JO125	2	1	11	0	6	SL	COSL	GR-SL	0.15	0.15	0	0	0	10	75	100	50	100	40	75	25	45	5	18	15	30	0.11	0.18	1.30	1.40
JO125	2	2	2	6	19	GRV-S	COSL	GRV-LS	0.05	0.05	0	0	10	40	25	50	25	50	10	30	0	10	0	5	0	0	0.03	0.05	1.30	1.40
JO127	1	1	11	0	3	L			0.37	0.37	0	0	0	0	95	100	95	100	80	90	60	70	15	30	20	25	0.16	0.18	1.30	1.40
JO127	1	2	2	3	8	CN-L	CN-CL		0.15	0.15	0	0	0	10	70	85	65	75	55	65	40	50	18	34	25	35	0.10	0.13	1.30	1.40
JO127	1	3	3	8	27	FLX-L	FLV-CL	FLV-L	0.10	0.10	0	0	45	60	70	85	40	50	30	40	20	30	18	30	25	35	0.07	0.09	1.30	1.40
JO127	2	1	11	0	2	L			0.24	0.24	0	0	0	10	85	100	70	100	45	90	20	50	18	34	15	35	0.10	0.15	1.30	1.40
JO127	2	2	2	2	14	SCL	L	SL	0.24	0.24	0	0	0	10	85	100	70	100	45	90	20	50	18	34	15	35	0.10	0.15	1.30	1.40
JO127	3	1	11	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	15	25	0.11	0.13	1.30	1.40
JO127	3	2	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	30	40	0.14	0.16	1.30	1.40
JO128	1	1	11	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	15	25	0.11	0.13	1.30	1.40
JO128	1	2	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	30	40	0.14	0.16	1.30	1.40
JO128	2	1	11	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0	0	0.11	0.13	1.30	1.40
JO128	2	2	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	25	35	0.14	0.16	1.30	1.40
JO128	3	1	11	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	20	30	0.11	0.13	1.30	1.40
JO128	3	2	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	30	40	0.14	0.16	1.30	1.40
JO139	1	1	11	0	16	FSL			0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0	0	0.13	0.15	1.25	1.35

JO139	1	2	2	16	20	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JO139	2	1	11	0	1	CN-SL			0.15	0.32	0	0	0	10	60	85	50	75	30	50	15	30	5	18	20	25	0.06	0.07	1.25	1.35
JO139	2	2	2	1	5	CNV-SL	CNX-SL		0.05	0.20	0	0	10	15	30	60	20	55	15	35	10	20	5	18	20	25	0.01	0.05	1.35	1.45
JO139	2	3	3	5	18	FLX-SL			0.02	0.00	0	0	50	60	70	90	60	80	40	55	20	30	5	18	20	25	0.01	0.03	1.35	1.45
JO139	2	4	4	18	22	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	3	1	11	0	2	L			0.37	0.37	0	0	0	0	75	100	75	100	70	100	50	70	18	27	25	30	0.16	0.18	1.25	1.35
JO139	3	2	2	2	10	L			0.43	0.43	0	0	0	0	75	100	75	100	60	75	50	60	10	18	20	30	0.16	0.18	1.35	1.45
JO139	3	3	3	10	14	CN-L			0.17	0.32	0	0	0	0	50	75	50	75	45	70	40	50	10	18	20	30	0.09	0.13	1.35	1.45
JO139	3	4	4	14	18	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	4	1	11	0	3	SL			0.24	0.24	0	0	0	0	80	100	75	100	55	75	35	50	5	18	0	0	0.11	0.13	1.25	1.35
JO139	4	2	2	3	14	GR-SL	CN-SL		0.10	0.20	0	0	0	0	55	80	50	75	35	55	15	30	5	18	0	0	0.07	0.11	1.35	1.45
JO139	4	3	3	14	18	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	5	1	11	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	6	1	11	0	3	L			0.28	0.28	0	0	0	0	100	100	100	100	80	90	60	80	15	25	20	25	0.14	0.18	1.20	1.30
JO139	6	2	2	3	28	CL	SICL		0.43	0.43	0	0	0	0	100	100	100	100	85	100	70	80	27	35	30	35	0.17	0.21	1.25	1.35
JO139	6	3	3	28	60	SCL	CL	SICL	0.43	0.43	0	0	0	0	100	100	90	100	80	100	55	80	20	35	25	35	0.12	0.17	1.30	1.40
JO139	7	1	11	0	2	FSL			0.32	0.32	0	0	0	5	80	100	75	100	50	80	10	40	10	20	20	30	0.09	0.12	1.25	1.35
JO139	7	2	2	2	18	SCL	CL		0.37	0.37	0	0	0	0	100	100	75	100	60	80	50	60	20	35	25	40	0.10	0.15	1.25	1.35
JO139	7	3	3	18	30	SCL	SL		0.32	0.32	0	0	0	0	100	100	75	100	60	80	45	55	15	25	25	40	0.06	0.10	1.30	1.40
JO139	7	4	4	30	34	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	8	1	12	0	3	FSL			0.24	0.24	0	0	0	5	80	100	75	100	50	80	25	50	5	18	15	25	0.11	0.14	1.25	1.35
JO139	8	2	2	3	10	FSL	SL		0.28	0.28	0	0	0	5	80	100	75	100	50	80	25	50	5	18	15	25	0.09	0.11	1.35	1.45
JO139	8	3	3	10	35	FSL	SL		0.28	0.28	0	0	0	5	80	100	75	100	50	80	25	50	5	18	15	25	0.09	0.11	1.35	1.45
JO139	8	4	4	35	39	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
JO139	9	1	11	0	6	FS			0.28	0.28	0	0	0	0	100	100	100	100	75	90	5	30	0	7	0	0	0.05	0.07	1.35	1.45
JO139	9	2	2	6	60	FS	LS		0.28	0.28	0	0	0	0	100	100	100	100	75	90	5	30	0	7	0	0	0.05	0.07	1.45	1.60
JO139	9	3	3	60	70	LFS			0.32	0.32	0	0	0	0	100	100	100	100	75	95	20	35	0	10	0	0	0.08	0.10	1.45	1.60

Soil properties to a depth of 9 inches are averaged.
The percent passing designated sieves in this table is used to calculate the KINEROS parameter for the rock fraction in the soil.

From the averaged layers and percentage composition of soils for each map unit, a texture is determined. From this texture, the other KINEROS parameters are estimated in AGWA, according to the kin-lut.dbf table (Table B-3).

Table B-3: AGWA Conversion from Soil Texture to KINEROS Input

TEXTURE	KS	G	POR	SMAX	CV	SAND	SILT	CLAY	DIST	KFF
C	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.340
CBV	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.050
CEM	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.280
CIND	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.020
CL	2.300	259.0	0.464	0.840	0.940	32.00	34.00	34.00	0.240	0.390
COS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.150
COSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.240
FB	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.050
FRAG	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.050
FS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.200

FSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.350
G	210.000	46.0	0.437	0.950	0.690	27.00	23.00	50.00	0.160	0.150
GYP	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.050
HM	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
ICE	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
IND	0.300	100.0	0.200	0.300	0.200	0.00	0.00	0.00	0.000	0.250
L	13.000	108.0	0.463	0.940	0.400	42.00	39.00	19.00	0.250	0.420
LCOS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.180
LFS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.250
LS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.230
LVFS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.440
MUCK	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
PC	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.320
PEAT	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
S	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.180
SC	1.200	302.0	0.430	0.750	1.000	50.00	4.00	46.00	0.340	0.360
SCL	4.300	263.0	0.398	0.830	0.600	59.00	11.00	30.00	0.400	0.360
SI	3.000	260.0	0.450	0.920	0.550	8.00	81.00	11.00	0.130	0.430
SIC	0.900	375.0	0.479	0.880	0.920	9.00	45.00	46.00	0.150	0.310
SICL	1.500	345.0	0.471	0.920	0.480	12.00	54.00	34.00	0.180	0.400
SIL	6.800	203.0	0.501	0.970	0.500	23.00	61.00	16.00	0.230	0.490
SL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.320
SPM	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
SR	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.330
UWB	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
VAR	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.550
VFS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.460
VFSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.500
WB	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
MPT	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
COARSE	67.100	92.7	0.445	0.920	1.357	75.16	14.15	10.69	0.486	0.268
MEDIUM	9.056	205.7	0.463	0.917	0.738	36.57	42.98	20.45	0.272	0.416
FINE	0.824	382.8	0.470	0.818	0.610	27.02	25.41	47.57	0.181	0.345
D/SS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.180
SALT	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.050
ROCK	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
GLACIER	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
WATER	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
NO DATA	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000

APPENDIX C: LANDCOVER DATABASE TABLES

CLASS	NAME	A	B	C	D	COVER	INT	N	IMPERV
11	Open Water	100	100	100	100	0	0.00	0.000	0.00
12	Perennial Ice/Snow	98	98	98	98	0	0.00	0.000	0.00
21	Low Intensity Residential	77	85	90	92	15	0.10	0.150	0.40
22	High Intensity Residential	81	88	91	93	10	0.08	0.120	0.75
23	Commercial/Industrial/Transportation	89	92	94	95	2	0.05	0.010	0.80
31	Bare Rock/Sand/Clay	96	96	96	96	2	0.00	0.010	0.00
32	Quarries/Strip Mines/Gravel Pits	78	85	90	92	2	0.00	0.010	0.00
33	Transitional	72	82	87	90	20	0.00	0.010	0.00
41	Deciduous Forest	55	55	75	80	50	1.15	0.015	0.00
42	Evergreen Forest	55	55	70	77	50	1.15	0.015	0.00
43	Mixed Forest	55	55	75	80	50	1.15	0.015	0.00
51	Shrubland	63	77	85	88	25	3.00	0.055	0.00
52	Shrubland Basin Big Sagebrush High Density	63	77	85	88	25	3.00	0.055	0.00
53	Shrubland Moderate Density	63	77	85	88	25	3.00	0.055	0.00
54	Shrubland Basin Low Density	63	77	85	88	25	3.00	0.055	0.00
55	Shrubland Basin Scattered / No Sagebrush	63	77	85	88	25	3.00	0.055	0.00
61	Orchards/Vineyards/Other	77	77	84	88	70	2.80	0.040	0.00
71	Grasslands/Herbaceous	49	69	79	84	25	2.00	0.015	0.00
81	Pasture/Hay	68	79	86	89	70	2.80	0.040	0.00
82	Row Crops	72	81	88	91	50	0.76	0.040	0.00
83	Small Grains	65	76	84	88	90	4.00	0.040	0.00
84	Fallow	76	85	90	93	30	0.50	0.040	0.00
85	Urban/Recreational Grasses	68	79	86	89	90	2.50	0.040	0.01
91	Woody Wetlands	85	85	90	92	70	1.15	0.060	0.00
92	Emergent Herbaceous Wetlands	77	77	84	90	70	1.15	0.060	0.00

APPENDIX D: SALINITY ESTIMATION

Table D-1: Salinity per Map Unit

Map Unit ID (MUID)	Soil Series	Soil Series Percent Composition per Map Unit	Estimated Salinity for Soil Series (ERO 1988) (mS/cm)	Estimated Numeric Value for Salinity (µS/cm)	Average Salinity (µS/cm) for Map Unit
JO102	Langspring Variant	72%	<2	1000	1000
	Langspring	28%	<2	1000	
JO104	Chrisman	100%	<2	1000	1000
JO106	Monte	67%	<2	1000	1000
	Leckman	33%	<2	1000	
JO108	Dines	45%	8-16	12000	7600
	Clowers	33%	4-8	6000	
	Quealman	22%	<2	1000	
JO110	Fraddle	72%	<2	1000	1000
	Tresano	28%	<2	1000	
JO113	Haterton	53%	2-4	3000	3000
	Garsid	47%	2-4	3000	
JO114	Ouard	35%	<2	1000	4300
	Ouard Variant	35%	<2	1000	
	Boltus	30%	8-16	12000	
JO116	Huguston	44%	2-4	3000	2660
	Horsley	39%	2-4	3000	
	Terada	17%	<2	1000	
JO119	Garsid	53%	2-4	3000	2060
	Monte	47%	<2	1000	
JO121	Garsid	47%	2-4	3000	1940
	Terada	29%	<2	1000	
	Langspring Variant	24%	<2	1000	
JO122	Baston	44%	<2	1000	4410
	Boltus	31%	8-16	12000	
	Chrisman	25%	<2	1000	
JO123	Spool Variant	41%	<2	1000	1540
	Ouard Variant	41%	<2	1000	
	San Arcacio Variant	18%	<8	4000	
JO124	Fraddle	35%	<2	1000	1900
	Ouard	35%	<2	1000	
	San Arcacio Variant	30%	<8	4000	
JO125	San Arcacio	56%	<8	4000	2680
	Saguache	44%	<2	1000	
JO127	Vermillion Variant	39%	<2	1000	1000
	Seedskadee	39%	<2	1000	
	Fraddle	22%	<2	1000	
JO128	Fraddle	56%	<2	1000	1660
	Ouard	22%	<2	1000	
	San Arcacio Variant	22%	<8	4000	

Table D-2: Salinity per Hydrologic Unit Watershed.

Watershed Name	Watershed Area (Acres)	Map Unit	Map Unit Area (acres)	Map Unit Area percentage of Watershed	Average Salinity (µS/cm) per Map Unit	Average Salinity (µS/cm) per Watershed
140401040603	730	JO114	99	13.6%	4300	1000
		JO127	631	86.4%	1000	
Big Sandy River-Bull Draw	3567	JO102	149	4.2%	1000	2000
		JO106	521	14.6%	1000	
		JO110	268	7.5%	1000	
		JO113	58	1.6%	3000	
		JO114	328	9.2%	4300	
		JO116	207	5.8%	2660	
		JO123	303	8.5%	1540	
		JO124	1600	44.8%	1900	
		JO125	4	0.1%	2680	
		JO127	129	3.6%	1000	
Expanded Sand Draw-Alkali Creek	13725	JO104	42	0.3%	1000	2000
		JO106	1509	11.0%	1000	
		JO108	268	2.0%	7600	
		JO110	575	4.2%	1000	
		JO113	1012	7.4%	3000	
		JO114	1315	9.6%	4300	
		JO116	542	3.9%	2660	
		JO119	2074	15.1%	2060	
		JO121	84	0.6%	1940	
		JO123	282	2.1%	1540	
		JO124	1209	8.8%	1900	
		JO125	2270	16.5%	2680	
		JO127	1147	8.4%	1000	
		JO128	1395	10.2%	1660	
Granite Wash	1344	JO106	289	21.5%	1000	2000
		JO108	1	0.1%	7600	
		JO110	22	1.6%	1000	
		JO113	116	8.6%	3000	
		JO114	2	0.2%	4300	
		JO119	3	0.2%	2060	
		JO121	11	0.8%	1940	
		JO123	680	50.6%	1540	
		JO124	221	16.5%	1900	
Jonah Gulch	294	JO114	286	97.5%	4300	4000
		JO127	7	2.5%	1000	
Long Draw	4987	JO106	1183	23.7%	1000	2000
		JO110	302	6.1%	1000	
		JO114	354	7.1%	4300	
		JO116	976	19.6%	2660	
		JO124	229	4.6%	1900	
		JO127	1943	39.0%	1000	
Reduced Upper Alkali Creek-Green River	3855	JO106	91	2.3%	1000	2000
		JO110	376	9.7%	1000	
		JO113	430	11.2%	3000	
		JO114	738	19.1%	4300	
		JO116	14	0.4%	2660	
		JO119	1011	26.2%	2060	
		JO121	959	24.9%	1940	
		JO125	34	0.9%	2680	
		JO127	9	0.2%	1000	
		JO128	194	5.0%	1660	
Upper Eighteenmile Canyon	2006	JO106	305	15.2%	1000	2000
		JO113	485	24.2%	3000	
		JO116	371	18.5%	2660	
		JO121	205	10.2%	1940	
		JO122	86	4.3%	4410	
		JO127	554	27.6%	1000	

APPENDIX F — ADAPTIVE MANAGEMENT IN THE JONAH INFILL DRILLING PROJECT AREA

I. INTRODUCTION

The Bureau of Land Management (BLM) proposes to implement an adaptive management process for the Jonah Infill Drilling Project Area (JIDPA) that will generally follow the framework described in this appendix. The Jonah Interagency Mitigation and Reclamation Office (JIO) would be established in the Jonah Infill Drilling Project Record of Decision (ROD) to implement the process.

The potential value of adaptive management to the National Environmental Policy Act (NEPA) process is discussed by Carpenter (1997)[1] and is strongly supported by a number of agencies at the national level, including BLM, U.S. Environmental Protection Agency (EPA), and U.S. Department of Agriculture Forest Service (USFS). Carpenter summarized as follows: "It is increasingly recognized that human interventions into natural systems seldom proceed as originally planned. Scientific uncertainties prevent environmental impacts from being reliably or precisely predicted. Thus, the style of management must provide for monitoring to guide mid-course corrections in adapting to inevitable surprises." Council on Environmental Quality (CEQ) NEPA regulations require continual monitoring.[2]

II. PURPOSE AND NEED

In addition to the uncertainties about how natural systems will react to human interventions, it has become apparent that current development guidelines and Conditions of Approval, and the restriction of 1 well pad/40 acres (16 well pads/640-acre section) authorized in the Modified Jonah Field II Project Area, are not adequate protection for some JIDPA resources. However, national demand makes it imperative that as much natural gas as possible be recovered from the JIDPA. Project proponents are continually striving to develop drilling and production mitigation technologies to lessen the impacts of natural gas recovery, but those technologies are largely untested. There is uncertainty regarding the short- and long-term effectiveness of these new technologies, as well as uncertainty regarding the effectiveness of the mitigations and management restrictions BLM may place on infill development. These uncertainties require that a number of assumptions be used to predict the impacts associated with infill development; those assumptions may or may not be partially or wholly correct, which means the impact analysis may or may not be partially or wholly correct. Also, considering the expected level of impacts associated with proposed development, a significant off-site mitigation program will be necessary.

Uncertainty regarding the accuracy of the predictive assumptions and models used in the impact analysis, and uncertainty regarding how the environment will react to future development in the JIDPA using current and future untested development and mitigation technologies and untried restrictions, creates a need for a mechanism through which BLM can make incremental adjustments to field management over time, as information is gained about how area resources are reacting to new technologies and/or restrictions. That mechanism is adaptive management.

The adaptive management process allows for changes in management without further NEPA analysis, unless designated thresholds are reached. The process increases the speed at which managers learn how resources react to their decisions and development activities, and thereby increases the speed at which managers can adjust mitigation and management restrictions for unanticipated impacts, or lack thereof. The adaptive management framework has several continuous steps: decision is implemented; impacts are monitored; monitoring data are evaluated; modifications to mitigations or management restrictions are recommended, based on monitoring data; adaptive management decision is made and implemented; impacts are monitored; etc.

The purpose of this adaptive management process is to ensure that the impacts of development and production are monitored, and that the information from that monitoring is evaluated and incorporated, on a regular basis, into the mitigation and management decisions that will be made following the project ROD. The purpose of the JIO is to implement this adaptive management process in the JIDPA, as well as select and manage all off-site mitigation projects.

III. GOALS AND OBJECTIVES OF THE ADAPTIVE MANAGEMENT PROCESS

- Determine the effects of JIDPA development on area resources;
- Determine the effectiveness of the mitigation measures contained in the project ROD;
- Modify the mitigation measures as deemed appropriate to achieve the stated goal/objective;
- Assure that oil and gas-related BLM decisions regarding the JIDPA are coordinated with non-oil-and-gas-related decisions (such as grazing, recreation, etc.);
- Provide a rapid response to unnecessary and undue environmental degradation;
- Validate predictive models used in the project Environmental Impact Statement (EIS) and revise the models/projections as necessary based on field observations and monitoring;
- Accurately monitor and predict cumulative impacts through BLM maintenance of a Geographic Information System (GIS) for the JIDPA, including all activities (natural gas, agricultural, recreational, etc.) on federal and non-federal lands and how they are affecting area resources;
- Provide guidance for monitoring upon which the need to initiate Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS) will be determined.

IV. IMPLEMENTATION MODEL

BLM will implement and coordinate the adaptive management process. The BLM Pinedale Field Manager will accomplish that by establishing the interagency JIO in the project ROD. The JIO will be staffed by full-time employees or contractors from BLM, Wyoming Department of Environmental Quality (WDEQ), Wyoming Game and Fish Department (WGFD), and Wyoming

Department of Agriculture (WDA). Details on JIO objectives and duties are included in the Draft JIO Charter (Attachment E-1).

A. JIO FUNCTIONS

The JIO will be fully staffed by the agencies as soon as possible following issuance of the project ROD. The scope of work for the JIO will be to:

- Oversee the selection and monitor the effectiveness of offsite mitigation;
- Develop and implement monitoring plans for resources within the JIDPA;
- Review existing field conditions and keep abreast of new technologies or management restrictions;
- Monitor, inspect, and verify compliance of reclamation activities;
- Ensure compliance with WDEQ air quality and water quality rules and regulations;
- Monitor big game and sage grouse populations;
- Monitor livestock utilization of existing permits;
- Account for all compensatory (offsite) mitigation financial expenditures;
- Validate, coordinate, and oversee research activities;
- Coordinate transportation planning;
- Assure vegetation surveys/invasive species control;
- Report to the Agency Managers Committee and public regarding impacts, monitoring data, mitigation success, and financial health.

B. JIO OPERATING PROCEDURES

It is anticipated the JIO would be necessary for the next 5 to 15 years, with funding support provided by EnCana Oil & Gas (USA), Inc. for the first 6 years. Office oversight would be provided by an Agency Managers Committee consisting of individual agency heads or representatives from BLM, WDEQ, WGFD, and WDA. The Committee would meet at least once per year to provide senior-level guidance, evaluate past progress, and review staffing levels and future needs.

In accordance with an escrow agreement between the Wyoming Wildlife and Natural Resource Trust Account Board (an instrumentality of the State of Wyoming) and the Jonah Interagency Office Charter Members, the Board will receive and hold all compensatory mitigation funding provided by Jonah Operators (Attachment E-2). As the entity charged with selecting, implementing, and monitoring offsite mitigation, the JIO would maintain an accurate accounting of all compensatory mitigation fund expenditures and provide the Agency Managers Committee an annual financial report.

Specific JIO operational procedures would be developed by the office staff to meet defined goals and objectives.

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[1] Carpenter, R.A. 1997. "The Case for Continuous Monitoring and Adaptive Management Under NEPA." In *Environmental Policy and NEPA*. R. Clark and L. Canter, eds. Boca Raton, FL: St. Lucie Press.

[2] CEQ regulations require appropriate application of continual monitoring and assessment. Section 102(2)(B) of NEPA calls for "methods…which will insure that presently unquantified environmental amenities and values may be given appropriate consideration." CEQ regulations at 40 CFR 1505.2(c) and 1505.3(c) state, "a monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation" and that agencies "may provide for monitoring to assure that their decisions are carried out and should do so in important cases." The lead agency must, "upon request, inform cooperating or commenting agencies on progress in carrying out mitigation measures which they have proposed and which were adopted by the agency making the decision," and, "upon request, make available to the public the results of relevant monitoring."

ATTACHMENT F-1

United States Department of the Interior
Bureau of Land Management
State of Wyoming

DRAFT CHARTER

1. OFFICIAL DESIGNATION: Jonah Interagency Mitigation and Reclamation Office

2. BACKGROUND: The Jonah Natural Gas Field is an area of west central Wyoming, south of the town of Pinedale, within the Upper Green River Basin. It includes about 30,000 acres of rolling sagebrush covered lands that are about 80 percent federally managed surface and 83 percent federally managed minerals. It is an area of intense oil and gas development in 'tight sands.' The drilling spacing necessary to efficiently recover the oil and gas resource is denser than in traditional oil and gas field development. Further, the area has visual, wildlife and other resource values that complicate resource management issues.

3. PURPOSE: The Jonah Interagency Office (Project Office) will provide the services necessary to execute plans, monitoring, and other activities necessary to assure the effectiveness of land management recommendations, reclamation actions, and mitigation in the vicinity of the Jonah Natural Gas Field in accordance with the Record of Decision (ROD) for the Jonah Infill Drilling Project. In addition, the Project Office will provide oversight of funds available for reclamation monitoring and mitigation (offsite and onsite).

The scope of work for the Project Office includes the following:

- Oversee the selection and effectiveness of 30,000 – 90,000 acres of offsite mitigation
- Inspect and verify compliance on up to 15,000 acres of surface reclamation
- Inspect and monitor reclamation on up to 3,100 new well locations.
- Ensure compliance with the Wyoming DEQ Air Quality and Water Quality rules and regulations
- Monitor big game and sage grouse populations
- Assure habitat restoration
- Monitor livestock utilization of existing permits
- Validate, coordinate, and oversee research
- Coordinate transportation planning
- Assure vegetation surveys/Invasive species control
- Provide information to the respective agencies and the public regarding impacts, monitoring data, and mitigation success

4. OFFICE OBJECTIVES AND DUTIES: The Project Office will be staffed by full time employees or contractors of the responsible agencies. All personnel will have primary duties related to the implementation or support of monitoring and environmental compliance and permitting, focusing on, but not limited to, air, water, wildlife and reclamation monitoring of on-site and designated off-site mitigation acres related to Jonah Field development. Any tasks assigned to these employees or contractors outside this primary function would be supported by funds other than those described below in paragraph 10. The Bureau of Land Management will maintain the lease for the Project Office space.

Public and interagency reporting of resource conditions will occur on a regular basis. From time to time, state agencies may meet with interested citizens to inform interested stakeholders, and to discuss ongoing and anticipated mitigation and monitoring.

5. TERMINATION DATE: The cooperators anticipate that a need for an expanded personnel presence in the vicinity of the Jonah Natural Gas Field will continue to exist for the next 5 to 15 years. Periodically, the interagency staff will meet to review Project Office staffing needs and need for continuance of the individual staff.

6. JONAH INTERAGENCY OFFICE MANAGEMENT:

Jonah Project Office Coordinator
Bureau of Land Management
Department of the Interior
432 East Mill Street
P.O. Box 768
Pinedale, Wyoming 82941

7. ADMINISTRATIVE SUPPORT: Administrative support and funding for the Project Office will be provided by EnCana Oil & Gas (USA) Inc. contributions as set forth in #10 below.

8. ESTIMATED ANNUAL COST: The Project Office will require approximately $600,000 annually for all personnel, support, and office costs. This is established as follows:

- Initial staffing for the office: $500,000
- Building Rental in Pinedale: $24,000
- Computers, software, furniture, technical support and vehicles: $76,000

Each of the agencies listed in #9 below will employ a person/contractor to accomplish the work identified above. Annually, each of the Charter Members in #9 will develop a budget. All Charter Members will concur on budget estimates. Annually, or at another mutually agreed to interval, the duties and needs for each Project Office position will be examined by the Agency Managers Committee and mutually agreed to adjustments will be made. This could include office staffing increases, decreases, identification and expansion or contraction of duties. The primary duty location of the team is Pinedale, Wyoming.

9. JONAH INTERAGENCY OFFICE CHARTER MEMBERS:

A. Wyoming Department of Agriculture
B. Wyoming Game and Fish Department
C. Wyoming Department of Environmental Quality
D. United States Department of the Interior/Bureau of Land Management

The Charter Members will approve all disbursements of funds contributed by EnCana Oil & Gas (USA) Inc. or other industry contributors for the purpose of wildlife habitat improvement, resource monitoring and/or other mitigation.

10. FUNDING: EnCana Oil & Gas (USA) Inc. will provide funding to support the costs of the project office for a period of six years. The Project Office funding mechanism will be memorialized in the Jonah Infill EIS ROD. It is expected that participating operator(s) will see

timely permitting to the extent permitted by law. Other time economies related to confirmation of reclamation activities and increased public visibility of timely and successful environmental remediation and reclamation are also anticipated.

11. NATURE AND DUTIES OF THE AGENCY MANAGERS COMMITTEE: At least once per year, the Agency Managers committee, consisting of the agency heads or representatives from the Agencies in #9 above, and a single member of each of the oil and gas industry proponents involved in the Project Office will meet. At that annual oversight meeting, progress will be evaluated, and direction, coverage and staffing for the next year would be considered and adopted. At a minimum, the Agency Managers committee would provide the 'big picture' needs for the Project Office. For the initial period, this would include: 1.) Establish the initial mitigation and monitoring program for Air, Water, Wildlife, Livestock and Reclamation: 2.) selection and utilization of appropriate software or reporting standards to insure that all data collected would be stored and utilized in meeting the monitoring commitments contained in EIS's and other environmental documents: 3.) Coordination and tracking of ongoing research being conducted in the Jonah Project area to provide advice and recommendations on environmental monitoring and needed science to document the effects of Energy development: and 4.) Reporting.

12. AUTHORITY: The establishment of the Project Office is in the public interest in connection with the duties and responsibilities delegated to the BLM by the Secretary of the United States Department of the Interior in managing the public lands under section 307(b) of the Federal Land Policy and Management Act of 1976, 43 USC § 1737(b).

13. Nothing in this charter shall change the responsibilities or negotiated agreements of any State agency as it relates to dealing with impacts of development in southwest Wyoming.

ATTACHMENT F-2

DRAFT ESCROW AGREEMENT

The Wyoming Wildlife and Natural Resource Trust Account Board ("Escrow Agent"), an instrumentality of the State of Wyoming; and the Jonah Interagency Office Charter Members ("JIOCM"), an inter-agency group organized in the Charter of the Jonah Interagency Mitigation and Reclamation Office (attached, section 9), enter into this Escrow Agreement for the purposes of mitigating the loss of wildlife habitat function caused by the development of oil and gas in the Jonah Field. All terms not otherwise defined herein shall have the meaning ascribed in the Schedule of Definitions in Exhibit A hereto.

RECITALS

A. EnCana Oil & Gas (USA) Inc. and other oil and gas companies proposed in 2002 to expand their existing, approved drilling program by increasing the density of well spacing from 40 acre spacing to 10- and 5- acre spacing (a process termed in-fill drilling). At these proposed wellhead densities, the opportunities for mitigating the impacts of development and production activities at the site of impact are reduced, sometimes to the point of ineffectiveness. Because of the recognized potential impacts to surface resources (particularly wildlife and air quality) resulting from these high-intensity gas field activities, some of the companies (collectively the "Contributing Companies") agree to deposit funds into an Escrow Account for purposes of funding a program of compensatory mitigation (sometimes referred to as "off-site" mitigation) to offset the impacts of gas field development. The Contributing Companies commit to place certain funds to be used exclusively for either the purpose of Wildlife Habitat Improvement or that of Resource Monitoring and Other Mitigation, all of which escrow funds shall constitute the Escrowed Monies (as defined in Section 1.2 hereto).

B. The Escrow Agent is authorized to enter into this Escrow Agreement pursuant to Wyo. Stat. §§ 9-15-103(a), 9-15-103(c), 9-15-104 (g)(ii) and in accordance with the criteria enumerated in Section 9 of the Rules and Regulations of the Wildlife and Natural Resource Trust Account Board adopted pursuant to Wyo. Stat. § 9-15-104(f)(vi).

C. The Escrow Agent must invest, maintain, and apply the Escrowed Monies in the manner hereinafter set forth.

NOW, THEREFORE, in consideration of the mutual covenants and agreements contained herein, the parties hereto agree as follows:

Section 1. ESCROW OF MONIES

1.1 Deposit of Monies by Contributing Companies. On or before ____________________ and on each anniversary thereof, the Contributing Companies shall deposit funds with the Escrow Agent for the Jonah Field Wildlife Habitat Improvement, Monitoring and Other Mitigation Account (collectively referred to as the Escrow Account). The amount to be deposited is based on estimated annual costs as determined by the JIOCM; the maximum yearly amount can not be more than 20% of the total EnCana Oil & Gas Inc. commitment in any one year.

1.2 Escrowed Monies. Cash funds and investments in the Escrow Account, together with any income, including interest or profit received or made by the Escrow Agent in respect of monies on deposit under this Escrow Agreement, shall constitute the "Escrowed Monies". The Escrow Agent agrees to accept the Escrowed Monies, which shall be held in trust by the Escrow Agent for the use and benefit of the Jonah Field mitigation, and shall be withdrawn and applied only on and subject to the terms set forth in Section 3 hereto.

Section 2. INVESTMENT OF ESCROWED MONIES

2.1 Permitted Investments. The Escrow Agent agrees to invest the Escrowed Monies in accordance with the State of Wyoming's master investment policy established pursuant to Wyo. Stat. § 9-4-709.

2.2 Reporting and Auditing.

(a) The Escrow Agent shall furnish to EnCana Oil & Gas (USA) Inc. and the JIOCM, on or prior to the fifteenth business day of each month, a statement showing the total amount of Escrowed Monies and Escrowed Interest on deposit in, and all deposits to, and disbursements from, the Escrow Account for the previous month..

(b) The JIOCM have the right to periodically audit the Escrow Account and may choose to exercise their right with reasonable notice and during normal business hours.

Section 3. DISBURSEMENT OF ESCROWED MONIES

The Escrow Agent shall disburse Escrowed Monies upon the receipt of, and in accordance with, written instructions from the Jonah Interagency Project Office Coordinator, such written instructions to be jointly agreed to by all Charter Members of the Jonah Interagency Office.

The Jonah Interagency Project Office Coordinator shall submit an order for disbursement no more frequently than four (4) times per month. Upon receipt of an order substantially in the form of Exhibit B hereto, executed by the Jonah Interagency Project Office Coordinator, the Escrow Agent must disburse the Escrowed Monies in the manner requested on the certificate within ten (10) business days.

Section 4. THE ESCROW AGENT

The Escrow Agent hereby accepts the duties and responsibilities of the Escrow Agent hereunder on and subject to the following terms and conditions:

4.1 Scope of Undertaking. Escrow Agent's duties and responsibilities in connection with this Escrow Agreement shall be purely ministerial and shall be limited to those expressly set forth in this Escrow Agreement. Escrow Agent is not a principal, participant or beneficiary in any transaction underlying this Escrow Agreement and shall have no duty to inquire beyond the terms and provisions hereof. Escrow Agent shall have no responsibility or obligation of any kind in connection with this Escrow Agreement or the Escrowed Monies and shall not be required to deliver the Escrowed Monies or any part thereof or take any action with respect to any matters that might arise in connection therewith, other than to receive, hold, invest, reinvest and deliver the Escrowed Monies as herein provided. Escrow Agent shall not be liable for any error in judgment, any act or omission, any mistake of law or fact, or for anything it may do or refrain from doing in connection herewith except its own willful misconduct or negligence. It is the intention of the parties hereto that Escrow Agent shall never be required to use, advance or risk its own funds or otherwise incur financial liability in the performance of any of its duties or the exercise of any of its rights and powers hereunder.

4.2 Sovereign Immunity. The State of Wyoming and Escrow Agent do not waive sovereign immunity by entering into this Escrow Agreement and specifically retain immunity and all defenses available to them as sovereigns pursuant to Wyo. Stat. § 1-39-104(a) and all other state law.

4.3 Resignation; Removal; Successors.

(a) The Escrow Agent may resign and be discharged of the trusts created hereunder by mailing notice specifying the date when such resignation shall take effect to the Jonah Interagency Project Office Coordinator. Such resignation shall take effect on the day specified in such notice (being not less than 30 days after the mailing of such notice) unless previously a successor escrow agent shall have been appointed as hereinafter provided, in which event such resignation shall take effect immediately upon the appointment of such successor.

(b) The Escrow Agent may be removed and a successor escrow agent may be appointed at any time by an instrument in writing contemporaneously delivered to the Escrow Agent, or to such successor escrow agent. Such instrument must be executed by the JIOCM. The successor escrow agent must meet the qualifying criteria set forth below in Section 4.3 (c) and agree in writing to be bound by all of the terms and conditions of this Escrow Agreement.

(c) Any successor escrow agent shall be a state or national bank, financial institution or trust company in good standing, organized under the laws of the United States of America or any State thereof, having a capital, surplus and undivided profits aggregating at least US $500,000,000.00, unless JIOCM agrees otherwise.

4.4 Acceptance of Appointment. Every successor escrow agent appointed hereunder shall execute and deliver to its predecessor and JIOCM an instrument in writing accepting such appointment hereunder, and thereupon such successor escrow agent, without any further act, deed or conveyance, shall become fully vested with all the estates, properties, rights, powers, trusts, duties and obligations of its predecessor; but such predecessor shall, nevertheless, on the written request of JIOCM execute and deliver an instrument transferring to any successor escrow agent all the estates, properties, rights, titles, powers and trusts of such predecessor hereunder. Should any deed, conveyance or instrument in writing from JIOCM be required to more fully and certainly vest in such successor escrow agent the estates, rights, titles, powers and duties hereby vested, any and all such instruments in writing shall, on request of the successor escrow agent, be executed and delivered by JIOCM.

4.5 Compensation. The Escrow Agent shall be entitled to reasonable and customary compensation for all services rendered, and to reimbursement for all reasonable expenses, disbursements and advances incurred or made by it in and about the administration of the trusts herein provided for, and in and about enforcement or other protection of this Escrow Agreement. For purposes of this Escrow Agreement, compensation shall be one quarter of one percent (0.25%) of the Escrowed Monies. For purposes of this Section, compensation shall be calculated on the total sum of Escrowed Monies deposited during the calendar year and shall be immediately payable to the Wildlife and Natural Resource Income Account on December 31 of each year.

4.6 Collection. Unless otherwise specifically indicated herein, the Escrow Agent shall proceed as soon as practicable to collect any checks or other collection items at any time deposited hereunder and be entitled to have its legal fees and costs reimbursed from Escrowed Monies.

4.7 Authority. The Escrow Agent represents and warrants that it has the necessary power and authority to execute, deliver and perform its obligations under this Escrow Agreement.

4.8 Unenforceability. If for any reason this Escrow Agreement is rendered unworkable, unenforceable or illegal, the Escrowed Monies, together with all interest and earnings thereon, less any accrued compensation due Escrow Agent pursuant to Section 4.5 of this Escrow Agreement, shall revert to the Successor Escrow Agent upon their appointment under Section 4.3 of this Escrow Agreement.

Section 5. MISCELLANEOUS

5.1 Successors and Assigns. Whenever any of the parties hereto is referred to, such reference shall be deemed to include the successors and permitted assigns of such party; and all the covenants, promises and agreements in this Escrow Agreement contained by or on behalf of the Escrow Agent shall bind and inure to the benefit of the respective successors and permitted assigns of such parties, whether so expressed or not.

5.2 Separability. The unenforceability or invalidity of any provision or provisions of this Escrow Agreement shall not render any other provision or provisions herein contained unenforceable or invalid.

5.3 Amendments. Any term, covenant, agreement or condition of this Escrow Agreement may be amended or compliance therewith may be waived—either generally or in a particular instance, and either retrospectively or prospectively—by an instrument in writing executed and agreed to by Escrow Agent and JIOCM.

5.4 Notices. Any notice or other communication required or permitted to be given under this Escrow Agreement by any party hereto to any other party hereto shall be considered as properly given if in writing and (a) delivered against receipt therefore, (b) mailed by registered or certified mail, return receipt requested and postage prepaid or (c) sent by tele-facsimile machine, in each case to the address or tele-facsimile number, as the case may be, set forth below:

If to JIOCM:	Jonah Interagency Office Project Coordinator Bureau of Land Management P.O. Box 768 Pinedale, WY 82941 - 0768
If to the Escrow Agent:	Wyoming Wildlife and Natural Resource Trust Account Board 124 State Capitol Cheyenne, WY 82002
If to EnCana Oil & Gas (USA) Inc:	EnCana Oil & Gas (USA) Inc. Jonah Team Lead 370 17th Street Suite 1700 Denver, CO 80202

Or to such other address as any of the parties hereto may have substituted therefore by written notification to the other parties hereto in accordance with this Section 5.4. Delivery of any communication given in accordance herewith shall be effective only upon actual receipt thereof by the party or parties to whom such communication is directed. Whenever under the terms hereto the time for giving a notice or performing an act falls upon a Saturday, Sunday, or Legal Holiday, such time shall be extended to the next business day.

5.5 Governing Law. This Escrow Agreement shall be construed in accordance with and governed by the laws of the State of Wyoming.

5.6 Counterparts. This Escrow Agreement may be executed and delivered in any number of counterparts, each of such counterparts constituting an original but all together only one agreement.

5.7 Termination. JIOCM may terminate this Escrow Agreement at will, in a writing executed by the JIOCM, and the Escrow Agent shall, upon termination, pay over Escrowed Monies, less any accrued compensation as set described under Section 4.5 of this Escrow Agreement, as JIOCM shall direct.

IN WITNESS WHEREOF, the parties hereto have caused this Escrow Agreement to be executed and delivered as of the date shown in the first paragraph of this document.

Jonah Interagency Office Charter Members

For the Wyoming Department of Agriculture:

By: _______________________________ Date Signed: ____________________

For the Wyoming Game and Fish Department:

By: _______________________________ Date Signed: ____________________

For the Wyoming Department of Environmental Quality:

By: _______________________________ Date Signed: ____________________

For the United States Department of Interior/Bureau of Land Management:

By: _______________________________ Date Signed: ____________________

WYOMING WILDLIFE AND NATURAL RESOURCES TRUST ACCOUNT BOARD "Escrow Agent"

By _______________________________ Date Signed: ____________________
Delaine Roberts, Chairman

Exhibit A to
Escrow Agreement

SCHEDULE OF DEFINITIONS

"Administrative Fees" shall mean annual administrative service fees of the Escrow Agent.

"Business day" shall mean any day that is not a Saturday, Sunday or Legal Holiday.

"Legal Holiday" shall mean any Monday through Friday in which mail is not delivered by the United States Postal Service, and any day on which the New York Stock Exchange is closed.

Exhibit B to
Escrow Agreement

ORDER TO DISBURSE

_______________________, 20____

Wyoming Wildlife and Natural Resource Trust Account Board

Gentlemen:

Reference is made to the Escrow Agreement of (date) ________________, (the "Escrow Agreement") among the Jonah Interagency Office Charter Members ("JIOCM") and the Wyoming Wildlife and Natural Resource Trust Account Board. The authorized officer of JIOCM, in accordance with Section 3 of the Escrow Agreement, authorizes and directs you to disburse $_______________ from Escrowed Monies on deposit in the Escrow Account, on the date hereto to ______________, at [Bank and Account information or Address].

Very truly yours,

Jonah Interagency Office Project Coordinator

By:
Name:___ _______________________
Title: ____________________________
Date: ____________________________

APPENDIX G — SUMMARY OF IMPACTS ACROSS ALTERNATIVES

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
AIR QUALITY					
Increased concentrations of criteria pollutants and Hazardous Air Pollutants (HAPs)	No impact above existing levels; no new developments	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential near-field concentrations could exceed the Prevention of Significant Deterioration (PSD) 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential near-field concentrations could exceed the PSD 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable National Ambient Air Quality Standards (NAAQS) and Wyoming Ambient Air Quality Standards (WAAQS); potential near-field concentrations could exceed the PSD 24-hour PM_{10} increment but would be below the annual PM_{10} increment and below the PSD increments for all other pollutants; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.	Potential near-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential near-field concentrations would be below PSD increments; potential far-field concentrations would be in compliance with applicable NAAQS and WAAQS; potential far-field concentrations would be below PSD increments; potential HAP impacts would be below applicable health-based levels for non-cancer compounds and within acceptable cancer risk ranges for carcinogens.
Visibility (regional haze) at Class I and Sensitive Class II areas (far-field)	No impact above existing levels; no new developments	Potential project impacts would be greater than 1.0 deciview (dv) for a maximum of 10 days per year; significant project-specific and cumulative air quality impacts to visibility are possible at regional Class I airsheds; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 10 days per year; significant project-specific and cumulative air quality impacts to visibility are possible at regional Class I airsheds; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 4 days per year; significant project-specific and cumulative air quality impacts to visibility are possible at regional Class I airsheds; impairment at Bridger Wilderness only	Potential project impacts would be greater than 1.0 dv for a maximum of 3 days per year; significant project-specific and cumulative air quality impacts to visibility are possible at regional Class I airsheds; impairment at Bridger Wilderness only
Visibility (regional haze) (mid-field communities)	No impact above existing levels; no new developments	Maximum of 23 days per year >1.0 dv at Big Sandy	Maximum of 23 days per year >1.0 dv at Big Sandy	Maximum of 6 days per year >1.0 dv at Big Sandy	Maximum of 4 days per year >1.0 dv at Big Sandy
Atmospheric/terrestrial deposition	No impact above existing levels; no new developments	Potential project impacts from sulfur deposition would be less than Deposition Analysis Threshold (DAT) at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.035 kg/ha/yr), Popo Agie Wilderness (0.017 kg/ha/yr), and Wind River Roadless Area (0.010 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.035 kg/ha/yr), Popo Agie Wilderness (0.017 kg/ha/yr), and Wind River Roadless Area (0.010 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.018 kg/ha/yr), and Popo Agie Wilderness (0.008 kg/ha/yr), and less than DAT at all other analyzed areas	Potential project impacts from sulfur deposition would be less than DAT at all analyzed areas; potential project impacts from nitrogen deposition would be greater than DAT (i.e., 0.005 kg/ha/yr) at Bridger Wilderness (0.015 kg/ha/yr), and Popo Agie Wilderness (0.007 kg/ha/yr), and less than DAT at all other analyzed areas
Sensitive lake acid neutralization capacity (ANC)	No impact above existing levels; no new developments	Potential project impacts would be less than Level of Acceptable Change (LAC) at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes	Potential project impacts would be less than LAC at acid sensitive lakes
TOPOGRAPHY					
Landscape feature alteration	Total surface disturbance of 4,209 acres (2,811 acres short-term, 1,409 acres Life-of-project [LOP]); duration of impact would be 63 years; no major landscape feature alterations	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; impacts significant	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives; impacts significant	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts significant
MINERAL RESOURCES					
Natural gas	3.37 trillion cubic ft (TCF) of gas recovered	7.95 TCF of gas recovered; impacts significant	8.19 TCF of gas recovered; impacts significant	6.12 TCF gas recovered	4.82–7.95 TCF of gas recovered; impacts significant
Oil (condensate)	32.0 million barrels of oil (MBO) recovered	75.5 MBO recovered; impacts significant	77.8 MBO recovered; impacts significant	58.2 MBO recovered	45.8–75.5 MBO recovered; impacts significant
Other minerals	Localized LOP loss of access but no known minerals available in minable quantities; violation of contractual agreements; duration of impact would be 63 years	Increased loss of access above No Action and no violation of contractual agreements; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Increased loss of access above No Action and no violation of contractual agreements; duration of impacts increased to 105 years	Increased loss of access above No Action and no violation of contractual agreements; duration of impacts increased to 76 years
GEOLOGIC HAZARDS					
Earthquake damage	No impacts likely; low earthquake potential	Same as No Action	Same as No Action	Same as No Action	Same as No Action
Landslides and slumping	No impacts likely; no known landslide areas or underground mines; no new facilities developed; duration of impact would be 63 years	Increased above No Action in some areas; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Increased above No Action at project feature sites; duration of impacts increased to 105 years	Increased above No Action in some areas; increased mitigative actions; duration of impacts increased to 76 years

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
PALEONTOLOGICAL RESOURCES					
Disturbance/loss of important fossils during construction	Total surface disturbance of 4,209 acres (1,409 acres LOP); duration of impact would be 63 years; no major landscape feature alterations	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years;
Fossil collection/vandalism for LOP	Total surface disturbance of 4,209 acres (1,409 acres LOP); duration of impact would be 63 years; no major landscape feature alterations	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
SOILS					
Soils in general	No additional significant impacts	Impacts significant	Impacts significant	Impacts significant	Impacts significant
Disturbance and erosional loss of soils; soil compaction and mixing of soil horizons; decreased topsoil productivity	Surface disturbance of 4,209 acres is currently authorized; no further surface disturbance would be authorized	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Contamination due to accidental hazardous material discharge	No new facilities developed; decreased probability of impact; duration of impact would be 63 years	duration of impacts increased to 76 years; adherence to Spill Prevention, Control, and Countermeasures Plans (SPCCPs), Storm Water Pollution Prevention Plans (SWPPPs,) and other applicable local, state, and federal rules and regulations; prompt soil remediation to minimize potential impact severity	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; prompt soil remediation to minimize potential impact severity	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; prompt soil remediation to minimize potential impact severity; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Reactivation of stabilized dunes	No new surface disturbance of stabilized dunes	LOP potential until disturbed areas are reclaimed; 38 acres of known stabilized dunes occur within JIDPA	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
SURFACE WATER RESOURCES					
Surface water resources in general	Impacts unlikely to be significant	Impacts could be significant	Impacts could be significant	Impacts could be significant	Impacts could be significant
Increased turbidity, salinity, and sedimentation of surface waters due to runoff from disturbed areas	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; no natural perennial surface waters in the JIDPA	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Contamination of surface waters from accidental hazardous material discharge	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years; no new facilities developed; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules and regulations; prompt remediation to minimize potential impact severity	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Contamination of surface waters from discharge of unsuitable quality produced water and/or pipeline test water	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years; no new pipelines developed; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules and regulations; prompt remediation to minimize potential impact severity	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Alteration of surface drainages for LOP	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years; no new drainage crossings; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules; prompt remediation to minimize potential impact severity	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; no long-term modification of drainages	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Flood damage to pipelines and facilities for LOP	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules; prompt remediation to minimize potential impact severity; no new project facilities other than what are authorized under the Record of Decision (ROD)	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; few flood-prone areas in the JIDPA	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
GROUNDWATER RESOURCES					
Depletion during development	No new consumption of groundwater; full recovery of aquifer within a few years	Consumption of 1,225.0 acre-ft/year; 6.0 years to full recovery of aquifer; duration of impact would be approximately 13 years and until aquifer recovery	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Consumption of groundwater at 367.5 acre-ft/year; 0.5 years to full recovery; duration of impacts would be approximately 42 years and until aquifer recovery	Consumption of 1,225.0 acre-ft/year; 6.0 years to full aquifer recovery; duration of impacts would be 13 years and until aquifer recovery
Contamination of groundwater from accidental hazardous material discharge and cross contamination in well bores	Potential exists for contamination; duration of impact would be 63 years; adherence to SPCCPs, WOGCC, Bureau of Land Management (BLM) well casing and abandonment procedures, and other applicable local, state, and federal rules and regulations would minimize potential impact severity; no new development	Increased potential for contamination above No Action because new wells would be drilled; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Increased above No Action because new wells would be drilled; duration of impacts increased to 105 years	Increased above No Action because new wells would be drilled; duration of impacts increased to 76 years; impacts reduced due to application of specific mitigation measures
NOISE AND ODOR					
Increased noise levels near wells, facilities, and roads for LOP	Noise levels would not be increased above existing authorized actions (i.e., 533 wells on 497 well pads); duration of impact would be 63 years; although impacts were determined not significant during analysis of currently authorized actions, subsequent monitoring data indicate that existing noise levels likely are causing significant impacts; no additional significant impacts beyond those of previously authorized actions	Noise levels higher than described for No Action as a result of new well pads, wells, and other project facilities proposed; noise associated with construction and drilling activities would be short term, but that associated with field traffic and well maintenance would be increased to 76 years; impacts significant	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives; impacts significant	Noise levels similar to those described for Proposed Action as a result of new well pads, wells, and other project facilities proposed, but noise would be concentrated at existing pads; noise associated with construction and drilling activities would be short-term, but that associated with field traffic and well maintenance would be increased to 105 years; impacts significant	Noise levels higher than as described for No Action as a result of new well pads, wells, and other project facilities proposed; noise associated with field traffic and well maintenance would be increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; impacts significant
Presence of offensive odors near wells, facilities, and roads for LOP	Temporary, localized impacts rapidly dispersed by wind; decreased after development completed; duration of impact would be 63 years; no additional development; no additional significant impacts beyond those of previously authorized actions	Temporary, localized impacts rapidly dispersed by wind; decreased after development completed; duration of impacts increased to 76 years; impacts significant	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives; impacts significant	Temporary, localized impacts rapidly dispersed by wind; decreased after development completed; development foci would be limited to existing well pads; duration of impacts increased to 105 years; impacts significant	Temporary, localized impacts rapidly dispersed by wind; decreased after development completed; intermediate level of impacts between No Action and Proposed Action; duration of impacts increased to 76 years; impacts significant
VEGETATION INCLUDING BWS PLANT SPECIES					
Loss of vegetation; changes in diversity following reclamation (i.e., shrubland to grassland); and potential weed infestation for LOP and until areas adequately reclaimed	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; no new surface disturbance beyond that currently authorized	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts significant	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives; impacts significant	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts significant	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; impacts significant
Disturbance of wetlands and riparian areas for LOP	No new wetland disturbance	No impacts; all wetlands would be avoided	No impacts; all wetlands would be avoided	No impacts; all wetlands would be avoided	No impacts; all wetlands would be avoided

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
Unsuccessful reclamation for LOP and beyond	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; no new surface disturbance beyond that currently authorized	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Direct BWS plant habitat loss	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; no new surface disturbance beyond that currently authorized	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; adherence to site-specific surveys for BWS species would limit potential impact severity	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; adherence to Reclamation Plan would mitigate, to some degree, potential severity of adverse impacts due to vegetation loss; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
WILDLIFE INCLUDING BWS ANIMAL SPECIES					
Direct habitat loss Specific impacts that would be considered significant include, but would not be limited to, the physical loss or the abandonment of important wildlife features (e.g., greater sage-grouse leks, greater sage-grouse winter concentration areas, raptor nests and nesting and foraging territories, and pronghorn migration corridors), diminished wildlife diversity in the JIDPA, and degradation of crucial winter ranges and/or other important wildlife habitats.	Total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; impacts to wildlife and BWS species and their habitat would be locally significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; impacts to wildlife and BWS species and their habitat would be locally significant	Type, magnitude, and duration of impacts same as the Proposed Action but possibly increased in areas that would have been avoided by the Proposed Action and the other alternatives; certain Operator-committed and BLM-required practices concerning the protection of raptor nests, sage-grouse leks, and the Sand Draw drainage corridor would not occur, increasing the potential for adverse impacts to wildlife and BWS species; impacts to wildlife and BWS species and their habitat would be locally significant	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; impacts to wildlife and BWS species and their habitat would be locally significant	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Increased mortality	Unquantified mortality related to vehicle/animal collisions, construction, and potential stress-related deaths, especially during critical seasons, as a result of previously authorized actions; no new actions would be authorized under this alternative	Unquantified increase in mortality related to vehicle/animal collisions, construction, and potential stress-related deaths, especially during critical seasons; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives (i.e., Sand Draw, raptor nest, and sage grouse lek vicinities)	Unquantified increase in mortality related to vehicle/animal collisions, construction, and potential stress-related deaths, especially during critical seasons; level of impacts would be greater than those under the No Action Alternative, but less than those under the Preferred Alternative because no new pads would be constructed; duration of impacts increased to 105 years	Unquantified increase in mortality related to vehicle/animal collisions, construction, and potential stress-related deaths, especially during critical seasons; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
Displacement; indirect habitat loss; habitat fragmentation	Human activity would displace some species from areas near project features, which, when coupled with direct habitat loss, would further fragment habitats; displacement would cause increased use of other habitats in the region; duration of impact would be 63 years; 87.4% of the JIDPA would be within 0.25 mile of project features; no new actions would be authorized under the proposed project; impacts would be significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated	Same types of impacts as under No Action, but degree greatly increased; duration of impacts increased to 76 years; impacts would be significant	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives (i.e., Sand Draw, raptor nest, and sage grouse lek vicinities) ; impacts would be significant	Degree somewhat increased above No Action and duration of impacts increased to 105 years; habitat fragmentation would be somewhat increased from the No Action Alternative; impacts would be significant	Degree greatly increased above No Action and duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; habitat fragmentation would increase, with the degree dependent on the location and arrangement of project facilities within the field; impacts would be significant
Alteration of pronghorn migration routes	Potential avoidance of the JIDPA by migrating pronghorn; relatively undisturbed areas remain west of the JIDPA; project disturbances unlikely to block or prohibit migration to and from crucial ranges; duration of impact would be 63 years	Potential avoidance of the JIDPA by migrating pronghorn; relatively undisturbed areas remain west of the JIDPA; project disturbances unlikely to block or prohibit migration to and from crucial ranges; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Potential avoidance of the JIDPA by migrating pronghorn; relatively undisturbed areas remain west of the JIDPA; project disturbances unlikely to block or prohibit migration to and from crucial ranges; duration of impacts increased to 105 years	Potential avoidance of the JIDPA by migrating pronghorn; relatively undisturbed areas remain west of the JIDPA; project disturbances unlikely to block or prohibit migration to and from crucial ranges; duration of impacts increased to 76 years
Loss of greater sage-grouse productivity for LOP	Loss of breeding, nesting, and winter habitat due to surface disturbance, noise, traffic, and human presence; total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; impacts to greater sage-grouse and their habitat would be significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated	Types of impacts to greater sage-grouse similar to those under the No Action Alternative, but total surface disturbance of 20,409 acres (6,043 acres LOP) vs. 4,209 acres (1,409 acres LOP) under No Action; duration of impacts increased to 76 years; impacts to greater sage-grouse and their habitat would be significant	Type, magnitude, and duration of impacts similar to those of the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives; certain Operator-committed and BLM-required practices concerning the protection of sage-grouse leks would not occur, thus further increasing potential adverse impacts to sage-grouse; impacts to greater sage-grouse and their habitat would be significant	Types of impacts to greater sage-grouse similar to those under the No Action Alternative, but total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; impacts to greater sage-grouse and their habitat would be significant	Types of impacts to greater sage-grouse similar to those under the No Action Alternative, but total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; impacts to greater sage-grouse and their habitat would be significant
Loss of raptor productivity for LOP	Fewer nesting initiations, nest site abandonment, and reproductive failure or decreased productivity due to increased human activity, habitat loss, and loss of prey base as a result of surface disturbance, noise, traffic, and human presence; total surface disturbance of 4,209 acres (1,409 acres LOP) currently authorized; duration of impact would be 63 years plus time needed for adequate reclamation; impacts to raptors and their habitat would be locally significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated	Types of impacts to raptors similar to those under the No Action Alternative, but total surface disturbance of 20,409 acres (6,043 acres LOP) vs. 4,209 acres (1,409 acres LOP) under No Action; duration of impacts increased to 76 years; impacts to raptors and their habitat would be locally significant	Type, magnitude, and duration of impacts similar to those of the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives; certain Operator-committed and BLM-required practices concerning the protection of raptor nests would not occur, thus further increasing potential adverse impacts to nesting raptors; impacts to raptors and their habitat would be locally significant	Types of impacts to raptors similar to those under the No Action Alternative, but total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; impacts to raptors and their habitat would be locally significant	Types of impacts to raptors similar to those under the No Action Alternative, but total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; impacts to raptors and their habitat would be locally significant

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
THREATENED, ENDANGERED, PROPOSED, AND CANDIDATE (TEP&C) SPECIES					
Direct habitat loss for LOP	Total surface disturbance of 4,209 acres (1,409 acres LOP); duration of impact would be 63 years; no new disturbance or facilities; impacts to TEP&C species and their habitat would be minimal because of infrequent use of the area by TEP&C species	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years; impacts to TEP&C species and their habitat would be minimal because of infrequent use of the area by TEP&C species	Type, magnitude, and duration of impacts similar to those of the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives; certain Operator-committed and BLM-required practices concerning the protection of wildlife would not occur, increasing the potential for adverse impacts to TEP&C species and their habitat; however, impacts to TEP&C species and their habitat still would be minimal because of infrequent use of the area by TEP&C species	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years; impacts to TEP&C species and their habitat would be minimal because of infrequent use of the area by TEP&C species	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; impacts to TEP&C species and their habitat would be minimal because of infrequent use of the area by TEP&C species
Displacement for LOP	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; some decrease in available habitat and habitat function for some species; no new disturbance	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; some decrease in available habitat and habitat function for some species	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; some decrease in available habitat and habitat function for some species	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; some decrease in available habitat and habitat function for some species	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; some decrease in available habitat and habitat function for some species
Increased mortality for LOP	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no new facility sites	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal
Disturbance of critical habitats for LOP	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no critical habitat present; no new disturbance affected	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no critical habitat present	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no critical habitat present	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no critical habitat present	No adverse effects - no bald eagle nests or roosts; no confirmed black-footed ferret presence; no Ute ladies'-tresses habitat or known occurrence; no surface water withdrawal; no critical habitat present
Potential downstream surface water depletion due to groundwater pumping	No adverse effects	Annual groundwater depletions of 1,225 acre-ft may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker; mitigation would be in the form of paying a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program	Annual groundwater depletions of 1,225 acre-ft may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker; mitigation would be in the form of paying a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program	Annual groundwater depletions of 367.5 acre-ft may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker; mitigation would be in the form of paying a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program	Annual groundwater depletions of 1,225 acre-ft may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker; mitigation would be in the form of paying a "depletion charge" to the Upper Colorado River Endangered Fish Recovery Program
WILD HORSES					
Loss of habitat; displacement; mortality	No impacts above existing levels; no new surface disturbance	2,415 acres new disturbance (715 acres LOP) within the Little Colorado Herd Management Area (LCHMA); displacement due to human presence; potential vehicle/animal collisions; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	867 acres new disturbance (305 acres LOP) within the LCHMA; displacement due to human presence; potential vehicle/animal collisions; more areas with human presence; increased traffic; duration of impacts increased to 105 years	1,469 new disturbance (452 acres LOP) within the LCHMA; displacement due to human presence; potential vehicle/animal collisions; more areas with human presence; increased traffic; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
CULTURAL RESOURCES					
Cultural resources in general		Potential significant impacts to cultural resources could occur	Potential significant impacts to cultural resources could occur	Potential significant impacts to cultural resources could occur	Potential significant impacts to cultural resources could occur

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

IMPACT BY ENVIRONMENTAL RESOURCE	NO ACTION (No New Well or Pads)	PROPOSED ACTION (3,100 New Wells / 2,825 New Pads)	ALTERNATIVE A (3,100 Wells / 3,100 New Pads)	ALTERNATIVE B (3,100 Wells/No New Pads)	PREFERRED ALTERNATIVE [2] (3,100 Wells / 2,825 New Pads / Reclamation Credit, Mitigation/Monitoring)
Disturbance/destruction of important sites	Potential impacts assumed to increase with increased surface disturbance; total surface disturbance 4,209 acres; no new surface disturbance	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP)	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP)	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Artifact collection/site vandalism	Total surface disturbance of 4,209 acres; no new surface disturbance beyond that currently authorized; no increased human presence	Total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP); duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP); duration of impacts increased to 105 years	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; duration of impacts increased to 76 years
Disturbance of Native American religious or culturally significant sites	Avoidance of known sites and continued consultation would minimize potential impact severity; no new disturbance	Avoidance of known sites and continued consultation would minimize potential impact severity; total surface disturbance increased by 16,200 acres (11,577 acres short-term, 4,631 acres LOP)	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Total surface disturbance increased by 3,222 acres (2,037 acres short-term, 1,193 acres LOP)	Total surface disturbance increased by 9,821–16,125 acres (6,971–11,577 acres short-term, 2,858–4,611 acres LOP); impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
SOCIOECONOMICS					
Local population increase	Up to 13,947 new secondary labor Annual Job Equivalents (AJEs) from production for 63-year LOP; no population impact anticipated beyond existing levels; some job loss may occur as wells become less productive and abandonment begins to occur	Up to 9,899 new worker-years direct labor and 52,930 new AJEs secondary labor for development; 6,964 new worker-years and 32,928 new AJEs secondary labor for LOP from production; any increase to population minimal due to Operator-committed recruitment from local population; some unquantifiable in-migration may occur from active job-seekers; LOP extended to 76 years	Up to 9,899 new worker-years direct labor and 52,187 new AJEs secondary labor for development; 6,964 new worker-years and 33,939 new AJEs secondary labor for LOP from production; any increase to population minimal due to Operator-committed recruitment from local population; some unquantifiable in-migration may occur from active job-seekers; LOP extended to 76 years	Up to 9,899 new worker-years direct labor and 61,110 new AJEs secondary labor for development; 6,964 new worker-years and 25,374 new AJEs secondary labor for LOP from production; any increase to population minimal due to Operator-committed recruitment from local population; some unquantifiable in-migration may occur from active job-seekers; LOP extended to 105 years	Effects on employment and population same as under the Proposed Action
Increased demand for housing	No further impact anticipated beyond existing levels	Possible small increase in population may exacerbate an already tight housing market	Effects on housing same as under the Proposed Action	Effects on housing same as under the Proposed Action	Effects on housing same as under the Proposed Action
Increased demand for services	No further impact anticipated beyond existing levels	Possible small increase in population may increase demand on services	Effects on demand for services same as under the Proposed Action	Effects on demand for services same as under the Proposed Action	Effects on demand for services same as under the Proposed Action
Change of community character	No impact anticipated beyond existing social changes	Increased economic activity could enhance the availability of goods, services, and cultural, educational, and certain recreational opportunities; however, additional conversion of land from rangeland to gas development may be seen by some as industrialization and a diminishment of the characteristics they most value in the region and a loss of cultural heritage.	Effects on change of community character same as under the Proposed Action	Effects on change of community character same as under the Proposed Action	Effects on change of community character same as under the Proposed Action
Increased tax revenues and royalties	Continued tax revenue and royalty streams for 63-year LOP ($1,753.7 million present value); tax revenues and royalty streams would decline as wells become less productive; potential tax revenues and royalties would remain unrealized due to lack of new development and failure to recover mineral resources	Tax revenues and royalties would be expected to increase to $3,474.7 million present value in taxes/royalties	Tax revenues and royalties would be expected to increase to $3,574.9 million present value in taxes/royalties	Tax revenues and royalties would be expected to increase to $2,108.2 million present value in taxes/royalties	Tax revenues and royalties would be the same as under the Proposed Action ($3,474.7 million present value)

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Loss of revenues from livestock grazing due to loss of animal unit months (AUMs)	Worst case impact on grazing would be loss of $0.9 million present value over 63-year LOP if all AUMs lost; however, it is unlikely AUMs would be lost proportionately to the degree of development; actual impact will depend on the success of ongoing reclamation efforts as evaluated by monitoring data. No impacts beyond those of previously authorized activities would occur	Worst case impact on grazing would be loss of $6.6 million present value over 76-year LOP if all AUMs lost; however, it is unlikely AUMs would be lost proportionately to the degree of development; actual impact will depend on the success of ongoing reclamation efforts as evaluated by monitoring data	Impacts would be the same as those under the Proposed Action	Worst case impact on grazing would be loss of $2.0 million present value over 105-year LOP if all AUMs lost; however, it is unlikely AUMs would be lost proportionately to the degree of development; actual impact will depend on the success of ongoing reclamation efforts as evaluated by monitoring data	Impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Loss of hunting revenues	No impact anticipated beyond existing levels; LOP would be 63 years	Reduction in economic activity from hunting expenditures would be $1.0 million present value over the 76-year LOP	Impacts would be the same as those under the Proposed Action	Reduction in economic activity from hunting expenditures would be $1.1 million present value over the 105-year LOP	Impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Loss of recreation revenues	No impact anticipated beyond existing levels; LOP would be 63 years	Reduction in economic activity from recreation-related expenditures would be $2.4 million present value over the 76-year LOP	Impacts would be the same as those under the Proposed Action	Reduction in economic activity from recreation-related expenditures would be $2.7 million present value over the 105-year LOP	Impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Stimulation of local economics	No new development; total economic activity of $11,028.5 million present value for 63-year LOP	Total economic activity of $28,060.4 million present value for 76-year LOP	Total economic activity of $28,637.3 million present value for 76-year LOP	Total economic activity of $16,424.7 million present value for 105-year LOP	Total economic activity would be the same as under the Proposed Action
Environmental justice for LOP	No impact anticipated; no minority communities in study area; no low-income populations in study area	No impact anticipated; no minority communities in study area; no low-income populations in study area	No impact anticipated; no minority communities in study area; no low-income populations in study area	No impact anticipated; no minority communities in study area; no low-income populations in study area	No impact anticipated; no minority communities in study area; no low-income populations in study area
LAND USE/LIVESTOCK GRAZING					
Loss of animal unit months (AUMs) for livestock, wild horses, and wildlife for LOP	No additional impacts to livestock/grazing management other than those already approved for the area; duration of impacts would be 63 years	Stud Horse Common, Sand Draw Common, and Boundary Allotments: significant potential for a decrease in livestock forage depending on the results of reclamation efforts as evaluated by monitoring data; unlikely that AUMs would be lost proportionately to the degree of development; duration of impacts increased to 76 years Blue Rim Desert Common Allotment: the Burma Road upgrade would require reclamation along the roadsides, attracting cattle; increased traffic and increased speed would increase potential for vehicular/cattle collisions	Impacts the same as under the Proposed Action but possibly increased in areas that would have been avoided by Proposed Action and the other alternatives	Stud Horse Common, Sand Draw Common, and Boundary Allotments: considerable potential for a decrease in livestock forage depending on the results of reclamation efforts as evaluated by monitoring data; unlikely that AUMs would be lost proportionately to the degree of development; duration of impacts increased to 105 years Blue Rim Desert Common Allotment: no impacts because the Burma Road would not be upgraded	Stud Horse Common, Sand Draw Common, and Boundary Allotments: considerable potential for a decrease in livestock forage depending on the results of reclamation efforts as evaluated by monitoring data; unlikely that AUMs would be lost proportionately to the degree of development; duration of impacts increased to 76 years; potential for impacts generally would be lower than for the Proposed Action because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources Blue Rim Desert Common Allotment: no impacts because the Burma Road would not be upgraded

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LAND USE/RECREATION					
Reduced recreational use of JIDPA and adjacent areas for LOP	No additional impacts to recreational resources beyond existing levels; duration of impact would be 63 years; impacts on dispersed recreation opportunities may be significant; however, no additional significant impacts beyond those of previously authorized actions are anticipated; no significant impacts to recreation sites or facilities are anticipated	Displacement of existing dispersed recreation (e.g., hunting, wildlife viewing, photography) due to the increased level of development (e.g., facilities noise, traffic, dust, human presence) and the perceived reduction in the quality of the recreational experience; duration of impacts increased to 76 years; significant impacts on dispersed recreation opportunities but no significant impacts to sites or facilities	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives; significant impacts on dispersed recreation opportunities but no significant impacts to sites or facilities	Displacement of existing dispersed recreation (e.g., hunting, wildlife viewing, photography) due to the increased level of development (e.g., facilities noise, traffic, dust, human presence) and the perceived reduction in the quality of the recreational experience; duration of impacts increased to 105 years; significant impacts on dispersed recreation opportunities but no significant impacts to sites or facilities	Displacement of existing dispersed recreation (e.g., hunting, wildlife viewing, photography) due to the increased level of development (e.g., facilities noise, traffic, dust, human presence) and the perceived reduction in the quality of the recreational experience; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources; significant impacts on dispersed recreation opportunities but no significant impacts to sites or facilities
LAND USE/TRANSPORTATION					
Increased road miles and road density in JIDPA for 63-year LOP	No additional roads over 199 miles of currently authorized resource roads; duration of impact would be 63 years	An additional 465 miles of resource roads, 8 miles of collector roads, and 12 miles of Burma Road improvement above No Action; impact severity would be somewhat mitigated with adherence to the Transportation Plan; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	No new roads or improvement of the Burma Road; impact severity would be somewhat mitigated with adherence to the Transportation Plan; duration of impacts increased to 105 years	No new roads or improvement of the Burma Road; impact severity of existing (i.e., approved roads would be somewhat mitigated with adherence to the Transportation Plan; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Increased traffic for the 63-year LOP	Traffic would be maintained at existing levels with some potential for reduction; duration of impacts would be 63 years	Traffic increase may cause congestion, road damage, and increased collision potential; new and existing roads would be built and maintained to facilitate safety and accommodate increased traffic; adherence to the Transportation Plan would to some extent mitigate impact severity; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Traffic increase may cause congestion, road damage, and increased collision potential; new and existing roads would be built and maintained to facilitate safety and accommodate increased traffic; adherence to the Transportation Plan would to some extent mitigate impact severity; duration of impacts increased to 105 years	Traffic increase may cause congestion, road damage, and increased collision potential; new and existing roads would be built and maintained to facilitate safety and accommodate increased traffic; adherence to the Transportation Plan would to some extent mitigate impact severity; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
VISUAL RESOURCES					
Visual resources in general	Significant impacts from the existing developments have since been identified since authorization; however, no additional significant impacts beyond those of previously authorized actions are anticipated	Significant impacts may occur to non-JIDPA VRM Class I and II areas, including wilderness and wilderness study areas	Significant impacts may occur to non-JIDPA VRM Class I and II areas, including wilderness and wilderness study areas	Significant impacts may occur to non-JIDPA VRM Class I and II areas, including wilderness and wilderness study areas	Significant impacts may occur to non-JIDPA VRM Class I and II areas, including wilderness and wilderness study areas

Summary of Impacts Across Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2006[1]

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Modification to basic visual elements and changes in visual character of JIDPA for the LOP and until areas reclaimed	No additional impacts to visual resources beyond current authorized actions; duration of impacts would be 63 years	Continued long-term modification of visual characteristics; current visual resource management (VRM) Class IV designation of JIDPA would be maintained; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Continued long-term modification of visual characteristics; current visual resource management (VRM) Class IV designation of JIDPA would be maintained; duration of impacts increased to 105 years	Continued long-term modification of visual characteristics; current visual resource management (VRM) Class IV designation of JIDPA would be maintained; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because maximum disturbance at any one time would be limited to 14,030 acres; additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
Light pollution effects at JIDPA and viewsheds where JIDPA is visible	No additional impacts beyond current levels; duration of impacts would be 63 years	Light impacts would be increased due to additional development; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Light impacts would be increased due to additional development; duration of impacts increased to 105 years	Light impacts would be increased due to additional development; duration of impacts increased to 76 years; impacts would be similar to those of the proposed action except potential for impacts generally would be lower because additional mitigation measures would be applied to facilitate achievement of specific management objectives and to minimize impacts to resources
HAZARDOUS MATERIALS					
Soil, surface water, and groundwater contamination and wildlife exposure from accidental spills, pipeline ruptures, etc., for the LOP	No additional opportunities for material spills, pipeline ruptures, and/or exposure to hazardous materials above present approved levels; LOP would be 63 years	Increased above No Action due to more materials, produced, used, stored, and transported; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules and regulations and appropriate monitoring, containment, and disposal of hazardous materials would limit potential impact severity; duration of impacts increased to 76 years	Type, magnitude, and duration of impacts same as the Proposed Action but increased in areas that would have been avoided by the Proposed Action and the other alternatives	Increased above No Action due to more materials, produced, used, stored, and transported; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules and regulations and appropriate monitoring, containment, and disposal of hazardous materials would limit potential impact severity; duration of impacts increased to 105 years	Increased above No Action due to more materials, produced, used, stored, and transported; adherence to SPCCPs, SWPPPs, and other applicable local, state, and federal rules and regulations and appropriate monitoring, containment, and disposal of hazardous materials would limit potential impact severity; duration of impacts increased to 76 years

1 Impacts assume successful implementation of the variously proposed mitigation/monitoring/development requirements (see Appendices A and C).
2 Assumes 3,100 additional wells.

APPENDIX H — U.S. FISH AND WILDLIFE SERVICE LETTER INITIATING FORMAL CONSULTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Airport Parkway
Cheyenne, Wyoming 82001

DEC 1 6 2005

In Reply Refer To:
ES/61411/W.02/WY9913
ES-6-RO-94-F-006(a)-WY113

Memorandum

To: Priscilla Mecham, Field Manager, Bureau of Land Management, Pinedale Field Office, Pinedale, Wyoming

From: Brian T. Kelly, Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, Wyoming

Subject: Revised Jonah Infill Drilling Project, Jonah Gas Field Native Habitat Surface Reclamation Project, and Jonah Bird to Opal III Project

In a letter of October 25, 2005, you requested formal consultation for a 67 acre-foot (af) depletion to the Green River resulting from the Jonah Gas Field Native Habitat Surface Reclamation Project, and for an average annual depletion of 1,000 af resulting from the revised proposed action for the Jonah Infill Drilling Project located at T28-29N, R107-109W in Sublette County, Wyoming. Information also was received by our office on November 7, 2005, regarding the use of Colorado River Basin water for the Jonah Bird to Opal III portion of the Jonah Infill Project and the resultant depletion of 16.2 acre-feet. In accordance with section 7 (a)(2) of the Endangered Species Act of 1973 (Act), as amended, 50 CFR §402.14, the U.S. Fish and Wildlife Service (Service) has reviewed the information provided regarding the impacts of the proposed Projects federally listed species.

We understand that the Pinedale Field Office is not the lead field office for the proposed Bird to Opal III portion of the Jonah Infill Drilling Project. Based on information provided, the Service expects to receive a complete Biological Assessment for the Bird to Opal III Project from either the Rock Springs or Kemmerer Field Office. In order to complete section 7 consultation for consumptive water use in the Colorado River Basin without treating it in a piece-meal fashion for different components of the proposed Jonah Infill Project, we are including the depletion associated with Bird to Opal III in this consultation. Consequently, this memo does not address impacts to all federally listed species or other Service trust resources that may be affected by the Bird to Opal III portion of the proposed Project, but addresses only those effects to downstream Colorado River fishes due to the 16.2 af depletion.

The Jonah Infill Drilling Project is an expansion of the existing natural gas development project described in the *Jonah Field II Natural Gas Project Record of Decision for the Environmental*

Impact Statement (EIS) (April 1998) and the *Modified Jonah Field II Natural Gas Project Environmental Assessment* (June 2000). The revised proposed action for the Jonah Infill Project proposes to further increase the number of wells and associated disturbance within the project area. Authorization of the revised proposed action will increase the existing natural gas development by 3,100 new wells and an additional 16,200 acres of disturbance.

The Service provided you with scoping comments in a memo dated January 6, 2004, concerning the revised proposed action for the Jonah Infill Drilling Project, in addition to comments provided in a memo dated May 9, 2003, for the preparation of the original EIS. In our January 6, 2004, memo we expressed concern that an additional 16,200 acres of disturbance could pose a serious threat to an area where wildlife habitat is already severally degraded. Because of the scale of the proposed action and concomitant impacts to local wildlife and habitat, we would like to reiterate several points. Habitat fragmentation, disruption of seasonal migration routes and disruption of breeding activity is caused by access roads, well pads, pipelines, power lines, transmission stations, compressors and increased traffic that accompany natural gas development. The Bureau should give considerable thought to the cumulative impacts that may occur from 3,100 new wells combined with existing development within the Green River Basin. This area is important to many species of wildlife, including listed and proposed species.

To further the conservation of federally-listed species, sensitive species, and their habitats the Service recommends that your decisions regarding increased drilling within the Jonah Gas Field include a thorough analysis of the effects of the proposed action on all wildlife and habitat resources that may be impacted. Therefore, the Service recommends that: (1) the Bureau and/or project proponent conduct a site specific analysis of each well pad site and include stipulations as recommended by the Service, the Bureau, and the Wyoming Game and Fish Department to minimize impacts to wildlife; (2) the project proponent commit to enhance off-site wildlife habitats in-kind at a minimum 1:1 ratio of enhanced habitat acreage to impacted habitat acreage; (3) the Bureau deny permitting of drilling activities in areas where impacts to wildlife are such that no stipulations or mitigation would replace the eliminated habitat; (4) the Bureau monitor truck traffic and human presence to ensure that it is minimized within the field; and (5) the Bureau deny exceptions to stipulations except in the case of an actual emergency. The Service is concerned with the number of exceptions to wildlife protection stipulations on Bureau lands within Wyoming.

Additionally, we strongly recommend that development be phased in over time ensuring that management objectives for wildlife species are met. Additional phases of development should be authorized only when previously disturbed areas have been reclaimed to such a level as to provide suitable habitat for species that are affected. The Service recommends that disturbed areas be reclaimed with native species that persisted prior to disturbance such as sage brush and native grasses. Reclamation with grass species in an area previously dominated by sage brush should not constitute complete and final reclamation.

The Service reminds the Bureau that habitat enhancement projects serving as mitigation also should consider potential effects (beneficial or negative) to listed and proposed species, migratory birds, and petitioned species. The Service further encourages continued research and monitoring regarding the impacts of natural gas development to wildlife within the Jonah Field. We would appreciate receiving data regarding listed and sensitive species.

Colorado River Fishes
On March 13, 1997, the Service issued a letter of concurrence for a may affect, not likely to adversely affect, determination for Colorado River fishes for consumptive use of water associated with the originally proposed Jonah Field II Natural Gas Development Project as described in the Preliminary Draft EIS. The Service believes that our concurrence was in error since any consumptive use of water to the Colorado River System, whether surface water or groundwater, constitutes an adverse effect to the downstream listed Colorado River fishes and their designated critical habitat: therefore, any such depletion requires formal section 7 consultation for compliance under the Act. Unfortunately, since the Project- related depletion has already occurred without formal section 7 consultation, the Service cannot provide after-the-fact concurrence for this depletion. Please be advised that in the future all such depletions within the Colorado River Basin must undergo formal section 7 consultation to ensure compliance under the Act.

We understand that the revised Jonah Infill Drilling Project as currently proposed will result in a total additional depletion of 12,483 acre-feet (af) over the 12.4 year life of the project: 12,400 af for well-drilling and hydrostatic testing of pipelines; 67 af for Native Habitat Surface Reclamation; and 16.2 af for hydrostatic pipeline testing associated with the Bird to Opal III portion of the Jonah Infill Drilling Project. The average annual depletion associated with all these components of the proposed Project is 1,006.7 af (i.e., 12,483 divided by 12.4 years).

A Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) was initiated on January 22, 1988. The Recovery program was intended to be the reasonable and prudent alternative to avoid jeopardy to the endangered fish by depletions from the Upper Colorado River. Because the estimated depletion of 1,006.7 af is over 100 af, it is considered a "major" depletion according to the Recovery Program for which an individual Biological Opinion (BO) will be issued by the Service's Mountain Prairie Regional Office. We anticipate completion of this BO within the next 30 days.

Greater Sage-grouse
Although the Service has determined that the greater sage-grouse (*Centrocercus urophasianus*) is unwarranted for listing at this time, we continue to have concerns regarding sage-grouse population status, trends and threats, as well as concerns for other sagebrush obligates. As you know, sage-grouse are dependent on sagebrush habitats year-round. Therefore, any activities that result in loss or degradation of sagebrush habitats that are important to this species should be closely evaluated for their impacts to sage-grouse. We recommend you contact the Wyoming Game and Fish Department to identify important greater sage-grouse habitats within the project area, and implement their recommended mitigative measures to protect these habitats. No project activities that may exacerbate habitat loss or degradation should be permitted in important habitats.

Increased development within the Jonah Gas Field should be carefully evaluated for long-term and cumulative effects on the greater sage-grouse as reclamation will not restore sage brush habitat to pre-development quality which may exacerbate greater sage-grouse declines on either a local or range-wide level.

We also remind the Bureau that they are a signatory, along with the U.S. Forest Service and the U.S. Fish and Wildlife Service, to the 2000 Memorandum of Understanding (MOU) with the Western Association of Fish and Wildlife Agencies (WAFWA) to conserve the greater sage-grouse and its habitat. This MOU outlined the participation of Federal and State wildlife agencies, including the Wyoming Game and Fish Department, in greater sage-grouse conservation, and these commitments should be considered in project planning in sage-grouse habitat. Additionally, unless site-specific information is available, greater sage-grouse habitat should be managed following the guidelines by Connelly *et al.* 2000 (also known as the WAFWA guidelines).

Pygmy Rabbit

Although the Service has concluded that the petition to list the pygmy rabbit (*Brachylagus idahoensis*) does not contain substantial scientific information to warrant a 12-month review, we continue to encourage federal agencies to analyze project areas for potential effects to pygmy rabbits and their habitats. This smallest of the *Leporidae* family occurs in portions of many western states including southwestern Wyoming where occurrence has been confirmed in a few isolated populations in Lincoln, Uinta, Sweetwater, Sublette and Fremont Counties. Pygmy rabbits are sagebrush obligate species, primarily found in dense western big sagebrush (*Artemisia tridentata ssp.*) communities preferably where at least two other species of sagebrush and forbs also occur. Conversion of sagebrush grasslands, habitat fragmentation and overgrazing are considered potential threats to pygmy rabbits. Project planning measures that retain large tracts of suitable habitat and corridors to adjacent habitat will aid in the conservation of this species.

Black-footed Ferret

Based on our review of the 2004 Wildlife Studies for the Jonah Gas Field Development Project (TRC Mariah Associates, Inc.) and the 2004 block-clearance efforts by the Service and the Wyoming Game and Fish Department (WGFD), we are interested in whether the Jonah Field prairie dog towns are associated with the Big Piney prairie dog complex. The Big Piney complex is not block-cleared and is generally located within T28, R111-112 and T29-31, R109-111, just west of the Jonah Field. It is well known that white-tailed prairie dog towns are dynamic and "move" across the landscape. Therefore, we would appreciate information as to the relationship between the Jonah Field prairie dog towns and the Big Piney complex. We recommend mapping the current prairie dog activity along the western edge of the EIS area and determining the distance to the nearest town within the Big Piney complex. This may require mapping of some towns outside of the EIS area but within the eastern portion of the Big Piney complex. The Service's 1989 Black-footed Ferret Guidelines define a complex as two or more towns less than 7 kilometers (4.3 miles) from each other. In the event that the Jonah Field prairie dog towns are within 4.3 miles of towns associated with the Big Piney complex then they should be considered part of that complex and additional information may be required before a decision on surveys for black-footed ferrets is made. More importantly, mapping, and information regarding previous surveys and history of plague will assist the Service and the WGFD to block-clear this complex and subsequently concentrate our efforts toward ferret reintroduction.

Wetlands/Riparian Areas

Wetlands and riparian areas perform significant ecological functions which rarely can be mitigated. These functions include: (1) providing habitat for numerous aquatic and terrestrial wildlife species, (2) aiding in the dispersal of floods, (3) improving water quality through retention and assimilation of pollutants from storm water runoff, (4) recharging the aquifer, and (5) supporting a greater variety of wildlife than any other habitat. The Service recommends that well pads, roads and associated development be prohibited within wetland and riparian areas.

Interrelated and Interdependent Effects

If an action on federal lands is in any way related to an action on state and/or private lands then the impacts to listed species on the non-federal lands must be considered interrelated and interdependent effects. Under the Act, the Bureau is obligated to evaluate all potential impacts to listed species from actions on state and private lands within the project area. An action on federal lands should only be authorized when the project proponent is committed to developing and implementing measures to avoid or minimize impacts to listed species on non-federal lands that would occur as a direct or indirect result of the action on federal lands.

The Bureau should notify all lessees and private land owners of their responsibilities to comply with federal and other applicable regulations, regardless of land or mineral ownership (including the Endangered Species Act, the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act). If the Bureau, surface owners and lessees agree, these private and state lands can be included in section 7 consultation conducted on federal lands within the project area.

We appreciate your efforts to ensure the conservation of endangered, threatened, and candidate species and migratory birds. If the scope of the project is changed, or the project is modified, in a manner that you determine may affect a listed species, this office should be contacted to discuss consultation requirements pursuant to section 7(a)(2) of the Act. If you have further questions regarding our comments or your responsibilities under the Act, please contact Kathleen Erwin of my staff at the letterhead address or phone (307)772-2374, extension 28, or Tyler Abbott at extension 23.

cc: BLM, Kemmerer, Field Manager (M. J. Rugwell)
BLM, Rock Springs, Field Manager (M. Holbert)
WGFD, Lander, Non-Game Coordinator (B. Oakleaf)
WGFD, Cheyenne, Statewide Habitat Protection Coordinator (V. Stelter)

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APPENDIX I — CULTURAL RESOURCES AND HISTORIC OVERVIEW

The following sections are from the Draft Environmental Impact Statement Jonah Field II Natural Gas Project (BLM 1997) and provide an overview of the cultural resources within the Jonah Infill Drilling Project Area. Understanding of the Jonah field cultural resources is undergoing extensive synthesis as part of the ongoing Pinedale RMP and other efforts. The below is a somewhat dated but still useful general summary.

I-1.0 CULTURAL RESOURCES

Cultural resources, which are considered under the National Historic Preservation Act of 1966 (NHPA) and the Archaeological Resources Protection Act of 1979 (ARPA), are the nonrenewable remains of past human activity. The archaeological record of the Jonah Field II Project Area (J2PA) has been partially examined through surveys, test excavations, examination of ethnographic materials, consultation with modern Native American people, archival sources, and the historic record. Euro-American exploration and settlement in the area is understood by historic and archival records, information provided by local ranchers, and informant interview. The J2PA is rich in prehistoric resources (though they are poorly understood), but contains fewer historic period sites. The historic period sites predominantly relate to open range ranching, stock grazing, and wagon road passage.

Prior to fall 1996, less than 50 sites had been recorded on the J2PA during an equivalent number of cultural resource inventory projects. In November and December 1996, Operators conducted a geophysical project covering portions of the J2PA. This project involved a cultural resource inventory, and 74 new sites were located and recorded (Kail and Sudman 1997). These cultural resource data have added substantially to our knowledge of the area's prehistory.

I-1.1 Site Types

Prehistoric site types known or suspected for the J2PA include prehistoric campsites, housepits, lithic scatters, kill/butchering sites, floral processing locales, sacred sites, extensive lithic procurement locales (see Section I-1.5), Traditional Cultural Properties, limited activity sites, and various rock alignment sites. Rock alignment sites include vision quest locales, stone circle sites such as tipi rings (three have been recorded), Medicine Wheels, and cairns. No drivelines are currently known, but the vicinity of Sites 48SU1327 and 48SU1328 is suggestive. While no human burials, petroglyphs, or pictograph sites currently are known, the geomorphology of the area is conducive to the presence of these most sensitive site types. The preliminary work conducted in the J2PA suggest high site density, complex geomorphology, and a different cultural character of prehistory as compared to other, better known regions of the Green River Basin.

I-1.2 Native American Sensitive Sites and Traditional Cultural Properties

In the late nineteenth century, the J2PA was used predominantly by the Shoshone Tribe, though the Bannock, Ute, and other tribes frequented the Upper Green River. In prehistoric times, this picture is clouded, as tribal distinctions are difficult, if not impossible, to determine. Both prehistoric sties and more modern Native American use sites are sensitive, or can be considered Traditional Cultural Properties.

Sites and properties within this class are protected by numerous laws, such as the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and Executive Orders. Human burials, rock alignment sites, petroglyphs, steatite procurement locales, and modern-day Native American use, extraction, or religious sites are considered sensitive or sacred to modern Native Americans. One such site is already identified (48SU2194), and others are known from the J2PA (e.g., 48SU2215). Consultation with potentially affected Native American Tribes concerning the identification and management of Traditional Cultural Properties and other sensitive sites in the J2PA began in 1996, was curtailed by the onset of winter, and is scheduled to resume in spring 1997.

I-1.3 Chronology

The earliest securely documented human occupations in North America are associated with diagnostic (temporally distinct) projectile points of the Clovis and Folsom Traditions. Clovis and Folsom sites have been radiocarbon dated to between 12,000 and 10,500 years before present (YBP). These Paleoindian sites represent early human adaptation to Late Pleistocene, post-glacial environmental conditions. Past emphasis on the “Big Game Hunting Tradition” (i.e., a reliance on Pleistocene megafauna for subsistence) may have been overstressed (personal communication, January 1997, with Kevin Thompson, Archaeologist, Western Wyoming College). Studies of Paleoindian sites continue to fascinate archaeologists, and the new trend in paleoenvironmental reconstruction of the late Pleistocene/early Holocene environments is welcome.

Early Paleoindian occupations are known from just south of the J2PA. Sites 48SU389, 48SU907, 48SU908, and 48SU909 record extensive prehistoric occupations associated with an assumed perennial watersource. Recorded in the 1970s and rerecorded by the State of Wyoming in the 1980s, the site complex has produces Folsom materials and Paleoindian artifacts in the Hell Gap, Agate Basin, Scottsbluff, and Cody Complexes, as well as numerous Archaic and Late Prehistoric period artifacts, including a bison bone bed, groundstone, and other artifacts. Paleoindian occupations spanning a 12,000 to 8,000 YBP period are suggested at this large and significant site complex.

The first documented Paleoindian presence within the J2PA is recorded at Site 48SU1421. Here, Late Paleoindian diagnostic artifacts in the Lanceolate and Medicine Lodge Creek/Lovell Constricted Series were found. The “Jimmy Allen” Lance point tentatively dates the site to about 9,000 YBP. A Pryor Stemmed Point suggests an 8,500 YBP occupation. Associated with a campsite adjacent to an ancient playa lake, the site setting is duplicated at several locales within the J2PA. There is potential for use of this site for paleoenvironmental reconstruction. Additional Paleoindian sites in the J2PA likely occur, such as Site 48SU2230 (recorded in 1996), though such sites are not abundant. Extensive prior artifact collecting makes location of temporally diagnostic material difficult.

By about 8,000 YBP, postglacial environmental conditions began to reflect a more modern setting. Pleistocene megafauna such as mammoth, prehistoric bison, camel, and early horse became extinct. Human occupation sites reflect this shift, and archaeologists refer to the subsequent 6,000 years of prehistory as the Archaic Period. Figure I-1.1 depicts several different interpretations of Archaic Period chronology. The Metcalf (1987) scenario drew from the Exxon LaBarge EIS project to the south and west of the J2PA; Wheeler et al.'s (1986) similar chronology reflects excavations at the Exxon Shute Creek Plantsite. The McKibbin et al. (1989) version reflects work in Sweetwater County, Wyoming, at the Black Butte Coal Mine, similar to that of McNees et al. (1994).

Finally, archaeologists at Western Wyoming College (WWC) continue to refine southwestern Wyoming's chronology based on the most recent data and a recognition that Late Paleoindian sites may indeed mirror "Archaic" lifestyles. Rather than exclusively big game hunters, Paleoindians early on may have developed a detailed knowledge of the environment and the seasonal availability of floral and faunal resources—a hunting/foraging/collecting subsistence strategy. The resultant settlement pattern would resemble an annual cycle or "seasonal round" tapping into different resources in different locales, when available.

Sites dating to the Archaic Period (roughly 8,000 to 2,000 YBP) are numerous in the J2PA. These sites are temporally divided into the Great Divide Phase, the Green River/Opal Phase, the Pine Springs Phase (roughly equivalent to the McKean Technocomplex in the northern Great Plains [Frison 1991]), and the Deadman Wash Phase (equivalent to the Late Archaic on the Plains). The Uinta Phase marks the introduction of the bow and arrow into southwestern Wyoming and, later, the production of ceramics. These cultural innovations mark the traditional end of the Archaic Period.

One site (Site 48SU1754) on the J2PA was located and salvaged in a joint effort by Operators and the Bureau of Land Management (BLM). Hearths, lithics, tools, and butchered and processed mammal bone were recovered from the excavations. Radiocarbon assay documented an occupation of 3,590 ± 60 YBP, a Pine Springs Phase/McKean Technocomplex site. Site 48SU1754 represents the only site in the J2PA that has been subject to controlled excavations, and the site is considered eligible for the National Register of Historic Places (NRHP).

Other Archaic-aged campsites like Sites 48SU1328, 48SU1561, 48SU1562, 48SU1751, 48SU1778, and 48SU1779 are commonly identified. These sites usually date to the Pine Springs and Deadman Wash Phases of the Archaic and produce McKean Technocomplex (Site 48SU1328) and Late Archaic Period (Site 48SU1751) dart points and numerous lithic tools. The Archaic dart point recovered from Site 48SU1751 was manufactured from obsidian, a volcanic glass that can be easily sourced via X-ray florescence techniques to the exact parent obsidian flow. Obsidian source analysis (Thompson et al. 1993) is proving to be important in discerning ancient trade patterns and population movement throughout the Intermountain region. Site within the J2PA area will undoubtedly play an important part in this study.

Sites dating to the Late Prehistoric Period, Uinta and Firehole Phases (about 1,800 to 200 YBP), are probably the most numerous. Recent inventory efforts recorded approximately 70 new sites, many of which date to the Late Prehistoric period. Sites like Site 48SU1563 have produced both Rose Springs Series arrow points (a diagnostic Uinta Phase marker) and groundstone, suggesting both hunting and vegetal food collecting as subsistence strategies. Sites 48SU2189, 48SU2198, and 48SU2204 contain similar Uinta Phase material.

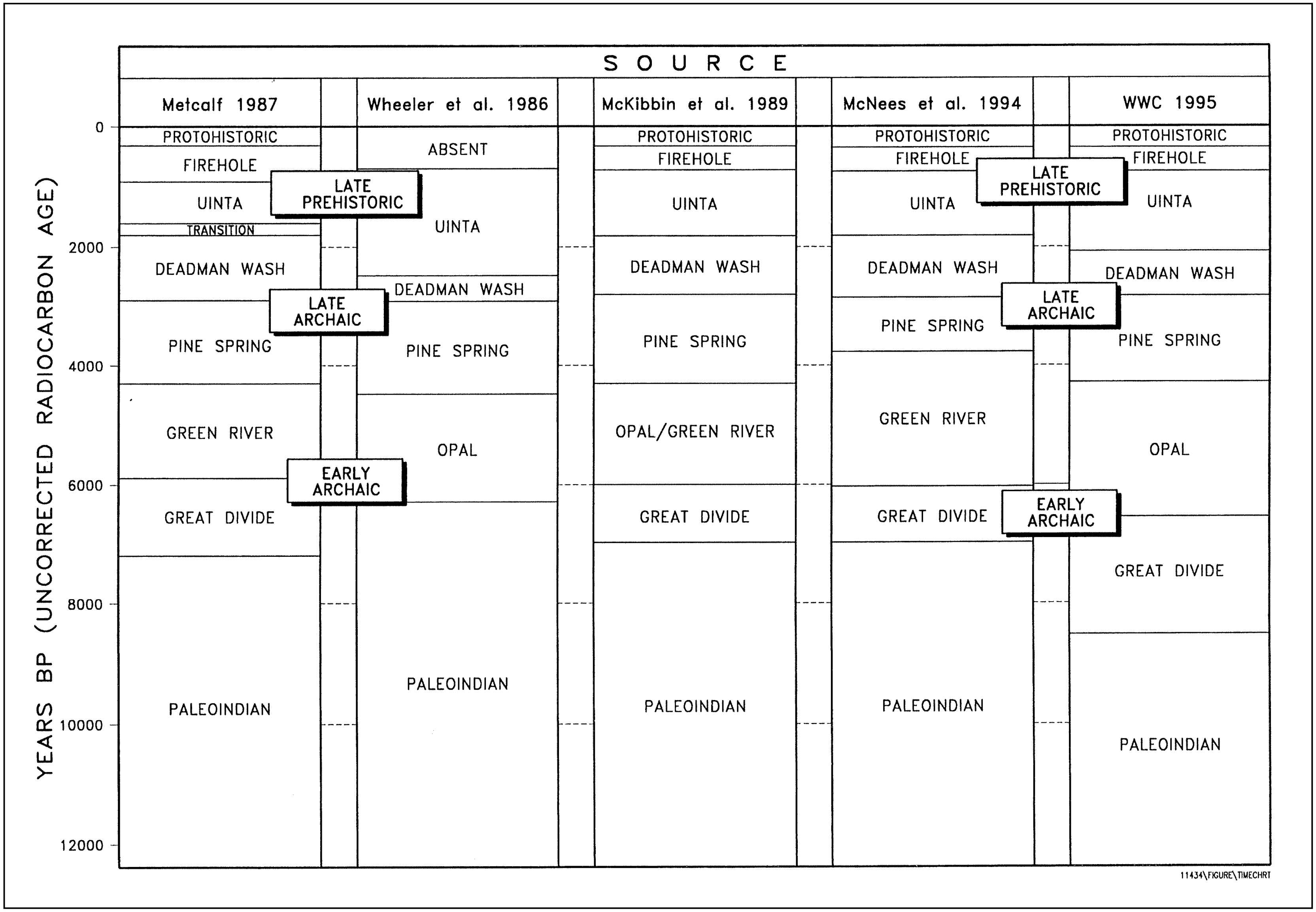

Figure I-1.1. Cultural Chronology Framework with Revisions, Jonah Field II Project, Sublette County, Wyoming, 1997.

An important site containing prehistoric Intermountain ware ceramics is Site 48SU1443, located in the J2PA. Here, sherds of brown-gray pottery containing sand (or grit) tempering may relate to similar ceramics recovered from the Wardell Site, located to the north. The identification of prehistoric ceramics on sites anywhere within the Green River Basin is unusual and adds to the site's significance. Ceramic analysis can shed light on shared cultural affiliation with adjacent groups, such as the Fremont regions within Utah to the west and south or the sedentary villagers to the south and east in Colorado. Distinctions between Uinta Phase peoples and the later Firehole Phase occupants can be drawn by ceramic analysis.

Stone circle sites like those recorded at Sites 48SU2194 and 48SU2215 represent preserved dwelling or residence sites that suggest a modicum of sedentary (or seasonal) existence. These sites, though currently undated, frequently are Late Prehistoric in age and are good candidates for containing ceramics in their assemblages. Stone circle sites are considered sensitive by some modern-day Native Americans.

One site, Site 48SU968, was also subject to a small salvage effort. Two hearths were excavated, but noteworthy was the recovery of portions of a steatite bowl (personal communication, January 1997, with Scott McKern, consulting archaeologist). Steatite was aboriginally quarried in the adjacent Wind River mountains (Vlcek 1993) and represents an unusual resource, subject to transportation or trade with adjacent prehistoric populations. The recovery of steatite on sites removed from the mountains is rare, but not unknown in the J2PA (personal communication, n.d., with Pete Olsen, local rancher). Steatite use is more commonly documented on Late Prehistoric and protohistoric sites, though Archaic aged use is documented. Steatite is also considered a sacred material by some modern-day Native Americans.

I-1.4 Geomorphology

Geomorphological studies that examine the relationship among geology, soils, topography, and vegetation are important to archaeologist because most significant prehistoric sites are located within specific soil matrices, the history of which contribute to archaeological site integrity, the integrity of cultural deposits, and the post-depositional history of the site. These factors are critical for understanding the nature, integrity, and preservation potential of the archaeological resources in the J2PA. Specialists in the field are often referred to as geoarchaeologists.

The geology and soils of the J2PA are described in Sections 3.2.2 and 3.2.6, respectively, of the Jonah Field II environmental impact statement. Geologic and soils descriptions and mapping have important cultural resource applications. For example, aeolian deposits (sand dunes) (see Map 3.1) in the region often contain buried archaeological sites (Monte-Leckman complex; Hateron-Garsid complex; Spool, Ouard, and San Arcacio Variant complex; and San Arcacio-Saguache association soils). Further, Monte-Leckman soils, which are located on alluvial fans and along major drainges, and San Arcacio-Saguache soils, which occur on old floodplains, fans, and terraces (see Table 3.5 and Appendix A), both have high potential to contain buried cultural resource sites.

A recent trend in assaying cultural resource potential at the regional level involves integrating geoarchaeological information from a diversity of locales within the Green River Basin. The major regional oil and gas fields (Moxa Arch, Fontenelle, LaBarge, Wamsutter) have been a target for geoarchaeologists, due to the intensive surface management in these fields, and geomorphologic data relating to climatic shifts has emerged. Eckerle (1996) and Miller (1996) are synthesizing these data in part to determine the influence of climatic shifts on prehistoric settlement patterns within the Green River Basin. Geoarchaeological studies are lacking for the

J2PA, and a further understanding of the geoarchaeology of the area will aid in cultural resource management and the avoidance of inadvertent impacts.

I-1.5 Archaeological Landscapes

Two geomorphic conditions that directly relate to the archaeology of the J2PA are noteworthy. They involve the surficial expression of lithic source material useful for prehistoric stone tool manufacturing. Weathered quartzite cobbles (Site 48SU1334) and nodules of a gray, medium- to high-quality chert (Wilkins Peak Chert, Site 48SU337) are commonly located on the surface throughout the area. Prehistoric occupants utilized this material in stone tool manufacture, heating rocks for food preparation, and hearths. In 1992, the term "Yellow Point Archaeological Landscape" (Site 48SU1334) (Enders 1992) was applied to the casual use and lithic reduction of secondary deposits of quartzite cobbles in the vicinity of Yellow Point Ridge. Since this artifact class represents an elemental aspect of prehistoric resource exploitation and is easily understood by prehistorians, expressions of the Yellow Point Archaeological Landscape are not eligible for NRHP inclusion (i.e., this cultural resource is by definition nonsignificant).

While attempting to apply a similar strategy to recording the surficial expressions and lithic procurement of Wilkins Peak Chert (Site 48SU337), a somewhat more complex situation arose. Early recognized by investigators in the area (Reed 1974; Love 1976; Hakiel 1982), procurement of Wilkins Peak Chert seems to co-occur with other prehistoric artifact classes, such as utilized flakes, campsite debris, features, and formal tools (Nelson and Nelson 1994). Utilization of Wilkins Peak Chert may not represent as elemental an aspect of prehistoric exploitation as first thought. First, the chert is found as both primary outcrops and secondary deposits, with operating geology not fully understood. Second, the material is found amidst site types of greater complexity. Finally, insufficient inventory has occurred in areas where Wilkins Peak Chert is found. The initial proposal to categorically recognize Wilkins Peak Chert lithic procurement as nonsignificant was rejected by the Wyoming State Historic Preservation Office (SHPO). Nonetheless, a 1995 field examination of select areas resurrected this approach, and it will be pursued in the near future.

I-2.0 HISTORIC OVERVIEW OF THE UPPER GREEN RIVER REGION OF WYOMING

I-2.1 Early Exploration

Early fur traders and trappers were the first Euro-Americans to penetrate and explore the Upper Green River region between present-day Pinedale and LaBarge, Wyoming, and by the 1830s, the South Pass route along the Oregon Trail was utilized to access the region. Captain Bonneville traveled over South Pass in 1832, and this was the first time wagons were used to traverse the pass. Nathaniel Wyeth led an expedition west over South Pass to the fur trade rendezvous on Green River in 1834 (Chittenden 1935; Gowans 1975; Johnson 1984; Todd 1986). Missionary activity spawned the earliest migration of emigrants west along the newly established trail when the Whitmans and Spaldings traveled over the Oregon Trail in 1836 (Coutant 1899; Hine 1984). In 1840, Jesuit missionary Pierre-Jean De Smet passed over the Oregon Trail and arrived at the rendezvous held on Green River near Horse Creek, where he held a Mass introducing Catholicism to the Shoshone and Flathead Indians gathered there with the traders and trappers (Gowans 1975; Larson 1984; Jording 1992).

Captain John C. Fremont and guide Kit Carson led the first scientific expedition by the U.S. Topographical Engineers into present Wyoming (Goetzman 1959; Larson 1984). As part of a diplomatic plan to open the Oregon region to settlement by mapping an emigrant road west, Fremont also explored the upper Green River and the Wind River Mountains. The results of the expedition, while supplying less scientific results than hoped for, succeeded in focusing the American psyche on the Far West and its settlement. In the 1850s, the Sublette and Lander Cutoffs were blazed to shorten the Oregon Trail route from South Pass across western Wyoming. No historic trails are present on the J2PA.

I-2.2 Early Settlement

Some of the first permanent settlement in the upper Green River region occurred along Fontenelle Creek, approximately 30 miles southwest of the J2PA (Stone 1924; Holden 1928). Prior to 1882, herds of cattle and sheep were driven through the area from Oregon to Nebraska, and local herds were pastured in the mountain valleys during the summer months, then driven east of Green River into the Little Colorado Desert for winter grazing (Holden 1928).

Settlers continued to arrive in the upper Green River Basin to settle along the tributaries of the Green River. Farther north, the first settler on Horse Creek was a man named Daniel. A post office was established at the mouth of Horse Creek on the Green River which was named for him, and the small town of Daniel grew (Stone 1924; Holden 1928).

In 1879, Daniel Budd and Hugh McKay brought 750 head of cattle into what is called the Piney Country in the vicinity of present Big Piney. Budd and his son opened a store and established a post office some years later that was named Big Piney, thus establishing the future town of Big Piney in what would become Sublette County (Stone 1924; Larson 1978). Following the survey of the public lands in the vicinity of the J2PA, numerous settlers filed on land holdings, fences were built, and irrigation ditches laid out in every valley from Fontenelle Creek to Big Piney (Holden 1928).

The number of cattle continued to increase in the Green River Basin during the early 1880s. However, the severe winter of 1888–1889 caused many ranchers not to rely upon open range for winter pasture, and to switch to haying and stockpiling hay as winter stock forage.

Sometime around the turn of the century, the town of Pinedale emerged on Pine Creek and became an important community amidst the sprawling cattle country on the upper Green River and its tributaries. The first post office was erected in May 1899, about 0.25 mile south of the present-day townsite, and served as the basis for the new community. The town's unofficial establishment dates to 1904, when a few hewn log buildings emerged in a sagebrush flat near the original post office. The town boasted of a newspaper, the *Pinedale Roundup*, by September 1904, and Pinedale was incorporated in 1912. With the addition of two new counties in 1921, Pinedale became the Sublette County seat, besting Big Piney in the contest by a small margin of votes (Stone 1924; Urbanek 1988; Rosenberg 1990). During the next few decades, Pinedale served as the community center for a sparsely settled countryside whose economic basis remained focused on livestock production coupled with an emerging dude ranch industry.

As communities like Big Piney and Pinedale were established (Rosenberg 1982, 1986), a wagon link with the railhead in Rock Springs was essential. Beginning in the 1880s, the Rock Springs to New Fork Wagon Road (Site 48SU1408) carried freight, mail, and supplies to the inhabitants of the Upper Green River Basin (Vlcek 1995). This vital link (and its sister freight road, the Opal Wagon Road) carried virtually all of the imported goods and supplies not locally produced, and these goods were used by virtually everyone in what was to become Sublette County. The Wagon Road not only had a commercial function, but stops along the route served to give place names to an otherwise desolate landscape. Ten Trees, The Wells, Mud Hole, and Sand Springs became real places and Farson developed into a community. Because the Rock Springs to New Fork Wagon Road played a critical function in settling the region, it is recognized as an NRHP eligible Expansion Era trail. Use of the wagon road continued until the paving of the Rock Springs to Pinedale Road (Site 48SU1281) in the 1920s (Gardner and Johnson 1991).

The exact location of the Rock Springs to New Fork Wagon Road in the vicinity of the J2PA is unknown; however, it is assumed to be on the eastern edge of the area, near U.S. Highway 191.

I-2.3 Irrigation and Agricultural Settlement

Raising livestock in the northern Green River Basin has shaped the image and influence of the region, its origins dating back to the 1870s and 1880s. The history of livestock associations in the region are almost as old. Beginning with the creation of the Big Piney Roundup Association following the harsh winter of 1889-1890, the Upper Green River Cattle and Horse Association evolved to care for livestock as their numbers increased within the region. The current Upper Green River Cattle Association (UGRCA) has seasonally trailed or drifted cattle up and down the Green River since its creation in 1925 from the former association. Over the decades, this seasonal movement from one grazing range to another has become known as the Green River Drift. Cooperative activities of the UGRCA have evolved from simply caring for livestock herds during seasonal drives to new pasture during the early twentieth century to working with government agencies (e.g., U.S. Forest Service [USFS], BLM) in better managing the use of the land and protecting natural resources. UGRCA has had an important role in sustaining a viable ranching culture that has become a tradition in the Upper Green River Basin (Sommers 1994).

The livestock industry brought only sparse settlement to the Green River Basin. Agricultural development of Wyoming's arable lands was necessary to provide the impetus for growth during the first decade of statehood, and irrigation was the key component to successful agriculture

(Hoyt 1878). The Green River Basin had a potential water supply, but the disadvantages included poor soils and high elevations, which severely limited the types of crops that could be produced.

Passage of the Carey Act in 1894 provided federal and state aid to irrigation projects and gave promoters and settlers alike the opportunity to undertake ambitious projects to convert sagebrush-covered benchlands into farms.

Several areas of the upper Green River Basin were suitable for irrigation under the Carey Act, and early agriculture in the area was probably limited to irrigating hay meadows and for domestic garden production along the tributaries of Fontenelle, LaBarge, and Piney Creeks (Holden 1928).

In 1883, an unknown engineer conceived the idea that the Big Sandy region was suitable for irrigated agriculture (Wright and Wright 1975), and permits for irrigation were first issued in 1886 (U.S. Department of the Interior [USDI] 1981). In 1906, the Eden Irrigation and Land Company was organized and incorporated under the laws of Wyoming (Wright and Wright 1975), and in 1907, the Eden Irrigation and Land Company constructed the Eden Dam on the Big Sandy River, creating Eden Reservoir. According to a newspaper article in the *Rock Springs Miner*, settlers arrived in the spring of 1908 and established the communities of Eden and Farson. The Eden Dam project was finished in 1914, and about 30 farmers utilized water from the system to irrigate crops of oats, wheat, barley, grass hay, alfalfa, and garden produce (USDI 1981).

The Green River itself was the focus of irrigation by several entities in the early 1900s. In 1908, permits were issued to the Green River Irrigation Company to construct the Green River Canal to divert water from the Green River above the mouth of Fontenelle Creek in order to irrigate lands between Green River and the Big Sandy River. It was estimated that up to 97,474 acres could be irrigated by this canal (Johnston 1909). By 1909, surveys were completed for a second canal to divert water from the west side of the Green River to reclaim 50,000-60,000 acres of land northwest of the town of Green River, and a third canal was considered to divert water from the Green River near the mouth of Horse Creek in the vicinity of Pinedale (Johnston 1909).

Expectations for the Carey Act fell short; however, with passage of the Reclamation Act of 1902, a new era of land use began with the formation of a new federal agency—the Reclamation Service (Bureau of Reclamation after 1923). In 1940, President Roosevelt approved a plan to develop and rehabilitate the Eden irrigation system under the water conservation provision of the Interior Department Appropriation Act of 1940, and the majority of work was completed by December 1959 (USDI 1981). The original system was augmented by the construction of the Big Sandy Dam and Reservoir 10 miles north of Farson. Ninety-four miles of lateral canals currently supply water to participating farmers. Livestock production is the mainstay of the area, and the principal crops include wheat, oats, barley, alfalfa, grass hay, and pasture (USDI 1981).

The Seedskadee project—part of the Colorado River Storage Project in the Upper Green River Basin—provides "storage and regulation of the flows of the Green River for power generation, municipal and industrial use, fish, wildlife, and recreation" (USDI 1981). Fontenelle Dam and its powerplant and reservoir are the key components of this project. The dam is an earth-filled structure located on the Green River 24 miles southeast of LaBarge (USDI 1981). The Seedskadee National Wildlife Refuge is an important part of the project that was created in 1965 to provide habitat for waterfowl. The refuge begins 6 miles below Fontenelle Dam and extends 35 miles downstream (USDI 1981).

I-2.4 Energy Resource Industries

While the agricultural and livestock potential of the Green River Basin was being realized, simultaneous developments were being made in the energy resource industries. Settlement in the Green River Basin at the beginning of the twentieth century remained sparse, and initial oil and gas discoveries were minimal except in the upper Green River region near LaBarge, Big Piney, and Pinedale. Coal deposits, while plentiful in the region north of Evanston, were minimal in the upper Green River Basin.

It was the twentieth-century industrial demand for petroleum products that had the greatest economic impact on the upper Green River Basin. Influenced by national and international political events, economic conditions, and perhaps most importantly by the advent of the mass-produced, affordable automobile, Wyoming's oil and gas industry rose to prominence in the early decades of the twentieth century (Larson 1978).

Oil seeps and springs were probably known to exist by Native Americans in the Green River Basin; however, the extent and type of aboriginal use, if any, is not understood at present (Veatch 1907). It may be on coincidence that the historic California, Oregon, or Mormon Trails passed oil seeps to allow their utilization by the westbound emigrants (Metz 1986). Oil and gas reserves of commercial potential were discovered during the first decade of the twentieth century in the vicinity of LaBarge Creek, approximately 25 miles southwest of the J2PA and 40 miles north of Opal. Studies of the surface geology resulted in the discovery of the current LaBarge Oil Field in 1924, which was part of the 1920s Wyoming oil boom (Espach and Nichols 1941; Wyoming Geological Association 1957; Biggs and Espach 1960). By January 1938, approximately 85 wells produced 1,100 barrels of oil per day, and six gas wells produced 35 million cubic feet per day (mmcfd) of natural gas. Unitization occurred in April 1949, and by 1960, 245 wells had been drilled in the LaBarge Field, and the oil was shipped 39 miles through a 4-inch pipeline to Opal, Wyoming.

The Big Piney Gas Field lies north of the LaBarge Field and includes North Big Piney, South Big Piney, Dry Piney, and Paff-Quealy Fields. The discovery well was completed in 1938; however, development of the field as a primary gas producer did not occur until September 9, 1952, when a well blew out in Section 28 of T28N, R113W and produced 75 mmcfd for 10 days before it could be capped and cemented. Following this occurrence, the area was developed as a gas field (Biggs and Espach 1960). In 1955, a 16-inch pipeline was constructed to Opal, Wyoming, and by 1957, gas production from 44 wells yielded 1.9 mmcfd (Biggs and Espach 1960).

The Pinedale Gas Field lies northeast of the Big Piney Field, and the town of Pinedale is located near the northern end of one of the largest anticlines in the state. In 1939, the first well was drilled, and in February 1955 a well was completed with daily production of 2.3 mmcfd from the Fort Union Formation. By 1956, five gas wells had been completed; however, no gas was produced except for testing and field use (Biggs and Espach 1960).

The Big Piney and LaBarge Fields have been enlarged since 1960 (Roberts 1989; BLM 1990b), and production levels for natural gas from the combined LaBarge, Big Piney, and Pinedale Fields are among the highest in the state (BLM 1987a). These fields figure prominently in the future development of Wyoming's natural gas reserves.

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APPENDIX J — AIR QUALITY IMPACT TABLES

Table J-1. Summary of Maximum Modeled Near-field NO_2 Concentrations Compared to Ambient Air Quality Standards and PSD Class II Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	PSD Class II Increment[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	Annual	nm[2]	25	3.4	3.4	100	3
Proposed Action[3]	Annual	18.9	25	3.4	22.3	100	22
Alternative A[3]	Annual	18.9	25	3.4	22.3	100	22
Alternative B[3]	Annual	18.9	25	3.4	22.3	100	22
Preferred Alternative[3]	Annual	18.9	25	3.4	22.3	100	22

[1] In µg/m³. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.
[2] nm = not modeled.
[3] Assumes 3,100 wells.

Table J-2. Summary of Maximum Modeled Near-field CO Concentrations Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	1-hour	nm[2]	3,336	3,336.0	40,000	8
	8-hour	nm[2]	1,381	1,381.0	10,000	14
Proposed Action[3]	1-hour	459.1	3,336	3,795.1	40,000	9
	8-hour	266.0	1,381	1,647.0	10,000	16
Alternative A[3]	1-hour	459.1	3,336	3,795.1	40,000	9
	8-hour	266.0	1,381	1,647.0	10,000	16
Alternative B[3]	1-hour	459.1	3,336	3,795.1	40,000	9
	8-hour	266.0	1,381	1,647.0	10,000	16
Preferred Alternative[3]	1-hour	459.1	3,336	3,795.1	40,000	9
	8-hour	266.0	1,381	1,647.0	10,000	16

[1] In µg/m³.
[2] nm = not modeled.
[3] Assumes 3,100 wells.

Table J-3. Summary of Maximum Modeled Near-field SO_2 Concentrations Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	3-hour	nm[2]	132	132.0	1,300	10
	24-hour	nm[2]	43	43.0	365/260	12/17
	Annual	nm[2]	9	9.0	80/60	11/15
Proposed Action[3]	3-hour	103.8	132	235.8	1,300	18
	24-hour	36.7	43	79.7	365/260	22/31
	Annual	5.2	9	14.2	80/60	18/24
Alternative A[3]	3-hour	103.8	132	235.8	1,300	18
	24-hour	36.7	43	79.7	365/260	22/31
	Annual	5.2	9	14.2	80/60	18/24
Alternative B[4]	3-hour	128.3	132	260.3	1,300	20
	24-hour	45.3	43	88.3	365/260	24/34
	Annual	6.4	9	15.4	80/60	19/26
Preferred Alternative[4]	3-hour	128.3	132	260.3	1,300	20
	24-hour	45.3	43	88.3	365/260	24/34
	Annual	6.4	9	15.4	80/60	19/26

[1] In µg/m^3.
[2] nm = not modeled.
[3] Assumes straight drilling.
[4] Assumes directional drilling.

Table J-4. Summary of Maximum Modeled Near-field PM_{10} Concentrations Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	24-hour	nm[2]	33	33.0	150	22
	Annual	nm[2]	16	16.0	50	32
Proposed Action[3]	24-hour	74.1	33	107.1	150	71
	Annual	3.4	16	19.4	50	39
Alternative A[3]	24-hour	74.1	33	107.1	150	71
	Annual	3.4	16	19.4	50	39
Alternative B[4]	24-hour	102.1	33	135.1	150	90
	Annual	5.6	16	21.6	50	43
Preferred Alternative[5]	24-hour	94.0	33	127.0	150	85
	Annual	4.7	16	20.7	50	41

[1] In µg/m^3.
[2] nm = not modeled.
[3] Assumes 3.8-acre well pads.
[4] Assumes 10.0-acre well pads.
[5] Assumes 7.0-acre well pads.

Table J-5. Summary of Maximum Modeled Near-field $PM_{2.5}$ Concentrations Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1,2]	Percent of NAAQS/ WAAQS
No Action	24-hour	nm[3]	13	13.0	65	20
	Annual	nm[3]	5	5.0	15	33
Proposed Action[4]	24-hour	27.0	13	40.0	65	62
	Annual	1.3	5	6.3	15	42
Alternative A[4]	24-hour	27.0	13	40.0	65	62
	Annual	1.3	5	6.3	15	42
Alternative B[5]	24-hour	32.2	13	45.2	65	70
	Annual	1.8	5	6.8	15	45
Preferred Alternative[6]	24-hour	31.0	13	44.0	65	68
	Annual	1.6	5	6.6	15	44

1 In µg/m³.
2 The WAAQS are not yet enforced in Wyoming per Wyoming Air Quality Standards and Regulations (WAQSR) Chapter 2, Section 2(b)(v).
3 nm = not modeled.
4 Assumes 3.8-acre well pads.
5 Assumes 10-acre well pads.
6 Assumes 7-acre well pads.

Table J-6. Summary of Maximum Modeled Near-field O_3 Concentrations Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	1-hour	nm[2]	75.2	75.2	235	32
	8-hour	nm[2]	75.2	75.2	157	48
All Alternatives	1-hour	78.2	75.2	153.4	235	65
	8-hour	54.7	75.2	129.9	157	83

1 In µg/m³.
2 nm = not modeled.

Table J-7. Summary of Maximum Modeled HAP Concentrations from Direct Project Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

		Benzene			Toluene			Ethylbenzene			Xylene			n-Hexane			Formaldehyde		
Alternative	Averaging Period	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Concen-tration[2]	Percent of Health-based Standard
No Action[3]	1-Hour	1,300	0.0	0.0	37,000	0.0	0.0	35,000	0.0	0.0	22,000	0.0	0.0	39,000	0.0	0.0	94	0.0	0.0
	Annual	30	0.0	0.0	400	0.0	0.0	1,000	0.0	0.0	430	0.0	0.0	200	0.0	0.0	9.8	0.0	0.0
Proposed Action[4]	1-Hour	1,300	996	76.6	37,000	1,994	5.4	35,000	109	0.3	22,000	1,085	4.9	39,000	536	1.4	94	31.9	33.9
	Annual	30	0.85	2.8	400	1.73	0.4	1,000	0.09	0.01	430	0.93	0.2	200	0.35	0.2	9.8	0.02	0.2
Alternative A[4]	1-Hour	1,300	996	76.6	37,000	1,994	5.4	35,000	109	0.3	22,000	1,085	4.9	39,000	536	1.4	94	31.9	33.9
	Annual	30	0.85	2.8	400	1.73	0.4	1,000	0.09	0.01	430	0.93	0.2	200	0.35	0.2	9.8	0.02	0.2
Alternative B[5]	1-Hour	1,300	309	23.8	37,000	619	1.7	35,000	34	0.1	22,000	337	1.5	39,000	166	0.4	94	31.9	33.9
	Annual	30	0.85	2.8	400	1.73	0.4	1,000	0.09	0.01	430	0.93	0.2	200	0.35	0.2	9.8	0.02	0.2
Preferred Alternative[5]	1-Hour	1,300	996	76.6	37,000	1,994	5.4	35,000	109	0.3	22,000	1,085	4.9	39,000	536	1.4	94	31.9	33.9
	Annual	30	0.85	2.8	400	1.73	0.4	1,000	0.09	0.01	430	0.93	0.2	200	0.35	0.2	9.8	0.02	0.2

[1] Based on EPA (2002).
[2] In µg/m³.
[3] No Action Alternative was not modeled.
[4] Assumes 5-acre well spacing.
[5] Assumes 40-acre well spacing.

Table J-8. Summary of Long-Term MLE and MEI Cancer Risk Analyses, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

			MLE			MEI		
Alternative	HAP Constituent	Modeled Concentration[2]	Unit Risk Factor[3]	Exposure Adjustment Factor	Cancer Risk	Unit Risk Factor[3]	Exposure Adjustment Factor	Cancer Risk
No Action[4]	Benzene	0.0	--	--	--	--	--	--
	Formaldehyde	0.0	--	--	--	--	--	--
	Total Combined							
Proposed Action	Benzene	0.85	7.8E-06	0.0949	6.3E-07	7.8E-06	0.71	4.73E-06
	Formaldehyde	0.02	1.3E-05	0.0949	2.0E-08	1.3E-05	0.71	1.80E-07
	Total Combined				6.5E-07			4.9E-06
Alternative A	Benzene	0.85	7.8E-06	0.0949	6.3E-07	7.8E-06	0.71	4.73E-06
	Formaldehyde	0.02	1.3E-05	0.0949	2.0E-08	1.3E-05	0.71	1.80E-07
	Total Combined				6.5E-07			4.9E-06
Alternative B	Benzene	0.85	7.8E-06	0.0949	6.3E-07	7.8E-06	0.71	4.73E-06
	Formaldehyde	0.02	1.3E-05	0.0949	2.0E-08	1.3E-05	0.71	1.80E-07
	Total Combined				6.5E-07			4.9E-06
Preferred Alternative	Benzene	0.85	7.8E-06	0.0949	6.3E-07	7.8E-06	0.71	4.73E-06
	Formaldehyde	0.02	1.3E-05	0.0949	2.0E-08	1.3E-05	0.71	1.80E-07
	Total Combined				6.5E-07			4.9E-06

[1] Based on EPA (1993, 1997).
[2] In µg/m³.
[3] In 1 ÷ µg/m³.
[4] No Action Alternative was not modeled.

Table J-9. Project and Non-Project Emissions (tons/yr) Included in Far-field Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Source Category	NO_X	SO_2	PM_{10}	$PM_{2.5}$
Project Sources				
3,100 wells – full field production (all alternatives with 3,100 producing wells)	377.6	0.7	736.1	134.1
No Action	14.5	0.0	47.0	8.6
3,100 wells, straight drilling (approximates Alternative A and Proposed Action)				
WDR 250 wells/yr	1,627.7	28.3	949.1	205.6
3,100 Wells, directional drilling (approximates Alternative B)				
WDR 75 wells/yr	826.4	10.8	803.4	159.4
3,100 wells, 50% straight drilling, 50% directional drilling (approximates Preferred Alternative)				
WDR 250 wells/yr – 80% Mitigation	641.2	32.6	273.4	124.7
Non-Project Sources				
RFD	3,166.5	56.1	84.0	81.9
RFFA	486.3	-1,407.0	-1,282.8	-586.6
State-permitted	4,098.9	-61.4	559.2	516.6

[1] Non-Project emissions sources (reasonably foreseeable development [RFD] and reasonably foreseeable future actions [RFFA]) are described in Section 4.1.2.11; WDR = well development rate.

Table J-10. Summary of Maximum Modeled NO_2 Concentration Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

		Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II		Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-ration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]	Direct Modeled Impact[2]	Total Concen-tration[3]
Alternative or Development Phase	WDR	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action[4]	--	--	3.40	--	3.40	--	3.40	--	3.40	--	3.40	--	3.40	--	3.40	--	3.40
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	0.026	3.43	0.001	3.40	0.009	3.41	0.006	3.41	0.000	3.40	0.000	3.40	0.000	3.40	0.000	3.40
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	0.132	3.53	0.006	3.41	0.044	3.44	0.026	3.43	0.002	3.40	0.001	3.40	0.001	3.40	0.001	3.40
Alternative B	75	0.062	3.46	0.003	3.40	0.023	3.42	0.013	3.41	0.001	3.40	0.000	3.40	0.000	3.40	0.001	3.40
Preferred Alternative	250	0.061	3.46	0.002	3.40	0.019	3.42	0.012	3.41	0.001	3.40	0.000	3.40	0.000	3.40	0.000	3.40

[1] Ambient Air Quality Standards: Annual NAAQS/WAAQS = 100 μg/m³.
[2] In μg/m³.
[3] Total concentration includes direct modeled impact and background concentration; annual background NO_2 concentration = 3.4 μg/m³.
[4] No Action Alternative was not modeled; total concentration represents background concentration only.

Table J-11. Summary of Maximum Modeled SO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I					Fitzpatrick Wilderness Class I					Popo Agie Wilderness Class II					Wind River Roadless Area Class II				
		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]	
		3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	Annual
No Action[4]	--	--	--	--	132.0	43.0	--	--	--	132.0	43.0	--	--	--	132.0	43.0	--	--	--	132.0	43.0
MAXIMUM PRODUCTION EMISSIONS																					
All alternatives with 3,100 wells	0	0.005	0.001	0.000	132.0	43.0	0.001	0.000	0.000	132.0	43.0	0.002	0.000	0.000	132.0	43.0	0.001	0.000	0.000	132.0	43.0
MAXIMUM FIELD EMISSIONS																					
Alternative A and Proposed Action	250	0.229	0.073	0.004	132.2	43.1	0.019	0.005	0.000	132.0	43.0	0.081	0.013	0.001	132.1	43.0	0.037	0.010	0.001	132.0	43.0
Alternative B	75	0.089	0.027	0.001	132.1	43.0	0.008	0.002	0.000	132.0	43.0	0.032	0.006	0.000	132.0	43.0	0.014	0.004	0.000	132.0	43.0
Preferred Alternative	250	0.246	0.076	0.004	132.3	43.1	0.020	0.006	0.000	132.0	43.0	0.087	0.014	0.001	132.1	43.0	0.039	0.011	0.001	132.0	43.0

Alternative or Development Phase	WDR	Grand Teton National Park Class I					Teton Wilderness Class I					Yellowstone National Park Class I					Washakie Wilderness Area Class I				
		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]		Direct Modeled Impact[2]			Total Concentration[3]	
		3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	24-hr	3-hr	24-hr	Annual	3-hr	Annual
No Action[4]	--	--	--	--	132.0	43.0	--	--	--	132.0	43.0	--	--	--	132.0	43.0	--	--	--	132.0	43.0
MAXIMUM PRODUCTION EMISSIONS																					
All alternatives with 3,100 wells	0	0.000	0.000	0.000	132.0	43.0	0.001	0.000	0.000	132.0	43.0	0.000	0.000	0.000	132.0	43.0	0.001	0.000	0.000	132.0	43.0
MAXIMUM FIELD EMISSIONS																					
Alternative A and Proposed Action	250	0.008	0.002	0.000	132.0	43.0	0.007	0.001	0.000	132.0	43.0	0.003	0.001	0.000	132.0	43.0	0.006	0.002	0.000	132.0	43.0
Alternative B	75	0.003	0.001	0.000	132.0	43.0	0.003	0.000	0.000	132.0	43.0	0.001	0.000	0.000	132.0	43.0	0.003	0.001	0.000	132.0	43.0
Preferred Alternative	250	0.008	0.002	0.000	132.0	43.0	0.008	0.001	0.000	132.0	43.0	0.003	0.001	0.000	132.0	43.0	0.006	0.002	0.000	132.0	43.0

[1] Ambient Air Quality Standards: 3-hr NAAQS/WAAQS = 1,300 μg/m³; 24-hr NAAQS/WAAQS = 365 μg/m³ (NAAQS) and 260 μg/m³ (WAAQS); Annual NAAQS/WAAQS = 100 μg/m³ 80 (NAAQS) and 60 μg/m³ (WAAQS).
[2] In μg/m³.
[3] Total concentration includes direct modeled impact and background concentration; annual background SO_2 concentration = 9 μg/m³; 8-hr background SO_2 concentration = 43 μg/m³; 3-hr background SO_2 concentration = 132 μg/m³.
[4] No Action Alternative was not modeled; total concentration represents background concentration only.

Table J-12. Summary of Maximum Modeled PM_{10} Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Popo Agie Wilderness Class II				Wind River Roadless Area Class II			
		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	--	--	33.0	16.00	--	--	33.0	16.00	--	--	33.0	16.00	--	--	33.0	16.00
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	0.75	0.030	33.7	16.03	0.07	0.003	33.1	16.00	0.15	0.008	33.1	16.01	0.12	0.006	33.1	16.01
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	1.66	0.063	34.7	16.06	0.18	0.006	33.2	16.01	0.26	0.018	33.3	16.02	0.19	0.013	33.2	16.01
Alternative B	75	0.99	0.041	34.0	16.04	0.11	0.004	33.1	16.00	0.17	0.011	33.2	16.01	0.14	0.008	33.1	16.01
Preferred Alternative	250	0.63	0.023	33.6	16.02	0.08	0.002	33.1	16.00	0.08	0.007	33.1	16.01	0.06	0.005	33.1	16.00

Alternative or Development Phase	WDR	Grand Teton National Park Class I				Teton Wilderness Class I				Yellowstone National Park Class I				Washakie Wilderness Area Class I			
		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	--	--	33.0	16.00	--	--	33.0	16.00	--	--	33.0	16.00	--	--	33.0	16.00
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	0.03	0.001	33.0	16.00	0.02	0.001	33.0	16.00	0.01	0.000	33.0	16.00	0.03	0.001	33.0	16.00
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	0.09	0.003	33.1	16.00	0.04	0.002	33.0	16.00	0.04	0.001	33.0	16.00	0.08	0.002	33.1	16.00
Alternative B	75	0.05	0.002	33.1	16.00	0.03	0.001	33.0	16.00	0.02	0.001	33.0	16.00	0.04	0.001	33.0	16.00
Preferred Alternative	250	0.04	0.001	33.0	16.00	0.02	0.001	33.0	16.00	0.02	0.000	33.0	16.00	0.03	0.001	33.0	16.00

1 Ambient Air Quality Standards: 24-hr NAAQS/WAAQS = 150 $\mu g/m^3$; Annual NAAQS/WAAQS = 50 $\mu g/m^3$.
2 In $\mu g/m^3$.
3 Total concentration includes direct modeled impact and background concentration; annual background PM_{10} concentration = 16 $\mu g/m^3$; 24-hr background PM_{10} concentration = 33 $\mu g/m^3$.
4 No Action Alternative was not modeled; total concentration represents background concentration only.

Table J-13. Summary of Maximum Modeled $PM_{2.5}$ Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Popo Agie Wilderness Class II				Wind River Roadless Area Class II			
		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	--	--	13.0	5.00	--	--	13.0	5.00	--	--	13.0	5.00	--	--	13.0	5.00
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	0.75	0.030	13.7	5.03	0.07	0.003	13.1	5.00	0.15	0.008	13.1	5.01	0.12	0.006	13.1	5.01
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	1.66	0.063	14.7	5.06	0.18	0.006	13.2	5.01	0.26	0.018	13.3	5.02	0.19	0.013	13.2	5.01
Alternative B	75	0.99	0.041	14.0	5.04	0.11	0.004	13.1	5.00	0.17	0.011	13.2	5.01	0.14	0.008	13.1	5.01
Preferred Alternative	250	0.63	0.023	13.6	5.02	0.08	0.002	13.1	5.00	0.08	0.007	13.1	5.01	0.06	0.005	13.1	5.00

Alternative or Development Phase	WDR	Grand Teton National Park Class I				Teton Wilderness Class I				Yellowstone National Park Class I				Washakie Wilderness Area Class I			
		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]		Direct Modeled Impact[2]		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	--	--	13.0	5.00	--	--	13.0	5.00	--	--	13.0	5.00	--	--	13.0	5.00
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	0.03	0.001	13.0	5.00	0.02	0.001	13.0	5.00	0.01	0.000	13.0	5.00	0.03	0.001	13.0	5.00
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	0.09	0.003	13.1	5.00	0.04	0.002	13.0	5.00	0.04	0.001	13.0	5.00	0.08	0.002	13.1	5.00
Alternative B	75	0.05	0.002	13.1	5.00	0.03	0.001	13.0	5.00	0.02	0.001	13.0	5.00	0.04	0.001	13.0	5.00
Preferred Alternative	250	0.04	0.001	13.0	5.00	0.02	0.001	13.0	5.00	0.02	0.000	13.0	5.00	0.03	0.001	13.0	5.00

1 Ambient Air Quality Standards: 24-hr NAAQS/WAAQS = 65 $\mu g/m^3$; Annual NAAQS/WAAQS = 15 $\mu g/m^3$; the WAAQS are not yet enforced in Wyoming per WAQSR Chapter 2, Section 2(b)(v).
2 In $\mu g/m^3$.
3 Total concentration includes direct modeled impact and background concentration; annual background $PM_{2.5}$ concentration = 5 $\mu g/m^3$; 24-hr background $PM_{2.5}$ concentration = 13 $\mu g/m^3$.
4 No Action Alternative was not modeled; total concentration represents background concentration only.

Table J-14. Summary of Maximum Modeled Direct NO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Significance Impact Levels (SILs) and PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	**Bridger Wilderness Class I** Direct Modeled Impact			**Fitzpatrick Wilderness Class I** Direct Modeled Impact			**Popo Agie Wilderness Class II** Direct Modeled Impact			**Wind River Roadless Area Class II** Direct Modeled Impact		
		Annual	PSD SIL [2]	PSD Increment	Annual	PSD SIL [2]	PSD Increment	Annual	PSD SIL[2]	PSD Increment	Annual	PSD SIL[2]	PSD Increment
No Action[3]	--	--	0.1	2.5	--	0.1	2.5	--	1.0	25	--	1.0	25
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.026	0.1	2.5	0.001	0.1	2.5	0.009	1.0	25	0.006	1.0	25
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.132	0.1	2.5	0.006	0.1	2.5	0.044	1.0	25	0.026	1.0	25
Alternative B	75	0.062	0.1	2.5	0.003	0.1	2.5	0.023	1.0	25	0.013	1.0	25
Preferred Alternative	250	0.061	0.1	2.5	0.002	0.1	2.5	0.019	1.0	25	0.012	1.0	25

Alternative or Development Phase	WDR	**Grand Teton National Park Class I** Direct Modeled Impact			**Teton Wilderness Class I** Direct Modeled Impact			**Yellowstone National Park Class I** Direct Modeled Impact			**Washakie Wilderness Area Class I** Direct Modeled Impact		
		Annual	PSD SIL [2]	PSD Increment	Annual	PSD SIL [2]	PSD Increment	Annual	PSD SIL [2]	PSD Increment	Annual	PSD SIL [2]	PSD Increment
No Action[3]	--	--	0.1	2.5	--	0.1	2.5	--	0.1	2.5	--	0.1	2.5
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.000	0.1	2.5	0.000	0.1	2.5	0.000	0.1	2.5	0.000	0.1	2.5
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.002	0.1	2.5	0.001	0.1	2.5	0.001	0.1	2.5	0.001	0.1	2.5
Alternative B	75	0.001	0.1	2.5	0.000	0.1	2.5	0.000	0.1	2.5	0.001	0.1	2.5
Preferred Alternative	250	0.001	0.1	2.5	0.000	0.1	2.5	0.000	0.1	2.5	0.000	0.1	2.5

[1] In $\mu g/m^3$. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.
[2] Proposed Class I significance impact level (SIL) in $\mu g/m^3$, *Federal Register* Vol. 61, No. 142, Pg. 38,292, July 23, 1996. Class II SILs (mg/m^3) are from *Draft New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting,* October 1990, EPA OAQPS.
[3] No Action Alternative was not modeled; annual background NO_2 concentration = 3.4 $\mu g/m^3$.

Table J-15. Summary of Maximum Modeled Direct SO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Significance Impact Levels (SILs) and PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I									Fitzpatrick Wilderness Class I									Popo Agie Wilderness Class II								
		Direct Modeled Impact			PSD SIL[2]			PSD Increment			Direct Modeled Impact			PSD SIL[2]			PSD Increment			Direct Modeled Impact			PSD SIL[2]			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[3]	--	--	--	--	1.0	0.2	0.1	25	5	2	--	--	--	1.0	0.2	0.1	25	5	2	--	--	--	25.0	5.0	1.0	512	91	20
MAXIMUM PRODUCTION EMISSIONS																												
All alternatives with 3,100 wells	0	0.005	0.001	0.000	1.0	0.2	0.1	25	5	2	0.001	0.000	0.000	1.0	0.2	0.1	25	5	2	0.002	0.000	0.000	25.0	5.0	1.0	512	91	20
MAXIMUM FIELD EMISSIONS																												
Alternative A and Proposed Action	250	0.229	0.073	0.004	1.0	0.2	0.1	25	5	2	0.019	0.005	0.000	1.0	0.2	0.1	25	5	2	0.081	0.013	0.001	25.0	5.0	1.0	512	91	20
Alternative B	75	0.089	0.027	0.001	1.0	0.2	0.1	25	5	2	0.008	0.002	0.000	1.0	0.2	0.1	25	5	2	0.032	0.006	0.000	25.0	5.0	1.0	512	91	20
Preferred Alternative	250	0.246	0.076	0.004	1.0	0.2	0.1	25	5	2	0.020	0.006	0.000	1.0	0.2	0.1	25	5	2	0.087	0.014	0.001	25.0	5.0	1.0	512	91	20

Alternative or Development Phase	WDR	Wind River Roadless Area Class II									Grand Teton National Park Class I									Teton Wilderness Class I								
		Direct Modeled Impact			PSD SIL[2]			PSD Increment			Direct Modeled Impact			PSD SIL[2]			PSD Increment			Direct Modeled Impact			PSD SIL[2]			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[3]	--	--	--	--	25.0	5.0	1.0	512	91	20	--	--	--	1.0	0.2	0.1	25	5	2	--	--	--	1.0	0.2	0.1	25	5	2
MAXIMUM PRODUCTION EMISSIONS																												
All alternatives with 3,100 wells	0	0.001	0.000	0.000	25.0	5.0	1.0	512	91	20	0.000	0.000	0.000	1.0	0.2	0.1	25	5	2	0.001	0.000	0.000	1.0	0.2	0.1	25	5	2
MAXIMUM FIELD EMISSIONS																												
Alternative A and Proposed Action	250	0.037	0.010	0.001	25.0	5.0	1.0	512	91	20	0.008	0.002	0.000	1.0	0.2	0.1	25	5	2	0.007	0.001	0.000	1.0	0.2	0.1	25	5	2
Alternative B	75	0.014	0.004	0.000	25.0	5.0	1.0	512	91	20	0.003	0.001	0.000	1.0	0.2	0.1	25	5	2	0.003	0.000	0.000	1.0	0.2	0.1	25	5	2
Preferred Alternative	250	0.039	0.011	0.001	25.0	5.0	1.0	512	91	20	0.008	0.002	0.000	1.0	0.2	0.1	25	5	2	0.008	0.001	0.000	1.0	0.2	0.1	25	5	2

Alternative or Development Phase	WDR	Yellowstone National Park Class I									Washakie Wilderness Area Class I								
		Direct Modeled Impact			PSD SIL[2]			PSD Increment			Direct Modeled Impact			PSD SIL[2]			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[3]	--	--	--	--	1.0	0.2	0.1	25	5	2	--	--	--	1.0	0.2	0.1	25	5	2
MAXIMUM PRODUCTION EMISSIONS																			
All alternatives with 3,100 wells	0	0.000	0.000	0.000	1.0	0.2	0.1	25	5	2	0.001	0.000	0.000	1.0	0.2	0.1	25	5	2
MAXIMUM FIELD EMISSIONS																			
Alternative A and Proposed Action	250	0.003	0.001	0.000	1.0	0.2	0.1	25	5	2	0.006	0.002	0.000	1.0	0.2	0.1	25	5	2
Alternative B	75	0.001	0.000	0.000	1.0	0.2	0.1	25	5	2	0.003	0.001	0.000	1.0	0.2	0.1	25	5	2
Preferred Alternative	250	0.003	0.001	0.000	1.0	0.2	0.1	25	5	2	0.006	0.002	0.000	1.0	0.2	0.1	25	5	2

1 In µg/m³. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.
2 Proposed Class I significance impact level (SIL) in µg/m³, *Federal Register* Vol. 61, No. 142, Pg. 38,292, July 23, 1996. Class II SILs (mg/m³) are from *Draft New Source Review Workshop Manual, Prevention of Significant Deterioration and Non Attainment Area Permitting*, October 1990, EPA OAQPS.
3 No Action Alternative was not modeled; annual background SO_2 concentration = 9 µg/m³; 8-hr background SO_2 concentration = 43 µg/m³; 3-hr background SO_2 concentration = 132 µg/m³.

Table J-16. Summary of Maximum Modeled Direct PM_{10} Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Significance Impact Levels (SILs) and PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Popo Agie Wilderness Class II						Wind River Roadless Area Class II					
		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment	
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[3]	--	--	--	0.3	0.2	8	4	--	--	0.3	0.2	8	4	--	--	5.0	1.0	30	17	--	--	5.0	1.0	30	17
MAXIMUM PRODUCTION EMISSIONS																									
All alternatives with 3,100 wells	0	0.75	0.030	0.3	0.2	8	4	0.07	0.003	0.3	0.2	8	4	0.15	0.008	5.0	1.0	30	17	0.12	0.006	5.0	1.0	30	17
MAXIMUM FIELD EMISSIONS																									
Alternative A and Proposed Action	250	1.66	0.063	0.3	0.2	8	4	0.18	0.006	0.3	0.2	8	4	0.26	0.018	5.0	1.0	30	17	0.19	0.013	5.0	1.0	30	17
Alternative B	75	0.99	0.041	0.3	0.2	8	4	0.11	0.004	0.3	0.2	8	4	0.17	0.011	5.0	1.0	30	17	0.14	0.008	5.0	1.0	30	17
Preferred Alternative	250	0.63	0.023	0.3	0.2	8	4	0.08	0.002	0.3	0.2	8	4	0.08	0.007	5.0	1.0	30	17	0.06	0.005	5.0	1.0	30	17

Alternative or Development Phase	WDR	Grand Teton National Park Class I						Teton Wilderness Class I						Yellowstone National Park Class I						Washakie Wilderness Area Class I					
		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment		Direct Modeled Impact		PSD SIL[2]		PSD Increment	
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[3]	--	--	--	0.3	0.2	8	4	--	--	0.3	0.2	8	4	--	--	0.3	0.2	8	4	--	--	0.3	0.2	8	4
MAXIMUM PRODUCTION EMISSIONS																									
All alternatives with 3,100 wells	0	0.03	0.001	0.3	0.2	8	4	0.02	0.001	0.3	0.2	8	4	0.01	0.000	0.3	0.2	8	4	0.03	0.001	0.3	0.2	8	4
MAXIMUM FIELD EMISSIONS																									
Alternative A and Proposed Action	250	0.09	0.003	0.3	0.2	8	4	0.04	0.002	0.3	0.2	8	4	0.04	0.001	0.3	0.2	8	4	0.08	0.002	0.3	0.2	8	4
Alternative B	75	0.05	0.002	0.3	0.2	8	4	0.03	0.001	0.3	0.2	8	4	0.02	0.001	0.3	0.2	8	4	0.04	0.001	0.3	0.2	8	4
Preferred Alternative	250	0.04	0.001	0.3	0.2	8	4	0.02	0.001	0.3	0.2	8	4	0.02	0.000	0.3	0.2	8	4	0.03	0.001	0.3	0.2	8	4

[1] In µg/m³. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.
[2] Proposed Class I significance impact level (SIL) in µg/m³, *Federal Register* Vol. 61, No. 142, Pg. 38,292, July 23, 1996. Class II SILs (mg/m³) are from *Draft New Source Review Workshop Manual, Prevention of Significant Deterioration and Non Attainment Area Permitting*, October 1990, EPA OAQPS.
[3] No Action Alternative was not modeled; annual background PM_{10} concentration = 16 µg/m³; 24-hr background PM_{10} concentration = 33 µg/m³.

Table J-17. Summary of Maximum Modeled Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources Using FLAG Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

		Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II		Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
Alternative or Development Phase	WDR	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	1.02	1	0.13	0	0.21	0	0.18	0	0.08	0	0.03	0	0.04	0	0.06	0
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	3.16	9	0.56	0	0.54	0	0.45	0	0.32	0	0.14	0	0.16	0	0.24	0
Alternative B	75	1.71	2	0.28	0	0.29	0	0.24	0	0.17	0	0.07	0	0.08	0	0.12	0
Preferred Alternative	250	1.50	2	0.28	0	0.25	0	0.22	0	0.13	0	0.06	0	0.06	0	0.10	0

[1] In deciviews (dv).
[2] No Action Alternative was not modeled.

Table J-18. Summary of Maximum Modeled Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources Using IMPROVE Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II		Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS																	
All alternatives with 3,100 wells	0	1.14	1	0.15	0	0.24	0	0.20	0	0.08	0	0.03	0	0.04	0	0.06	0
MAXIMUM FIELD EMISSIONS																	
Alternative A and Proposed Action	250	3.48	10	0.64	0	0.62	0	0.52	0	0.33	0	0.14	0	0.16	0	0.24	0
Alternative B	75	1.90	4	0.32	0	0.34	0	0.28	0	0.17	0	0.07	0	0.08	0	0.12	0
Preferred Alternative	250	1.66	3	0.33	0	0.29	0	0.26	0	0.14	0	0.06	0	0.06	0	0.10	0

[1] In deciviews (dv).
[2] No Action Alternative was not modeled.

Table J-19. Summary of Maximum Modeled Change in ANC at Acid-Sensitive Lakes from Direct Project Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

		Black Joe Lake - Bridger Wilderness Class I		Deep Lake - Bridger Wilderness Class I		Hobbs Lake - Bridger Wilderness Class I		Lazy Boy Lake - Bridger Wilderness Class I		Upper Frozen Lake - Bridger Wilderness Class I		Lower Saddlebag - Popo Agie Wilderness Class II		Ross Lake - Fitzpatrick Wilderness Class I	
Alternative or Development Phase	WDR	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change
Background ANC	--	67.0	--	59.9	--	69.9	--	18.8	--	5.0	--	55.5	--	53.5	--
Level of Acceptable Change	--	6.70	10	5.99	10	6.99	10	1.00	--	1.00	--	5.55	10	5.35	10
No Action[2]	--	67.0	--	59.9	--	69.9	--	18.8	--	5.0	--	55.5	--	53.5	--
MAXIMUM PRODUCTION EMISSIONS															
All alternatives with 3,100 wells	0	0.02	0.033	0.02	0.041	0.00	0.006	0.00	0.008	0.03	0.567	0.03	0.046	0.00	0.003
MAXIMUM FIELD EMISSIONS															
Alternative A and Proposed Action	250	0.10	0.155	0.11	0.190	0.02	0.030	0.01	0.038	0.14	2.808	0.13	0.231	0.01	0.013
Alternative B	75	0.05	0.079	0.06	0.095	0.01	0.014	0.00	0.019	0.07	1.386	0.06	0.117	0.00	0.007
Preferred Alternative	250	0.05	0.070	0.05	0.085	0.01	0.014	0.00	0.016	0.07	1.280	0.06	0.103	0.00	0.006

4 In µeq/L.
2 No Action Alternative was not modeled; ANC represents background only.

Table J-20. Summary of Maximum Modeled Sulfur (S) Deposition Impacts at PSD Class I and Sensitive Class II Areas from Direct Project Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I[1]	Fitzpatrick Wilderness Class I[1]	Popo Agie Wilderness Class II[1]	Wind River Roadless Area Class II[1]	Grand Teton National Park Class I[1]	Teton Wilderness Class I[1]	Yellowstone National Park Class I[1]	Washakie Wilderness Area Class I[1]
No Action[2]	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.00003	0.00000	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.00144	0.00015	0.00073	0.00043	0.00007	0.00004	0.00002	0.00004
Alternative B	75	0.00062	0.00005	0.00030	0.00016	0.00002	0.00001	0.00001	0.00002
Preferred Alternative	250	0.00154	0.00016	0.00078	0.00045	0.00007	0.00004	0.00003	0.00005

1 In kg/ha-yr.
2 No Action Alternative was not modeled; sulfur deposition analysis threshold (DAT) for direct Project impacts = 0.005 kg/ha-yr.

Table J-21. Summary of Maximum Modeled Nitrogen (N) Deposition Impacts at PSD Class I and Sensitive Class II Areas from Direct Project Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I[1]	Fitzpatrick Wilderness Class I[1]	Popo Agie Wilderness Class II[1]	Wind River Roadless Area Class II[1]	Grand Teton National Park Class I[1]	Teton Wilderness Class I[1]	Yellowstone National Park Class I[1]	Washakie Wilderness Area Class I[1]
No Action[2]	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.0067	0.0006	0.0034	0.0021	0.0002	0.0001	0.0001	0.0001
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.0349	0.0027	0.0165	0.0099	0.0012	0.0006	0.0004	0.0007
Alternative B	75	0.0184	0.0013	0.0084	0.0049	0.0006	0.0003	0.0002	0.0004
Preferred Alternative	250	0.0154	0.0011	0.0071	0.0043	0.0005	0.0002	0.0002	0.0003

1 In kg/ha-yr.
2 No Action Alternative was not modeled; nitrogen deposition analysis threshold (DAT) for direct Project impacts = 0.005 kg/ha-yr.

Table J-22. Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Communities from Direct Project Sources Using FLAG Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	**Big Piney**		**Big Sandy**		**Boulder**		**Bronx**		**Cora**	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.57	0	0.76	0	0.49	0	0.31	0	0.60	0
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	1.75	2	2.77	19	2.09	9	1.48	1	2.81	1
Alternative B	75	0.90	0	1.61	3	1.08	2	0.73	0	1.44	1
Preferred Alternative	250	0.79	0	1.30	1	0.95	0	0.77	0	1.52	1

Alternative or Development Phase	WDR	**Daniel**		**Farson**		**LaBarge**		**Merna**		**Pinedale**	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.49	0	0.47	0	0.26	0	0.19	0	0.93	0
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.24	1	2.04	5	1.15	2	0.68	0	3.78	2
Alternative B	75	1.15	1	1.05	1	0.57	0	0.36	0	2.09	1
Preferred Alternative	250	1.19	1	1.03	1	0.50	0	0.30	0	2.07	1

1 In deciviews (dv).
2 No Action Alternative was not modeled.

Table J-23. Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Communities from Direct Project Sources Using IMPROVE Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Big Piney		Big Sandy		Boulder		Bronx		Cora	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.66	0	0.85	0	0.56	0	0.36	0	0.69	0
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.01	6	3.05	23	2.39	12	1.70	1	3.20	1
Alternative B	75	1.04	1	1.79	6	1.24	3	0.85	0	1.66	1
Preferred Alternative	250	0.92	0	1.45	4	1.10	2	0.89	0	1.75	1

Alternative or Development Phase	WDR	Daniel		Farson		LaBarge		Merna		Pinedale	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action[2]	--	--	--	--	--	--	--	--	--	--	--
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.57	0	0.55	0	0.30	0	0.22	0	1.07	1
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.56	1	2.33	6	1.32	2	0.79	0	4.27	3
Alternative B	75	1.32	1	1.21	3	0.66	0	0.42	0	2.39	1
Preferred Alternative	250	1.37	1	1.19	1	0.57	0	0.35	0	2.37	1

[1] In deciviews (dv).
[2] No Action Alternative was not modeled.

Table J-24. Summary of Maximum Modeled In-field Pollutant Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	NO_2			SO_2								
		Direct Modeled Impact	Total Concen-tration[2]	NAAQS/WAAQS	Direct Modeled Impact			Total Concentration[2]			NAAQS/WAAQS		
		Annual	Annual	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[4]	--	--	3.4	100	--	--	--	132	43	9	1,300	365/260	80/60
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	2.5	5.9	100	0.2	0.1	0.0	132.2	43.1	9.0	1,300	365/260	80/60
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	13.7	17.1	100	18.3	3.7	0.4	150.3	46.7	9.4	1,300	365/260	80/60
Alternative B	75	11.8	15.2	100	17.1	4.2	0.3	149.1	47.2	9.3	1,300	365/260	80/60
Preferred Alternative	250	6.8	10.2	100	20.0	4.1	0.4	152.0	47.1	9.4	1,300	365/260	80/60

Alternative or Development Phase	WDR	PM_{10}						$PM_{2.5}$					
		Direct Modeled Impact		Total Concentration[2]		NAAQS/WAAQS		Direct Modeled Impact		Total Concentration[2]		NAAQS/WAAQS[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	--	--	33	16	150	50	--	--	13	5	65	15
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	90.4	12.6	123.4	28.6	150	50	16.3	2.0	29.3	7.0	65	15
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	113.2	16.0	146.2	32.0	150	50	21.6	3.1	34.6	8.1	65	15
Alternative B	75	97.1	13.8	130.1	29.8	150	50	17.7	2.7	30.7	7.7	65	15
Preferred Alternative	250	23.2	3.5	56.2	19.5	150	50	5.0	0.9	18.0	5.9	65	15

1 In µg/m³.
2 Total concentration includes direct modeled impact and background concentration; annual background NO_2 concentration = 3.4 µg/m³; annual background SO_2 concentration = 9 µg/m³; 8-hr background SO_2 concentration = 43 µg/m³; 3-hr background SO_2 concentration = 132 µg/m³; annual background PM_{10} concentration = 16 µg/m³; 24-hr background PM_{10} concentration = 33 µg/m³; annual background $PM_{2.5}$ concentration = 5 µg/m³; 24-hr background $PM_{2.5}$ concentration = 13 µg/m³.
3 WAAQS for $PM_{2.5}$ are not yet enforced in Wyoming per WAQSR Chapter 2, Section 2(b)(v).
4 No Action Alternative was not modeled; total concentration represents background concentration only.

Table J-25. RFD Projects Included in Cumulative Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Big Piney-LaBarge	Eighth Granger Gas Plant Expansion	Piney Creeks - MA 26
BTA Bravo	Fontenelle Natural Gas Infill Drilling	Pioneer Gas Plant
Burley	Ham's Fork Pipeline	Powder River Basin
Burlington Little Monument	Hickey Mountain-Table Mountain	Riley Ridge
Cave Gulch	Horse Creek - MA 24	Road Hollow
Cliff Creek - USFS Management Area (MA) 22	Horse Trap	Sierra Madre
Compressor Station, Pipeline- Williams	Jack Morrow Hills	Soda Unit
Continental Divide/Wamsutter II EIS	LaBarge Creek - MA 12	South Baggs
Cooper Reservoir (1998)	Little Greys River - MA 31	South Piney
Copper Ridge Shallow Gas Project	Lower Bush Creek CBM (Kennedy Oil)	Stage Coach
Cottonwood Creek - MA 25	Lower Greys River - MA 32	Upper Hoback - MA 23
Creston-Blue Gap	Moxa Arch	Vermillion Basin
Cutthroat Gas Processing Plant	Mulligan Draw	Willow Creek - MA 49
Desolation Flats	Pinedale Anticline Project	Wind River (Bureau of Indian Affairs [BIA] lead agency)

Table J-26. Summary of Maximum Modeled Cumulative NO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[2]

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]
		Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	--	0.119	3.52	0.011	3.41	0.027	3.43	0.024	3.42
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.143	3.54	0.012	3.41	0.036	3.44	0.030	3.43
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.245	3.64	0.017	3.42	0.070	3.47	0.051	3.45
Alternative B	75	0.175	3.57	0.014	3.41	0.049	3.45	0.037	3.44
Preferred Alternative	250	0.174	3.57	0.013	3.41	0.044	3.44	0.036	3.44

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]	Direct Modeled Impact	Total Concentration[3]
		Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	--	0.029	3.43	0.007	3.41	0.003	3.40	0.009	3.41
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.029	3.43	0.007	3.41	0.003	3.40	0.010	3.41
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.030	3.43	0.007	3.41	0.003	3.40	0.010	3.41
Alternative B	75	0.030	3.43	0.007	3.41	0.003	3.40	0.010	3.41
Preferred Alternative	250	0.029	3.43	0.007	3.41	0.003	3.40	0.010	3.41

1 Ambient Air Quality Standards: annual NAAQS/WAAQS = 100 $\mu g/m^3$.
2 In $\mu g/m^3$.
3 Total concentration includes direct modeled impact and background concentration; annual background NO_2 concentration = 3.4 $\mu g/m^3$.

Table J-27. Summary of Maximum Modeled Cumulative SO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources for Comparison to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[2]

Alternative or Development Phase	WDR	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Popo Agie Wilderness Class II					
		Direct Modeled Impact			Total Concentration[3]			Direct Modeled Impact			Total Concentration[1,2]			Direct Modeled Impact			Total Concentration[3]		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.16	0.04	0.00	132.16	43.04	9.00	0.02	0.01	0.00	132.02	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
MAXIMUM PRODUCTION EMISSIONS																			
All alternatives with 3,100 wells	0	0.16	0.04	0.00	132.16	43.04	9.00	0.02	0.01	0.00	132.02	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
MAXIMUM FIELD EMISSIONS																			
Alternative A and Proposed Action	250	0.24	0.08	0.00	132.24	43.08	9.00	0.02	0.01	0.00	132.02	43.01	9.00	0.08	0.01	0.00	132.08	43.01	9.00
Alternative B	75	0.17	0.04	0.00	132.17	43.04	9.00	0.02	0.01	0.00	132.02	43.01	9.00	0.03	0.01	0.00	132.03	43.01	9.00
Preferred Alternative	250	0.26	0.08	0.00	132.26	43.08	9.00	0.02	0.01	0.00	132.02	43.01	9.00	0.09	0.02	0.00	132.09	43.02	9.00

Alternative or Development Phase	WDR	Wind River Roadless Area Class II						Grand Teton National Park Class I						Teton Wilderness Class I					
		Direct Modeled Impact			Total Concentration[3]			Direct Modeled Impact			Total Concentration[3]			Direct Modeled Impact			Total Concentration[3]		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.11	0.01	0.00	132.11	43.01	9.00	0.20	0.04	0.01	132.20	43.04	9.01	0.04	0.01	0.00	132.04	43.01	9.00
MAXIMUM PRODUCTION EMISSIONS																			
All alternatives with 3,100 wells	0	0.11	0.01	0.00	132.11	43.01	9.00	0.20	0.04	0.01	132.20	43.04	9.01	0.04	0.01	0.00	132.04	43.01	9.00
MAXIMUM FIELD EMISSIONS																			
Alternative A and Proposed Action	250	0.12	0.01	0.00	132.12	43.01	9.00	0.20	0.04	0.01	132.20	43.04	9.01	0.04	0.01	0.00	132.04	43.01	9.00
Alternative B	75	0.11	0.01	0.00	132.11	43.01	9.00	0.20	0.04	0.01	132.20	43.04	9.01	0.04	0.01	0.00	132.04	43.01	9.00
Preferred Alternative	250	0.12	0.02	0.00	132.12	43.01	9.00	0.20	0.04	0.01	132.20	43.04	9.01	0.04	0.01	0.00	132.04	43.01	9.00

Alternative or Development Phase	WDR	Yellowstone National Park Class I						Washakie Wilderness Area Class I					
		Direct Modeled Impact			Total Concentration[3]			Direct Modeled Impact			Total Concentration[3]		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.07	0.01	0.00	132.07	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.07	0.01	0.00	132.07	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.07	0.01	0.00	132.07	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
Alternative B	75	0.07	0.01	0.00	132.07	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00
Preferred Alternative	250	0.08	0.01	0.00	132.07	43.01	9.00	0.02	0.01	0.00	132.02	43.01	9.00

1 Ambient Air Quality Standards: 3-hr NAAQS/WAAQS = 1,300 µg/m^3; 24-hr NAAQS/WAAQS = = 365 µg/m^3 (NAAQS) and 260 µg/m^3 (WAAQS); Annual NAAQS/WAAQS = 100 µg/m^3 80 (NAAQS) and 60 µg/m^3 (WAAQS).
2 In µg/m^3.
3 Total concentration includes direct modeled impact and background concentration; annual background SO_2 concentration = 9 µg/m^3; 8-hr background SO_2 concentration = 43 µg/m^3; 3-hr background SO_2 concentration = 132 µg/m^3.

Table J-28. Summary of Maximum Modeled Cumulative PM_{10} Concentration Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources Compared to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[2]

Alternative or Development Phase	WDR	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Popo Agie Wilderness Class II			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[1,2]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.46	0.018	33.46	16.02	0.13	0.005	33.13	16.00	0.14	0.008	33.14	16.01
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.91	0.047	33.91	16.05	0.15	0.008	33.15	16.01	0.20	0.015	33.20	16.01
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	1.82	0.081	34.82	16.08	0.20	0.011	33.20	16.01	0.31	0.024	33.31	16.02
Alternative B	75	1.16	0.058	34.16	16.06	0.16	0.009	33.16	16.01	0.23	0.018	33.23	16.02
Preferred Alternative	250	0.79	0.041	33.79	16.04	0.15	0.007	33.15	16.01	0.18	0.013	33.18	16.01

Alternative or Development Phase	WDR	Wind River Roadless Area Class II				Grand Teton National Park Class I				Teton Wilderness Class I			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.21	0.009	33.21	16.01	0.12	0.012	33.12	16.01	0.04	0.005	33.04	16.00
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.23	0.014	33.23	16.01	0.13	0.013	33.13	16.01	0.05	0.006	33.05	16.01
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.29	0.021	33.29	16.02	0.14	0.015	33.14	16.02	0.08	0.007	33.08	16.01
Alternative B	75	0.25	0.016	33.25	16.02	0.13	0.014	33.13	16.01	0.06	0.006	33.06	16.01
Preferred Alternative	250	0.23	0.012	33.23	16.01	0.13	0.013	33.13	16.01	0.06	0.006	33.06	16.01

Alternative or Development Phase	WDR	Yellowstone National Park Class I				Washakie Wilderness Area Class I			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.05	0.004	33.05	16.00	0.04	0.003	33.04	16.00
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.05	0.004	33.05	16.00	0.05	0.004	33.05	16.00
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.06	0.005	33.06	16.00	0.09	0.005	33.09	16.00
Alternative B	75	0.05	0.004	33.05	16.00	0.06	0.004	33.06	16.00
Preferred Alternative	250	0.05	0.004	33.05	16.00	0.05	0.004	33.05	16.00

1 Ambient Air Quality Standards: 24-hr NAAQS/WAAQS = 150 μg/m^3; Annual NAAQS/WAAQS = 50 μg/m^3.
2 In μg/m^3.
3 Total concentration includes direct modeled impact and background concentration; annual background PM_{10} concentration = 16 μg/m^3; 24-hr background PM_{10} concentration = 33 μg/m^3.

Table J-29. Summary of Maximum Modeled Cumulative $PM_{2.5}$ Concentrations at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources Compared to Ambient Air Quality Standards[1], Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[2]

Alternative or Development Phase	WDR	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Popo Agie Wilderness Class II			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.43	0.019	13.43	5.02	0.12	0.006	13.12	5.01	0.13	0.009	13.13	5.01
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.91	0.048	13.91	5.05	0.14	0.008	13.14	5.01	0.20	0.016	13.20	5.02
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	1.82	0.081	14.82	5.08	0.20	0.012	13.20	5.01	0.31	0.026	13.31	5.03
Alternative B	75	1.15	0.059	14.15	5.06	0.16	0.010	13.16	5.01	0.23	0.020	13.23	5.02
Preferred Alternative	250	0.79	0.042	13.79	5.04	0.15	0.008	13.14	5.01	0.17	0.015	13.17	5.02

Alternative or Development Phase	WDR	Wind River Roadless Area Class II				Grand Teton National Park Class I				Teton Wilderness Class I			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.19	0.010	13.19	5.01	0.11	0.013	13.11	5.01	0.04	0.005	13.04	5.01
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.22	0.015	13.22	5.02	0.13	0.013	33.13	16.01	0.05	0.006	33.05	16.01
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.28	0.022	13.28	5.02	0.14	0.015	13.14	5.02	0.08	0.007	13.08	5.01
Alternative B	75	0.24	0.017	13.24	5.02	0.12	0.014	13.12	5.01	0.06	0.006	13.06	5.01
Preferred Alternative	250	0.22	0.014	13.22	5.01	0.12	0.014	13.12	5.01	0.06	0.006	13.05	5.01

Alternative or Development Phase	WDR	Yellowstone National Park Class I				Washakie Wilderness Area Class I			
		Direct Modeled Impact		Total Concentration[3]		Direct Modeled Impact		Total Concentration[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.04	0.004	13.04	5.00	0.04	0.004	13.04	5.00
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.05	0.004	33.05	16.00	0.05	0.004	33.05	16.00
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.06	0.005	13.06	5.01	0.09	0.005	13.09	5.01
Alternative B	75	0.05	0.005	13.05	5.00	0.06	0.005	13.06	5.00
Preferred Alternative	250	0.05	0.004	13.05	5.00	0.06	0.004	13.05	5.00

1 Ambient Air Quality Standards: 24-hr NAAQS/WAAQS = 65 $\mu g/m^3$; Annual NAAQS/WAAQS = 15 $\mu g/m^3$; the WAAQS are not yet enforced in Wyoming per WAQSR Chapter 2, Section 2(b)(v).
2 In $\mu g/m^3$.
3 Total concentration includes direct modeled impact and background concentration; annual background $PM_{2.5}$ concentration = 5 $\mu g/m^3$; 24-hr background $PM_{2.5}$ concentration = 13 $\mu g/m^3$.

Table J-30. Summary of Maximum Modeled Cumulative NO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
		Annual		Annual		Annual		Annual	
No Action[2]	--	0.119	2.5	0.011	2.5	0.027	25	0.024	25
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.143	2.5	0.012	2.5	0.036	25	0.030	25
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.245	2.5	0.017	2.5	0.070	25	0.051	25
Alternative B	75	0.175	2.5	0.014	2.5	0.049	25	0.037	25
Preferred Alternative	250	0.174	2.5	0.013	2.5	0.044	25	0.036	25

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
		Annual		Annual		Annual		Annual	
No Action[2]	--	0.029	2.5	0.007	2.5	0.003	2.5	0.009	2.5
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.029	2.5	0.007	2.5	0.003	2.5	0.010	2.5
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.030	2.5	0.007	2.5	0.003	2.5	0.010	2.5
Alternative B	75	0.030	2.5	0.007	2.5	0.003	2.5	0.010	2.5
Preferred Alternative	250	0.029	2.5	0.007	2.5	0.003	2.5	0.010	2.5

[1] In $\mu g/m^3$. Annual background NO_X concentration = 3.4 $\mu g/m^3$. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.

Table J-31. Summary of Maximum Modeled Cumulative SO_2 Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Popo Agie Wilderness Class II					
		Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.16	0.04	0.00	25	5	2	0.02	0.01	0.00	25	5	2	0.02	0.01	0.00	512	91	20
MAXIMUM PRODUCTION EMISSIONS																			
All alternatives with 3,100 wells	0	0.16	0.04	0.00	25	5	2	0.02	0.01	0.00	25	5	2	0.02	0.01	0.00	512	91	20
MAXIMUM FIELD EMISSIONS																			
Alternative A and Proposed Action	250	0.24	0.08	0.00	25	5	2	0.02	0.01	0.00	25	5	2	0.08	0.01	0.00	512	91	20
Alternative B	75	0.17	0.04	0.00	25	5	2	0.02	0.01	0.00	25	5	2	0.03	0.01	0.00	512	91	20
Preferred Alternative	250	0.26	0.08	0.00	25	5	2	0.02	0.01	0.00	25	5	2	0.09	0.02	0.00	512	91	20

Alternative or Development Phase	WDR	Wind River Roadless Area Class II						Grand Teton National Park Class I						Teton Wilderness Class I					
		Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.11	0.01	0.00	512	91	20	0.20	0.04	0.01	25	5	2	0.04	0.01	0.00	25	5	2
MAXIMUM PRODUCTION EMISSIONS																			
All alternatives with 3,100 wells	0	0.11	0.01	0.00	512	91	20	0.20	0.04	0.01	25	5	2	0.04	0.01	0.00	25	5	2
MAXIMUM FIELD EMISSIONS																			
Alternative A and Proposed Action	250	0.12	0.01	0.00	512	91	20	0.20	0.04	0.01	25	5	2	0.04	0.01	0.00	25	5	2
Alternative B	75	0.11	0.01	0.00	512	91	20	0.20	0.04	0.01	25	5	2	0.04	0.01	0.00	25	5	2
Preferred Alternative	250	0.12	0.02	0.00	512	91	20	0.20	0.04	0.01	25	5	2	0.04	0.01	0.00	25	5	2

Alternative or Development Phase	WDR	Yellowstone National Park Class I						Washakie Wilderness Area Class I					
		Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
		3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	--	0.07	0.01	0.00	25	5	2	0.02	0.01	0.00	25	5	2
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.07	0.01	0.00	25	5	2	0.02	0.01	0.00	25	5	2
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.07	0.01	0.00	25	5	2	0.02	0.01	0.00	25	5	2
Alternative B	75	0.07	0.01	0.00	25	5	2	0.02	0.01	0.00	25	5	2
Preferred Alternative	250	0.08	0.01	0.00	25	5	2	0.02	0.01	0.00	25	5	2

[1] In $\mu g/m^3$. Annual background SO_2 concentration = 9 $\mu g/m^3$; 8-hr background SO_2 concentration = 43 $\mu g/m^3$; 3-hr background SO_2 concentration = 132 $\mu g/m^3$. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.

Table J-32. Summary of Maximum Modeled Cumulative PM_{10} Concentrations at PSD Class I and Sensitive PSD Class II Areas Compared to PSD Increments, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Popo Agie Wilderness Class II			
		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.46	0.018	8	4	0.13	0.005	8	4	0.14	0.008	30	17
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.91	0.047	8	4	0.15	0.008	8	4	0.20	0.015	30	17
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	1.82	0.081	8	4	0.20	0.011	8	4	0.31	0.024	30	17
Alternative B	75	1.16	0.058	8	4	0.16	0.009	8	4	0.23	0.018	30	17
Preferred Alternative	250	0.79	0.041	8	4	0.15	0.007	8	4	0.18	0.013	30	17

Alternative or Development Phase	WDR	Wind River Roadless Area Class II				Grand Teton National Park Class I				Teton Wilderness Class I			
		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.21	0.009	30	17	0.12	0.012	8	4	0.04	0.005	8	4
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	0.23	0.014	30	17	0.13	0.013	8	4	0.05	0.006	8	4
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	0.29	0.021	30	17	0.14	0.015	8	4	0.08	0.007	8	4
Alternative B	75	0.25	0.016	30	17	0.13	0.014	8	4	0.06	0.006	8	4
Preferred Alternative	250	0.23	0.012	30	17	0.13	0.013	8	4	0.06	0.006	8	4

Alternative or Development Phase	WDR	Yellowstone National Park Class I				Washakie Wilderness Area Class I			
		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	--	0.05	0.004	8	4	0.04	0.003	8	4
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.05	0.004	8	4	0.05	0.004	8	4
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.06	0.005	8	4	0.09	0.005	8	4
Alternative B	75	0.05	0.004	8	4	0.06	0.004	8	4
Preferred Alternative	250	0.05	0.004	8	4	0.05	0.004	8	4

[1] In $\mu g/m^3$. Annual background PM_{10} concentration = 16 $\mu g/m^3$; 24-hr background PM_{10} concentration = 33 $\mu g/m^3$. The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD Increment Consumption Analysis.

Table J-33. Summary of Maximum Modeled Cumulative Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources Using FLAG Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action	--	1.69	3	0.42	0	0.50	0	0.73	0
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	1.98	4	0.48	0	0.57	0	0.82	0
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	3.65	11	0.76	0	0.85	0	1.08	1
Alternative B	75	2.38	5	0.53	0	0.68	0	0.90	0
Preferred Alternative	250	2.29	5	0.49	0	0.64	0	0.86	0

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action	--	0.33	0	0.14	0	0.15	0	0.17	0
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.34	0	0.16	0	0.17	0	0.20	0
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.50	0	0.23	0	0.25	0	0.34	0
Alternative B	75	0.36	0	0.18	0	0.18	0	0.25	0
Preferred Alternative	250	0.34	0	0.17	0	0.17	0	0.23	0

[1] In deciviews (dv).

Table J-34. Summary of Maximum Modeled Cumulative Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources Using IMPROVE Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action	--	1.94	3	0.49	0	0.58	0	0.81	0
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	2.26	4	0.56	0	0.66	0	0.92	0
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	4.01	17	0.87	0	0.99	0	1.21	2
Alternative B	75	2.71	7	0.61	0	0.78	0	1.01	1
Preferred Alternative	250	2.62	6	0.57	0	0.75	0	0.96	0

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv	Maximum Visibility Impact[1]	Number of Days >1.0 dv
No Action	--	0.33	0	0.14	0	0.16	0	0.17	0
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.35	0	0.16	0	0.17	0	0.20	0
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.50	0	0.24	0	0.25	0	0.34	0
Alternative B	75	0.36	0	0.18	0	0.18	0	0.25	0
Preferred Alternative	250	0.35	0	0.17	0	0.18	0	0.23	0

[1] In deciviews (dv).

Table J-35. Summary of Maximum Modeled Cumulative Change in ANC at Acid Sensitive Lakes from Direct Project and Regional Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	**Black Joe Lake - Bridger Wilderness Class I**		**Deep Lake - Bridger Wilderness Class I**		**Hobbs Lake - Bridger Wilderness Class I**		**Lazy Boy Lake - Bridger Wilderness Class I**	
		ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change
Background ANC	--	67.0	--	59.9	--	69.9	--	18.8	--
Level of Acceptable Change (μeq/L)	--	6.70	10	5.99	10	6.99	10	1.00	--
No Action	--	0.085	0.13	0.087	0.14	0.042	0.06	0.025	0.13
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.107	0.16	0.111	0.18	0.046	0.07	0.026	0.14
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.185	0.28	0.196	0.33	0.062	0.09	0.032	0.17
Alternative B	75	0.137	0.20	0.142	0.24	0.051	0.07	0.028	0.15
Preferred Alternative	250	0.127	0.19	0.133	0.22	0.050	0.07	0.028	0.15

Alternative or Development Phase	WDR	**Upper Frozen Lake - Bridger Wilderness Class I**		**Lower Saddlebag - Popo Agie Wilderness Class II**		**Ross Lake - Fitzpatrick Wilderness Class I**	
		ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change	ANC Change[1]	Percent ANC Change
Background ANC	--	5.0	--	55.5	--	53.5	--
Level of Acceptable Change (μeq/L)	--	1.00	--	5.55	10	5.35	10
No Action	--	0.091	1.83	0.096	0.17	0.026	0.05
MAXIMUM PRODUCTION EMISSIONS							
All alternatives with 3,100 wells	0	0.120	2.39	0.122	0.22	0.027	0.05
MAXIMUM FIELD EMISSIONS							
Alternative A and Proposed Action	250	0.227	4.53	0.220	0.40	0.032	0.06
Alternative B	75	0.159	3.17	0.160	0.29	0.029	0.05
Preferred Alternative	250	0.149	2.98	0.147	0.27	0.028	0.05

[1] In μeq/L.

Table J-36. Summary of Modeled Cumulative Sulfur (S) Deposition Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]
No Action	--	-0.001	0.749	-0.001	0.749	-0.003	0.747	-0.001	0.749
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	-0.001	0.749	-0.001	0.749	-0.003	0.747	-0.001	0.749
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	-0.001	0.749	-0.001	0.749	-0.002	0.748	-0.001	0.749
Alternative B	75	-0.001	0.749	-0.001	0.749	-0.002	0.748	-0.001	0.749
Preferred Alternative	250	-0.001	0.749	-0.001	0.749	-0.002	0.748	-0.001	0.749

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]
No Action	--	0.003	0.753	0.001	0.751	0.001	0.751	0.000	0.750
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.003	0.753	0.001	0.751	0.001	0.751	0.000	0.750
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.003	0.753	0.001	0.751	0.001	0.751	0.000	0.750
Alternative B	75	0.003	0.753	0.001	0.751	0.001	0.751	0.000	0.750
Preferred Alternative	250	0.003	0.753	0.001	0.751	0.001	0.751	0.000	0.750

[1] In kg/ha-yr. Sulfur deposition analysis level of concern for cumulative impacts = 5.0 kg/ha-hr. Negative values reflect a reduction in SO_2 emissions noted in the regional source inventory.
[2] Includes S deposition value of 0.750 kg/ha-yr measured at the Pinedale CASTNET site for the year 2001.

Table J-37. Summary of Modeled Cumulative Far-field Nitrogen (N) Deposition Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Popo Agie Wilderness Class II		Wind River Roadless Area Class II	
		Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]
No Action	--	0.030	1.530	0.005	1.505	0.012	1.512	0.011	1.511
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.035	1.535	0.006	1.506	0.016	1.516	0.013	1.513
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.057	1.557	0.008	1.508	0.029	1.529	0.021	1.521
Alternative B	75	0.042	1.542	0.007	1.507	0.021	1.521	0.016	1.516
Preferred Alternative	250	0.042	1.542	0.006	1.506	0.019	1.519	0.015	1.515

Alternative or Development Phase	WDR	Grand Teton National Park Class I		Teton Wilderness Class I		Yellowstone National Park Class I		Washakie Wilderness Area Class I	
		Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]
No Action	--	0.009	1.509	0.003	1.503	0.002	1.502	0.003	1.503
MAXIMUM PRODUCTION EMISSIONS									
All alternatives with 3,100 wells	0	0.009	1.509	0.003	1.503	0.002	1.502	0.004	1.504
MAXIMUM FIELD EMISSIONS									
Alternative A and Proposed Action	250	0.010	1.510	0.004	1.504	0.003	1.503	0.004	1.504
Alternative B	75	0.010	1.510	0.003	1.503	0.002	1.502	0.004	1.504
Preferred Alternative	250	0.010	1.510	0.003	1.503	0.002	1.502	0.004	1.504

[1] In kg/ha-yr. Nitrogen deposition analysis level of concern for cumulative impacts = 3.0 kg/ha-hr.
[2] Includes N deposition value of 1.500 kg/ha-yr measured at the Pinedale CASTNET site for the year 2001.

Table J-38. Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Communities from Direct Project and Regional Sources Using FLAG Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	**Big Piney**		**Big Sandy**		**Boulder**		**Bronx**		**Cora**	
		Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv
No Action	--	1.91	5	1.27	1	2.56	4	0.66	0	0.74	0
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	1.98	7	1.64	4	2.67	5	0.69	0	0.81	0
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.29	16	3.29	31	3.26	19	1.56	1	2.92	6
Alternative B	75	2.05	10	2.20	13	2.79	9	0.82	0	1.57	1
Preferred Alternative	250	1.99	8	1.88	9	2.72	6	0.84	0	1.62	1

Alternative or Development Phase	WDR	**Daniel**		**Farson**		**Labarge**		**Merna**		**Pinedale**	
		Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv
No Action	--	0.68	0	1.33	3	1.62	6	0.88	0	1.55	2
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.79	0	1.47	6	1.79	6	0.91	0	1.69	4
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.34	6	2.49	11	2.54	9	0.99	0	3.91	8
Alternative B	75	1.26	1	1.78	10	2.07	6	0.94	0	2.23	5
Preferred Alternative	250	1.28	1	1.63	8	2.02	6	0.93	0	2.19	5

[1] In deciviews (dv).

Table J-39. Summary of Maximum Modeled Cumulative Visibility Impacts at Wyoming Regional Communities from Direct Project and Regional Sources Using IMPROVE Background Data, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005

Alternative or Development Phase	WDR	Big Piney		Big Sandy		Boulder		Bronx		Cora	
		Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv
No Action	--	2.18	7	1.45	2	2.92	4	0.74	0	0.85	0
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	2.26	11	1.88	9	3.04	5	0.77	0	0.93	0
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.62	20	3.62	34	3.70	21	1.79	1	3.32	8
Alternative B	75	2.34	14	2.43	16	3.17	9	0.94	0	1.80	3
Preferred Alternative	250	2.28	13	2.13	12	3.09	9	0.97	0	1.86	2

Alternative or Development Phase	WDR	Daniel		Farson		Labarge		Merna		Pinedale	
		Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv	Maximum Visibility Impact[1]	Number of Days > 1.0 dv
No Action	--	0.79	0	1.48	3	1.86	6	0.98	0	1.78	2
MAXIMUM PRODUCTION EMISSIONS											
All alternatives with 3,100 wells	0	0.89	0	1.69	8	2.05	6	1.01	1	1.94	5
MAXIMUM FIELD EMISSIONS											
Alternative A and Proposed Action	250	2.67	11	2.75	12	2.90	12	1.13	5	4.41	10
Alternative B	75	1.44	2	2.04	10	2.37	6	1.05	1	2.55	8
Preferred Alternative	250	1.47	2	1.87	10	2.30	6	1.03	1	2.50	6

[1] In deciviews (dv).

Table J-40. Summary of Maximum Modeled Cumulative In-field Pollutant Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2005[1]

Alternative or Development Phase	WDR	NO_x			SO_2								
		Direct Modeled Impact	Total Concen-tration[2]	NAAQS/WAAQS	Direct Modeled Impact			Total Concentration[2]			NAAQS/WAAQS		
		Annual	Annual	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action[4]	--	1.2	4.6	100	0.7	0.1	0.0	132.7	43.1	9.0	1,300	365/260	80/60
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	3.2	6.6	100	0.7	0.1	0.0	132.7	43.1	9.0	1,300	365/260	80/60
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	14.0	17.4	100	18.2	3.6	0.4	150.2	46.6	9.4	1,300	365/260	80/60
Alternative B	75	12.2	15.6	100	17.1	4.0	0.3	149.1	47.0	9.3	1,300	365/260	80/60
Preferred Alternative	250	7.1	10.5	100	19.9	3.9	0.4	151.9	46.9	9.4	1,300	365/260	80/60

Alternative or Development Phase	WDR	PM_{10}						$PM_{2.5}$					
		Direct Modeled Impact		Total Concentration[2]		NAAQS/WAAQS		Direct Modeled Impact		Total Concentration[2]		NAAQS/WAAQS[3]	
		24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action[4]	--	0.3	0.0	33.3	16.0	150	50	0.3	0.0	13.3	5.0	65	15
MAXIMUM PRODUCTION EMISSIONS													
All alternatives with 3,100 wells	0	90.5	12.6	123.5	28.6	150	50	16.5	2.0	29.5	7.0	65	15
MAXIMUM FIELD EMISSIONS													
Alternative A and Proposed Action	250	113.4	16.0	146.4	32.0	150	50	21.8	3.1	34.8	8.1	65	15
Alternative B	75	97.2	13.8	130.2	29.8	150	50	17.9	2.7	30.9	7.7	65	15
Preferred Alternative	250	23.3	3.5	56.3	19.5	150	50	5.0	1.0	18.0	6.0	65	15

1 In $\mu g/m^3$.
2 Total concentration includes direct modeled impact, including RFD and RFFA, and background concentration; annual background NO_X concentration = 3.4 $\mu g/m^3$; annual background SO_2 concentration = 9 $\mu g/m^3$; 8-hr background SO_2 concentration = 43 $\mu g/m^3$; 3-hr background SO_2 concentration = 132 $\mu g/m^3$; annual background PM_{10} concentration = 16 $\mu g/m^3$; 24-hr background PM_{10} concentration = 33 $\mu g/m^3$; annual background $PM_{2.5}$ concentration = 5 $\mu g/m^3$; 24-hr background $PM_{2.5}$ concentration = 13 $\mu g/m^3$.
3 WAAQS for $PM_{2.5}$ are not yet enforced in Wyoming per WAQSR Chapter 2, Section 2(b)(v).