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

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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
Rock Springs, Wyoming

and

Jonah Infill Drilling Project Operators
South Piney Natural Gas Development Project Companies

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ACRONYMS AND ABBREVIATIONS

APD	Application for Permit to Drill
AQD	Air Quality Division
BACT	Best Available Control Technologies
bbl	Barrels
BCF	Billion cubic feet
BLM	Bureau of Land Management
CERLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COA	Conditions of Approval
DR	Decision Records
EA	Environmental Assessments
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
JIDPA	Jonah Infill Drilling Project Area
LOP	Life-of-project
LQD	Land Quality Division
mmcf	Million cubic feet
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 Data Acquisition
TCF	Trillion cubic feet
TDS	Total Dissolved Solids
TRPH	Total recoverable petroleum hydrocarbons

ACRONYMS AND ABBREVIATIONS (CONTINUED)

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 summary of the primary facets for development of the Jonah Infill Drilling 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] 2004). Where development actions would likely differ among development alternatives (i.e., Proposed Action, Alternatives A-G, and the Preferred Alternative), these differences are identified.

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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 well/year case). The BLM may, however, restrict the pace of development in the area to only 75 or 150 wells developed per year, and in these cases the number of simultaneously operating rigs may be reduced or drilling may not continue year-round.

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% per well (i.e., from 200 trips to 240 trips per well) primarily as a result of increased drilling duration. 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 A of this document.

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 2.1 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	--
Drilling (22 days)[3]	200	620	--
Completion/Testing (17 days)	570	1,767	--
Pipeline Construction (4 days)	20	62	--
Total well construction and development (54 days/well site)	810	2,511	529
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 Includes rig up/rig down and assumes no directional drilling; directional wells average approximately 26 days to drill.

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.

Table 2.2 Estimated Work Force Requirements, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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 x 4 workers)	16	77	136	191
Rig Up/Down (5 days x 15 workers)	75	361	635	895
Drilling[3] (22 days x 11 workers x 2 shifts)	528	2,539	4,468	6,296
Completion Testing (17 days x 11 workers)	187	900	1,583	2,230
Pipeline Construction (4 days x 6 workers)	24	116	203	287
Production and Maintenance Activities				
Production[4,5]	305	1,767	2,881	3,863
Workovers[6] (every 10 to 20 years) (10 days x 7 workers)	210	1,010	1,777	2,504
Abandonment and Reclamation				
(5 days x 10 workers)	50	241	423	597
Total	1,395	7,011	12,106	16,863

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

Depending upon the number of wells authorized (1,250, 2,200, or 3,100) and the number of wells developed per year (75, 150, or 250), project construction, drilling, completion, and production would require from 43 to 85 years to complete (see EIS Table 2.1). The fewer the number of wells 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 A.

2.2 PRECONSTRUCTION PLANNING AND SITE LAYOUT

Pursuant to *Onshore Oil and Gas Order No. 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., wellpad 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 site-specific environmental assessments (EAs) and decision records (DRs). 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 C.F.R. 43 Subpart 3814 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. Topsoil stockpiles would be stabilized with vegetation until used for reclamation. Further detail on proposed reclamation activities is provided in the Reclamation Plan, included as Appendix 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;
- 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 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-ft initial disturbance width) and 0.5 acre of disturbance would be required for the LOP (29-ft 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, 1991a). On completion of construction activities, the

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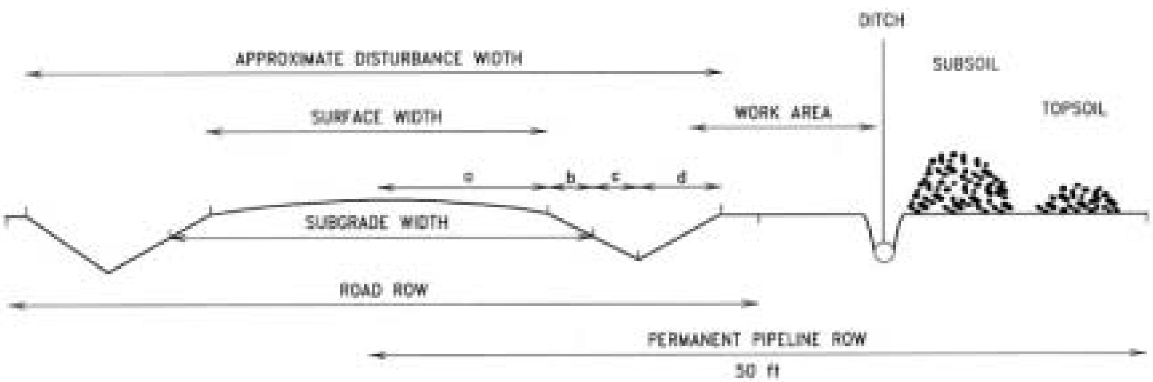


	MINIMUM SUBGRADE WIDTH (ft)	MINIMUM SURFACED TRAVELWAY WIDTH (ft)	a (ft)	b (ft)	c (ft)	d (ft)	APPROXIMATE DISTURBANCE WIDTH (ft)	ROW WIDTH (ft)	DESIGN SPEED (mph)
RESOURCE ROAD	16	12	6	2	4	8	40	50	15–30
LOCAL ROAD	24	20	10	2	4	8	48	55	20–50
COLLECTOR ROAD	28	24	12	2	4	8	52	60	30–50

DIAGRAM OF TYPICAL TURNOUTS ON RESOURCE ROADS

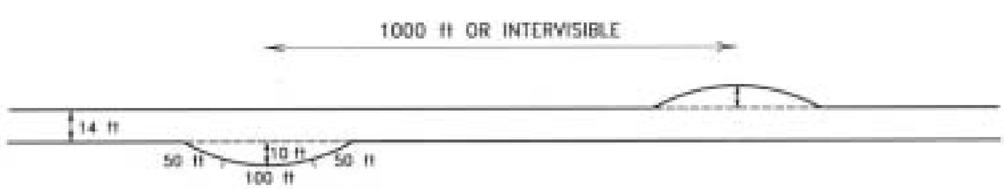


Figure 2.1 Typical Access Road with Adjacent Pipeline Schematic, Jonah Infill Drilling Program, Sublette County, Wyoming, 2004.

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 ft 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 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 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. New or upgraded collector roads in the JIDPA would be developed under all alternatives except No Action, and under Alternative B, only the Burma Road would be upgraded. 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 10.5 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). Map 2.1 shows projected down-hole well spacing for maximum resource recovery. Without additional drilling in the area, a total of approximately 3,366 billion cubic feet (BCF) would be recovered by existing operations, leaving approximately 7,134 BCF unrecovered (Table 2.3). 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 twenty drilling rigs rated for drilling to depths of 12,000 ft or more may be employed simultaneously during project development to accommodate development of 250 wells per year. However, if a slower development pace occurs (e.g., 150 or 75 wells developed per year), the number of simultaneously operating rigs would likely be reduced. Drilling is scheduled to begin in 2005, 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 B. 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 ft. Drilling would require approximately 22 individuals, including two 11-person rig operations crews necessary to conduct drilling 24-hr/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).

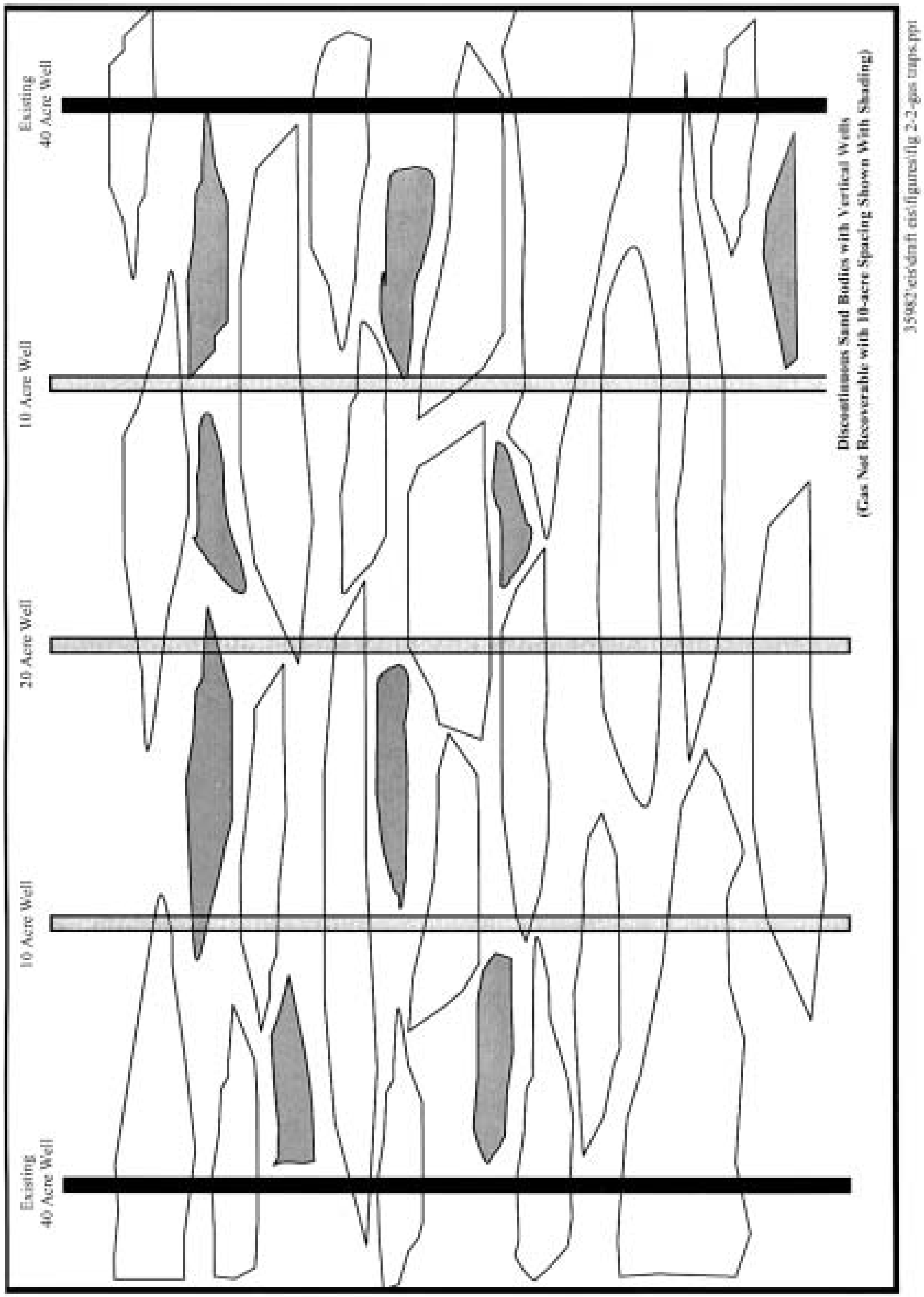
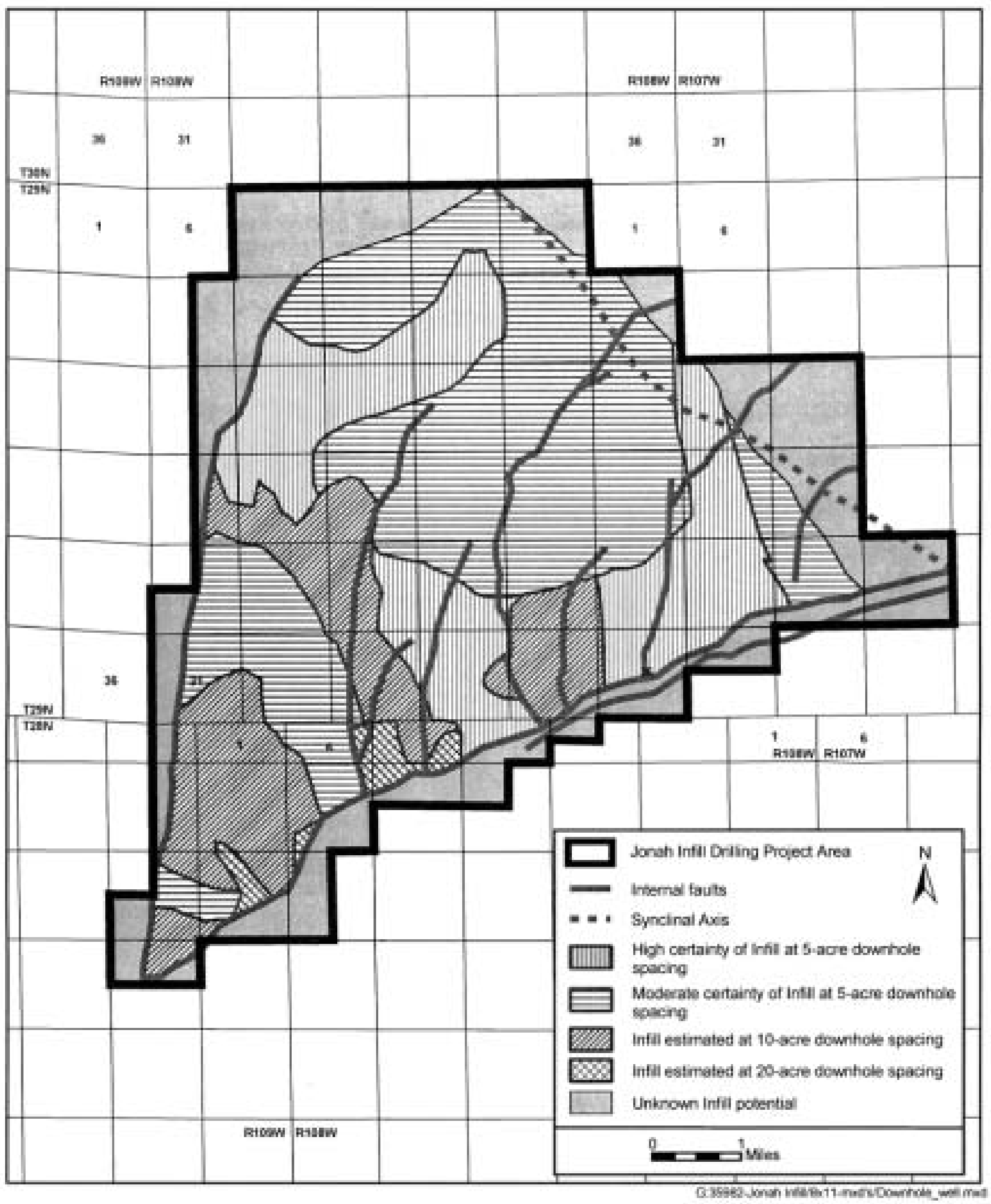


Figure 2.2 Representation of Gas Traps, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.



Map 2.1 Down-hole Well Spacing Potential, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Table 2.3 Anticipated Gas Recovery Volumes, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[1]

Development Technique	Estimated Recovery Volumes (billion cubic feet [BCF])[2]	Estimated Unrecovered Volumes (BCF)[2]
No New Wells	3,366	7,134
3,100 Wells/16,200 acres disturbance[3]	7,947	2,533
3,100 Wells/3,100 new well pads	8,191	2,309
3,100 Wells/Existing 497 Well Pads[3]	6,124	4,376
1,250 wells/1,250 new well pads	6,657	3,843
2,200 wells/2,200 new well pads	7,554	2,946
3,100 wells/266 new well pads (16 total pads/section)[3]	6,302	4,198
3,100 wells/1,028 new well pads (32 total pads/section)[3]	7,186	3,314
3,100 wells/2,553 new well pads (64 total pads/section)[3]	7,876	2,624

1 Data provided by EnCana.
2 Assumes 10,500 billion cubic feet (BCF) of gas in place; 1 BCF corresponds to the annual use by approximately 13,700 residences (Energy Information Administration 2004). Typical gas field recoveries range from 75%-85% of gas in place.
3 Assumes 10% of directional wells do not reach total depth and 1,000 ft of formation cannot be developed. Does not fully account for losses/unrecovered resources associated with undeveloped wells (assumed uneconomic).

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-ft active raptor nest buffers, and the 600-ft Sand Draw buffer) (Map 2.2). 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

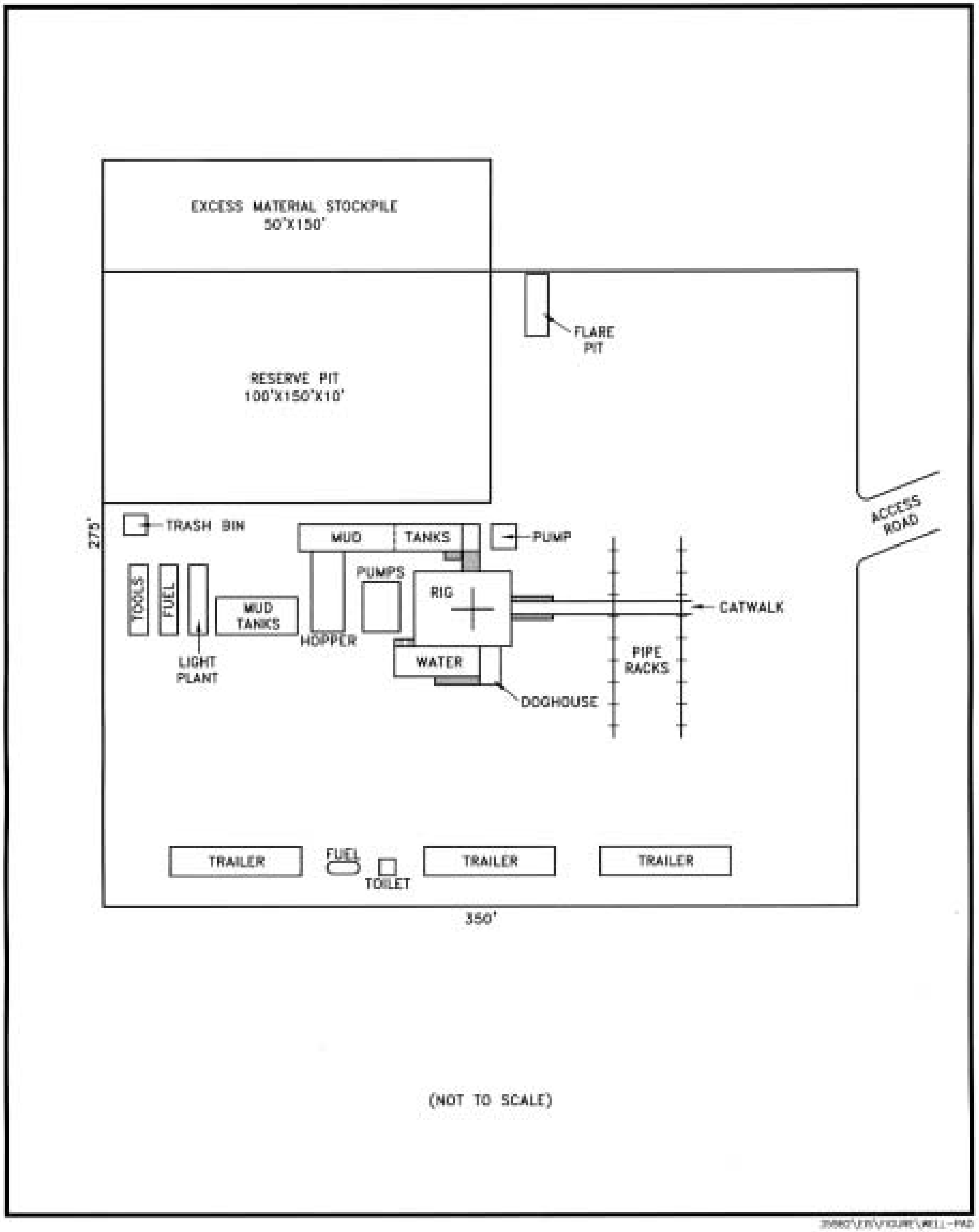
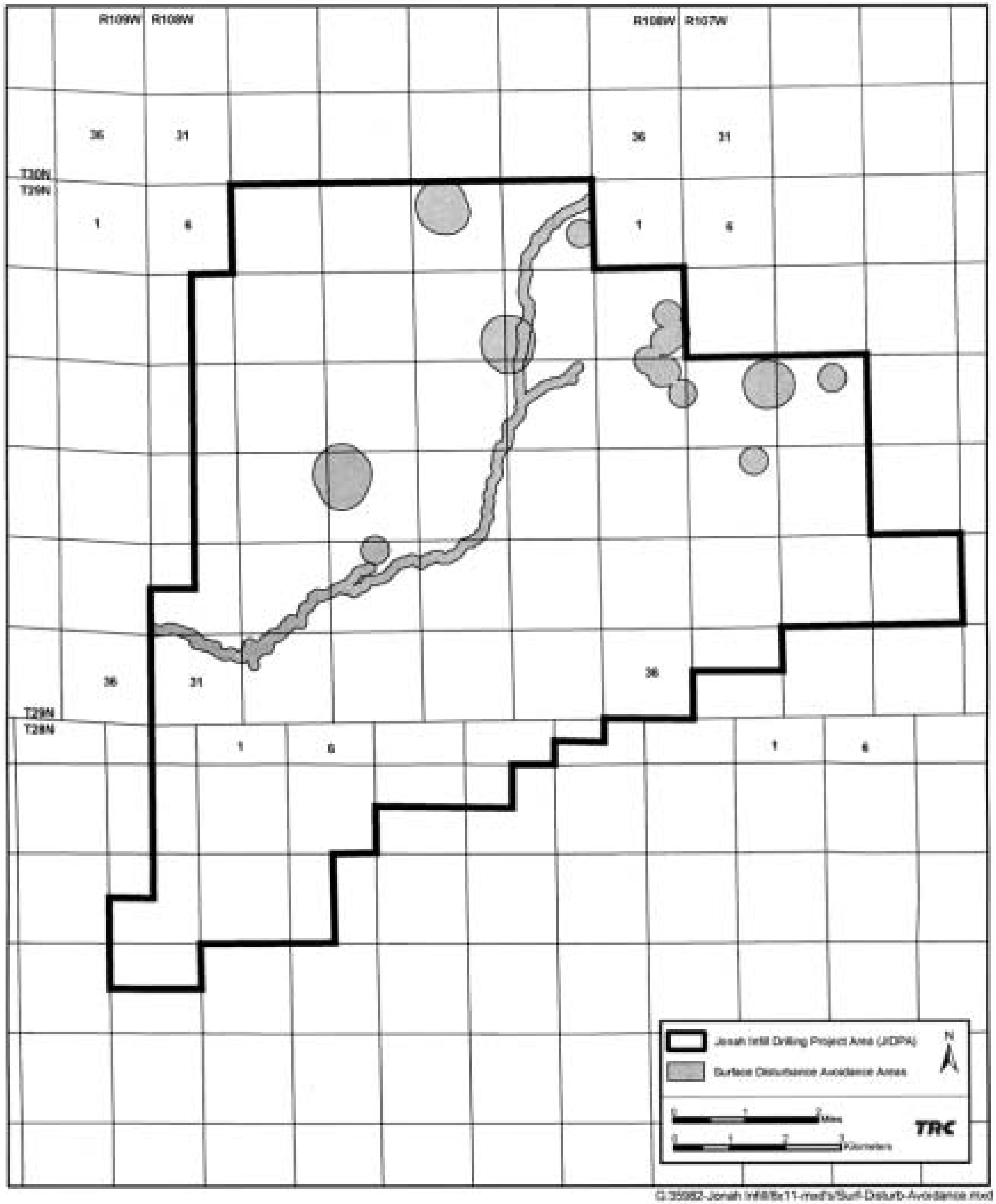


Figure 2.3 Schematic Representation of a Typical Vertical Well Pad Layout During Drilling, Jonah Infill Drilling Project, Sublette County, 2004.



Map 2.2 Surface Disturbance Avoidance Areas, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

alternatives to access reserves beneath areas with steep slopes and other topographic features. Additional directional wells would likely be developed under Alternatives B and E-G 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 gal/bbl) (1.4 acre-ft). Total drilling water requirements for a 3,100 well project would be approximately 4,395 acre-ft, or 338 acre-ft per year over a 13-year well development period (250 wells per year case). The rate of water use

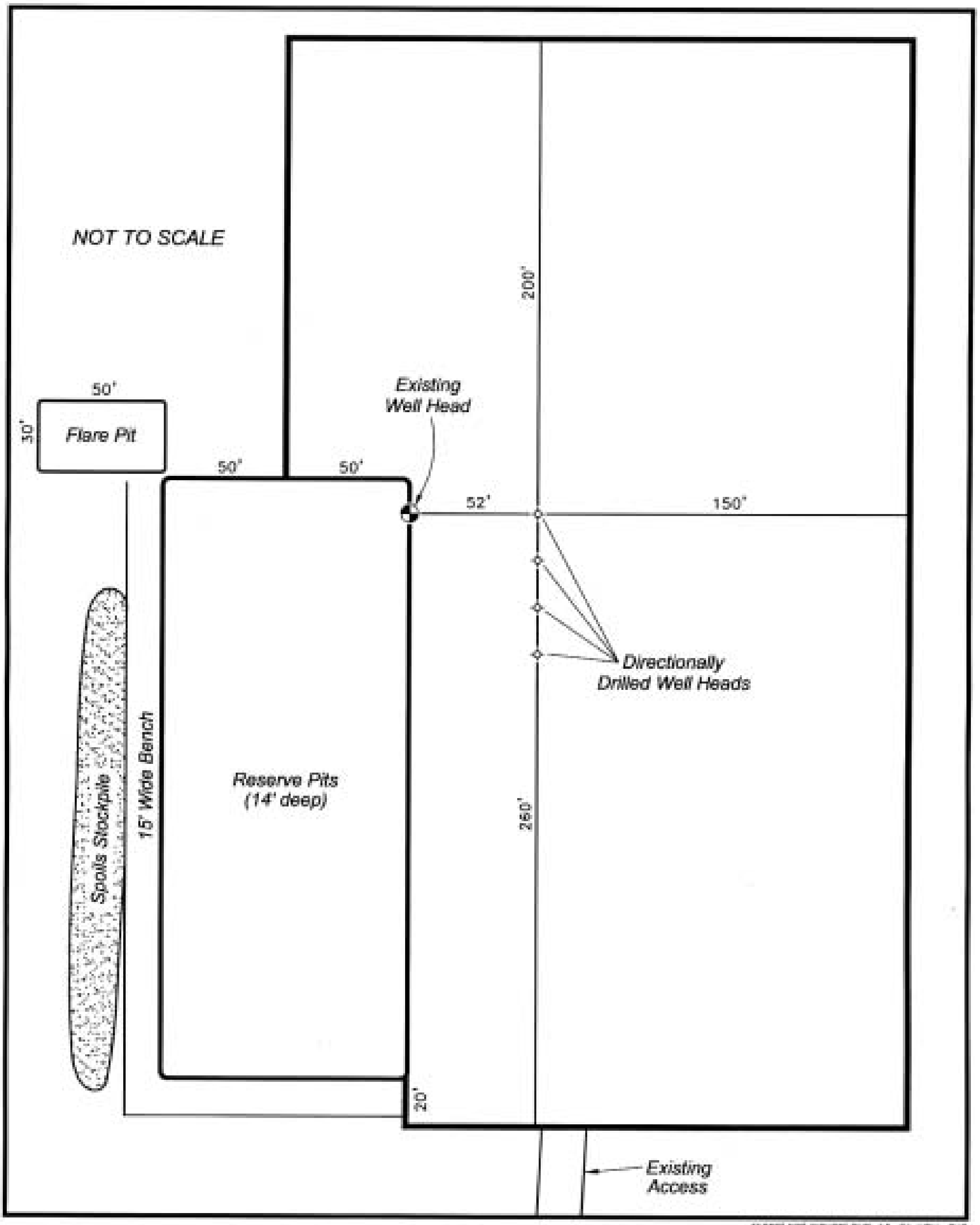


Figure 2.4 Example Directional Drill/Multi-well Pad Layout at an Existing Well Pad, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

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 may 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 approximately 16 new water wells. 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.

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.

Cuttings and all drilling fluids would be contained in the reserve pit, and drilling fluids would be recovered and reused to drill the next well to the maximum extent possible. 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 ft). Production casing would be run and cement circulated to a minimum of 400 ft 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 well bore, 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.

On 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.

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, for this project, it is anticipated that only about 50% of all future completion operations would utilize flaring. To minimize the need for flaring, a high-pressure flow-back unit designed to separate sand,

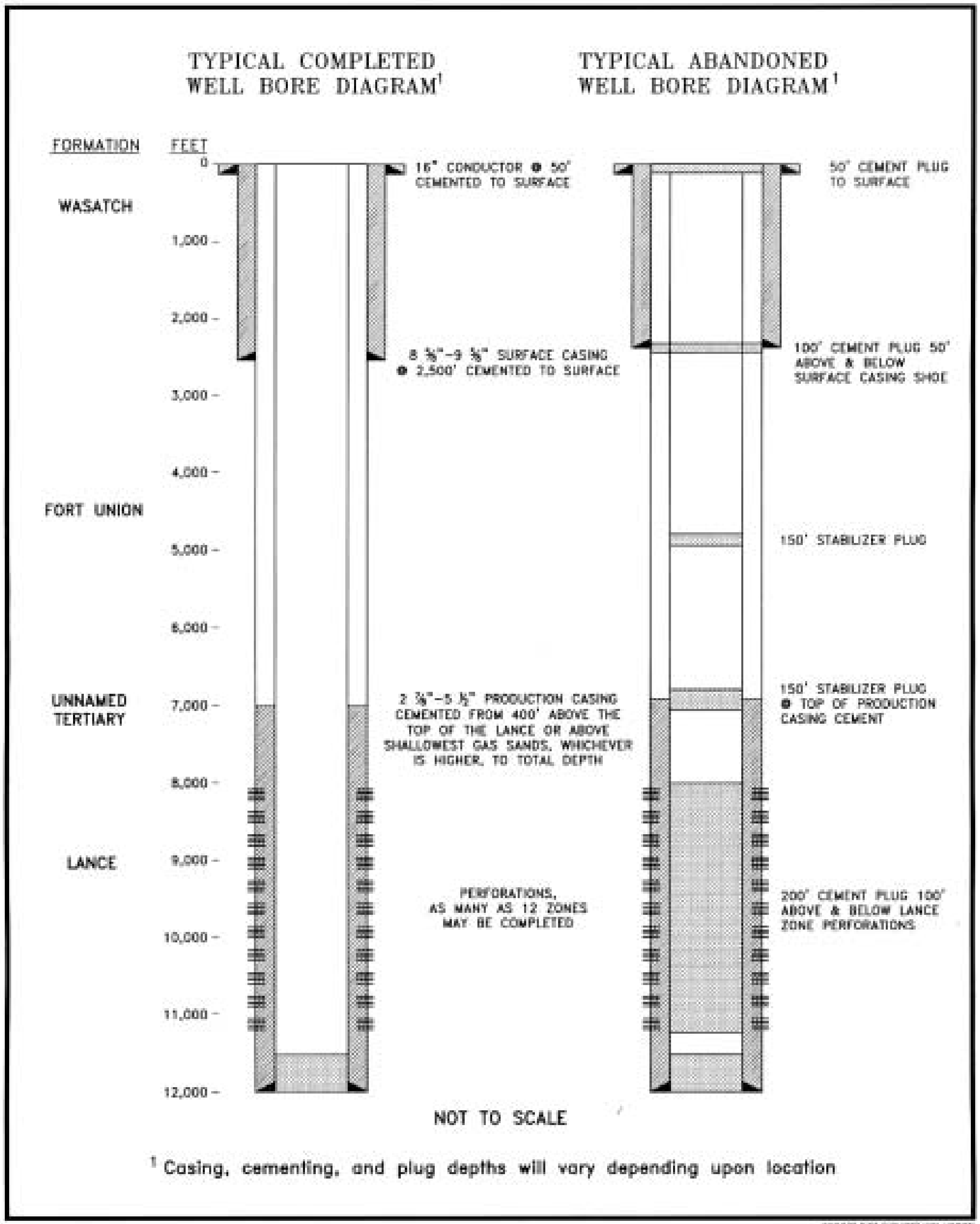


Figure 2.5 Typical Completed and Abandoned Well Bore Diagrams, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

condensate, natural gas, and water would be used. Sand would be piped to the reserve pit, 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.

Approximately 33,300 bbl of water (4.3 acre-ft) 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-ft), and 10% or more of this water may be from recycling operations (see Section 2.8). Water requirements for 3,100 wells are estimated to be 17,700 acre-ft, approximately 1,362 acre-ft per year over a 13-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.

The reserve pit would be closed pursuant to WOGCC rules and regulations and would generally be backfilled within two to three years following termination of drilling and completion operations, depending upon the rate of reserve pit fluid evaporation. If natural evaporation of the reserve pit is not feasible, alternative methods of drying, removal of fluids, or other treatment would be implemented. If fluids would be disposed of by any method other than evaporation or hauling to an approved disposal facility, approval by the BLM would be obtained. 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 well head (a series of valves designed to control pressures and regulate flows from the well); separators to segregate natural gas, condensate, and water and to lower volatile organic compound (VOC) emissions; aboveground tanks for condensate and produced water storage; 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 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 2-3 mmcfpd per well. As wells age, produced gas volumes would decline. Gas composition data is provided in Table 2.4. 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 2.5. Condensates would be stored in tanks at each well location, and all tank batteries would be bermed to contain 110% of the volume of the largest tank. Condensates would be

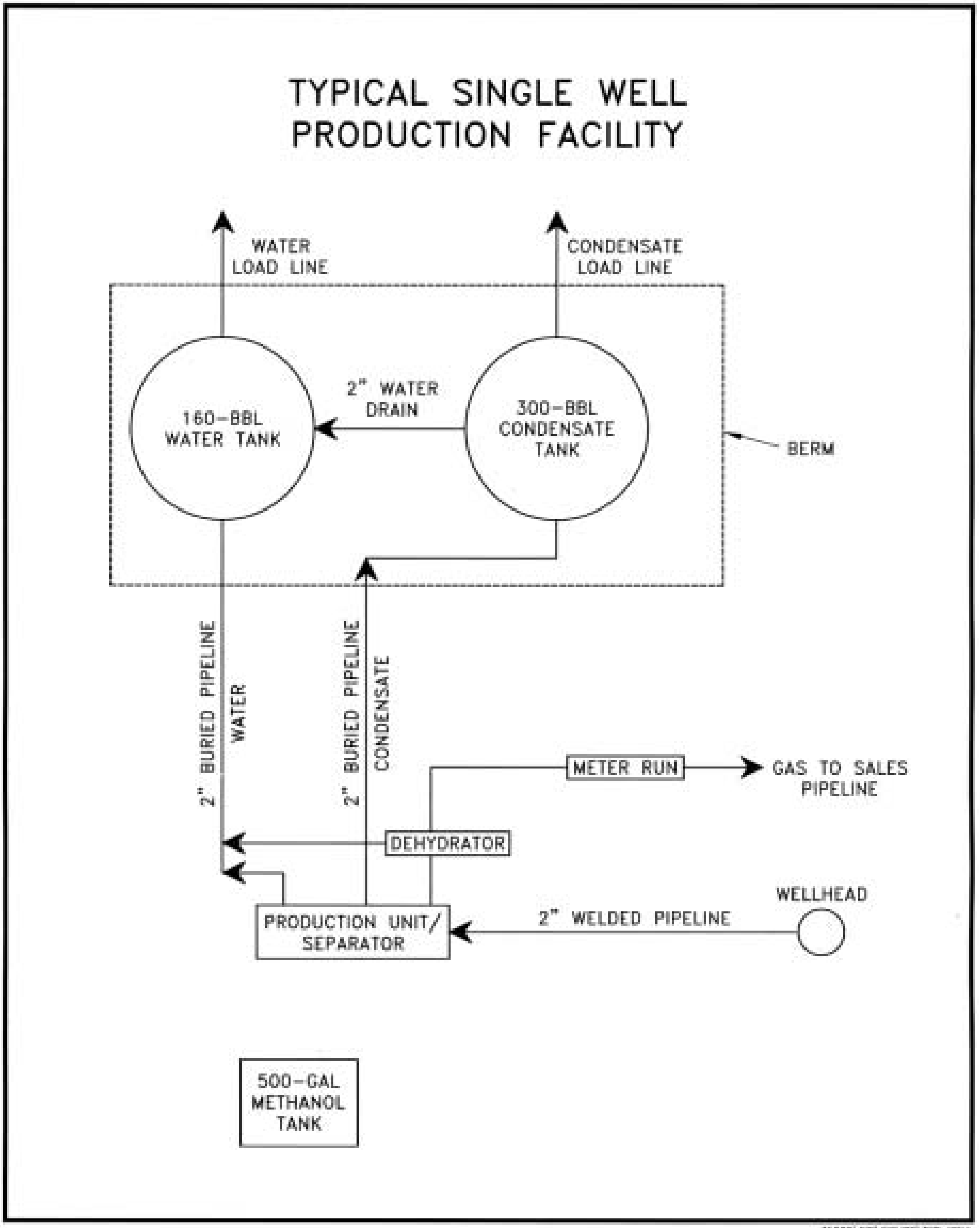


Figure 2.6 Typical Production Facility Layout, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Table 2.4 Natural Gas Composition Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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 2.5 Condensate Constituent Analysis, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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.

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. Produced water quality data are provided in Table 2.6. 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 trucked to approved disposal 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, this water is 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. 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 pit sizes, total drill bore lengths, and other requirements; more mud is necessary for directional drilling.

Table 2.6 Average Water Quality from Natural Gas Wells, Water Wells, and the Existing Evaporation Pond and Relevant Class III Ground Water Quality Standards, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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 ground water.

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% 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.

One water disposal well is present in the JIDPA (6,500 ft deep/Fort Union Formation) (see EIS Map 1.2) 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 Data Acquisition (SCADA) facilities are being established at many 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% 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 well bore 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 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 ft wide and located 8 to 10 ft 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 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 ft outside of and adjacent to road ROWs (50-ft 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 2.7 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 C.F.R. 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 wellpads, 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 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 wellpad and access road performed as soon as practicable after final abandonment.

Table 2.7 Existing and Anticipated Compression Requirements (Horsepower), Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Compression Status	Compressor Stations: Bird Canyon[1]	Luman[2]	Yellow Point[3]	Jonah Field[4]	Falcon[5]	Total
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 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 x 200 ft. Containment berm walls 2 ft high x 4 ft wide would be located on the east, south, and west perimeters of the pad to contain storm water 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 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 ft wide x 120 ft 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 hrs 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 C.F.R. 117, would be reported as required by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended (42 *United States Code* [U.S.C.] 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 C.F.R. 1910.1028 (benzene).

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APPENDIX A:

TRANSPORTATION PLAN,
JONAH INFILL DRILLING PROJECT

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TRANSPORTATION PLAN,
JONAH INFILL DRILLING PROJECT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Bureau of Land Management
Pinedale Field Office
Pinedale, Wyoming

and

Bureau of Land Management
Rock Springs Field Office
Rock Springs, Wyoming

TRC Mariah Associates Inc.
Laramie, Wyoming
MAI Project 35982

February 2005

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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
PFO	Pinedale Field Office
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

A-1.0 INTRODUCTION

A-1.1 OBJECTIVES

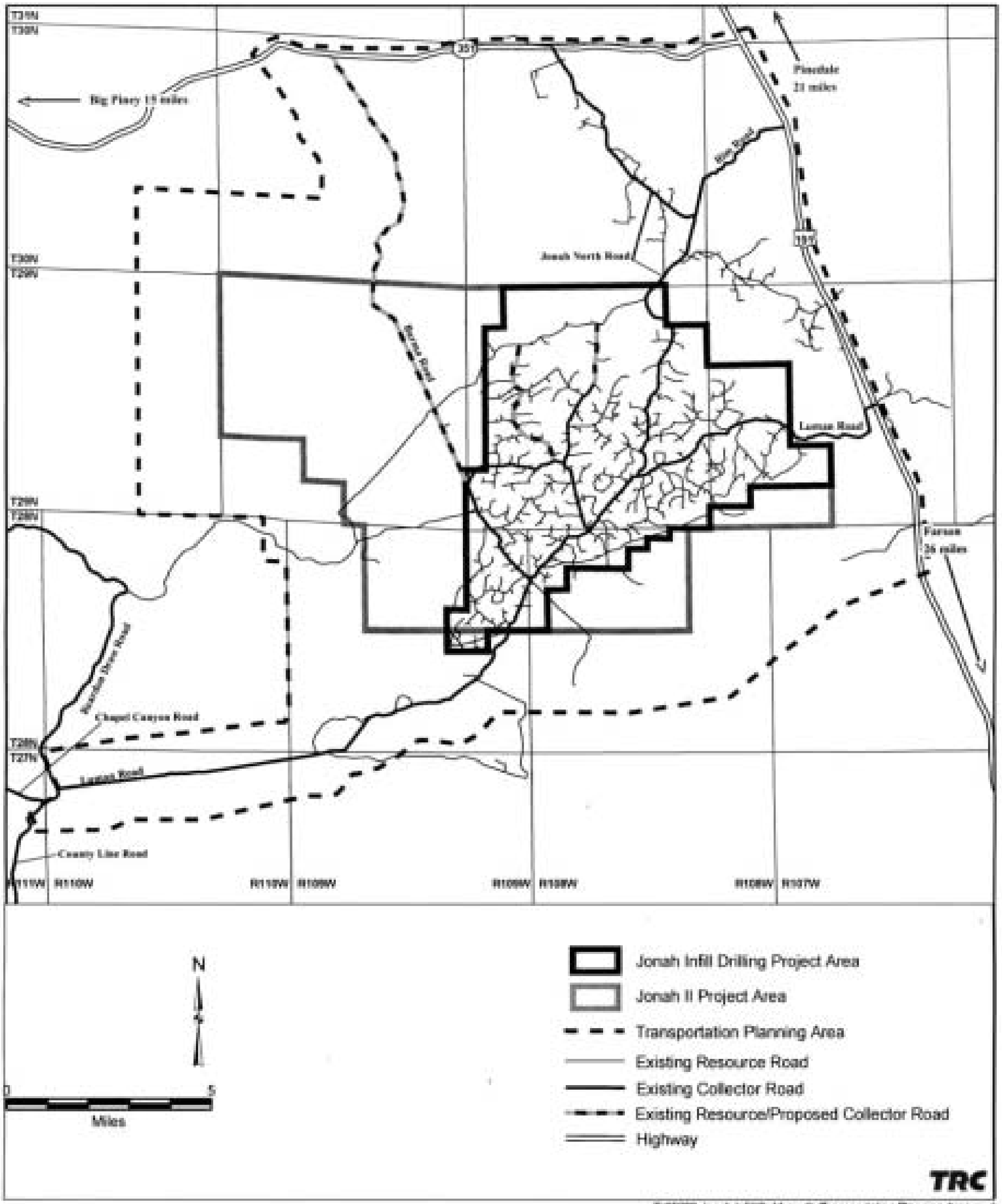
This Transportation Plan (TP) was prepared to supplement a proposal by oil and gas companies (Operators) to drill new wells in the Jonah Infill Drilling Project Area (JIDPA), as described in the Jonah Infill Drilling Project Area environmental impact statement (EIS). This TP provides an assessment of 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 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.



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

- Existing roads in the JIDPA are described, and primary routes (i.e., project-required collector and local roads) are identified on maps. High 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.

This document was prepared for the BLM by TRC Mariah Associates Inc. (TRC Mariah).

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 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.

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 paleontologic 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.

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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 phone 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 permitees; 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-ft buffer 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.

A-3.0 ROAD ROUTE DESCRIPTIONS

There are two paved all-weather roads currently providing access to the TPA--U.S., Highway 191 and Wyoming State Highway 351. The remainder of the roads are 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 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.

A-3.1 U.S. HIGHWAY 191

U.S. Highway 191 is the primary transportation corridor currently linking the JIDPA (at the Luman Road and Rim 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, turnout lanes may be deemed appropriate at the junction of U.S. Highway 191 and the Rim Road. Additionally, 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 and Rim Road), animal crossings, etc.

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 a day in 2002 to 1,200 vehicles a 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.

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.

A-3.4 BURMA ROAD

The Burma Road extends from Wyoming State Highway 351 12 miles south 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. 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.

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 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.

A-3.6 RIM ROAD

The Rim Road serves as a connector road between the Jonah North Road and U.S. Highway 191 approximately 2.4 miles south from the Wyoming State Highway 351 junction. This road has resource road status and has been gravel/aggregate-surfaced but does not receive regular maintenance. The road is not intended for oil and gas development traffic, and its primary purpose is to provide for livestock management and recreation traffic. No improvements are currently scheduled, and any additional road upgrades or improvements would be planned and built according to BLM standards, under the analyses provided in the Pinedale Anticline EIS (BLM 2000). The road is treated with magnesium chloride to control fugitive dust. To preclude oil and gas development traffic from the road, signs may be posted indicating closure to oil field traffic and/or the cattle guard at U.S. Highway 191 may be replaced with a gate. At field abandonment, the entire route would be reclaimed unless there is an identified need for the improved road by other area users.

A-3.7 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.

A-4.0 EXISTING AND PROPOSED TRANSPORTATION NEEDS

A-4.1 THE EXISTING NETWORK

The existing transportation network on the TPA is shown on Map A-1.1. This system includes four primary access roads: the Luman Road that connects the JIDPA to U.S. Highway 191 east of the JIDPA and the County Line Road southwest of the area; the Burma Road that runs north from the JIDPA to State Highway 351; and the Jonah North Road that 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 principle 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 on 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-tracks to access water developments.

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 A-4.1 through A-4.8 and are summarized in Table A-4.9. 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 A-4.10). All well development activities are anticipated to require from 5 to 42 years to complete depending upon the total number of wells developed and the pace of development (Table A-4.11).

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

Construction Activities	Average Weight x 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 wellpad.
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 A-4.3 Vehicle Characteristics and Number of Trips for a 1,250 Wells on 1,250 New Well Pads Project.

Construction Activities	Average Weight x 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 Roads						
Gravel/Haul Trucks[3]	35	18	20	15	8	10,000
Light trucks/Pickups[3]	7	4	30	20	12	15,000
Drilling (vertical)						
Semi	44 (28-60)	18	20	15	140	175,000
Logging/Mud Trucks	48	10	20	15	10	12,500
Roustabouts	20	6	30	20	20	25,000
Vendors/Marketers[4]	7	4	30	20	30	37,500
Completion Traffic						
Semi/Transport/Water/ Sand	54 (28-80)	18	20	15	350	437,500
Large Haul Trucks	48	10	20	15	50	62,500
Small Haul Trucks	20	6	20	15	30	37,500
Light Trucks/Pickups	7	4	30	20	140	175,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	10,000
Light trucks/Pickups[5]	7	4	30	20	12	15,000
Subtotal Development					810	1,012,500
Production Activities						
Workover Rig	90	18	20	15	3	800
Haul Trucks[6]	54 (28-80)	10	20	15	1,750	2,187,500
Light Trucks/Pickups[7]	7	4	30	20	243	303,800
Subtotal Production					1,996	2,495,100
Total[8]					2,806	3,507,600

1 Loaded and empty weights provided in parentheses.
2 Based on 1,250 new well pads and 1,250 new wells.
3 Based on 1,250 new well pads and access roads.
4 Based on 300 round trips/well with 10 wells visited/trip.
5 Based on one pipeline/wellpad.
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 A-4.4 Vehicle Characteristics and Number of Trips for a 2,200 Wells on 2,200 New Well Pads Project.

Construction Activities	Average Weight x 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	17,600
Light trucks/Pickups[3]	7	4	30	20	12	26,400
Drilling (vertical)						
Semi	44 (28-60)	18	20	15	140	308,000
Logging/Mud Trucks	48	10	20	15	10	22,000
Roustabouts	20	6	30	20	20	44,000
Vendors/Marketers[4]	7	4	30	20	30	66,000
Completion Traffic						
Semi/Transport/Water/ Sand	54 (28-80)	18	20	15	350	770,000
Large Haul Trucks	48	10	20	15	50	110,000
Small Haul Trucks	20	6	20	15	30	66,000
Light Trucks/Pickups	7	4	30	20	140	308,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	17,600
Light trucks/Pickups[5]	7	4	30	20	12	26,400
Subtotal Development					810	1,782,000
Production Activities						
Workover Rig	90	18	20	15	3	6,600
Haul Trucks[6]	54 (28-80)	10	20	15	1,750	3,850,000
Light Trucks/Pickups[7]	7	4	30	20	243	534,600
Subtotal Production					1,996	4,450,600
Total[8]					2,806	6,232,600

1 Loaded and empty weights provided in parentheses.
2 Based on 2,200 new well pads and 1,250 new wells.
3 Based on 2,200 new well pads and access roads.
4 Based on 300 round trips/well with 10 wells visited/trip.
5 Based on one pipeline/wellpad.
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 A-4.5 Vehicle Characteristics and Number of Trips for a 3,100 Wells on 266 New Well Pads Project.

Construction Activities	Average Weight x 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	4-8	4,100
Light trucks/Pickups[3]	7	4	30	20	6-12	6,200
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/Pickups	7	4	30	20	140	434,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	6,100
Light trucks/Pickups[5]	7	4	30	20	12	9,200
Subtotal Development					850	2,536,600
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/ Pumpers[7]	7	4	30	20	487	371,600
Subtotal Production					2,240	5,805,900
Total[8]					3,090	8,342,500

1 Loaded and empty weights provided in parentheses.
2 Based on 266 new well pads and 3,100 new wells.
3 Based on 266 new well pads and access roads, and well pad expansion at the 497 existing pads.
4 Based on 360 round trips/well with 10 wells visited/trip.
5 Based on one pipeline/wellpad (includes 266 new and 497 existing pads; 763 total).
6 Includes water and condensate hauling.
7 Assumes all wells visited every 3 days, approximately 10 well pads (about 5 wells/pad) visited daily, and a 40-year well life.
8 Some additional low-volume traffic would also be necessary for reclamation activities.

Table A-4.6 Vehicle Characteristics and Number of Trips for a 3,100 Wells on 1,028 New Well Pads Project.

Construction Activities	Average Weight x 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	4-8	10,200
Light trucks/Pickups[3]	7	4	30	20	6-12	15,300
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/Pickups	7	4	30	20	140	434,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	12,200
Light trucks/Pickups[5]	7	4	30	20	12	18,300
Subtotal Development					850	2,567,000
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	742,700
Subtotal Production					2,240	6,177,000
Total[8]					3,090	8,744,000

1 Loaded and empty weights provided in parentheses.
2 Based on 1,028 new well pads and 3,100 new wells.
3 Based on 1,028 new well pads and access roads, and well pad expansion at the 497 existing pads.
4 Based on 360 round trips/well with 10 wells visited/trip.
5 Based on one new pipeline/wellpad (includes 1,028 new and 497 existing pads; 1,525 total).
6 Includes water and condensate hauling.
7 Assumes all wells visited every 3 days, approximately 10 well pads (about 3 wells/pad) visited daily, and a 40-year well life.
8 Some additional low-volume traffic would also be necessary for reclamation activities.

Table A-4.7 Vehicle Characteristics and Number of Trips for a 3,100 Wells on 2,553 New Well Pads Project.

Construction Activities	Average Weight x 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	4-8	22,400
Light trucks/Pickups[3]	7	4	30	20	6-12	33,600
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/Pickups	7	4	30	20	140	434,000
Pipeline Construction						
Gravel/Haul Trucks[5]	54 (28-80)	18	20	15	8	24,400
Light trucks/Pickups[5]	7	4	30	20	12	36,600
Subtotal Development					810	2,504,000
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	8,691,600

1 Loaded and empty weights provided in parentheses.
2 Based on 2,553 new well pads and 3,100 new wells.
3 Based on 2,553 new well pads and access roads, and well pad expansion at the 497 existing pads.
4 Based on 360 round trips/well with 10 wells visited/trip.
5 Based on one new pipeline/wellpad.
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 A-4.8 Vehicle Characteristics and Number of Trips for a 533 Wells on 497 Well Pads Project (No New Wells).

Construction Activities	Average Weight x 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 A-4.9 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 from 5 to 42 years, well life is 40 years, and LOP is from 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 A-4.10 Approximate Traffic Volumes for Selected Roads, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[1]

	Approximate Number of Round Trips[2]			Approximate Average Daily Traffic[3]		
Road Type (Number of Wells)	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 (1,747 wells)[4]	1,012,500-1,062,500	3,487,000-3,913,300	4,499,500-4,975,800	172-189	239-268	145-284
Luman Road (2,697 wells)[5]	1,782,000-1,870,000	5,383,200-6,041,300	7,165,200-7,911,300	172-189	369-414	231-452
Luman Road (3,597 wells)[6]	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 A-4.1 through A.4.7.
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 a LOF of 43 to 85 years (see Table A-4.11).
4 1,250 new and 497 existing wells; no development actions would occur for the 497 existing wells.
5 2,250 new and 497 existing wells; no development actions would occur for the 497 existing wells.
6 3,100 new and 497 existing wells; no development actions would occur for the 497 existing wells. Approximates maximum project traffic.

Table A-4.11 Estimated Life-of-Project (Years), Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Project Phase/Rate	No New Wells	1,250 Wells	2,200 Wells	3,100 Wells
Development				
75 wells drilled/year	0	17	30	42
150 wells drilled/year	0	9	15	21
250 wells drilled/year	0	5	9	13
Total Development	0	5-17	9-30	13-42
Production	40	40	40	40
Reclamation	3	3	3	3
Life-of-Project	43[1]	48-60	52-73	56[2]-85

[1] No New Wells.
[2] Proposed Action LOP.

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 to 552 vehicles per day) (Table A-4.10). 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 (Table A-4.10).

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-tracks 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 likely would be retained after project completion in an upgraded status. 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.

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A-5.0 ROAD CLASSIFICATIONS

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.

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, and three additional in-field roads are identified as local/collector roads for this project (see Map 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.

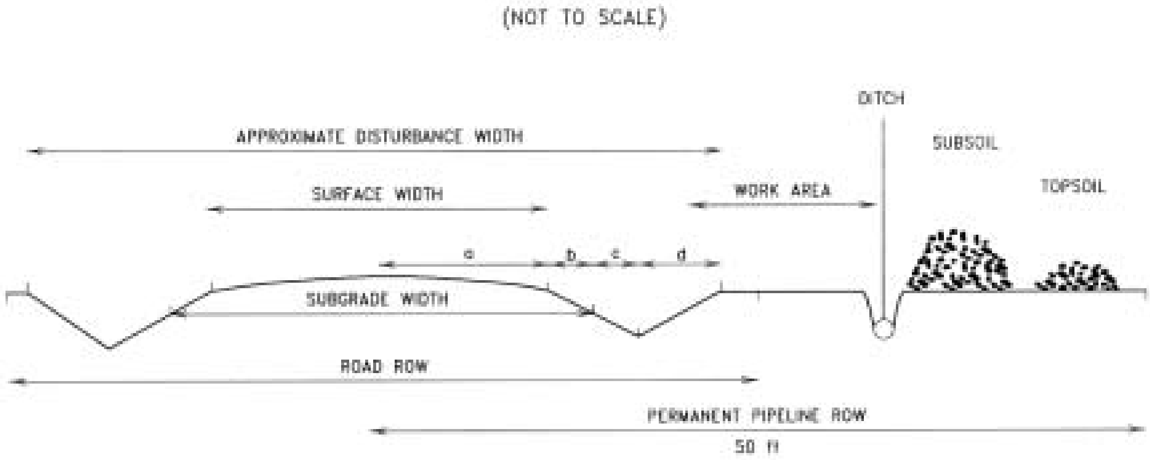
The public local/collector roads in the JIDPA include the three main BLM roads: the Luman, Burma and Jonah North Roads. There are also numerous undesignated casual routes (unimproved/two-track roads) on the area and Operator-maintained well access (resource) roads (see Map A-1.1).

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 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 A-5.1 and would be commensurate with BLM 9113 Manual specifications (BLM 1985, 1991). No roads required for this project would have travel surface widths of less than 29 ft.

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	12	2	4	8	52	60	30–50

DIAGRAM OF TYPICAL TURNOUTS ON RESOURCE ROADS

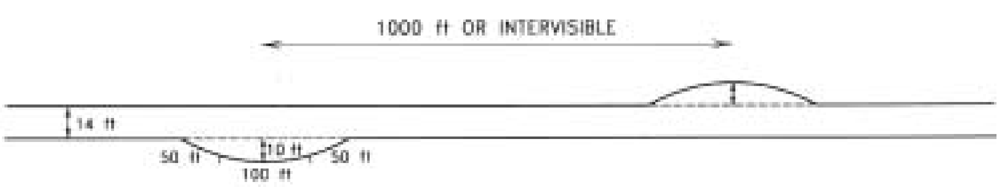


Figure A-5.1 Typical Access Road (Local/Collector and Resource) with Adjacent Pipeline Schematic, Jonah Infill Drilling Program, Sublette County, Wyoming, 2004.

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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.

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.

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).

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.

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.

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 A-6.1 to A-6.4). Laboratory testing to determine the structural values of the soil may be advisable on roads

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

	Rating[2]			
Parameter	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
Soil adsorption 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	S	Sand
CL	Clay loam	SC	Sandy clay
FS	Fine sand	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
LVFS	Loamy very fine sand	VFS	Very fine sand
		VFSL	Very fine sandy loam

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

	Limits			
Property	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	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

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

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

[3] Weighted average to 40 inches.

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

Factors Affecting Location and Use	Limits			Restrictive Feature
	Slight	Moderate	Severe	
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	SC	Sandy clay
CL	Clay loam	SCL	Sandy clay loam
FSL	Fine sandy loam	SI	Silt
L	Loam	SIC	Silty clay
LS	Loamy sand	SICL	Silty clay loam
S	Sand	SIL	Silt loam
		SL	Sandy loam

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

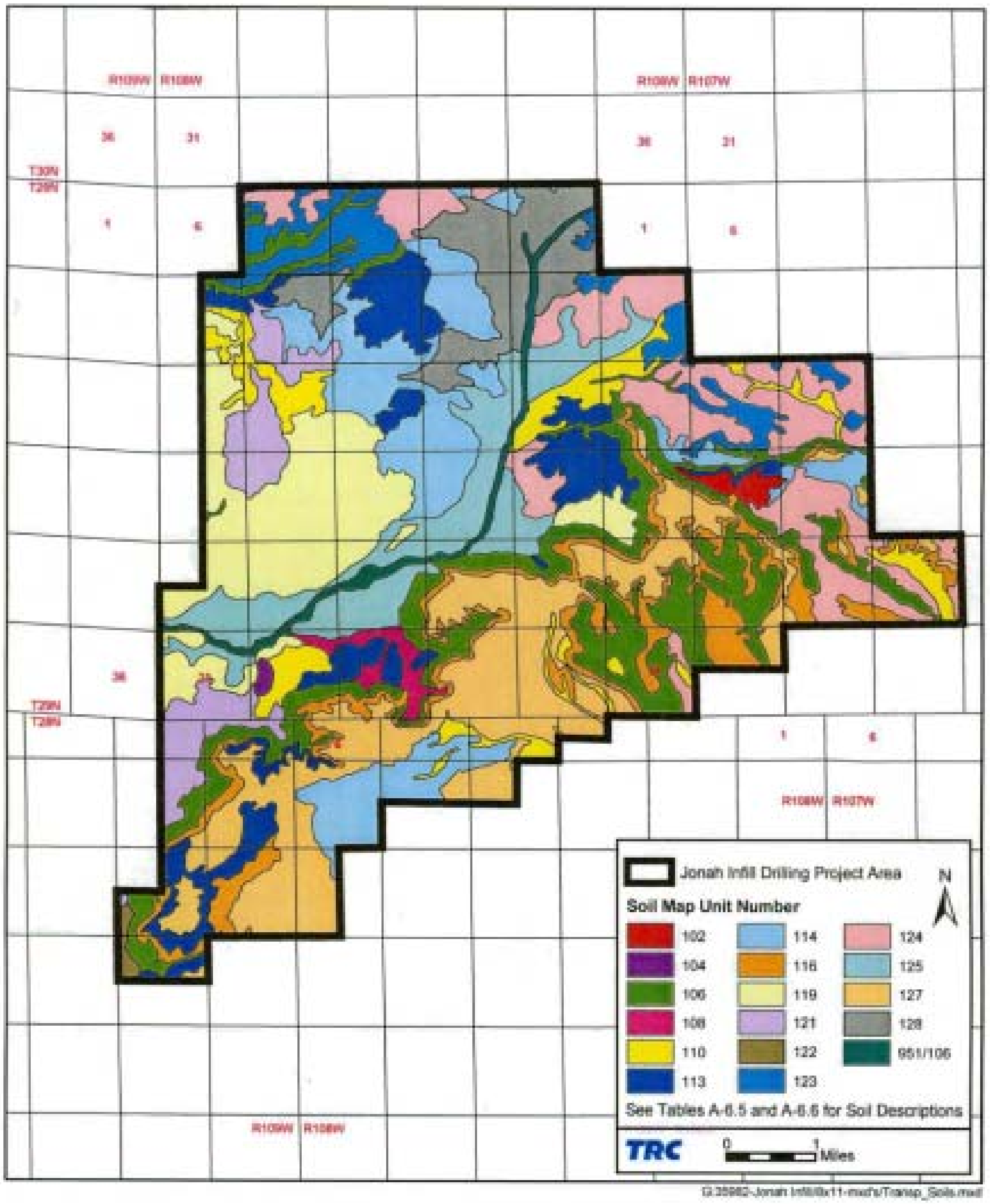
4 If friable like some kaolinitic clays, reduce rating to "moderate."

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.

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 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 A-6.1 through A-6.4).

Major soils within the JIDPA include the Vermillion Variant-Seedskadee-Fraddle complex on 0-3% slopes (Unit 127); Monte-Leckman complex on 1-6% slopes (Unit 106); the Fraddle-Ouard-San Arcacio Variant complex on 3-8% slopes (Unit 124); the Ouard-Ouard Variant-Boltus complex on 1-8% slopes (Unit 114); the Garsid-Monte Association on 1-6% slopes (Unit 119); the San Arcacio-Saguache association on 0-3% slopes (Unit 125); the Huguston-Horsley-Terada complex on 6-30% slopes (Unit 116); and the Haterton-Garsid complex on 1-8% slopes (Unit 113) (Table A-6.5). These mapping units collectively cover approximately 78% of the JIDPA. Primary limitations associated with these soils include thin soils, shallow depth to rock, low strength, sandiness, and stoniness (Tables A-6.5 and 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% slopes (Unit 951/106) and the Monte-Leckman complex (Unit 106) on 1-6% 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.



Map A-6.1 Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

Table A-6.5 Soil Types, Soil Use, and Management Considerations, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

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 to 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 to 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 A-6.6 Soil Salvage Depth and Soil Characteristics for Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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/	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 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 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
			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	--	--	--
124	6	3-8%	Fraddle	Loamy	0-4	SL	6.6-7.8	<2	Low

Table 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
					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 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	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	--

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 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 L Loam Loamy sand SIC Sandy loam
FSCL Fine Sandy clay loam S Sand VFSL Very fine sandy loam

Texture Modifier:

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

FLX LS

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 A-6.5 and 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 A-6.5 and A-6.6).

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.

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.

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A-7.0 ROAD SPECIFICATIONS, PLANS, AND MAINTENANCE

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.

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.

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 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.

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.

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).

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.

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 ft for single-lane roads and 24 ft 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.

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.

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 ft, at all fence or utility crossings, and at all abrupt breaks in ground profile of vertical change of 1 ft or more. Stakes would be placed on the centerline of the road at a maximum distance of 50 ft around curves of 4º 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.

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.

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 ft for single-lane roads and 24 ft 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.

A-7.7 MAINTENANCE

All roads on the project area would be maintained to BLM 9113 Manual 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 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.

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.

A-9.0 LITERATURE CITED

Bureau of Land Management. 1985. Manual 9113-Roads. Engineering Rel. 9-247. U.S. Department of the Interior, Bureau of Land Management.

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APPENDIX B:

RECLAMATION PLAN,
JONAH INFILL DRILLING PROJECT

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RECLAMATION PLAN, JONAH INFILL DRILLING PROJECT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

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Pinedale Field Office
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ACRONYMS AND ABBREVIATIONS

BLM	Bureau of Land Management
EIS	Environmental impact statement
JIDPA	Jonah Infill Drilling Project Area
Operators	Natural gas developers
POD	Plan of Development
PLS	Pure Live Seed
RMP	Resource Management Plan
ROW	Right-of-way
SPCCP	Spill Prevention, Control, and Countermeasure Plan
SUP	Surface Use Plan
SWPPP	Storm Water Pollution Prevention Plan

B-1.0 INTRODUCTION

This reclamation plan will be used by natural gas developers (the Operators) of the Jonah Infill Drilling Natural Gas Development Project 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 Resource Management Plan (RMP) (BLM 1987a, 1987b, 1988) and the Rock Springs Field Office RMP (BLM 1992, 1996, 1997). This reclamation plan is also based on *Executive Order* 13112, impacts and scoping issues identified for the Jonah Infill Drilling environmental impact statement (EIS) (see EIS Section 1.4), and an on-site evaluation of reclamation status on selected areas in the JIDPA.

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B-2.0 RECLAMATION REQUIREMENTS AND SUCCESS STANDARDS

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, water courses, and drainage features to minimize erosion and sedimentation (also protecting surface and ground water 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 B-2.2 are the measures that will show whether or not these goals are being met.

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.

1) 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 ft of spoil.

2) 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.

3) Sites would be free of trash.

4) 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 are actively eroding, perceptible soil movement or head cutting in drainages, and/or slope instability on or adjacent to the reclaimed area.

5) Soil surfaces would have adequate surface roughness to reduce runoff and to capture rainfall and snow melt.

6) 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. 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 1 to 2 years after seeding, the following standards would be met (in addition to standards 1-6).

a) Vegetative canopy cover would be at least 35% of the cover found on adjacent undisturbed areas.

b) At least 20% of the total vegetation cover would be by the species contained in the seed mix and/or present on adjacent areas.

c) Invasive, non-native species (weeds) or other undesirable species would not dominate the reclaimed area.

Within 4 years after seeding, the following standards would be met (in addition to standards 1-6).

d) Vegetative canopy cover would be at least 60% of the cover found on adjacent undisturbed areas.

e) At least 50% of total vegetation cover would be by the species contained in the seed mix and/or present on adjacent undisturbed areas, and no single species would account for more than 50% of total vegetative cover unless it comprises greater than 50% 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 15% of total vegetative cover.

Within 10 years after seeding, the following standards would be met.

g) Vegetative canopy cover would be at least 80% of the cover found on adjacent undisturbed areas.

h) At least 90% of the species present on revegetated areas would be species from the seed mixture, from the surrounding native vegetation, and/or other desirable species, and no single species would make up more than 25% of the total vegetative cover unless it comprises greater than 25% of the total vegetative cover on adjacent undisturbed sites.

i) Undesirable species (e.g., noxious, non-native, or invasive species) would make up less than 5% 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, 6g, 6h, 6i, and 7 have been achieved.

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% 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.

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B-4.0 RECLAMATION PLAN

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

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

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.

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%], stabilized sand dunes, floodplains);
- areas with saturated soils;
- areas within 500 ft of wetland or riparian areas (e.g., playas and open water areas); and
- areas within 100 ft 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 and/or Plans of Development for each

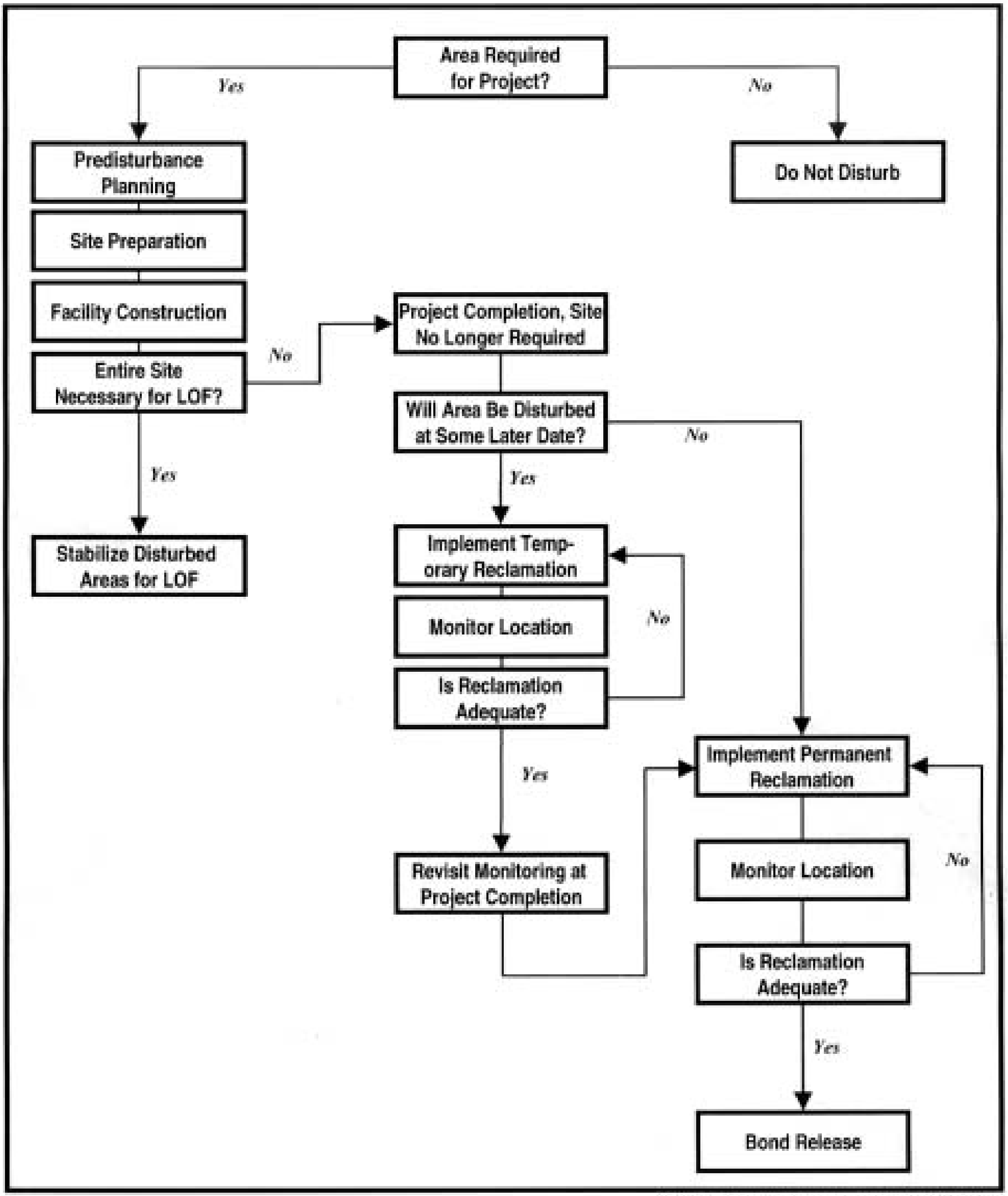

Figure B-4.1 Reclamation Process, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

proposed surface disturbance area or corridor. These plans would include the following components:

- project administration, time frames, 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 Surface Use Plans and Plans of Development, Storm Water Pollution Prevention Plans (SWPPPs) would be prepared for all project activities requiring greater than 5 acres of disturbance to ensure that storm water runoff would not cause surface water pollution. The SWPPP would include provisions for periodic inspection of storm water 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.

B-4.1.2 Site Preparation

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.

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 B-4.4.3) if the Year 4 reclamation success standards (see Section 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 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.

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

Parameter	Suitability: Good	Suitability: Fair	Suitability: 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:

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

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%, 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%, topsoil would be transported to more level terrain for storage.

Topsoil and spoil stockpiles would be constructed to remain stable until they are used for reclamation. Whenever possible, topsoil would be used immediately. If topsoil would be stockpiled for more than 2 years, than the piles would be reduced to 3 ft in height and seeded. 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 ft deep and 3 ft 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 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.

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.

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).

B-4.3 TEMPORARY RECLAMATION

The objectives of temporary reclamation are to meet success standards 1-6 above (see Section 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 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 B-4.2) or one of the seed mixtures for permanent reclamation (see Tables B-4.3 through

Table 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.

B-4.7 below). Operators would determine which mixture to use based on seed availability, cost, or other operational considerations.

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.

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 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 would be completely reclaimed in the first fall or spring after drying. If reclamation involves facility removal (Section B-4.4.1), regrading and reseeding would occur in the first fall or spring following facility removal.

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 wellpad, 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 wellpad, 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.

B-4.4.2 Surface Preparation

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.

B-4.4.2.2 Ripping and Discing

Compacted areas such as roads and wellpads would be ripped to a depth of approximately 2 ft 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 to 2 ft apart. Discing is typically accomplished using a tractor-drawn disc set 2-6 inches deep.

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.

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 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 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.

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.

B-4.4.4 Revegetation

B-4.4.4.1 Seeding

Reclaimed areas would be seeded using the seed mixtures presented in Tables B-4.3 through 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 B-2.2.

Seed mixtures would be certified weed-free.

Table 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 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 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 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 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 would determine which seed mixture to use and which substitute species may be appropriate to include in the mixture either 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.

B-4.4.4.2 Mulching

Where mulching is deemed necessary, the reclaimed area would be uniformly mulched (75% 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% 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.

B-4.5 EROSION CONTROL

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 ft deep and 3 ft 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 ft 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 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 ft 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 ft 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.

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 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% 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.

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 ft of open water or during extremely windy conditions. Aerial application of herbicides would be prohibited within 0.25 mi 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 ft of such occurrences. Certified weed-free seed mixtures and mulches would be used, thereby minimizing the potential for noxious weed introduction.

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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 B-2.2 and 2) to provide an expeditious means for monitoring all reclamation sites to document reclamation progress.

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).

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 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 NEPA documents for the Jonah Field, as well as all infill operations that may be authorized in the future.

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 coal mines, 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 for 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 judgement of a suitable professional and would be supported by monitoring forms and color photographs.

Table 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 ______________________________

____

____

____

____

____

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____

____

Table 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 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 B-5.1 (Continued)

Additional Field Notes ______________________________

Table B-5.1 (Continued)

Photographs of Reclaimed Area (attach additional sheets if needed).
Photograph 1
Photograph 2

The form presented in Table 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 B-2.2.

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 B-5.1) and color photographs would be taken. Where success Criteria 1-6 (see Section B-2.2) are not met (i.e., if any of Table B-5.1 questions 1-6 are answered "no"), Operators would correct the problem within 3 weeks of discovery.

B-5.4 MONITORING PERMANENT RECLAMATION

For permanent reclamation, reclamation success standards 1-6 (see Section 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 B-5.1) and color photographs would be taken. Where success Criteria 1-6 are not met (i.e., if any of Table 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 B-2.2) would occur in Year 2 and annually thereafter until permanent reclamation success standards are achieved (standards 1-5, 6g, 6h, 6i, 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 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 on Figure B-4.1.

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B-6.0 REFERENCES

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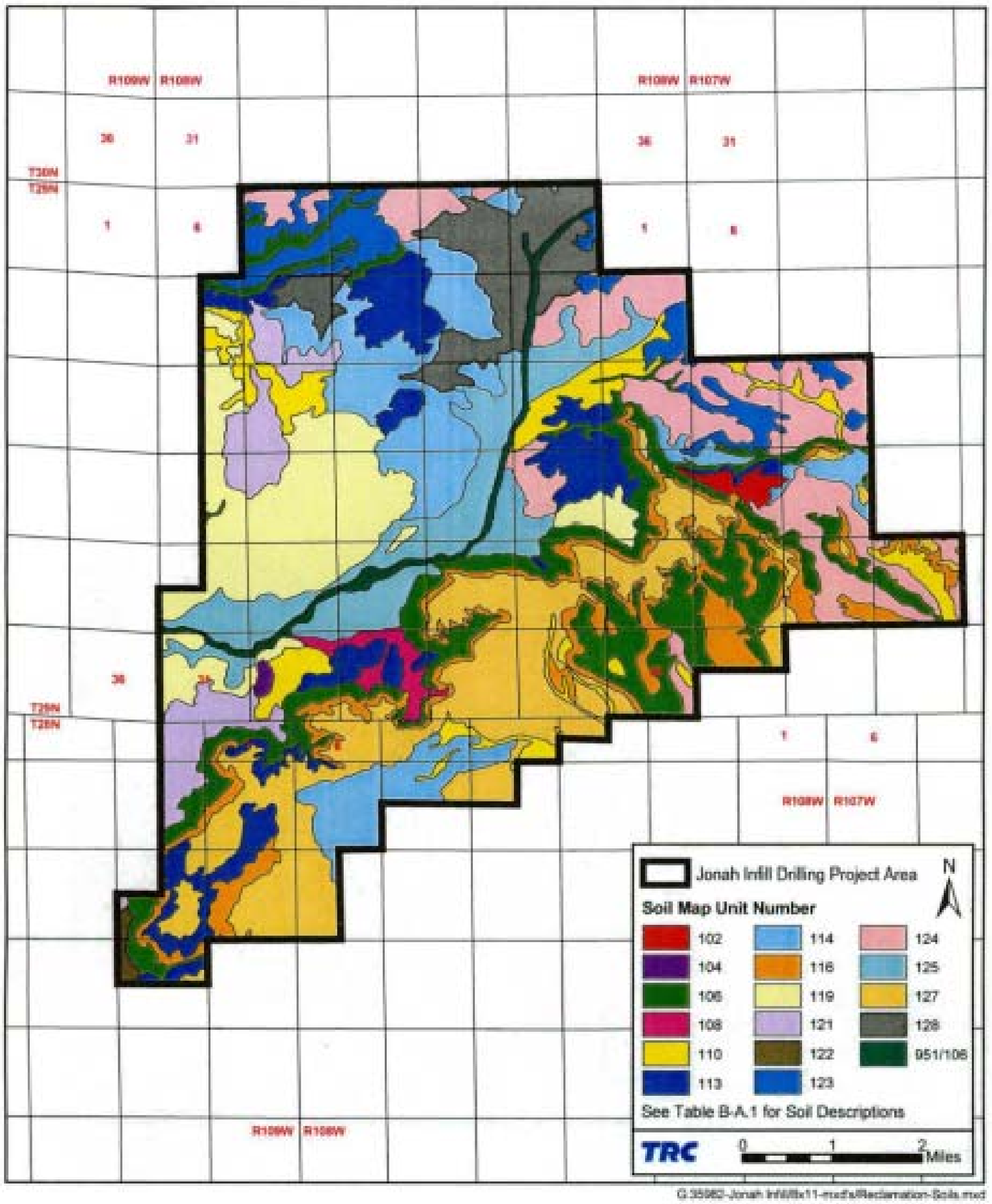
ADDENDUM B-A:

SOILS MAP AND TOPSOIL SALVAGE DEPTHS TABLE



Map B-A.1 Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004

Table B-A.1 Soil Salvage Depths and Soil Characteristics for Project Area Soils, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[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 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	--
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 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	--	--	--

Table 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
			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 3-28	FSCL C	8.0-9.0 >8.4	<2 <4	Low --
					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

Table 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
					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 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%	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	--

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 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 L Loam Loamy sand SIC Sandy loam
FSCL Fine Sandy clay loam S Sand VFSL Very fine sandy loam

Texture Modifier:
CN Channery GR Gravelly SL
FLV Very flaggy GRV Very gravelly
Extremely flaggy SR Stratified

FLX LS

APPENDIX C:

HAZARDOUS MATERIALS MANAGEMENT SUMMARY,
JONAH INFILL DRILLING PROJECT

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HAZARDOUS MATERIALS MANAGEMENT SUMMARY,
JONAH INFILL DRILLING PROJECT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Bureau of Land Management
Pinedale Field Office
Pinedale, Wyoming

and

Bureau of Land Management
Rock Springs Field Office
Rock Springs, Wyoming

TRC Mariah Associates Inc.
Laramie, Wyoming
MAI Project 35982

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C-1.0 INTRODUCTION

This Hazardous Materials Management Summary is provided pursuant to Bureau of Land Management (BLM) *Instruction Memoranda Numbers 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* [C.F.R.] 355).

Project proponents (Encana Oil & Gas [U.S.A.], 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 C.F.R. 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 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 C-1.1).

Table 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, 2004.

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		--

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Fracturing Materials (cont.)				
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		--
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

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Production Products (cont.)				
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		--
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

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Pipeline Materials (cont.)				
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
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

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Compressor Station Materials (cont.)				
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
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

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Miscellaneous Materials (cont.)				
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
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		--

Table C-1.1 (Continued)

Source	Approximate Quantities Used or Produced Per Well[1]	Hazardous Substances[2]	Extremely Hazardous Substances[3]	CAS No.
Miscellaneous Materials (cont.)				
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
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 *Superfund Amendments and Reauthorization Act of 1986* (SARA), as amended.
[3] Extremely hazardous substances are those defined in 40 C.F.R. 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.

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 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, and reserve pits would be lined as directed by the BLM to conserve water and to protect near-surface aquifers. When the reserve pit is no longer required, its contents would be evaporated or solidified in place, and the pit would be backfilled as approved by the BLM. If oil-based drilling fluids are used, these fluids would be contained in a closed system (a series of tanks) to prevent their release to the environment. 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).

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C-3.0 CEMENTING AND PLUGGING MATERIALS

Well completion and abandonment operations include cementing and plugging various segments of the well bore to protect freshwater aquifers and other down-hole resources. Wells would be cased and cemented as approved by the 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 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.

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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 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.

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C-5.0 PRODUCTION PRODUCTS

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 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.

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 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% 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.

C-5.3 PRODUCED WATER

Hazardous materials potentially present in trace amounts in produced water are listed in Table 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).

C-6.0 FUELS

Diesel fuel, gasoline, natural gas, and propane would be used for the project. All contain hazardous materials (see Table 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.

C-6.1 GASOLINE

Gasoline is known to contain hazardous materials (see Table 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).

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.

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 C-1.1). No extremely hazardous materials are known to exist in the natural gas from the project area.

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.

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 C.F.R. 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 C-1.1. Hazardous materials associated with pipeline construction, operation, and maintenance would be handled in accordance with applicable state and federal regulations.

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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 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.

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C-9.0 COMPRESSOR STATIONS

Materials potentially containing hazardous substances that are used at compressor stations are listed in Table 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.

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C-10.0 MISCELLANEOUS MATERIALS

Miscellaneous materials potentially containing hazardous substances that may be used for the proposed project are listed in Table 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.

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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 C.F.R. 117, would be reported as required by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended (*42 United States Code* [U.S.C.] 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 the 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:

- pursuant to 40 C.F.R. 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 x 200 ft. Containment berm walls 2 ft high x 4 ft wide would be located on the east, south, and west perimeters of the pad to contain storm water 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 ft wide x 120 ft 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.

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C-12.0 LITERATURE CITED

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