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DRAFT
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
PINEDALE ANTICLINE OIL AND GAS EXPLORATION AND DEVELOPMENT PROJECT
SUBLETTE COUNTY, WYOMING

(Volume 2 of 2)

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

In Cooperation with

State of Wyoming
Sublette County

December 2006

APPENDIX A

Authorizations in the PAPA ROD

Authorizations in the PAPA ROD

Table 1
Location of Actionable Items in the PAPA ROD

Resource/Issue	Location of Actionable Items in PAPA ROD					
	Required by Statute or Policy	Plan of Development Required	MOU or other Agreement	AEM and/or Monitoring, Reporting	Limits or Controls Stipulated	Required or Suggested Mitigation
Transportation	Section 3	Section 3 Appendix B	Section 3	Section 3 Appendix C	Appendix A-2	Appendix A-3
Air Quality	Section 3	-	Section 3	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2	Section 3 Appendix A-3
Special Status Species	Section 3	-	-	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2	Section 3 Appendix A-3
Raptor Nest Protection	-	-	-	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2 Appendix A-6	Section 3 Appendix A-3
Sage Grouse Protection	-	-	-	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2 Appendix A-6	Section 3 Appendix A-3
Big Game Crucial Winter Range Protection	-	-	-	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2 Appendix A-6	Section 3 Appendix A-3
Water Resources Protection/Monitoring	-	-	-	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2	Section 3 Appendix A-3
Water Well Protection/Monitoring	-	-	-	Section 3 Appendix C	Section 3 Appendix A-2	Section 3 Appendix A-3
Paleontological Values Protection	-	-	-	-	Section 3 Appendix A-2	Appendix A-3
Soils Protection/ Reclamation/Monitoring	Section 3	-	-	Section 3 Appendix C	Section 3 Appendix A-2	Appendix A-3
Vegetation Protection/ Reclamation/Monitoring	-	-	-	Section 3 Appendix C	Section 3 Appendix A-2	Appendix A-3
Noise and Odor	-	-	-	-	Section 3 Appendix A-2	Appendix A-3
Night Lighting	-	-	-	-	Section 3	-
Cultural/Historical Resources Protection	Section 3	Section 3 Appendix E	Section 3 Appendix E	Section 3 Appendix C	Section 3 Appendix A-1 Appendix A-2	Appendix A-3
Socioeconomics	-	-	-	-	Section 3 Appendix A-6	-
Land Use	-	-	-	Section 3 Appendix C	-	Section 3
Livestock Grazing	-	-	-	Section 3 Appendix C	Appendix A-2 Appendix A-3	Section 3
Hazardous Materials	-	-	-	-	Appendix A-2 Appendix D	-
Remedial Action/ Compliance Monitoring	-	-	-	Section 3	-	-

Table 2
Management Area Description, Area, and Objectives

Management Area Description, Area, and Objectives	Allowable Level of Development
MA 1 - Lander Trail – 3,460 acres or 5.41 square miles **Management Area Objectives:**	• 0 average pads/square mile • 0 maximum pads/square mile • 0 total producing pads threshold
• Preserve the integrity of the trail and the trail viewshed.	
MA 2 - Mesa Breaks – 7,366 acres or 11.51 square miles **Management Area Objectives:**	• 0 average pads/square mile • 0 maximum pads/square mile • 0 total producing pads threshold
• Maintain the existing quality, suitability and habitat effectiveness of the Mesa Breaks deer crucial winter range. These breaks provide thermal cover and forage during sever winters. • Retain the existing character of the landscape and sensitive viewshed. • Avoid disturbance on slopes 10 percent or greater and on sensitive soils to prevent erosion and altering the sensitive viewshed.	
MA 3 - Unleased Federal Minerals – 1,347 acres or 2.10 square miles **Management Area Objectives:**	• 0 average pads/square mile • 0 maximum pads/square mile • 0 total producing pads threshold
• These Federal minerals have been closed to mineral lease. They include Federal minerals under the industrial park west of Pinedale, several tracts near Boulder that were withdrawn at the request of the Department of Defense, Native American sensitive sites, etc. The management objective of this MA will be to continue to hold these parcels closed to development.	
MA 4 - Sensitive Viewshed – 8,686 acres or 13.57 square miles **Management Area Objectives:**	• 2 average pads/square mile • 4 maximum pads/square mile • 28 total producing pads threshold
• Protect the sensitive viewshed by retaining the existing character of the landscape. • Protect/maintain winter and crucial winter deer range. • Protect and maintain existing raptor nesting habitat.	
MA 5 - Big Game Winter Range and Sage Grouse Strutting and Nesting Habitat – 67,801 acres or 105.94 square miles **Management Area Objectives:**	• 2 average pads/square mile • 16 maximum pad/square mile • 212 total producing pads threshold
• Limit surface disturbance and human activity which could displace deer and antelope from winter ranges and sage grouse from strutting and nesting habitat resulting mortalities and reduced population levels. • Implement measures to screen activities and facilities so they do not attract the attention of a casual observer in VRM Class III on either side of the New Fork and Green Rivers.	
MA 6 - Sage Grouse Strutting and Nesting Habitat – 39,205 acres or 61.26 square miles **Management Area Objectives:**	• 3 average pads/square mile • 16 maximum pads/square mile • 183 total producing pads threshold
• Protect this area from unnecessary surface disturbance and human activities which could displace sage grouse from crucial strutting and nesting habitat resulting in mortalities and reduced population levels. • Ensure protection of the Green River and adjacent sub-basins from increased erosion and sedimentation. • Avoid activities and facilities that create barriers to the seasonal movements of antelope. • Partially retain the existing character of the landscape, on each side of U.S. Highway 191 and the Wind River Front Special Recreation Management Area (SRMA), by implementing measures which reasonably incorporate into the surface disturbance and/or facility, visual design considerations that will mitigate anticipated visual impacts so they do not dominate the view of the casual observer and so they replicate the existing characteristics of the landscape.	
MA 7 - Ross Butte/Blue Rim – 10,953 acres or 17.11 square miles **Management Area Objectives:**	• 4 average pads/square mile • 16 maximum pads/square mile • 68 total producing pads threshold
• Avoid disturbance to the fossil-bearing formations on a site-specific basis and protect paleontological fossil resources. • Avoid disturbance on highly erodible soils and maintain soil stability and productivity. • Protect and maintain existing raptor nesting habitat and protect sensitive plant species. • Protect the visual quality of the unique badland area.	

Management Area Description, Area, and Objectives	Allowable Level of Development
MA 8 - Minimal Conflict Area – 26,605 acres or 41.45 square miles **Management Area Objectives:**	• 4 average pads/square mile • 16 maximum pads/square mile • 168 total producing pads threshold
• Maintain antelope summer range and avoid activities and facilities that will create barriers to the seasonal movements of antelope. • Avoid highly erodible soils. • Partially retain the existing character of the landscape, on each side of U.S. Highway 191 (classified as VRM Class III) and the Wind River Front SRMA, by implementing measures which reasonably incorporate into the surface disturbance and/or facility, visual design considerations that will mitigate anticipated visual impacts so they do not dominate the view of the casual observer and so they replicate the existing characteristics of the landscape.	
MA 9 - Non-Federal Lands – 31,925 acres or 49.88 square miles **Management Area Objectives:**	• 4 average pads/square mile • 16 maximum pads/square mile • 200 total producing pads threshold
• Private and state lands not under the jurisdiction of the BLM. • BLM cannot impose management objectives or restrictions/limitations on these lands. However, it was suggested during the public workshops that the operators voluntarily adopt the interrelated and interdependent objectives for these areas. Recommendations included maintenance, improvement and restoration of riparian habitat to provided enhanced wildlife and livestock forage/habitat; avoidance of disturbance to scrub-shrub or forested wetland types to protect water quality; survey for cultural and Native American sacred sites; cooperation with private landowners to avoid impacts to area residences; protecting raptor nesting habitat; and continuing the maintenance of livestock grazing and trailing operations.	

Table 3
Stipulations

Stipulation	Number of Actions	Period of Applicable Stipulation			
		2001-02	2002-03	2003-04	2004-05
Big Game Crucial Winter Range	Total Requested	46	50	63	81
	Granted	36	42	53	67
	Partially Granted	0	0	1	12
	Denied	10	8	9	2
Sage Grouse Lek, Winter, and Nesting	Total Requested	31	88	106	107
	Granted	31	86	98	72
	Partially Granted	0	2	0	7
	Denied	0	0	8	28
Raptor Nesting and Winter	Total Requested	8	12	24	49
	Granted	6	10	22	44
	Partially Granted	0	2	0	4
	Denied	2	0	2	1

Table 4
Approved Components in Decision Record

NEPA Document	Approved Components in Decision Record	Decision Conditioned on Requirements
Questar Year-Round Drilling Proposal WY-100-EA05-034 November 2004	1. Construction of a 107-mile long, 6-inch diameter condensate pipeline using the alignment shown in Appendix B of the EA. Approval of drilling operations between November 15, 2005 and April 30, 2006 would be contingent upon that pipeline and the produced water pipeline being operational by that date; if the pipelines were not operational by November 15, 2005, Questar would not winter-drill after that date unless and exception was granted. That exception would be considered on its own merits. 2. Up to two rigs drilling on one well pad between November 15, 2004 and April 30, 2005. Pad location would be selected in coordination with BLM and WGFD. 3. All mitigation described in Section 2.5 of the EA would be in place and operational by November 15, 2005, including initiation of habitat enhancement projects within Questar's leasehold in 2005, except for full implementation of EPA Tier II compliant or alternate fuel drilling rigs. 4. As committed to by Questar, by January 1, 2007, all drilling rigs operating in Questar's leasehold would be either EPA Tier II compliant or would utilize alternate fuels engines whose emissions are equivalent to Tier II engines. 5. Beginning in the winter of 2005-2006, Questar would implement an expanded mule deer research study to determine impacts of winter drilling on mule deer populations. Questar would provide a proposed expanded research design to BLM by July 1, 2005; BLM would submit that proposed design to the Pinedale Anticline Working Group (PAWG) and to the WGFD for review and recommendation. The PAWG and WGFD would make their recommendations to BLM by September 1, 2005; and BLM would approve the proposed or modified research design before September 1, 2005; and BLM would approve the proposed or modified research design before November 1, 2005. Questar must have implemented that research by November 15, 2005. 6. Over a nine year period beginning November 15, 2005, through the winter of 2013-2014, Questar would be allowed to utilize up to six rigs (two rigs per well pad) drilling on up to three well pads between November 15 and April 30 each year. Between May 1 and November 15 of any year under the proposal, Questar could drill with as many rigs from as many of the 61 total well pads as is feasible, with appropriate authorization. 7. Questar could construct and begin drilling from the winter-long well pads before November 15 of any year; however, continuation of activity on those pads after November 15 would be contingent upon all appropriate mitigation being in place and/or operational. 8. This Decision Record authorized a maximum of 61 well pads (52 currently existing and 9 new well pads) within Questar's leasehold. 9. Leasehold development and production would be based on performance objectives to allow Questar maximum flexibility to utilize innovation to maximize gas recovery while providing optimal short- and long-term protection for other resources in their leasehold.	1. Questar would fully implement the applicant-committed mitigation measures described in Section 2.5 of the EA and the original ROD for the PAPA EIS, except as modified by this decision, by November 15, 2005. Habitat enhancement activities could have begun prior to November 15, at the discretion of BLM and WGFD; 2. Questar would be required to fully implement the performance-based development and production objectives, Conditions of Approval, mitigation, monitoring, and Best Management Practices listed in Appendix A of the Decision Record; 3. The PAWG advisory committee would review and evaluate the above-referenced requirements and make recommendations to BLM on an annual basis regarding continuation, cessation, or addition to those requirements; and 4. The BLM Pinedale Field Manager or designee was the Authorized Officer (AO) for the project. Mitigation and monitoring measures may be modified. Mitigation and monitoring requirements would be determined annually by the AO after receiving the results of on-site inspections, recommendations from the PAWG, and stakeholder consultations. BLM could require additional field studies or documentation in addition to those listed in Appendix A (of the DR) to ensure that reclamation and other resource protection goals are met.

NEPA Document	Approved Components in Decision Record	Decision Conditioned on Requirements
Questar Year-Round Drilling Proposal – Condensate Pipeline Modification (QYDP-CPM) WY-100-EA05-283 July 2005	1. Construction of the 14.4-mile long, 6-inch diameter condensate pipeline using the alignment shown in Appendix A of the EA. Approval of drilling operations between November 15, 2005 and April 30, 2006 would be contingent upon that pipeline and the produced water pipeline being operational by November 15, 2005; if the pipelines were not operational by November 15, 2005, Questar would not winter-drill after that date unless and exception was granted. That exception would be considered on its own merits. 2. Construction of an underground power line to Stewart Point 16-18 CDP from an existing nearby power line. 3. Construction of connecting pipelines between the NGL Stabilizer and Water Handling Facility and Gobblers Knob Compressor Station, and the associated power line. 4. Placement of one blowdown tank on each well pad within the Questar leasehold. 5. Tier II-compliance (or equivalent, or better) of drilling rig engine emissions on all year-round drilling rigs operating in Questar's leasehold by January 1, 2008, as committed to by Questar.	1. The Questar Year-Round Drilling Proposal (QYDP) Decision Record and its Appendix A (see above) would be in full force and effect except where modified by this Decision Record and its Appendix A. 2. Questar and QGM would fully implement the applicant-committed mitigation measures described in Section 2.5 of the QYDP EA (WY-100-EA05-034) and the original ROD for the PAPA EIS except as modified by the QYDP DR (see above), by November 15, 2005. 3. Questar would fully implement an expanded mule deer research study beginning in the winter of 2005-2006, which will continue existing research and add research into the physiological effects of winter drilling activity, to determine impacts of winter drilling on mule deer populations. 4. Questar would provide a proposed expanded research design to BLM by September 1, 2005; BLM would submit that proposed design to the PAWG and to the WGFD for review and recommendation. Based on PAWG and WGFD recommendations (to BLM by October 15, 2005); BLM would approve an expanded study research design before November 1, 2005. Questar must have implemented that research by November 15, 2005. If BLM, PAWG, and WGFD agree that it is not feasible, a new expanded study implementation date would be set and the public would be notified. 5. Blowdown tanks on all pads put into production after the date of the DR will be no bigger than 90 bbl, low-profile (6-foot high) tanks; blowdown tanks on pads put into production prior to the date of the DR would have existing blowdown tanks converted to these 90 bbl, low-profile (or smaller, technology permitting) tanks by August 1, 2007, as committed to by QGM. 6. QGM would provide a paleontology monitor who would be present during pipeline construction within Bird Canyon; the monitor would coordinate with BLM prior to construction in that area; 7. Questar and QGM would fully implement the performance-based objectives for development and production, Conditions of Approval, mitigation, monitoring, inventories, and Best Management Practices listed in Appendix A of the DR; habitat enhancement activities could begin prior to November 15, 2005, at the discretion of BLM and WGFD, and could be subject to additional NEPA analysis. 8. The PAWG advisory committee would review and evaluate the above-referenced requirements and make recommendations to BLM on an annual basis regarding continuation, cessation, or addition to those requirements; and 9. The BLM Pinedale Field Manager or designee was the Authorized Officer (AO) for the project. Mitigation and monitoring measures may be modified. Mitigation and monitoring requirements would be determined annually by the AO after receiving the results of on-site inspections, recommendations from the PAWG, and stakeholder consultations. BLM could require additional field studies or documentation in addition to those listed in Appendix A (of the DR) to ensure that reclamation and other resource protection goals are met.

NEPA Document	Approved Components in Decision Record	Decision Conditioned on Requirements
ASU Year-Round Drilling Demonstration Project WY-100-EA05-254 September 2005	1. ASU would fully implement the applicant-committed measures described in Section 2.6 of the EA and the ROD for the PAPA EIS, except as modified by this decision, by November 15, 2005. 2. ASU would be required to fully implement the performance-based development and production objective, Conditions of Approval, mitigation, monitoring, and Best Management Practices listed in Appendix A of the DR. 3. As committed to by Shell, catalytic aftertreatment technology would be installed on both of their existing Tier I EPA compliant rigs proposed for the Mesa 7-29 pad to demonstrate EPA Tier II equivalent emissions. Shell would conduct monitoring of rig emissions as discussed in the EA and provide a report to BLM on the effectiveness of the catalytic aftertreatment technology by April 30, 2006. 4. As committed to by Anschutz and Ultra, bi-fuel technology would be installed on the two rigs proposed for the Mesa 10-35 pad and the two rigs proposed for the Mesa 7-34 pad to demonstrate EPA Tier II equivalent emissions. Anschutz and Ultra would conduct monitoring of rig emissions as discussed in the EA and provide a report to BLM on the effectiveness of the catalytic aftertreatment technology by April 30, 2006. 5. The PAWG advisory committee would evaluate and monitor the effectiveness of the above-referenced requirements and make recommendations to BLM regarding continuation, cessation, or addition to those requirements; and 6. The BLM Pinedale Field Manager or designee was the Authorized Officer (AO) for the project. Mitigation and monitoring measures may be modified. Mitigation and monitoring requirements would be determined by the AO after receiving the results of on-site inspections, recommendations from the PAWG, and stakeholder consultations. BLM could require additional field studies or documentation in addition to those listed in Appendix A (of the DR) to ensure that reclamation and other resource protection goals are met.	1. ASU would fully implement the applicant-committed measures described in Section 2.6 of the EA and the ROD for the PAPA EIS, except as modified by this decision, by November 15, 2005. 2. ASU would be required to fully implement the performance-based development and production objective, Conditions of Approval, mitigation, monitoring, and Best Management Practices listed in Appendix A of the DR. 3. As committed to by Shell, catalytic aftertreatment technology would be installed on both of their existing Tier I EPA compliant rigs proposed for the Mesa 7-29 pad to demonstrate EPA Tier II equivalent emissions. Shell would conduct monitoring of rig emissions as discussed in the EA and provide a report to BLM on the effectiveness of the catalytic aftertreatment technology by April 30, 2006. 4. As committed to by Anschutz and Ultra, bi-fuel technology would be installed on the two rigs proposed for the Mesa 10-35 pad and the two rigs proposed for the Mesa 7-34 pad to demonstrate EPA Tier II equivalent emissions. Anschutz and Ultra would conduct monitoring of rig emissions as discussed in the EA and provide a report to BLM on the effectiveness of the catalytic aftertreatment technology by April 30, 2006. 5. The PAWG advisory committee would evaluate and monitor the effectiveness of the above-referenced requirements and make recommendations to BLM regarding continuation, cessation, or addition to those requirements; and 6. The BLM Pinedale Field Manager or designee was the Authorized Officer (AO) for the project. Mitigation and monitoring measures may be modified. Mitigation and monitoring requirements would be determined by the AO after receiving the results of on-site inspections, recommendations from the PAWG, and stakeholder consultations. BLM could require additional field studies or documentation in addition to those listed in Appendix A (of the DR) to ensure that reclamation and other resource protection goals are met.
Questar Year-Round Drilling Proposal, Addendum WY-100-EA06-043 November 2005.	1. Winter drilling of Mesa 15C-20D after November 15, 2005. The well is on a pad approved in the QYDP EA (WY-100-EA05-034). Well completion was approved with mitigation. 2. Mesa 6-7D would be completed before November 15, 2005. Some equipment would remain on-site, then moved after November 15, 2005. 3. Winter drilling and completion of Mesa 9B-7D and 10-7D from one pad was allowed, with mitigation. 4. Addition on a third rig to drill on the approved Mesa 3-20 winter drilling pad. Well completions were not included.	1. The accelerated winter development on the Mesa would be monitored for compliance and project effectiveness consistent with the mitigation measures and management requirement described in the Questar Year-Round Drilling Environmental Assessment and Decision Record, November 2004. In addition the attached required mitigation activities would be monitored for compliance during the winter season 2005-2006 (Attachment #1 – Required Mitigation).

Appendix B

Scoping Comments

Scoping Comments

Air Quality

- provide a detailed air quality analysis.
- include modeling scenarios with mitigation measures that will result in no impacts to visibility in nearby Class I and Class II wilderness areas.
- include water and condensate gathering as mitigation for air analysis.
- address stabilization of rig numbers.
- disclose potential impacts to Class I and II areas from drilling, completion and flaring in cold winter conditions.
- provide for project and cumulative – a comparison of emissions from original PAPA and the proposed action; discuss and evaluate mitigation measures to reduce emissions.
- provide a complete cumulative analysis of SW Wyoming.
- reduce air emissions.
- use Tier 2 technology.
- address regional haze issues and potential mitigation for visibility impairment in Class I areas.
- should include project specific and cumulative effects air quality analysis.
- include effectiveness of ASU emissions mitigation.
- include latest monitoring results for ozone in Pinedale area and statement of compliance with NAAQS.
- include modeled ozone concentrations resulting from development in the PAPA.
- conduct extensive air modeling.
- evaluate effectiveness of Naughton Power Plant Unit 3 retrofit on air quality in area.
- companies should be striving to use best available technology to reduce emissions right now regardless of winter access.
- concerns about impacts to high mountain lakes resulting in impacts to trout and downstream water users.
- identify and analyze cumulative impacts including visibility in Class I areas.

- consider impact of project on ozone concentrations and compare to NAAQS.
- address balance between directional drilling and increased air quality impacts.
- low emission drill rigs should be used and should comply with WDEQ regulations on flaring.
- requests that strictest possible standards for emissions be applied.
- public health issue of air quality.
- concerned about dust and truck emissions.
- winter inversions can trap air pollutants.
- operators should use natural gas or clean diesel engines on all rigs.
- road construction and dust should be minimized.
- monitoring should be increased.
- monitoring should be used and pollutions should be decreased.
- air pollution, air pollution mitigation, air pollution modeling and air quality monitoring should all be addressed. Include necessary compression and gas processing plants (Granger).
- evaluate air quality impacts and detail mitigation steps to minimize impacts, identify types of fuels to be used during construction, increased traffic and related VOC and NO_x emissions.

Alternatives

- should include at least one conservation alternative.

Cultural

- the integrity of trail and trail viewshed should be preserved.
- confirm compliance with the national Historic preservation Act Section 106 consultation with the Wyoming SHPO Officer.

Environmental Justice

- disclose and evaluate these aspects. Coordinate with potentially impacted Native American tribes.

General

- BLM should require adaptive management strategies.
- companies should be bound to commitments and responsibilities as well as successor companies.

- there should be full coordination for all activities between the operators.
- supports year round drilling to shorten development time.
- no arbitrary restrictions on development activities.
- any restrictions should provide for waivers, modifications or exceptions.
- request a map of all private and public lands and current leases in the document.
- concern about pace of development outside of PAPA ROD.
- document should be thorough in investigating technical and managerial “best practices”.
- include findings of pilot and demonstration projects; address directional drilling reach of 3,000 feet; establish peer review procedures.
- interagency collaboration should occur.
- identify adaptive approach to impacts from any waivers of wildlife stipulations and define measures for reinstating them.
- BLM must address unnecessary or undue degradation of the lands; maintain adaptive environmental management.
- BLM should implement PAWGs recommendations.
- BLM must independently verify accuracy of information submitted by proponents.
- acknowledge precedents that this approval will set.
- BLM should implement PAWG recommendations.
- cautions that directional drilling is not applicable everywhere.
- limit scope of analysis to potential impact on wildlife species from year round drilling.
- objects to analysis of anything except for impacts to wildlife as a result of year round drilling.
- why does BLM have to consider proposal; should consider Questar’s test winter drilling before this proposal is approved.
- operators should incorporate same proposals into summer drilling; technological improvements should be made in any case – not only to benefit wildlife.

- concern that RMP is not yet available; why is human access limited but not gas company access.
- Public should have access to maps in review process.
- benefits of proposal should be implemented without lifting winter restrictions.
- monitoring should involve real action to prevent negative impacts.
- technological mitigation measures should be in place for all drilling on the Mesa including summer months.
- technological mitigation measures should be in place for all drilling on the Mesa including summer months.
- concern over meeting existing regulatory environmental compliance standards with regard to air quality and water quality.
- concern over implementation of adaptive management.
- discuss technological advances in document (especially drilling and casing techniques to eliminate blowouts).
- discuss potential for “connected actions” within the entire Green River Basin.
- discuss monitoring and enforcement within the anticline.
- concerned about setting precedents in the Green River Basin (take time to get it right).
- opposes the project.
- slow pace of development until realistic evaluation can be done on effects to wildlife, residential water wells the river, etc.
- opposes removal of winter drilling restrictions.
- pace of development is too fast Water Quality – concern over aquifer/groundwater contamination.
- surface disturbance should be reduced regardless of waivers of winter stipulations.
- pace of development is too fast.
- monitoring data should be analyzed and changes made accordingly.
- slow pace of development.

- slow pace of development; require mitigation in only summer months.
- opposes winter drilling.
- operators should implement directional drilling and gathering systems regardless of winter drilling approval.
- hold operators to one well per section and pipe condensate and water.
- address all changes in development made in recent NEPA documents to determine adequacy of existing monitoring and research.
- evaluate how monitoring and research will be used to modify development once impact is demonstrated.
- support of the project – should place no arbitrary restrictions on development – any restrictions should provide for waivers, modifications or exceptions.
- supports the proposal, pipeline should follow existing corridors, NEPA process should be streamlined with analysis of real not perceived issues, reasonable alternatives should be analyzed, mitigation and lease stipulations should use sound science.
- address road construction and dust control, identify crossing methods for streams.
- Vegetation, Wildlife Habitats and Area Hunting and Fishing – address the effects of the pipeline project activities on area ecology.
- pipeline through crucial winter range should not be constructed in the winter.

Geology

- address “shifting geology” and need to drill year-round.
- companies should be required to get more gas out of their existing wells before drilling additional wells.

Land Use

- address impacts to ranchers and landowners as a result of wildlife being displaced to their lands.
- BLM should consider property rights.
- increased presence of displaced animals on ranchers.
- multiple use objectives are being overlooked.
- concerned about gas companies industrializing private lands to avoid restrictions on BLM land.

- address required permits for pipeline crossings or approaches to the highway.
- address additional policies regarding split estate lands.
- include an analysis of potential effects of the proposed action and alternatives to reclamation lands and facilities.

Noise

- use mitigation in crucial winter range.
- discuss short-term and long-term noise pollution and detail mitigation measures.

Public Health

- address hand washing and waste elimination for large number of people – other than portable-potties.

Range and Grazing

- mule deer will be pushed to private land.
- should be offsite mitigation to landowners.
- need plan for handling livestock permits.
- concerned about AUM decrease as a result of offsite mitigation.
- supports alternative which would reduce surface disturbance.
- need more coordination between operators and livestock producers who graze the Mesa.
- concerned that offsite mitigation will pressure cattle use on the rest of the Mesa.

Reclamation

- encourage BLM to insure reclamation areas are successfully restored and provide wildlife benefits.
- need timely reclamation.
- encourage BLM to insure reclamation areas are successfully restored and provide wildlife benefits.
- surface should be revegetated in manner that prevents the invasion of noxious weeds, use surface fill that supports native ground cover, prevent erosion and riling of soil down slopes.

Recreation

- address impacts to hunting and fishing communities as a result of lifting winter restrictions.

- populations have declined making hunting more difficult.
- public should have use of the Mesa if gas companies do.
- concerned about populations declining for hunting.
- construction should not interfere with water recreations.

Socioeconomic

- increase coordination with public.
- support for the project – will provide stability for working citizens in Sublette County.
- address impacts to local and adjacent communities as a result of lifting winter restrictions.
- effects to citizens of Pinedale should be considered.
- in support of proposal to establish stable economy.
- BLM should consider impacts to the human environment (winter restrictions allow Pinedale to return to pre-gas industry ways for the winter).
- concern over man camps, too much development and potential for “bust”.
- concern over “bust’ when drilling ceases.
- concerned about seasonal employment and safety associated with winter restrictions.
- look at impacts to local communities.
- supports winter drilling to stabilize economy.

Transportation

- reduce impacts by busing, stockpiling or convoys.
- truck traffic is dangerous on E. Green River Rd – CR 110 – only intended for ranch activity.
- concerned that winter drilling will create a safety hazard on County Road 23-110.
- concerned about safety of County Road 23-100 and increased risk during winter

Vegetation

- minimize disturbance; multiple wells from one pad should be standard procedure.

Visual

- evaluate impacts and detail mitigation steps that will be taken to minimize associated impacts. Address light pollution.

Water Resources

- address heavy metal concentrations (mercury and selenium) in production waters.
- concern about aquifer contamination from drilling and fracing.
- discuss methods to prevent, monitor and mitigate impacts to groundwater.
- concern over groundwater/aquifer contamination.
- potential for impacts to downstream water users.
- must evaluate subsurface water zones by additional investigational drilling.
- SEIS should contain level of information and analysis to support and comply with the 404 Guidelines.
- address any TMDL plans, produced water disposal, pretreatment of stormwater and mitigation plans. Address hydrostatic testing of the pipeline and the requirements for NPDES Clean Water Act Section 402 storm water permits.
- address potential for impact to drinking water aquifers and protection from cathodic protection structures.

Wetland and Riparian Areas

- identify all wetlands and waters of the U.S. that would be crossed or impacted including farmed wetlands and prior converted wetlands. Address need for buffer areas and commitments to reestablish wetlands and the need for compensatory mitigation.

Wildlife

- concerned with the request to remove all wildlife stipulations.
- ensure that large unfragmented areas are left undisturbed; expand wildlife studies.
- compliment initial mule deer study.
- oppose waiving wildlife habitat protection stipulations on the leases in the PAPA; do not support winter well completions.
- recommends that BLM consider short-term impacts (5 to 20 years) to wildlife and their habitats as well as long-term impacts to wildlife (mule deer, antelope and sage grouse.

- recommend that BLM consider an alternative that protects wildlife habitat on portions of the PAPA while allowing gas development in other portions.
- discuss effectiveness of mitigation for loss of critical winter range.
- include discussion on directional drilling to preserve crucial winter range.
- BLM should look outside of administrative boundaries for better mitigation strategies; continue research on mule deer.
- look at offsite mitigation as a regional issue.
- deal with human component to wildlife effectively.
- look at larger ecosystem for species.
- monitoring should be actively in place and should be long-term commitment (20 years or the life of the gas field).
- include an analysis of effectiveness of wildlife stipulations.
- explain monitoring; clarify intention of Proponents request to remove seasonal stipulations for all species in all habitat types.
- must provide scientific support before abandonment of any seasonal stipulations or claim that they are unnecessary or ineffective or that removal of them can be compensated for.
- Address any deviations from the “Minimum Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats on BLM Lands” – WGDF, 2004.
- concern for removal of seasonal stipulations.
- concern that management objectives of MA-2 have not been met.
- do not remove winter restrictions.
- seasonal stipulations should be continued.
- buying back suspended leases in the Upper Bridger Teton and Wyoming Range should be mitigation for removal of winter restrictions in the Pinedale Anticline.
- the quantitative data on the impacts of winter drilling on wildlife should be made available to the public.
- concern over winter drilling due to potential negative impacts.
- buying back suspended leases in the Upper Bridger Teton and Wyoming Range should be mitigation for removal of winter restrictions in the Pinedale Anticline.

- should include data on roadkills on Highway 191 between Boulder and Pinedale; winter drilling should not be approved until effects are fully understood.
- winter drilling restrictions should be enforced.
- opposes consideration for expansion of year round drilling.
- opposes approval of additional winter drilling on the Mesa.
- in offsite mitigation, consider potential for conflicts with people and other wildlife.
- address chronic wasting disease in ungulates.
- winter drilling exceptions should only be made on a case-by-case basis.
- against winter drilling, concerned about CWD, increased roadkills.
- do not allow winter drilling on the Mesa.
- opposes year round access on the Mesa; concerned for mule deer populations disruption of sage grouse leks and antelope populations.
- concerned about declining deer population on the Mesa.
- no drilling should be allowed in the wintering areas; sage grouse should be protected.
- supports offsite mitigation; should buy back leases in the South Rim Unit and not allow drilling there.
- issues are a concern to the community.
- does not support elimination of seasonal restrictions; concerned about mule deer, sage grouse and antelope.
- concerned about roadkill from increased winter traffic on County Road 23-100.
- provide documentation of operators' assertion that the proposed action (including completions) provides protection at least to the level of existing stipulations; provide GIS-based evaluation of habitat on and off the PAPA.
- evaluate effects of current development with current knowledge of effects to wildlife to allow better management of development and operation.
- adopt an objective of no further loss of key wildlife habitat s and specify how to achieve the objective.
- evaluate trends in sage grouse on impacted and non-impacted areas, including winter habitats with a plan for sage grouse conservation in the region.

- evaluate implementation and effectiveness of applicant-committed mitigation measures.
- develop a management plan to address wildlife and continued development.
- address impact to summer range used by mule deer wintering on the PAPA.
- too late for mitigation to work on the Mesa for mule deer.
- opposes drilling on big game winter range during critical periods.

APPENDIX C

Development Procedures for Wellfield Activities

(Includes Operator-Prepared Plans)

Attachment 1 – Transportation Plan
Attachment 2 – Reclamation Plan
Attachment 3 – Hazardous Materials Plan
Attachment 4 – Wildlife and Habitat Mitigation Plan

Development Procedures for Wellfield Activities

1.0 INTRODUCTION

These development procedures include plans prepared by Ultra Resources, Inc., Shell Exploration & Production Company, and Questar Market Resources including Operator committed mitigation. The plans include a Transportation Plan (Attachment 11), Reclamation Plan (Attachment 2), Hazardous Materials Summary (Attachment 3), and Wildlife and Habitat Mitigation Plan (Attachment 4).

2.0 DEVELOPMENT PROCEDURES

Drilling and development operations would continue year-round and may utilize as many as 48 drilling rigs operating in the PAPA. However, depending on the alternative selected, some areas would be restricted for winter drilling. Approximately 300 wells per year would be drilled in the PAPA during peak drilling.

Traffic and Workforce

The traffic volume in and out of the PAPA varies seasonally. During the development period (through 2023), traffic would be much greater in summer than in winter due to construction traffic required for construction of roads, pads and pipelines. Workers, material and equipment would be transported to the project area over U.S. Highways 191 and 189, State Highway 351, and county and BLM roads located within the PAPA. A comparison of traffic requirements for each of the alternatives for 2009 with and without the Shell and Ultra's liquid gathering system is provided in Table 1 below. A Transportation Plan is provided as Attachment 1.

Table 1
Comparison of Traffic (vehicles per day) During Development for all Alternatives in 2009

	No Action Alternative			Proposed Action Alternative and Alternative C		
	Light	**Heavy**	**Total**	**Light**	**Heavy**	**Total**
Summer	1,959	1,034	2,993	622	595	1,217
w/o gathering	1,589	665	2,254	521	443	964

Workforce Requirements. Estimated workforce requirements to develop a single well in the PAPA are provided in Table 2.

Table 2
Workforce Requirements Necessary to Develop A Single Well in the PAPA

Category	Average Number of Workers	Average Number of Days
Well Pad and Access Road Construction	15	5
Rig U/Down	15	5
Drilling	25	50
Testing and Completion	20	12

Preconstruction Planning and Site Layout

Pursuant to *Onshore Oil and Gas Order No. 1* and BLM regulation 42 *Code of Federal Regulations* (CFR) § 3162.3-1, each proposed well would requires an Application for Permit to

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

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

Construction and Drilling Operations

All activities at each well in the PAPA 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* concerning road construction standards on projects subject to federal jurisdiction. Sufficient topsoil to facilitate revegetation would be segregated from subsoils during all construction and would be replaced on the surface upon completion of operations as part of the reclamation and revegetation program. Operators would employ appropriate topsoil storage technology and procedures to ensure soil viability and plant rooting potential are maintained. When topsoil piles exceed 3 feet in height or will be stored for 2 years or longer, Operators would develop a plan for BLM approval that details methods and/or procedures to maintain or replace soil microbial and nutrient viability for reclamation.

Well Pads

Major components of each individual well pad include the following:

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

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

pit (if such pit is approved) would be stockpiled adjacent to the reserve pit and used to backfill the pit during reclamation.

The area required for drilling and completion of each well would vary depending upon the total number of wells to be developed from the pad, and whether new development would occur from an existing pad. In general, single well pads would require 5 to 10-acre pads, and directional well pads with multiple wells would require from 6 to 28 acres.

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 1 acre, in compliance with the Wyoming Department of Environmental Quality (WDEQ) Water Quality Division requirements.

Roads

New resource road construction would average approximately 0.44 mile for each new well pad. With the inclusion of an adjacent gathering pipeline, 5.35 acres of disturbance would be required initially (100-foot initial disturbance width) and 1.89 acres of disturbance would be required for the LOP (35-foot LOP disturbance width).

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. On completion of construction activities, the engineer would certify that the road was constructed in accordance with the approved road construction design, if deemed necessary by the BLM. Any deficiencies would be corrected to ensure compliance with both the approved Road Construction Plan and the APD. Once resource road construction is complete, all but 35 feet of the ROW (road surface area and portions of borrow ditch) would be reclaimed and revegetated.

Aggregates used for road and well location construction would be acquired from commercial sources in and adjacent to the PAPA. 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.

Drilling Operations

Up to 48 drilling rigs rated for drilling to depths of 14,000 feet or more may be employed simultaneously during project development to accommodate development of approximately 300 wells per year. 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 well would take an average of approximately 50 days.

Directional drilling provides for the construction of a single well pad that may accommodate as many as 32 wells (consolidated well pad). The initial and LOP disturbance required for each consolidated well pad is increased over that for a pad with a single well, however, there are fewer total pads for a given number of wells. Consolidated 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.

Drilling operations would utilize either water-based or oil based mud system or both, with additives to minimize downhole problems. The quantity of water used in drilling and completion varies between Operator because of mud type, and the re-use of partially treated produced water in drill-out and fracturing. If water based mud is used throughout the hole and there is no re-use of produced water, as much as 40,000 bbl Wasatch well water may be required per gas well. Use of oil-based mud in drillout below casing and re-use of produced water in completions can reduce that requirement to less than 5,000 bbl per gas well. There are currently approximately 98 water supply wells in the PAPA, but it is proposed that each new consolidated well pad would have its own water supply well to avoid haulage and piping. Because they are located on drilling pads, new water supply wells would require no additional disturbance. The All water well would be permitted with the Wyoming State Engineer's Office (WSEO).

Water might still be trucked or piped to some well pads from water wells and/or treatment facilities 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.

Operators would utilize closed drilling systems (no reserve pits) for well locations where certain environmental conditions exist (e.g. high water table). If reserve pits are approved, Operators would remove/vacuum fluids from reserve pits within 1 year of all wells on the pad being put into production. If this timeframe is infeasible on a particular site, the Operators would notify the WOGCC or BLM and fluids would be removed as soon as practical. If oil-based fluids are used, they would be recovered in tanks. If any oil enters reserve pits, it would be removed pursuant to WOGCC rules and regulations and the pit would be flagged overhead or covered with netting to prevent waterfowl use in compliance with BLM Informational Bulletin Number WY-93-054.

Surface casing is typically set to approximately 2,500 feet to isolate shallow water zones (alluvium and Wasatch). After drilling out each well and logging it, production casing is run and cemented to at least 400 feet above the Lance Formation, effectively isolating all geologic formations and eliminating fluid migration between hydrocarbon-bearing zones and freshwater aquifers.

Completion Operations

Once the well has been drilled and cased, completion operations would begin to clean the wellbore, to conduct pressure testing, and to perforate potentially productive zones. A bond log would be run (a bond log tests 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 fluids and proppants (typically water or nitrogen foam with sand) are pumped downhole under pressure through the casing perforations and into the formation. As the formation is fractured by applied pressure, the fractures are filled with sand to prop them open, so that they facilitate the flow of gas into the well.

Upon completion of fracturing, the well is flowed back to the surface to recover as much of the fracture fluid as possible and to clean excess sand out of the perforations. Production tubing might be permanently set, if warranted.

All fracture fluid additives would meet BLM and/or 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 were flared, but this project will employ “green completions“ as required by WDEQ, Air Quality Division flaring permits for the operators in the Pinedale Anticline. To minimize the need for flaring, a high-pressure multiphase flow-back separation unit designed to separate sand, condensate, natural gas, and water would be used. Sand would be piped to a steel pit (if such pit is approved), water would be captured in a flow-back tank, and gas and condensate would be piped to the production units. This process would result in the capture and sale of at least 90 percent of the gas and condensate per well that would otherwise have been lost during flowback. Gathering pipelines must be installed prior to the use of flareless completions, and the gas must be suitable for delivery into an interstate sales pipeline; if it is not suitable, then some flaring may still be required.

If reserve pits are approved, Operators would remove/vacuum fluids from reserve pits within 1 year of all wells on the pad being put into production. If this timeframe is infeasible on a particular site, the Operators would notify the WOGCC or BLM and fluids would be removed as soon as practical. Off-lease disposal of fluids would be in strict accordance with all appropriate rules and regulations regarding the discharge, transport, and/or disposal of such fluids.

Interim reclamation of disturbed areas not needed for production would occur as specified in APDs. Up to 60 percent of the disturbed acres would be reclaimed during interim reclamation. 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. Production equipment typically would include a “Christmas tree” at the wellhead (a series of valves designed to control pressures and regulate flows from the well); separators to segregate natural gas, condensate, and water; aboveground tanks for condensate and produced water storage with emission control devices to lower volatile organic compounds (VOCs) where required by WDEQ; a methanol tank and pump; a glycol dehydrator, with emission control devices to lower VOCs and hazardous air pollutants (HAPs) and pump; and a meter run for measurement of gas volumes produced into the pipeline. More 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 or smaller tanks may be substituted to accommodate reduced storage requirements for condensate and produced water.

All aboveground production facilities would be painted a standard environmental color that blends with the surrounding landscape, except for structures that require safety coloration to comply with Occupational Safety and Health Administration (OSHA) regulations.

Shell and Ultra Liquid Gathering System

Shell and Ultra plan to install liquids gathering systems to collect condensate and water from existing and future well pads. The piping right-of-way disturbance would be a short-term impact during piping construction and burial. Following installation of the piping, reclamation and seeding of right-of-ways would take place to restore the disturbed areas to a native state.

The liquids gathering system would require approximately 640-miles of piping to be installed by Shell and Ultra, or by 3rd party gatherer(s). However, sharing of right-of-ways has been considered in an effort to minimize surface disturbance, resulting in an assessment of 250-miles of net disturbance for liquids gathering system right-of-ways.

The liquids gathering systems would also require facilities for transporting, treating, and storing the collected liquids. These facilities will consist of central gathering facilities, which will include components such as: pumps, compressors, pressure vessels, tanks, liquids treating equipment, sales metering, and associated utilities systems necessary to provide power, heat, and other process needs.

Secondary pipelines wouldl be necessary to transport the processed liquids from the central gathering facilities. These pipelines will be for condensate, water recycling and disposal, and for gas recovered from the facilities. Again, the sharing of right-of-ways has been considered in an effort to minimize surface disturbance associated with these secondary lines.

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Attachment 1

Transportation Plan

Prepared by

Ultra Resources, Inc.
Shell Exploration & Production Company
Questar Market Resources

Transportation Plan

Purpose

Questar Market Resources (Questar), Shell Exploration & Production Company (Shell), and Ultra Resources, Inc. (Ultra), hereinafter collectively referred to as "Proponents", propose this Transportation Plan to supplement the 2000 PAPA ROD Transportation Plan (TP 2000) as provided below.

The purpose of this plan is to incorporate measures that: 1) reduce surface use to maintain habitat function and minimize habitat fragmentation; 2) reduce human activity to lessen disturbance to wildlife and reduce impacts to community, county and state infrastructure; and, 3) reduce air emissions through consolidation of locations and associated development and production activities.

Proponents propose to accomplish these goals through reduction of the number of pads through multi-well pad development, directional drilling, and simultaneous operations; concentration of pad locations into three operation areas; reduction of rig moves on and off pads; use of liquids gathering systems and centralized facilities where feasible to reduce truck traffic and the number of production tanks and associated VOC's; management of traffic through busing and scheduling during seasonal stipulation periods; and the increased use of computer assisted operations (CAO) reducing trips and traffic during production. Proponents' proposal will also result in a decrease of the expected period for development in concentrated areas under seasonal restrictions by up to 50 percent.

Scope

This plan applies to roads and the transportation of gas, condensate, or water via pipelines and as outlined in the TP 2000. The plan includes assumptions, mitigation measures, and guidelines. Relevant requirements for road construction or reconstruction and the development of agreements for surface use, rights-of-ways (ROW), and maintenance will be addressed and quantified in the Technical Support Document (TSD) submitted to BLM within 1 year of the release of the SEIS ROD and will be updated annually.

Pipelines / flowlines will be installed either within the road easement and / or within existing pipeline corridors to the extent feasible. Pipelines generally will be located adjacent to roads to reduce new surface disturbance. In instances where paralleling roads and lines lead to increased environmental and / or safety impacts, pipelines may be located along alternative routes. These alternative routes will be evaluated and sited to minimize environmental impacts.

Multi-well pads utilizing directional drilling may accommodate use of multiple drilling rigs operating year round as well as simultaneous drilling, completion, construction, and production operations. Concentrating operational activity into specific multi-section areas will lessen road development PAPA-wide during a given time period leaving large blocks of undeveloped acreage available to wildlife and livestock.

Proponent Committed Measures

1. Proponents will use public and existing roads as much as possible to lessen new surface disturbance and habitat fragmentation. New road construction under the concentrated development, multi-well pad proposal would be reduced by at least 70% PAPA-wide as compared to non-concentrated, single-well pad development. Per section, this equates to up to 1.16 miles or about 12 acres (roadway, flowline easement).

2. When siting new roads, Proponents will work with the Bureau of Land Management (BLM) to ensure this is done in the most efficient and environmental effective way. Proponents will continue use and development of ROW Surface Use Plans.

3. Annual road planning, development, maintenance, and other issues and concerns will be incorporated into a Technical Support Document (TSD), as will detailed information (including maps) on existing roads/routes and natural obstacles. The TSD and associated maps, as well as proposed project activities; operator construction and maintenance responsibilities; and road-specific dust abatement, construction, and surfacing requirements, will be updated annually or as necessary and submitted to the BLM.

4. Proponents will not move drill rigs to and from well pads in crucial big game winter range after November 15 and before May 1 outside of the agreed upon concentrated activity areas. Rigs within the concentrated areas will normally move onto a pad and stay until all scheduled wells for that rig are drilled as feasible. Delineation wells as discussed in Chapter 2 will be determined in the annual plans in consultation with BLM and WG&FD.

5. Proponents will deliver and store equipment and bulk supplies on or near the well pads prior to seasonal stipulation periods to the maximum extent feasible to reduce traffic and human disturbance on wildlife.

6. Proponents are committed to utilizing liquids gathering systems and centralized facilities where feasible. After the construction phase and where appropriate, liquids gathering systems and centralized facilities will significantly reduce tanker truck traffic by up to 475 truck trips per day during peak production.

7. Between November 15 and April 30 in a given year in crucial big game winter range and sage grouse winter concentration areas, Proponents will make reasonable effort to bus rig crews from appropriate vehicle staging areas to minimize commuting traffic. Proponents will not tolerate workers who miss the bus and drive personal vehicles to the pads during this time period.

8. Proponents will each coordinate the transportation routes and scheduling of service contractors to minimize the amount of traffic associated with year round development.

9. Proponents will fund hosted workers to the BLM Pinedale Office to operate an access station from November 15 through April 30 each year to monitor essential traffic to the pads. Proponents will determine in consultation with BLM how long the access station will be in place. Hosted workers would report to the BLM Pinedale Field Office. Traffic data would be compiled to differentiate between essential activity and non-essential traffic. Proponents would use this information to adjust their practices, if needed, to

reduce traffic. The access station would be open 24 hours a day, seven days a week. Proponents would fund signage appropriate to inform the public and industry of the access station and travel restrictions.

10. Where feasible, Proponents will utilize computer assisted remote monitoring of producing wells to reduce the need for daily site visits during the production phase.

11. Proponents will reclaim any road not required for routine operation and maintenance of producing wells or ancillary facilities as directed by the BLM, State Land Board, or private landowner. These roads would be blocked, recontoured, reclaimed, and revegetated by Proponents, as would disturbed areas associated with permanently abandoned pads.

12. As part of normal operational winter maintenance, Proponents will plow roads the minimum amount necessary to allow safe navigation. Plows would provide breaks in snow piled berms along the road margins (knockouts) in order to allow free movement of wildlife across roads.

13. Proponents will advise personally and/or by mail to all project-related personnel and vendors traffic activity restrictions and rules of conduct while on the PAPA. These will include, but are not limited to,
    a. No stopping to observe wildlife
    b. No harassment of wildlife
    c. No firearms
    d. No pets outside a vehicle

14. Proponents will provide a laminated sheet entitled “Code of Conduct during Seasonal Stipulation Periods” that will be required to be carried in each company vehicle. The sheets will also provide instruction on the types of human activity that create stress in wildlife.

15. Proponents would observe speed limits within the PAPA and will encourage service contractors and vendors to do the same. This will be included in the “Code of Conduct during Seasonal Stipulation Periods”.

16. Proponents will implement voluntary fugitive dust control measures on primary access roads and heavily used resource roads.

17. Proponents will instruct personnel on behaviors appropriate for minimizing disturbance to wildlife consistent with current documents on such conduct and developed in consultation with BLM, WG&FD or other wildlife experts.

18. In consultation with BLM and WG&FD, Proponents will install gates as appropriate and supply other needed material in crucial winter range and sage grouse concentration areas to encourage compliance with traffic restrictions. After construction, the BLM would maintain the gates. Gate keys would be managed by the BLM. Gate closures would be consistent with traffic restrictions. Proponents would assist BLM with signage on or near the gate explaining the traffic restrictions.

Estimated Traffic Volumes – Drilling

Following are the anticipated traffic and activity associated with drilling in a concentrated area on a consolidated multi-well pad:

1. Each rig will have the following personnel on location 24 hours per day. Each person will have a vehicle, but would typically not leave location on most days.
    a. Drilling Foreman
    b. Toolpusher
    c. Mud Engineer
    d. Directional Driller, when needed
    e. MWD Technician, when needed
    f. Mud Logger
    g. Top Drive Operator

2. Each rig will typically have two six-man crews, each working a 12-hour shift. Shift changes are generally at 6:00 a.m. and 6:00 p.m.

3. Rig traffic. The estimated traffic required for each well for the 45 to 55 days it takes to drill the well has been estimated as follows:
    a. Fuel Tankers – 17
    b. General Hauling – 88
    c. Mud and Waste Haulers – 44
    d. Water Trucks – 49, unless on-site water wells are permitted
    e. Down hole tool delivery and Misc. Supplies – 70
    f. Construction, management, roustabouts and services – 284
    g. Cement, barite, and mud chemicals – 48
    h. Rig moves on / off pad – 70
    i. Skids – 6

    This traffic estimate includes approximately 299 roundtrips by heavy trucks and 301 roundtrips by pickup truck or autos per well excluding the rig moves on / off pad and skids. The trip total reflects a decrease in supply traffic on multi-well pads at approximately 33 percent less than normal traffic to single wells on separate pads.

Estimated Traffic Volumes – Completions

Following are the anticipated traffic and activity associated with completions in a concentrated area on a consolidated multi-well pad. Estimates are per well and will be reduced with concurrent multiple well completions.

a. Proppant Hauling	53
b. Frac Fleet Semi Transport	40
Light Trucks	53
c. Water Delivery	35
Hauling	130
d. Wireline- Perforating and Logging	10
e. Coiled Tubing Drillout	28
f. Other semis/transport	19
g. Other light truck/pickup	120
TOTAL	488

Estimated Traffic Volumes – Production

Where feasible, upon gathering systems being fully operational and in combination with computer assisted operations being utilized, Proponents anticipate 1 roundtrip per day associated with pad production.

Estimated Traffic Volumes – Pad and Road Construction

Proponents expect to construct / expand pads and roads primarily outside of winter conditions.

Anticipated traffic to construct / expand one pad is 708 roundtrips which include heavy and light trucks, dump trucks, and water trucks.

Anticipated traffic to construct one access road is 146 roundtrips which include heavy and light trucks, dump trucks, and water trucks.

Emergency Vehicle Traffic Volumes

Emergency vehicle traffic for emergencies cannot be predicted or quantified, but are noted they will occur even as Proponents continue to enhance the safety of their contractors, service providers, and themselves in their operations.

Attachment 2

Reclamation Plan

Prepared by

Ultra Resources, Inc.
Shell Exploration & Production Company
Questar Market Resources

Reclamation Plan

Purpose

Questar Market Resources (Questar), Shell Exploration & Production Company (Shell), and Ultra Resources, Inc. (Ultra), hereinafter collectively referred to as "Proponents", propose this reclamation plan to supplement the 2000 PAPA ROD reclamation components as provided below.

A high priority of the Proponents is to limit surface disturbance through multiple-well pads, interim reclamation, directional drilling and consolidated development. Use of these multiple-well pads will correspondingly reduce associated development impacts such as roads and pipelines. By concentrating pad locations and operational activities, Proponents will leave large blocks of acreage undisturbed and available for wildlife and livestock use.

The purpose of this plan is to incorporate measures which will support the return of as much of the disturbed acreage to its pre-disturbed state as quickly as feasible upon conclusion of drilling and completion operations from a given surface pad.

Scope

This plan applies to practices within the PAPA to protect vegetation and to ensure proper and timely restoration of disturbed areas to approximate pre-disturbance levels. Monitoring of reclaimed areas and pilot / demonstration reclamation plots will be done to assure successful reclamation occurs.

The Standard Practices as to soils and vegetation which are specified in the 2000 PAPA ROD page 20 – 21 and in Appendix A, pages A-2, A-12 - 15, and A-27 - 30 should be incorporated into the SEIS. In addition, as stated in Appendix A, page A-14, "BLM will continue to allow applicants to use their own expertise in recommending and implementing construction and reclamation projects," thus permitting new methods and application practices to be implemented to accelerate and improve revegetation.

Proponent Committed Measures to Lessen Disturbance and the Need for Reclamation

1. The proposed concentrated development, multiple-well pad plan will reduce overall vegetation disturbance by 48 percent over development envisioned under the 2000 PAPA ROD, a significant benefit to wildlife and livestock.

2. Proponents will use public and existing roads as much as possible to lessen new surface disturbance and habitat fragmentation. By using multiple-well pads, proponents will be able to eliminate up to 1.16 miles or about 12 acres of roadway and flowline easement per section.

3. Proponents will use existing pads to the extent feasible for infill development to reduce the need for new pads and lessen new surface disturbance.

Proponent Committed Measures for Reclamation

1. Proponents will return as much of the disturbed acreage as possible to its pre-disturbed state as quickly as possible. Final revegetation will begin when the last of the wells on the pad is completed. Drilling and completing all wells on a pad sequentially results in earlier final revegetation and a smaller disturbed area. Proponents propose to use a variety of options and methods, such as the new habitat seed mixture of grasses, shrubs, and forbs and new application method which is in its second year of demonstration. This expedited reclamation will increase habitat patch sizes and reduce habitat fragmentation for sagebrush-obligate species. Proponents estimate that on the larger consolidated pads, approximately 70% of the pad will be reclaimed if pits were on the pad. If there are no reserve pits, the surface disturbance area is smaller and about 50% of that smaller pad would be reclaimed.

2. Proponents will utilize interim reclamation, where reasonable, to return as much of the landscape as possible to a condition usable by wildlife and livestock as quickly as possible. Interim reclamation will increase habitat patch sizes and reduce habitat fragmentation for sagebrush-obligate species.

3. Proponents will continue to monitor reclaimed areas and will encourage review of the monitoring data by BLM, Wyoming Game and Fish Department, and Wyoming Department of Agriculture habitat experts.

4. Proponents will adapt reclamation practices as appropriate based upon monitoring information. Successful reclamation to maintain soil stability and provide habitat function will be measured in stages, as follows:

    a. The establishment of a viable seedling cover within 1 year of initiation of reclamation. Viable seedling cover shall consist of indigenous species and/or ecologically-comparable species as approved by BLM habitat experts;
    b. Within 5 years of initiation of reclamation, the operator will establish at least 50% of indigenous vegetative cover and species composition; and,
    c. Within 8 years of initiation of reclamation establish at least 80% of indigenous vegetative cover and species composition.

5. The initiation of reclamation will commence immediately after the last well scheduled on a pad is put into production, as weather permits. In the event that more than two years will lapse between the drilling and / or completion of wells on a pad, the BLM may require interim reclamation and / or temporary site stabilization measures.

6. Proponents will test and implement, as appropriate, new methods of reclamation, seed mixtures, and application practices to accelerate and improve the revegetation in consultation with BLM and WGFD.

ATTACHMENT 3

Hazardous Materials Summary

Prepared by

Ultra Resources, Inc.
Shell Exploration & Production Company
Questar Market Resources

Hazardous Materials Plan
Pinedale Anticline Year Round Access SEIS

PURPOSE

Ultra Resources, Inc. (Ultra), Shell Exploration & Production Company (Shell) and Questar Market Resources (Questar), hereinafter collectively referred to as "Proponents," propose this Hazardous Materials Plan to supplement the 2000 Record of Decision on the Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming (2000 PAPA ROD) as provided below.

The purpose of the Hazardous Materials Plan is to protect public and worker health and safety and support the Bureau of Land Management's (BLM's) inspection and enforcement capability.

SCOPE

This plan applies to construction, development and production practices within the Pinedale Anticline Project Area (PAPA) applicable to handling, storage and disposal of hazardous materials.

PROPONENTS' COMMITTED MEASURES

1. Each individual Proponent would be responsible for ensuring that all production, use, storage, transport and disposal of hazardous and extremely hazardous materials used or produced in their respective operations 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.

2. Each individual Proponent would be responsible for communication and/or training for its employees, visitors on a site and requirements of subcontractor programs in accordance with all applicable existing or hereafter promulgated federal, state and local government rules, regulations and guidelines.

3. Each individual Proponent would be responsible for maintaining chemical and hazardous materials records and distributing such records to appropriate entities in compliance with all applicable existing or hereafter promulgated federal, state and local government rules, regulations and guidelines

4. A release of a hazardous substance, such as a leak or spill, in excess of the reportable quantity as established by 40 CFR Part 117.3, would be reported by each individual Proponent as required by the Comprehensive Environmental Response, Compensation, and Liability Act, Section 102 B.

5. If toxic substances are necessary, their usage would comply with provisions of the Toxic Substances Control Act of 1976, as amended (40 CFR Part 702-799).

6. Each individual Proponent would adhere to internal Hazard Waste Management policies and procedures.

HAZARDOUS MATERIALS MANAGEMENT SUMMARY

This Hazardous Materials Management Summary is provided pursuant to BLM instruction memoranda 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.

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

Proponents 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 EPA's List of Extremely Hazardous Substances as defined in 40 CFR 355 (as amended) and have determined that various materials listed as hazardous and/or extremely hazardous would be used or generated by this project. All known hazardous and extremely hazardous materials potentially produced, used, stored, transported and/or disposed of as a result of the project are presented in the table below.

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/centralized processing, wellhead processing and storage facility materials and miscellaneous materials.

GENERIC LIST OF MATERIALS, HAZARDOUS MATERIALS AND HAZARDOUS AND EXTREMELY HAZARDOUS MATERIALS POTENTIALLY UTILIZED OR PRODUCED DURING CONSTRUCTION, DRILLING, PRODUCTION AND RECLAMATION OPERATIONS

All materials in the following list are dependent on quantity used for determination of hazardous and/or extremely hazardous status. The following materials, dependent on the amount used, are listed as potentially hazardous and extremely hazardous materials.

This is a generic list of materials that were contained in the March 2006 Record of Decision for the Jonah Infill Drilling Project Environmental Impact Statement and in the July 2000 Record of Decision for the Pinedale Anticline Oil and Gas Exploration and Development Project Sublette County, Wyoming Environmental Impact Statement. These materials may be used during operations but not always and not by each operator.

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Drilling Materials		
Anionic polyacrylamide		Acrylamide
Barite	Barium compounds Fine mineral fibers	
Bentonite	Fine mineral fibers	
Caustic soda	Sodium hydroxide	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Glutaraldehyde	Isopropyl alcohol	
Lime	Calcium hydroxide	
Mica	Fine mineral fibers	
Modified tannin	Ferrous sulfate Fine mineral fibers	
Phosphate esters	Methanol	
Polyacrylamides	Petroleum distillates	Acrylamide
Polyanionic cellulose	Fine mineral fibers	
Retarder	Fine mineral fibers	
Cementing and Plugging Materials		
Bentonite	Fine mineral fibers	
Anti-foamer	Glycol ethers	
Calcium chloride flake	Fine mineral fibers	
Cellophane flake	Fine mineral fibers	
Cements	Aluminum oxide Fine mineral fibers	
Chemical wash	Ammonium hydroxide Glycol ethers	
Diatomaceous earth	Fine mineral fibers	
Extenders	Aluminum oxide Fine mineral fibers	
Fluid loss additive	Fine mineral fibers Napthalene	Acrylamide
Friction reducer	Fine mineral fibers Napthalene PAHs POM	
Mud flash	Fine mineral fibers	
Retarder	Fine mineral fibers	
Salt	Fine mineral fibers	
Silica flour	Fine mineral fibers	
Fracturing Materials		
Biocides	Fine mineral fibers PAHs POM	
Breakers	Ammonium persulphate Ammonium sulphate Copper compounds Ethylene glycol Fine mineral fibers Glycol ethers	
Clay stabilizer	Fine mineral fibers Glycol ethers Isopropyl alcohol Methanol PAHs POM	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Crosslinkers	Ammonium chloride Methanol Potassium hydroxide Zirconium nitrate Zirconium sulfate	
Foaming agent	Glycol ethers	
Gelling agent	Benzene Ethylbenzene Methyl tert-butyl ether Napthalene PAHs POM Sodium hydroxide Toluene m-Xylene o-Xylene p-Xylene	
pH buffers	Acetic acid Benzoic acid Fumaric acid Hydrochloric acid Sodium hydroxide	
Sands	Fine mineral fibers	
Solvents	Glycol ethers	
Surfactants	Glycol ethers Isopropyl alcohol Methanol PAHs POM	
Production Products		
Liquid hydrocarbons	Benzene Ethyl benzene n-Hexane PAHs POM Toluene m-Xylene o-Xylene p-Xylene	
Natural gas	n-Hexane PAHs POM	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Produced water/cuttings	Arsenic Barium Cadmium Chromium Lead Manganese Mercury Radium 226 Selenium Uranium Other radionuclides	
Fuels		
Diesel fuel	Benzene Cumene Ethylbenzene Methyl tert-butyl ether Naphthalene PAHs POM Toluene m-Xylene o-Xylene p-Xylene	
Gasoline	Benzene Cumene Cyclohexane Ethylbenzene n-Hexane Methyl tert-butyl ether Naphthalene PAHs POM Toluene m-Xylene o-Xylene p-Xylene	
Natural gas	n-Hexane PAHs POM	
Propane	Propylene	
Pipeline Materials		
Coating	Aluminum oxide	
Cupric sulfate solution	Cupric sulfate Sulfuric acid	
Diethanolamine	Diethanolamine	
LP Gas	Benzene n-Hexane Propylene	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Molecular sieves	Aluminum oxide	
Pipeline primer	Naphthalene Toluene	
Potassium hydroxide solution	Potassium hydroxide	
Rubber resin coatings	Acetone Coal tar pitch Ethyl acetate Methyl ethyl ketone Toluene Xylene	
Emissions		
Gases	Formaldehyde	Nitrogen dioxide Ozone Sulfur dioxide Sulfur trioxide
Hydrocarbons	Benzene Ethylbenzene n-Hexane PAHs Toluene m-Xylene o-Xylene p-Xylene	
Particulate matter	Barium Cadmium Copper Fine mineral fibers Lead Manganese Nickel POM Zinc	
Coolants	Ethylene glycol	
Crude Oil	Benzene PAHs POM	
Grease	Zinc compounds	
Heat Transfer Fluid	Benzene	
Lubricants	1,2,4-trimethylbenzene Barium Cadmium Copper n-Hexane Lead Manganese Nickel PAHs POM Zinc	
Methanol	Methanol	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Marking Paints	Hexane Naphthalene Toluene Xylene Acetone Cyclohexane	
Primers	Acetone Methanol Methyl Ethyl Ketone Napthalene Toluene Xylene Zinc	
Plant Condensate	Benzene Ethyl benzene n-Hexane PAHs POM Toluene m-Xylene o-Xylene p-Xylene	
Silicone Seal	Silane	
Miscellaneous Materials		
Acids	Acetic anhydride Formic acid Sodium chromate Sulfuric acid	
Antifreeze, heat control, and dehydration agents	Acrolein Cupric sulfate Ethylene glycol Freon Phosphoric acid Potassium hydroxide Sodium hydroxide Triethylene glycol Polyethylene glycol	
Batteries	Cadmium Cadmium oxide Lead Nickel hydroxide Potassium hydroxide Sulfuric acid	
Biocides	Formaldehyde Isopropyl alcohol Methanol	
Cleaners	Hydrochloric acid	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Corrosion inhibitors	4-4' methylene dianiline Acetic acid Ammonium bisulfite Basic zinc carbonate Diethylamine Dodecylbenzenesulfonic acid Ethylene glycol Isobutyl alcohol Isopropyl alcohol Methanol Napthalene Sodium nitrite Toluene Xylene	
Emulsion breakers	Acetic acid Acetone Ammonium chloride Benzoic acid Isopropyl alcohol Methanol Napthalene Toluene Xylene Zinc chloride	
Fertilizers	Unk	
Herbicides	Unk	
Lead-free thread compound	Copper Zinc	
Lubricants	1,2,4-trimethylbenzene Barium Cadmium Copper n-Hexane Lead Manganese Nickel PAHs POM Zinc	
Methanol	Methanol	
Motor oil	Zinc compounds	

Materials	**Hazardous Substances** [1]	**Extremely Hazardous Substances** [2]
Paints	Aluminum Barium n-Butyl alcohol Cobalt Lead Manganese PAHs POM Sulfuric acid Toluene Triethylamine Xylene	
Paraffin control	Carbon disulfide Ethylbenzene Methanol Toluene Xylene	
Photoreceptors	Selenium	
Scale inhibitors	Acetic acid Ethylene diamine tetra Ethylene glycol Formaldehyde Hydrochloric acid Isopropyl alcohol Methanol Nitrilotriacetic acid	
Sealants	1,1,1-trichloroethane n-Hexane PAHs POM	
Solvents	1,1,1-trichloroethane Acetone t-Butyl alcohol Carbontetrachloride Isopropyl alcohol Methyl ethyl ketone Methanol PAHs POM Toluene Xylene	
Starting fluid	Ethyl ether	
Surfactants	Ethylene diamine Isopropyl alcohol Petroleum naphtha	

[1] 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.
[2] Extremely hazardous substances are those defined in 40 CFR 355.

ATTACHMENT 4

Wildlife and Habitat Mitigation Plan

Prepared by

Ultra Resources, Inc.
Shell Exploration & Production Company
Questar Market Resources

WILDLIFE AND HABITAT MITIGATION PLAN

Purpose

Ultra Resources, Inc. (Ultra), Shell Exploration & Production Company (Shell), and Questar Market Resources (Questar), collectively referred to as the "Proponents", propose this wildlife and habitat mitigation plan to supplement wildlife and habitat provisions identified in the 2000 Pinedale Anticline Exploration and Development Project Record of Decision (ROD) (Bureau of Land Management [BLM] 2000).

On December 6, 2004, the Wyoming Game and Fish Department (WGFD) issued the guidance document Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats (WY Game & Fish Department. 2004 Cheyenne, WY). This document recommends various mitigation and management practices to address impacts to wildlife which could be employed by oil and gas industry in the development of oil and gas resources in Wyoming. In addition to its recommended standard management practices to reduce wildlife impacts associated with oil and gas development, the WGFD also recommended additional mitigation/management prescriptions including: directional drilling, clustered development, condensate removal, remote monitoring, travel plans, environmental monitoring, and as appropriate, gate and close all newly constructed roads to public travel. The following Proponent commitments have incorporated not only most of the recommended standard management practices, but all of the recommended additional mitigation/management prescriptions.

The Proponents' development proposal limits surface fragmentation through directional drilling, multiple-well pads, interim reclamation and consolidated development areas. Use of these multiple-well pads within consolidated development areas will correspondingly reduce associated development impacts such as roads and pipelines. In addition, the Proponents will substantially reduce the amount of human activity and on-site facilities through the use of liquids gathering systems and consolidated production facilities which will result in decreased surface disturbance. By concentrating pad locations and operational activities, Proponents will leave large blocks of acreage undisturbed and available for wildlife use.

Scope

This plan applies to practices within the Pinedale Anticline Project Area (PAPA) to ensure avoidance and minimization of impacts to wildlife and wildlife habitat and to ensure in the event that avoidance and minimization are unachievable, the proper and timely mitigation of wildlife and habitat impacts both on-site and off-site, if needed.

This Plan amends the 2000 PAPA ROD and Mitigation Guidelines and Standard Practices, Appendix A, as they apply to big game and sage grouse except for surface occupancy within 0.25 mile of an active lek. Proponents are requesting waivers of existing stipulations for big game and sage grouse during wintering, nesting, and brood rearing periods within the concentrated development areas (CDA) for construction and development activities. This will allow for year round construction and development activities within these CDA's during the multi-year period required to complete these actions thereby substantially reducing the time required for the project development phase. A 0.25-mile restriction of no surface occupancy of permanent facilities near active sage grouse leks will remain in effect. Exceptions for raptor and/or Bald Eagle stipulations will be sought on an individual basis by the Proponent wishing to conduct operations and will be addressed through Voluntary Best Management Practices (BMP's) and in coordination with the U.S. Fish and Wildlife Service (USFWS). Permitting mitigation alternatives outlined below will be implemented.

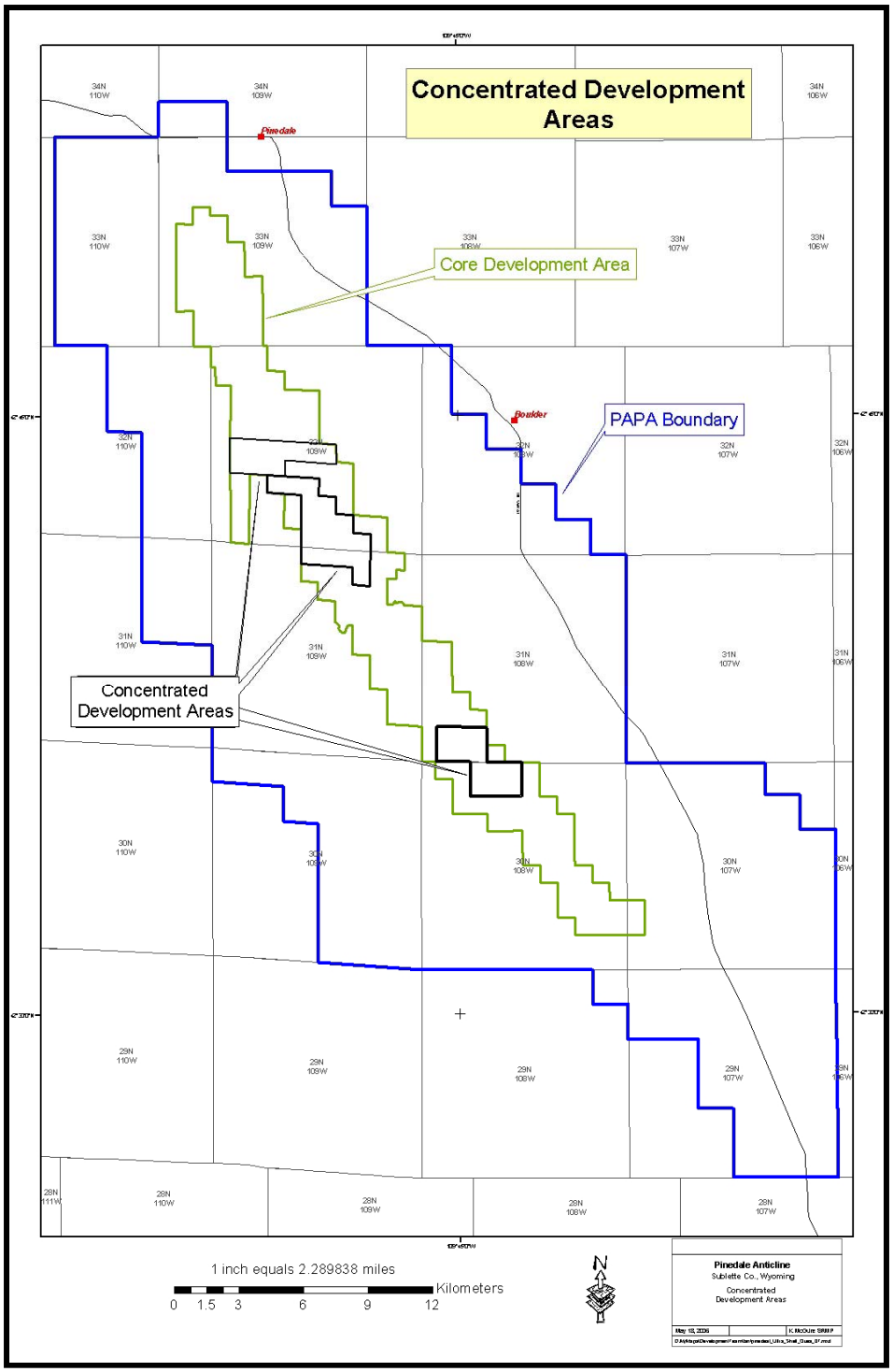
Proponent Committed Measures

The Proponents' commitments for wildlife and habitat mitigation are designed to offset impacts resulting from their development activities within the PAPA, and center on: avoiding impacts**;** minimizing impacts; rectifying, repairing, rehabilitating, or restoring environmental conditions; reducing or eliminating impacts over time; and compensating for impacts on-site or off-site. As outlined under the National Environmental Policy Act (NEPA), 40 CFR 1508.20:

Avoidance of Impact: "Avoiding the impact altogether by not taking a certain action or parts of an action."

- The Proponents will make efforts to avoid the impacts that could otherwise occur if development was implemented pursuant to the 2000 PAPA ROD. Proponents propose to use directional drilling on larger multi-well pads in consolidated development areas year round. Under a No Action alternative, operators could require up to 839 new pads (with additional NEPA analysis) to develop 4,399 new wells. The Proposed Action will require 253 new pads to develop the 4,399 new wells. The year round access development proposal utilizes a total of 601 pads for natural gas development including some possible downspacing to 20, 10 and 5 acre down-hole well density. The No Action total is 1,187 pads. The Proposed Action provides about a 50% percent reduction in total pads. Thirty or more wells may be developed from a single pad in some areas. The 2000 PAPA ROD analyzed wells at 40-acre spacing and limited active pads to 700 pads.

- The arrangement of the consolidated areas will leave large, contiguous blocks of land without active development activities. The estimated total disturbed acreage (without reclaimed acreage calculated into the number) will leave 92% of the PAPA undisturbed by natural gas development. An example of CDA development:



- The Proponents will utilize the following voluntary eagle and raptor BMP's from which they may choose any or all as voluntary measures, and will seek technical assistance from the BLM and the USFWS as necessary.

1. Conduct appropriate raptor surveys before commencement of ground disturbing activities within 1 mile of proposed disturbance to determine status of known nests and roosts and to identify new nests and roosts.

2. Monitor any activities that may adversely impact bald eagles and other raptor species.

3. Restrict activities within 0.5 mile of active raptor nests (1 mile of active bald eagle and ferruginous hawk nests) from the period of early courtship through the fledging of chicks (generally from February 1 to August 15). With assistance from the USFWS, modifications to protective buffers may be considered when topography, vegetation and other variables serve as natural protective buffers.

4. Restrict activities within 1 mile of known bald eagle winter roosts from November 1 to April 1, when activity has been verified. With assistance from the USFWS, modifications to the 1-mile protective buffer may be considered when topography, vegetation and other variables serve as natural protective buffers.

5. In coordination with the USFWS noise reduction barriers may be used to minimize disturbance when activities are proposed within an established protective buffer.

6. Prohibit activities that produce extremely loud noises within 1 mile of active bald eagle nests during nesting periods unless greater tolerance to the activity (or similar activity) has been demonstrated by the particular pair of bald eagles through monitoring.

7. Build all power lines to standards identified in Avian Power Line Interaction Committee and utilize industry-accepted standards to prevent raptors from being electrocuted on towers and poles.

8. To preclude bald eagles or other raptors from nesting on human-made structures such as cell phone towers and condensate tanks and to avoid impeding operation or maintenance activities, install anti-perching devices on structures to discourage use by raptors. Additionally, in coordination with the USFWS and based on appropriate ecosystem management, construct artificial nesting platforms to encourage nesting away from human activity.

9. As necessary, notify the appropriate authorities (Wyoming Department of Transportation on Highways and WGFD or BLM on rural and county roads) of the presence of roadside carrion and ask that they remove the carrion as soon as possible. Carcasses may be covered in the interim to discourage scavenging by bald eagles and other raptors, but only authorized personnel may touch or remove the carcasses.

10. When possible, include the USFWS in on-site reviews for future project sites.

11. The Proponents will work to identify voluntary opportunities to conserve and/or improve natural resources in the area to promote a positive land ethic.

Maintain adequate buffer from riparian habitats where possible (outside edge of trees as area of effect). Buffers would be site specific depending on vegetation and topography. They will be developed in coordination with qualified biologists, the USFWS and/or the BLM as necessary. Proponents will strive to conserve potential nesting, roosting and foraging habitat whenever possible by retaining mature trees and old growth stands wherever possible, particularly within 0.5 mile of water.

Minimize Impacts: "Minimizing impacts by limiting the degree or magnitude of the action and its implementation."

- All activities will be conducted in such a manner that minimizes impacts on wildlife, habitat and the local communities.

- The Proponents will minimize the total area of surface disturbance and associated areas of indirect habitat loss by reducing to the extent possible human presence and activity.

    1. The Proponents will utilize liquids gathering systems and centralized processing and storage facilities where feasible thereby reducing traffic.

    2. The Proponents will utilize computer assisted remote monitoring of producing wells, and anticipate an average of only 1 roundtrip per day to each well pad during production.

    3. In addition to minimizing surface disturbance by restricting activities to existing roads, traffic on those roads will also be minimized to the extent practical by coordinating and scheduling the transportation routes and use of the roads by project personnel and service contractors.

    4. Commuting traffic will be minimized in crucial big game winter range and sage grouse winter concentration areas by bussing rig crews from staging areas to work areas.

    5. Total acreage disturbance by 2024, without reclamation considered, is estimated at 14,961 leaving 92% of the PAPA undisturbed.

- The Proponents will make efforts to reduce the total duration of project activities in the PAPA.

    1. The areas of concentrated simultaneous drilling, completion, construction, and production activities will be completed in as short a time as possible by completely drilling and completing all wells on a pad as feasible prior to moving development activities to another pad.

- Development (drilling, and completion activities) within the core area (48.36 square miles) will be concentrated to a maximum of 19 square miles in the three development areas which is 39.29% of the core acreage, leaving 60.71% of the core available for wildlife. This will result in leaving the greatest amount of undisturbed habitat as possible at any point in time in the best combination of the following:

- o largest area
- o largest contiguous blocks
- o best functional connectivity
- o highest quality

- The Proponents' implementation of a road management plan, which voluntarily restricts their activities to existing roads where possible, will reduce surface disturbance and expansion of human disturbance into new areas and will lessen road mileage by 70% as compared to traditional non-concentrated, single-well pad development.

- The Proponents will plan their activities to avoid to the extent practical moving drill rigs in crucial big game winter range after November 15 and before May 1, thereby reducing the number of trucks, equipment and associated traffic during big game stipulations.

- Each year, the specific areas of concentrated activities will be determined through joint review of Proponent development plans. The Proponents (combined or separate as appropriate), BLM, and WGFD will work to reach agreement on the final plans as early in the calendar year as possible to allow sufficient time to plan, permit, and execute new construction as required in the summer months for the next activity year.

- The Proponents will also provide a 10-year rolling forecast of PAPA activity at the same time each year to fully describe the future development plans on an ongoing basis.

- Each year, the Proponents will collaborate as appropriate seeking opportunities to adjust the size of the areas required for concentrated activities and reduce impacts. The Proponents, BLM, and WGFD will jointly seek improvements to the annual and 10-year development plans designed to further reduce potential project impacts.

- The Proponents may choose any or all of the following BMP's as voluntary measures which can be used to minimize disturbance to bald eagles and other raptors when oil and gas development activities occur within recommended protective buffers.

    1. During night operations, direct lighting toward the pad to avoid light disturbance to surrounding areas if no negative pad safety impact is foreseen.

    2. Reduce unnecessary traffic and encourage travel times to be during daylight hours between 9-3.

    3. In areas within 1 mile of active nests where there is line of sight from active nests to the activity, pipeline installation equipment shall be shielded from the affected area with camouflage netting.

    4. Avoid potentially disruptive activities or permanent above ground structures in the bald eagles' direct flight path between their nest and roost sites and important foraging areas.

Restoration of Impacts: "Rectifying the impact by repairing, rehabilitating, or restoring the affected environment."

- Mitigation measures will begin immediately or as soon as practical, to avoid any lag time between impacts that decrease habitat function and the on-the-ground mitigation actions that increase habitat function. Mitigation in the form of interim reclamation (utilizing native cool-season grasses, forbs, and shrubs in the seed mix) will proceed as soon as practical after development drilling, completion and construction activities are completed on individual pads, which will reduce the net surface disturbance as development proceeds. Beginning in 2008, once all drilling and completion work has been finished and all wells on the pad are on production, the Proponents forecast that 70% of the disturbed pad area will be reclaimed on individual pads containing pits, and 50% of the disturbed pad area will be reclaimed on pads developed without reserve pits. The Proponents will also temporarily reclaim pads when no forecasted drilling or completion activity is expected on the pad for the following two years.

- Impacts will be mitigated by developing coordinated mitigation approaches with the BLM, WGFD, and other federal and state agencies to seek opportunities to further benefit wildlife.

- Key habitats and habitat components, such as crucial winter ranges, migration routes, sage grouse seasonal habitats, and identified sensitive species habitats, will receive first consideration for mitigation. Specific mitigation actions will as much as possible:

    - occur on-site, or immediately adjacent to impacts
    - address the same animals or species that are being impacted
    - address the same habitat components that are being impacted

Reduction and Elimination of Impacts: "Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the project."

- The Proponents have committed to utilizing liquids gathering systems and centralized processing and storage facilities where feasible. Liquids gathering systems and centralized facilities will significantly reduce tanker truck traffic, most notably after the project construction phase.

- The Proponents will utilize computer assisted remote monitoring of producing wells. Proponents anticipate 1 field operator visit per day per pad.

- Proponents will use existing roads where possible which will reduce surface disturbance and expansion of human disturbance into new areas and will lessen road mileage by 70% compared to traditional non-concentrated, single-well pad development.

Compensation for Impacts: "Compensating for the impact by replacing or providing substitute resources or environments."

- The Proponents have agreed to a 3:1 acre off-site mitigation ratio in the event that off-site mitigation is required to compensate for loss of on-site habitat (i.e., for every acre of long-term on-site habitat disturbed by the project, Proponents will improve three acres off-site habitat). This would supersede existing Questar commitments for off-site mitigation as identified in Decision Records for Questar's existing over-winter development proposals (BLM 2004 [*Finding of No Significant Impact, Decision Record and Environmental Assessment for the Questar Year-Round Drilling Proposal, Sublette County, Wyoming*], and BLM 2005 [*Finding of No Significant Impact, Decision Record and Environmental Assessment for the Questar Year-Round Drilling Addendum, Sublette County, Wyoming*]).

- The Proponents commit to developing a comprehensive off-site mitigation plan within one year of SEIS ROD release. Options that may be included in the plan are enhancing habitat on land contiguous to the PAPA and acquisition of property rights (leasehold interest, short-term or long-term conservation easements, etc.) designed to set aside habitats, protect key migration routes and preserve open space.

- Off-site mitigation will generally be implemented if on-site actions are not considered adequate, or if off-site measures are considered to be of significantly greater value. Off-site mitigation would occur as close to the impacted area as possible, and provide habitat for the specific animals being displaced or experiencing habitat declines as a result of development. Off-site mitigation that occurs farther away would provide a key year-round life requirement for the animals that occupy the development area during part of the year.

- To assure implementation and use of effective monitoring efforts and mitigation options, annual mitigation planning for wildlife and habitats will be coordinated among BLM, WGFD, and the Proponents. The Proponents, BLM and WGFD will jointly seek improvements to the proposed development plans to further reduce project impacts.

- The Proponents would support formation of a dedicated multi-agency management team to plan and implement permitting, monitoring, mitigation, and reclamation activities. This will benefit both the Proponents and agencies by streamlining the development process, providing continual focus on plan implementation, and providing coordination and cost-efficiencies with other adjacent developments that could impact some of the same animals and habitats impacted by this project.

- The Proponents will monitor mitigation measures to determine mitigation effectiveness and provide ongoing information and direction for future mitigation efforts during the life of the field.

- The Proponents will commission and fund a habitat inventory of the PAPA. Habitat inventory data will be used for development, reclamation, and potential habitat improvement planning for key habitats and habitat components. Habitat improvements may be applied in important habitats to restore degraded or lost habitat functions.

- Concurrent with and complementing these on-site efforts to avoid, minimize and mitigate impacts, the Proponents have commissioned and funded wildlife research, wildlife monitoring and other special studies. The first year of a five year study on pronghorn antelope is now complete as is the first year of a five year research project on sage grouse. The mule deer study is in its sixth year of a seven year research and monitoring project.

- The Proponents will promote communication with other stakeholders as mitigation objectives and approaches are being developed. Specific wildlife and habitat mitigation objectives and actions should, as much as possible, be designed to minimize impacts to other important area resources (e.g., livestock, recreation, visual resources).

APPENDIX D

Pipeline Design and Construction Procedures

Pipeline Design and Construction Procedures

1.0 INTRODUCTION

Rendezvous Gas Services, L.L.C. (RGS) proposes to construct a 103.6-mile long, 30-inch diameter, natural gas pipeline (Rendezvous Phase 6 (R6) Pipeline) within the proposed Bird Canyon Corridor (BCC) and Blacks Fork Granger Corridor (BFGC) to transport natural gas produced in the PAPA to gas processing plants: Segment 1 of the proposed R6 Pipeline (41.5 miles) would be located in the BCC and Segment 2 (62.1 miles) would be located in the BFGC. Segment 1 of the proposed R6 Pipeline would begin at the Pinedale/Gobblers Knob Compressor Station and end at the Bird Canyon Compressor Station. Segment 2 of the proposed R6 Pipeline would begin at the Bird Canyon Compressor Station and end at the Blacks Fork Processing Plant. It is anticipated that the R6 Pipeline would be constructed during the summer and fall of 2008.

Jonah Gas Gathering Company (JGGC) proposes to construct a 41.5-mile long, 36-inch natural gas pipeline (Paradise to Bird Canyon (PBC) Pipeline) and a connecting 45.5-mile long, 30-inch pipeline (Opal Loop III Pipeline) to transport natural gas from the PAPA to gas processing plants. The PBC Pipeline is proposed to be located in the BCC and will parallel the R6 Pipeline. The Opal Loop III Pipeline is proposed to be located in the OPC and will parallel the Bridger Pipeline that was constructed in 2006.

The design and engineering of the proposed pipelines would be completed by RGS/JGGC personnel or their contractors in accordance with safe and proven engineering practices. All pipeline plans and specifications, alignment sheets, road profiles, cross sections, site-specific details, and design drawings associated with the project would be available for review at RGS's office in Green River, Wyoming, JGGC's office in Rock Springs, Wyoming, and the BLM Field Offices in Pinedale, Rock Springs, and Kemmerer, Wyoming prior to issuance of the right-of-way (ROW) grant.

RGS/JGGC would secure all rights of way on adjacent nonfederal lands prior to pipeline construction. RGS/JGGC would notify authorized ROW users of RGS/JGGC's proposed pipeline crossings or overlaps on the surface occupied by the affected ROW users. Any associated road and utility permits would be secured from the appropriate regulatory agency prior to construction. RGS and JGGC are requesting federal ROW grants for a period of 30 years with options to renew for as long as there are marketable quantities of natural gas available. All equipment and vehicular access would be confined to existing roads and the established ROW corridors. No major reconstruction or rerouting of roads is proposed.

2.0 PIPELINE DESCRIPTIONS

Surface disturbance associated with the proposed pipelines is provided in Table 1.

Table 1
Estimated Total and Life of Project (LOP)
Disturbance for Gas Sales Pipelines and the Granger Gas Plant

Component	Number or miles	Total Disturbance (acres)	LOP Disturbance (acres)
30-inch Rendezvous (R6) Pipeline[1]	103.6 miles	1,506.9	1.0
R6 temporary extra work areas[2]	168	23.3	0.0
R6 temporary extra work areas – HDDs[3]	4 sites	8.3	0.0
Subtotal		**1,538.5**	**1.0**
36-inch Paradise to Bird Canyon (PBC) Pipeline[1]	41.5 miles	603.6	1.0
PBC temporary extra work areas[2]	48	9.4	0.0
PBC temporary extra work areas – HDDs[3]	2 sites	4.2	0.0
Subtotal		**617.2**	**10**
30-inch Opal Loop III Pipeline[1]	45.5 miles	661.8	10
Opal Loop III temporary extra work areas[2]	68	10.5	0.0
Subtotal		**672.3**	**1.0**
Granger Gas Plant	1 site	86.4	86.4
Total Sales Pipelines/Gas Plant	**1 site**	**2,914.4**	**89.40**

[1] Disturbance based on 120 feet construction ROW width.
[2] Temporary extra work areas are required for road, foreign line, historic trail and waterbody crossings.
[3] horizontal directional drill.

Rendezvous Phase 6 Pipeline

The proposed R6 natural gas pipeline (both R6 Segments 1 and 2) would be constructed of 30-inch x 0.438- or 0.625-inch w.t., Grade X-70, steel pipe. Maximum operating pressure would be approximately 1,440 psig. The proposed R6 Pipeline would be buried to a minimum depth of 48 inches.

RGS proposes a 120-foot wide construction ROW which includes a 50-foot wide permanent ROW and a 70-foot temporary construction ROW. Additional temporary extra work areas would be required on both sides of road, historic trail, railroad, and waterbody crossings. At these locations, the total ROW width would increase to 150 feet. For all waterbody and railroad crossings, a temporary extra work area of 150 feet in width x 300 feet in length would be required. New disturbance for staging areas including pipe and equipment storage yards is not anticipated. Existing storage facilities located off-ROW would be used.

The proposed BCC and BFGC corridors and the specific route for R6 Pipeline within the proposed 500-foot and 300-foot corridors would be located parallel and adjacent to existing pipelines for approximately 81.0 miles (78 percent) of the pipeline's total length. The remaining 24.4 miles (22 percent) of the proposed route would parallel other linear features such as roads or traverse the landscape cross-country. The proposed 103.6-mile long R6 Pipeline would cross approximately 85.5 miles (83 percent) of federal lands, 0.8 mile (0.8 percent) of state lands, and 16.5 miles (16 percent) of private lands.

Estimated surface disturbance required for construction of the proposed R6 Pipeline is presented in Table 1. Disturbance associated with construction and operation of main line valve assemblies, pig launchers/receivers, side taps, and meter stations would be confined within the

50-foot wide permanent ROW. Off-ROW staging areas are not required due to the availability of existing storage yards for pipe and other equipment. Access by vehicles and equipment to the ROW for construction and operations would be via existing roads and would require no upgrades or improvements. Repairs to existing roads would be made should pipeline construction activities result in road damage.

In conjunction with the proposed pipeline project, RGS is requesting approximately 87 acres of BLM-administered federal land to expand the existing Granger Plant. The expansion would provide space for additional processing facilities to handle an additional 600 (MMSCF/D) of natural gas and associated natural gas liquids.

Paradise to Bird Canyon and Opal Loop III Pipelines

The Paradise to Bird Canyon Pipeline would be constructed of 36-inch x 0.515-inch w.t., Grade X-70, steep pipe. The Opal Loop III Pipeline would be constructed of 30-inch x 0.438-inch w.t., Grade X-70, steel pipe. Maximum operating pressure would be approximately 1,440 psig for both segments. The proposed JGGC pipelines would be buried to a minimum depth of 48 inches.

JGGC proposes a 120-foot wide corridor for construction of both the 36-inch and 30-inch pipelines with a 50-foot wide permanent ROW for operational and maintenance purposes and 70-foot wide temporary construction ROW within the 500-foot wide BCC and 300-foot wide OPC (PBC Pipeline and Opal Loop III Pipeline, respectively) of the proposed pipeline corridor. Additional temporary extra work areas, 30 feet wide by 100 feet long, would be required on both sides of road, historic trail, railroad, and creek crossings. At these locations, the total ROW width would increase to 150 feet. At river crossings, temporary extra work areas of 150 feet in width x 300 feet on both sides of horizontal directional drill (HDD) locations beyond the 120-foot construction ROW width would be required. Total construction ROW width at HDD crossings of rivers and other features would be 260 feet wide and 300 feet long on both sides.

The proposed BCC and OPC corridors and the specific route for the PBC Pipeline within the proposed 500-foot wide corridor, and the Opal Loop III Pipeline within the proposed 300-foot wide corridor, would be located parallel and adjacent to existing pipelines for approximately 66.8 miles (76.8 percent) of the pipeline's total length. The remaining 20.2 miles (23.2 percent) of the proposed route parallel other linear features such as roads or traverse the landscape cross-country.

The PBC and Opal Loop III pipelines would be placed 35 feet from adjacent existing pipelines. The permanent ROW for these pipelines would require 25 feet of the 35 foot separation. Although the spoil side of the JGGC pipeline's construction ROWs would likely overlap with areas previously disturbed by the construction of the adjacent, existing pipeline, the amount of overlap with previous disturbed areas is unknown; therefore, the assessment of anticipated disturbance from construction of the JGGC pipelines is based on the convention that all disturbance would be considered new disturbance. The combined BCC and OPC corridors and the proposed 87.0 miles of JGGC pipelines would cross approximately 81.9 miles (94 percent) of federal lands, 0.9 mile (1 percent) of state lands, and 4.2 miles (5 percent) of private lands.

Estimated surface disturbance required for construction of the proposed PBC and Opal Loop III pipelines is presented in Table 1. Disturbance associated with construction and operation of main line valve assemblies, pig launchers/receivers, side taps, and meter stations would be confined within the 50-foot wide permanent ROW. The need for off-ROW staging areas where new disturbance would be necessary is not anticipated due to the availability of existing storage yards for pipe and other equipment. Access by vehicles and equipment to the proposed ROW for construction and operations would use existing roads and would require no upgrades or

improvements. Repairs to existing roads would be made, should pipeline construction activities result in road damage.

3.0 WORKFORCE REQUIREMENTS AND CONSTRUCTION SCHEDULE

Pipeline firms/proponents would notify the authorized officers of the appropriate agencies five days prior to commencing construction activities. Proponents would also comply with all timing stipulations for wildlife. Easements would be obtained from private landowners. The construction force for each pipeline is expected to number approximately 200 to 300 persons at the peak of construction and it is expected to take three (3) to five (5) months. No temporary work camps are anticipated.

The following is a list of construction equipment that would likely be required for a large diameter pipeline project:

- 15 welding trucks
- 12 tractor trailers
- 6 two ton trucks
- 25 pickup trucks
- 2 dump trucks
- 2 seed drillers and tractors (if applicable)
- rubber tired backhoes
- 12 trackhoes
- 20 side boom caterpillar
- wheel trenchers
- 8 D7 dozers
- 1 fuel truck
- 1 low head pump
- 1 pressure pump
- 1 air compressor -1750 cfm
- 1 air compressor-1200 cfm
- 2 motor graders

4.0 CONSTRUCTION SEQUENCE

Pipeline construction within the proposed corridors would commence when all permits and ROW documents have been secured, and BLM authorization is received. Proponents would notify the AO 5 days in advance of starting construction activities. All private surface landowners would be contacted prior to construction for access and surface usage. All materials, construction, operation, maintenance, and termination practices for the proposed pipeline would be completed by proponent personnel or their contractors in accordance with safe and proven engineering practices.

Construction sites would be maintained in a sanitary condition at all times; waste materials at those sites would be disposed of promptly at an appropriate waste disposal site. The term "waste" refers to all discarded matter including human waste, trash, garbage, refuse, oil drums, petroleum products, ashes, and equipment. A litter policing program which would cover all roads and sites associated with the ROW would be implemented by the proponent and approved in writing by the AO.

Construction of the pipeline would not inhibit public use of existing roads and trails, or inhibit wildlife or livestock movement. No additional trench would be opened than that which could be successfully backfilled and compacted in a 10 day period. Areas within 0.25 mile of livestock would be fenced, if required.

Clearing and Grading. The staked ROW would be cleared and graded to provide a smooth and even work area to facilitate the safe movement of equipment and personnel. A motor grader with a blade would be used to knock down vegetation, such as sagebrush within as much of the construction ROW as is needed to provide a safe working area. Grading usually requires cutting and/or filling to achieve a more uniform grade for the pipeline, and may include ripping rock close to the surface. Blading may be required to provide a safe and suitable working area in areas of excessively steep hillsides or at approaches to waterbody crossings and at established temporary extra work areas. The top six inches of soil would be salvaged, stockpiled on the side of the ROW, and spread back over the area after final grading.

For more typical but less steep terrain, a minimum of the top six inches of soil, more if the BLM deems necessary, would be stockpiled on the side of the ROW and spread back over the area after the final grading. Spoil and topsoil would be windrowed and separated along the nonworking side of the trench.

Hauling and Stringing. All construction materials would be hauled to the job by truck (80-foot pole trailers), as needed, and strung as it arrives. Pipe would be strung in such a manner as to cause the least interference with the normal use of the land.

Trenching. A wheel trencher would be used to dig an approximate 60-inch wide, 84-inch deep trench, stacking the dirt beside the ditch. In rocky areas or in areas where the pipeline changes direction, an excavator would be used. The ditch would be excavated to a minimum depth adequate to allow for 48 inches of cover on the pipeline. Spoil and topsoil would be windrowed and stockpiled separately along the nonworking side of the trench.

Soft plugs would be constructed and left in the open trench every 0.25 mile to allow for wildlife crossings. These plugs would be removed just prior to lowering the welded pipe into the trench.

Road Crossings. Construction at road and railroad crossings would use heavier-walled pipe to withstand greater external loads. Roads that are not heavily used would be open cut. The open cut roads would be backfilled and compacted in a way that would maintain the integrity of the road. Roads that are more heavily traveled and railroads would be bored to avoid disruption of traffic. Two-track roads or trails which are rarely traveled and do not usually accommodate heavy loads would be crossed by conventional construction techniques.

Bending, Welding, and Coating. A bending machine would be used to bend the pipe to fit the trench and contour of the land. Induction bends (prefabricated bends) would be used for changes in direction greater than 30 degrees.

The pipeline welding crews would align the pipe for welding, and complete the welding of the pipeline above the trench. The welds would be nondestructively tested (x-rayed) to insure the quality of the weld. The pipe string would be temporarily stored on skids until lowered into the trench.

Although the pipe would arrive at the ROW with a corrosion resistant coating, crews would apply additional coating to the weld areas and repair any damage to the factory-applied coating to prevent corrosion.

Lowering In, Padding, & Backfilling. Side booms would be used to lower the pipe into the trench. In rocky areas, the trench would be padded with sand or soil using a padding machine, which separates rocks from satisfactory padding materials.

After the pipe is placed in the trench, a motor grader or caterpillar would be used to push the dirt back into the trench. The fill in the trench would then be tamped into place with the grader wheels, leaving a berm of four inches to accommodate settling. Any excavated material that cannot be placed in the trench would be disposed of in accordance with landowner and agency requirements.

Horizontal Directional Drills. In areas where it is impractical to use conventional construction techniques, or where environmentally sensitive areas exist, a horizontal directional drill (HDD) may be used. This construction technique uses equipment to drill a pilot hole beneath the waterbody crossing or other sensitive area at a depth that maintains minimum coverage requirements. Once the pilot hole has been successfully completed, the hole is enlarged by reaming out the pilot hole in multiple passes with a reamer. After the hole has been enlarged to a diameter large enough to receive the pipeline, a pre-welded and pre-tested section of pipe (coated with abrasion resistant coating), located on the opposite side of the drilling equipment, is pulled back into the bore hole. The annulus around the pipeline would be sealed with bentonite.

RGS is proposing to cross the New Fork River, the Green River and the Blacks Fork River by HDD construction methods. JGGC is proposing to cross the New Fork River and the Green River using HDD. All other waterbodies for both pipelines would be crossed by open-cut methods using conventional trenching techniques, however, they would only be crossed when the streambed is dry.

Fabrication/Tie Ins. The mainline valve assemblies, pig receivers, pig launchers, side taps, and meter stations would be prefabricated off site. In order to keep the construction assembly line moving as efficiently as possible, tie-in crews would be used to complete the final installation of fabricated assemblies.

5.0 HYDROSTATIC TESTING

Pipelines would be pressure tested with water after the trench is backfilled. A pipeline would be filled with water and pressurized to a minimum of 1.1 times the designated operating pressure for 8 hours to verify integrity. Test water would most likely be obtained from the New Fork, Green, and/or Blacks Fork rivers and hauled to the pipeline for testing. Permits or license agreements for the withdrawal would be obtained from the Wyoming State Engineer's Office and the Bureau of Reclamation. Prior to release, the test water would be analyzed and processed, if necessary, to ensure it meets local, state, and federal water quality standards. The test water would be discharged to an upland area. In order to prevent scouring and erosion, test water would be discharged into energy dissipation devices, filter bags, or straw bale dewatering structures, which would be removed upon completion of testing. Hydrostatic test water discharge would be approved in writing by the Wyoming Department of Environmental Quality/Water Quality Division (WDEQ/WQD).

A total of 65.1 acre-feet of water would be necessary for hydrostatic testing of the R6 Pipeline, 45.1 acre-feet for the length of the pipeline and 20 acre-feet for testing of the HDDs and railroad crossing. Approximately 13.4 acre-feet would be withdrawn from the New Fork River; approximately 12.4 acre-feet from the Green River; and approximately 19.3 acre-feet from the Blacks Fork River. An additional 5 acre-feet of water would be used at each HDD crossing (three rivers and one railroad crossing) for a total of 20 acre-feet of water for the HDDs (Table 2).

Table 2
Rendezvous Phase 6 Pipeline Hydrostatic Testing

Source Waterbody	Volume (acre-feet)	Withdrawal Location	Discharge Location
Pipeline Testing			
New Fork River	13.4	SWSE Sec. 11, T. 31 N., R. 109 W.	SWSE Sec. 11, T. 31 N., R. 109 W. NWNW Sec. 4, T. 30 N., R. 108 W. NE Sec. 34, T. 27 N., R. 111 W.
Green River	12.4	NESE Sec. 17, T. 23 N., R. 111 W.	NESE Sec. 17, T. 23 N., R. 111 W. SESE Sec. 21, T. 26 N., R. 111 W.
Blacks Fork River	19.3	SW Sec. 28, T. 19 N., R. 111 W.	SW Sec. 28, T. ;19 N., R. 111 W.
HDD Testing			
New Fork River	5	SWSE Sec. 11, T. 31 N., R. 109 W.	SWSE Sec. 11, T. 31 N., R. 109 W.
Green River	5	NESE Sec. 17, T. 23 N., R. 111 W.	NESE Sec. 17, T. 23 N., R. 111 W.
Blacks Fork River	5	SW Sec. 28, T. 19 N., R. 111 W.	SW Sec. 28, T. 19 N., R. 111 W.
Railroad Testing			
Blacks Fork River	5	SW Sec. 28, T. 19 N., R. 111 W.	SW Sec. 28, T. 19 N., R. 111 W.
Total	**65.1**		

A total of 40.6 acre-feet of water would be required for hydrostatic testing of the PBC and Opal Loop III pipelines. Hydrostatic testing would likely be performed in 7 to 10 mile sections repeated for the length of the pipelines using water from two sources and multiple discharge point locations. Approximately 10.0 acre-feet would be withdrawn from the New Fork River, and approximately 20.6 acre-feet would be withdrawn from the Green River. An additional 5.0 acre-feet of water would be used at each HDD crossing (two rivers) for a total of 10 acre-feet of water (Table 3).

Table 3
Paradise to Bird Canyon and Opal Loop III Pipelines Hydrostatic Testing

Source Waterbody	Volume (acre-feet)	Withdrawal Location	Discharge Location
Pipeline Testing			
New Fork River	10.0	SWSE Sec. 11, T. 31 N., R. 109 W.	SWSE Sec. 11, T. 31 N., R. 109 W. NWNW Sec. 4, T. 30 N., R. 108 W. NE Sec. 34, T. 27 N., R. 111 W.
Green River	20.6	NESE Sec. 17, T. 23 N., R. 111 W.	NESE Sec. 17, T. 23 N., R. 111 W. SESE Sec. 21, T. 26 N., R. 111 W.
HDD Testing			
New Fork River	5	SWSE Sec. 11, T. 31 N., R. 109 W.	SWSE Sec. 11, T. 31 N., R. 109 W.
Green River	5	NESE Sec. 17, T. 23 N., R. 111 W.	NESE Sec. 17, T. 23 N., R. 111 W.
Total	**40.6**		

6.0 SPECIAL CONSTRUCTION TECHNIQUES

General. Pipeline warning signs would be installed at line-of-sight intervals at road crossings to identify the location of the pipeline within the ROW.

Cathodic test stations would be installed at all foreign line crossings, on one side of all road bores, and at intervals of one mile along the pipeline. These stations would be used to test and monitor the corrosion resistance of the pipeline.

Wet Construction. RGS and JGGC would not allow any construction or routine maintenance activities during periods when soil is too wet to adequately support construction equipment. If such equipment creates surface ruts in excess of 4 inches deep, proponents would deem that soil conditions are too wet to adequately support construction equipment. Construction activities would not be allowed until soil conditions improve.

Dust Control. In addition to water withdrawn from rivers for hydrostatic testing, water would be withdrawn from the New Fork, Green, and Blacks Fork rivers for use in dust control during pipeline construction. Construction of the 103.6 mile long R6 Pipeline would require approximately 67.0 acre-feet of water from a combination of New Fork, Green, and Blacks Fork river sources. Construction of the 41.5-mile long PBC Pipeline would require approximately 26.9 acre feet of water from the New Fork and Green rivers. Construction of the 45.5 mile long Opal Loop III Pipeline would require approximately 29.3 acre feet of water from the Green River. Water would be pumped into 80- and 100-barrel tanker trucks/trailers and hauled to the construction sites where the water would be sprayed from the tanks to the ground.

Winter Construction 6 Step Frozen Ground Procedure. Should winter construction be necessary, proponents would:

- remove snow and slightly scalp vegetation with a grader blade and windrow it to one side of the ROW;
- use a wheeled trencher equipped with rock teeth to remove approximately 6 to 8 inches of topsoil by appropriately setting trencher depth (frosted top soil would be broken to smallest density possible; a kick board would be installed on the trencher to distribute topsoil directly down on the ROW near the trench and deter top soil from being thrown too far off ROW; the kick board would enable operator to vary speed for better cultivation of top soil);
- allow trencher to provide for 4 feet of burial and stockpile the soil or spoil to one side;
- install pipe and backfill trench with spoil;
- place stockpiled topsoil in the trench; and
- place the scalped vegetation back on the ROW using a grader.

The BLM would be contacted prior to construction in frozen ground.

7.0 RECLAMATION

Following the completion of hydrostatic testing, the ROW would be restored in accordance with the regulatory agency or landowner requirements. All disturbed areas would be re-contoured so that the disturbed area blends into the surrounding terrain. Topsoil would be evenly spread across the ROW. Appropriate measures would be taken to prevent erosion through the use of construction diversion terraces, rip-rap, matting/erosion control fabric, mulch, and/or water bars.

All disturbed areas would be reseeded. Seed would be planted using a drill and in areas not suitable for drilling, the seed would be broadcasted. The seed would be raked or chained to cover the seed. The application rate and seed mixture would comply with landowner or agency specifications. The proposed upland seed mix is provided in Table 4.

Table 4
Upland Seed Mix and Application Rates

Species/Variety	Drill Seeding Rate lbs/acre PLS[1]
Western Wheatgrass/Rosanna	4
Thickspike Wheatgrass/Critana	4
Indian Ricegrass	4
Bitterbrush	1
Scarlet Globe mallow	1
Winterfat	2
Fourwing Saltbush	1
Total	**17**

[1] PLS=pure live seed. Formula: % of purity of seed mixture times % germination of seed mixture=portion of seed mixture that is PLS.

If herbicides are required following construction, proponents would comply with all applicable federal and state laws. Herbicides would be used in accordance with registered uses and within limitations imposed by the Secretary of Interior. Before using herbicides (including emergency situations), proponents would obtain, from the AO, written approval of a plan showing the type and quantity of material used, weed(s) to be controlled, method of application, location of storage, disposal of containers, and any other information deemed necessary.

Proponents would be responsible for weed control on the disturbed areas within the established limits of the ROW. Proponents would coordinate with the AO, or local authorities, to obtain acceptable weed control methods for the disturbed areas within the ROW.

8.0 OPERATION AND MAINTENANCE

Proponents would conduct all activities associated with the operation and maintenance of the pipeline within the authorized limits of the ROW. The pipeline would be routinely patrolled and inspected by foot and/or vehicle to check for problems such as erosion, ROW condition, unauthorized encroachment, and any other situation that could cause a safety hazard or require preventive maintenance. If damage should occur to the pipe from external sources, repair or replacement of the portion of the pipeline could be necessary. Detailed line break and emergency procedures would be used by proponents as routine operational procedures. All permanent aboveground facilities, including piping and valving, would be painted a flat, non-contrasting color harmonious with the surrounding landscape (Carlsbad Canyon (2.5Y 6/2) or as identified by the AO).

Proponents would remain responsible for weed control within the established limits of the ROW. Proponents would coordinate with the AO to develop acceptable weed control methods for implementation, as needed. Prior to use of herbicides, including use in emergency situations, proponents would obtain written approval of a plan, detailing the type and quantity of herbicide to be used, weed to be controlled, method of application, location of storage, disposal of containers, and any other information deemed necessary by the AO. Proponents would comply with all applicable federal and state laws regarding the use of herbicides. Herbicides would be used in accordance with registered uses and within limitations imposed by the appropriate regulatory authority.

9.0 ABANDONMENT

Prior to cessation of pipeline operations, proponents would obtain necessary authorization to abandon the facilities. All aboveground pipeline facilities would be removed and all unsalvageable materials would be disposed of at authorized sites. Regrading, reclamation, and revegetation of disturbed areas (if applicable) would be completed as necessary.

10.0 ENVIRONMENTAL PROTECTION MEASURES

Hazardous Materials. No toxic substances are proposed for use in connection with the construction project; however if toxic substances are required, usage shall conform with provisions of the Toxic Substances Control Act of 1976, as amended (40 CFR Part 702-799). Any release of toxic substances (leaks, spills, etc.) in excess of the reportable quantity as established by 40 CFR Part 117.3 shall be reported as required by the Comprehensive Environmental Response, Compensation, and Liability Act, Section 102 B. A copy of any requested report required by any Federal or State agency of a reportable release or spill of any hazardous material shall be furnished to the AO within 5 working days of the occurrence of the spill or release.

The holder(s) shall comply with all applicable Federal laws and regulations existing or hereafter enacted or promulgated. In any event, the holder(s) shall comply with the Toxic Substances Control Act of 1976, as amended (15 U.S.C. 2601, et seq.) with regard to any toxic substances that are used, generated by or stored on the ROW or on facilities authorized under this ROW grant.(See 40 CFR, Part 702-799 and especially, provisions on polychlorinated biphenyls, 40 CFR 761.1-761.193.) Additionally, any release of toxic substances (leaks, spills, etc.) in excess of the reportable quantity established by 40 CFR, Part 117 shall be reported as required by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, Section 102b. A copy of any report required or requested by any Federal agency or State government as a result of a reportable release or spill of any toxic substances shall be furnished to the AO concurrent with the filing of the reports to the involved federal agency or state government.

A proponent, the applicant for the proposed ROW grant, agrees to indemnify the United States against any liability arising from the release of any hazardous substance or hazardous waste (as these terms are defined in the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. 9601, et seq. or the Resource Conservation and Recovery Act of 1976, 42 U.S.C.6901 et seq.) on the ROW (unless the release or threatened release is wholly unrelated to the ROW holder's activity on the ROW. This agreement applied without regard to whether a release is caused by a proponent, its agent, or unrelated third parties.

Survey Monuments. Proponents would protect all survey monuments, witness corners, reference monuments, and bearing trees within the ROW against disturbance during construction, operation, maintenance, and rehabilitation. If any monument, corner, or accessory is destroyed, obliterated, or damaged, proponents would arrange for a registered land surveyor to restore the disturbed monument, corner, or accessory using surveying procedures specified in the *Manual of Surveying Instruction for the Survey of Public Lands of the United States,* 1973 edition. Proponents would record the survey in the appropriate BLM office.

Fire Control. Proponents would notify the AO of any fires during construction and would comply with all rules and regulations administered by the AO concerning the use, prevention, and suppression of fires on federal lands.

In the event of a fire, proponents or their contractors would initiate fire suppression actions in the work area. Suppression would continue until the fire is out or until the crew is relieved by an authorized representative of the agency on whose land the fire occurred. Heavy equipment would not be used for fire suppression outside the ROW without prior approval of the AO unless there is imminent danger to life or property. Proponents or their contractors would be responsible for all costs associated with the suppression of fires and the rehabilitation of fire damage resulting from their operations, employees, or contractors.

Proponents would designate a representative to be in charge of fire control during pipeline construction. The fire representative would ensure that each construction crew has fire fighting tools and equipment, such as extinguishers, shovels, and axes available at all times. The number of tools needed would depend on the number of persons working in the area. Proponents would, at all times during construction, maintenance, and operations, require that satisfactory spark arresters be maintained on internal combustion engines.

Cultural Resources. Proponents and contractors would inform their employees about relevant federal regulations protecting cultural resources. If any cultural remains, monument sites, objects, or antiquities subject to the Antiquities Act of June 8, 1906 or the Archaeological Resources Protection Act of 1979 are discovered during construction, activities shall immediately cease and the responsible AO would be notified.

An open trench inspection would be conducted on the pipeline. Previously unknown or unanticipated resources found during this activity would be recorded, tested, and evaluated in consultation with the Wyoming State Preservation Office.

Proponents would comply with all BLM and State Historic Preservation Office (SHPO) recommendations for crossings of Historic Trails. Trails would be crossed in areas of existing disturbance and no new disturbance would occur in undisturbed portions of trails. Historic Trail segments would not be used by proponents or their contractors to access the pipeline ROW.

Direct impacts to the Sublette Cutoff, the East Bank Kinney Cutoff, and the Baker Davis Road/Slate Creek Cutoff would be prohibited. The areas where these trails are crossed by the proposed pipelines would be fenced so as to prohibit construction damage to existing trail ruts. All fences would extend a minimum of 50 feet from each side of a trail center point for a total of 100 feet. The position of the fence would be determined by a permitted archaeologist. The trails would be bored from outside of the fenced areas. This approach to trail crossing would eliminate new impacts to historic trail ruts.

All surface disturbing activity within 200 feet of the Sublette Cutoff, the East Bank Kinney Cutoff, and the Baker Davis Road/Slate Creek Cutoff would be monitored by an archaeologist who meets or exceeds the qualification standards recommended by the Secretary of the Interior.

The proposed crossing of the Oregon Trail and the second crossing of the Oregon Trail/Pony Express Route by the BFGC and R6 pipelines is contained within previous disturbance. These historic trails are crossed by existing pipelines and the proposed corridor in an area previously determined non-contributing to the overall eligibility of the sites. Construction would be contained within the existing disturbance.

Paleontological Resources. Proponents of pipelines would support a BLM-approved paleontologist's review, evaluation, and possible monitoring of potential paleontological resources for a proposed pipeline ROW. The paleontologist would conduct a literature search for information pertinent to the proposed pipeline ROW, complete a pre-construction survey of the proposed ROW where previous surveys have not been completed, collect surface fossil specimens if deemed necessary, and make recommendations for mitigation, including monitoring if necessary, of potential impacts from construction.

If paleontological resources are uncovered during construction activities, proponents or their contractors would suspend all operations to prevent further disturbance of such materials and would immediately contact the BLM's AO, who would arrange for a determination of significance and, if necessary, recommend a recovery or avoidance plan. Mitigation of paleontological resources would occur on a case-by-case basis, and proponents would be responsible for the costs. Proponents would abide by the mitigation plan approved by the BLM.

Wildlife. Proponents would comply with the following guidelines concerning avoidance of raptor nests, greater sage-grouse leks and nesting areas.

Raptors. Where feasible, pipeline ROWs and temporary extra work areas would be selected and designed to avoid disturbance to raptor nests. If construction activities are to occur between February 1 and July 31, surveys for raptor nests within 0.5 to 1.0 mile of the proposed pipeline route would be conducted, to determine nest occupancy. All construction activities would be restricted between February 1 and July 31 within a 0.5-mile radius of all occupied raptor nests, except ferruginous hawk and bald eagle nests, for which the seasonal buffer would be 1.0 mile. Surface structures requiring repeated human presence would not be constructed within 825 feet (2,000 feet for bald eagles) of active raptor nests, where practical. An active raptor nest is defined as a nest that has been occupied within the past 3 years.

Greater Sage- Grouse. Surface disturbance within 0.25 mile of greater sage-grouse leks would be avoided. If construction activities are planned in potential greater sage-grouse nesting habitat (i.e., areas within 2 miles of an active lek) between March 1 and July 31, BLM wildlife biologists would conduct field evaluations to identify active nests or leks. If an active greater sage-grouse nest is identified in an area proposed for disturbance, construction activities would be delayed until nesting is complete and the young are fledged.

Special Status Animals and Plants. The BLM would conduct U.S. Fish and Wildlife Service (FWS) consultation and coordination, as necessary, for all mitigation activities relating to threatened or endangered (T&E), candidate species, proposed species, and their habitats. In areas that have not been previously surveyed or cleared for these species, a qualified biologist/botanist would conduct surveys for these species in areas of potential habitat prior to disturbance. If T&E, candidate, or proposed species are found, consultation with the FWS would be initiated, as necessary, and construction activities would be curtailed until the BLM, FWS, and proponents concur on which activities can be authorized.

Proponents would conduct site-specific surveys for sensitive plants on uncleared areas as directed by the BLM.

APPENDIX E

Performance Based Objectives

Performance Based Objectives

Development under Alternative C has been designed to confine year-round development to specific areas of the PAPA, while stabilizing development sites, reclaiming disturbance, and reducing human presence to the maximum extent possible through the use of BMP's and the following Performance Based Objectives.

These objectives are provided to mitigate impacts associated with development under Alternative C. For each objective, the performance, or outcome, is the basis for judging the effectiveness the measures. If the outcome is achieved, then the objective is met.

Performance based objectives have been adopted to provide BLM greater flexibility in protection of physical, environmental, and cultural resources. Successful application of performance or outcome-based resource management objectives require implementation of adaptive management principles, specifically requiring implementation of monitoring and subsequent evaluation to determine whether or not the requirements and/or standards (or use of new techniques and/or practices) have been applied and whether the desired objective has been achieved in a timely and efficient manner.

Best Management Practices from *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* - a joint effort by the United States Department of the Interior and United States Department of Agriculture (2006) also known as the Gold Book – would be attached to APD's, where applicable.

Planning Process. The objectives and operating standards identified in the following sections would be presented, reviewed, and implemented in the following steps:

- **Perform Preapplication Consultation.** The Operators would present preliminary plans to BLM on about January 1 of each year for activities that would occur during the following field season. During the preapplication consultation, the Operators would be informed of BLM procedures and operating requirements, including any other federal, state, or local permit requirements so that inadequacies and deficiencies in the verbal proposal can be addressed with the submittal of the application. The BLM, the Operators, and other affected parties may visit the proposed site to identify unknown issues during the preapplication consultation.

- **Evaluate Application.** BLM would review the proposal to:

    - Determine if the proposal complies with the Outcome and Operating Standards; this may be accomplished by adhering to the recommended requirements/standards or by the use of new techniques/practices that meet the objective(s).
    - Based on additional analysis (e.g., environmental assessment - EA, or environmental impact statement - EIS), identify any new mitigation that may be required based on site and project specific information, including new issues identified throughout this process.
    - Identify appropriate monitoring levels to determine the effectiveness of the mitigation.

- **Review Written Application for Completeness.** Operators and BLM would meet again about March 1 to finalize plans for implementation. Based upon an initial review of the written application, additional information may be requested, or the application may be rejected. At this time, Operators would present annual reports (from November 15 to November 15 of the following year). The March 1 implementation plan would incorporate any conclusions from the annual report.

- **Issue Authorization**. BLM would issue authorizations with appropriate terms and conditions of approval identified or attached.

Outcomes and operating standards are requirements, procedures, management practices, or design features that the BLM, through the Record of Decision (ROD), could adopt as operational requirements. These requirements would be addressed through the permitting process. Seismic operations, well pad construction, drilling, pipeline construction, and other development activities require land use authorizations in addition to the oil and gas lease, which does not authorize subsequent surface disturbing activity as described above. Any applicant requesting such authorization must address the outcomes and operating standards either before submitting the application or as part of the application proposal. Requirements that are met before submission of the application, as well as procedures, practices, and design features that are an integral part of a proposal, do not need to be stipulated in a permit or lease. Because mitigating operating standards would be identified in the ROD as operational requirements and not a general lease stipulation, their applicability goes beyond the oil and gas lease to any permitted activity where the requirement is relevant.

Outcomes Related to Full Wellfield Development and Production.

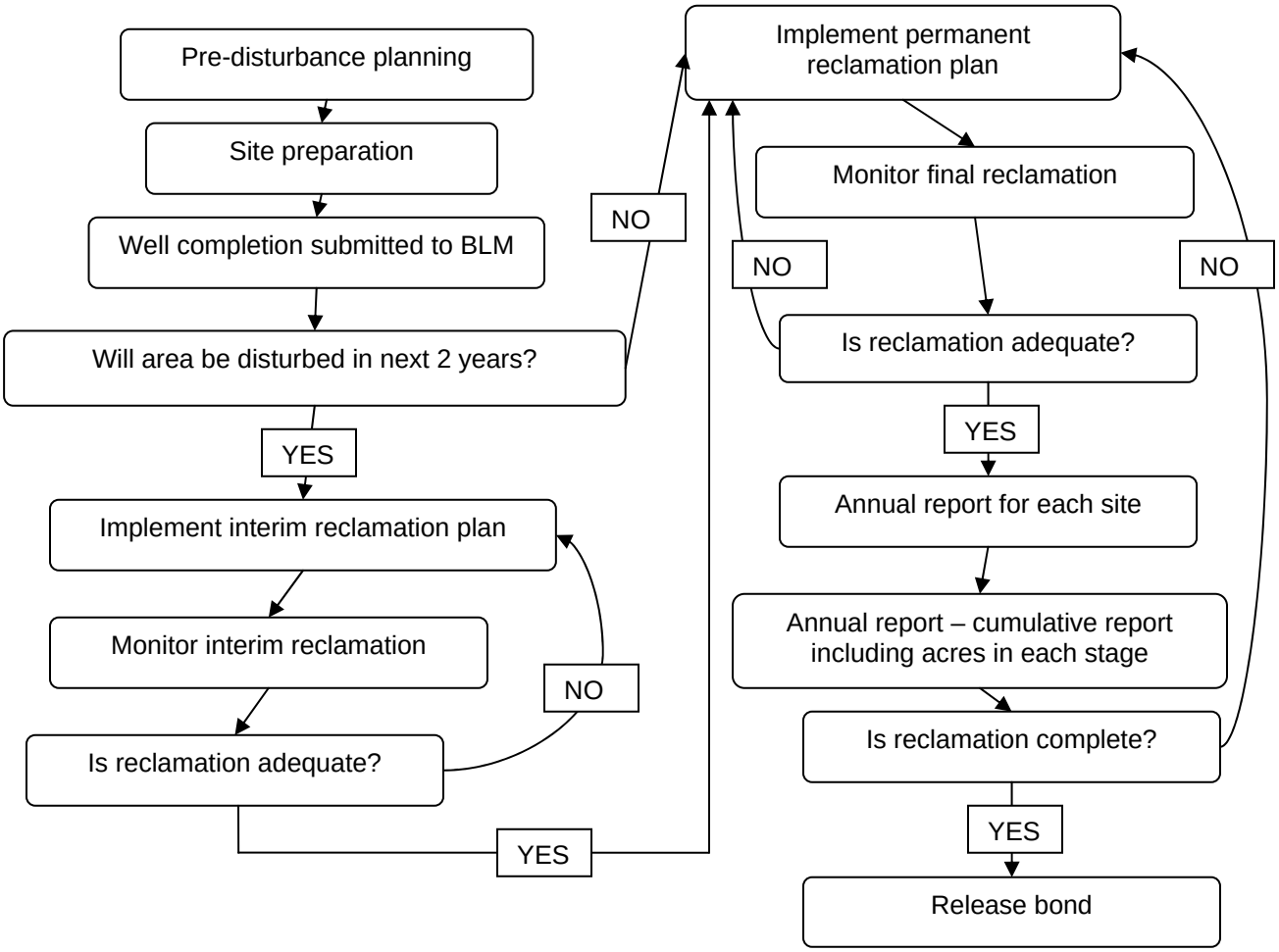
All past and present development has proceeded under authority of the PAPA ROD. Implementation of Alternative C would require integrating new wellfield components and other permitted actions with existing wellfield disturbances. For example, BLM would issue APDs for new wells, some of which would be on existing well pads and some, if not all, existing well pads would have to be expanded. Some well pads would have to be expanded by 21 or more acres, to accommodate additional wells. Expansion of existing well pads is an actions permitted by BLM. Consequently, BLM has authority to require the Operators to increase mitigation over the measures in Appendix A of the PAPA ROD that may or may not have been explicitly attached to permits as conditions of approval.

Planning

Submit a Plan of Development within each Development Area that has been designated by BLM for year-round drilling. The plan would address Operator(s) actions for the annual cycle beginning (May or April or June) 2007 following authorization by BLM in the SEIS ROD. A new plan would be submitted in May each year thereafter until the Operator(s) lease has been fully developed. The plan would indicate which pads within the Operators' leases would be drilled and which pads would not be drilled during the upcoming annual cycle. The plan would clearly indicate locations of new access roads and pipelines.

Operators would fully develop each existing and/or new well pad within a Development Area that has been designated by BLM for year-round drilling during a single, continuous time span for as long as necessary to drill and complete all wells on the pad. Once an Operator has determined that a pad has been fully developed, Operator(s) would not reinitiate development on the pad.

Performance Based Objectives specific to Reclamation and Monitoring described in items 1 through 26, below, follow the general sequence in the following schematic diagram:



Temporary Site Stabilization

Achieving these objectives would, in part, mitigate impact to Land Use/Land Cover, Recreation Resources, Visual Resources, Surface Water, Soil Resources, Vegetation Resources, Grazing Resources, Riparian Resources, Threatened and Endangered Species and Special Status Species, and Wildlife and Aquatic Resources.

1. On existing well pads that would not be fully developed within the upcoming annual cycle, all bare ground would have at least a 75 percent protective cover that may include but not be limited to organic mulch, herbaceous vegetation, jute matting, or other erosion-preventative fabric. Protective cover may be excluded on active work sites (up to the wellhead with production equipment) if justified by the Operator and with concurrence of BLM.

2. During the period when an existing well pad is not being fully developed, there would be no runoff of water or sediment from the existing pad. Operators would modify all existing well

pads to achieve zero sediment discharge for a 25-year storm or snowmelt event within 1 year of following authorization by BLM in the SEIS ROD.

3. During the period when an existing well pad is not being fully developed, the well pad would be vegetated prior to the first winter after the ROD to achieve at least 50 percent vegetative cover of desirable herbaceous species by the following spring.

4. If an existing well pad would not be fully developed in 2 or more years after the ROD, desirable vegetation growth on the well pad would be at least 80 percent cover within three growing seasons.

5. Reserve pits on existing pads that would not be fully developed in 2 or more years after the ROD would be reclaimed prior to the first winter after the ROD.

6. Access road(s) leading to the temporarily stabilized well pad would be revegetated to the same levels required on the well pad.

7. Vehicular access on the revegetated road(s) would be on two-tracks established during road revegetation. Two-track access would be sufficient for use by only one vehicle at a time.

8. Pipeline corridor(s) leading to the temporarily stabilized well pad would be revegetated immediately after construction.

9. Vehicular access on the reclaimed, revegetated pipeline corridors would be on two-tracks only if there is no adjacent road. No vehicular access would be allowed along reclaimed, revegetated pipeline corridors. Two-track access, if allowed, would be sufficient for use by only one vehicle at a time.

Full Site Reclamation

Achieving these objectives would, in part, mitigate impact to Land Use/Land Cover, Recreation Resources, Visual Resources, Surface Water, Soil Resources, Vegetation Resources, Grazing Resources, Riparian Resources, Threatened and Endangered Species and Special Status Species, and Wildlife and Aquatic Resources.

10. Once a well pad has been fully developed, full site restoration and reclamation would begin as soon as the ground is not frozen and would be completed before the onset of winter.

11. Full site restoration would require re-grading the pad to conform to the original contours.

12. Full site restoration would require redistributing the original topsoil or transfer and distribution of topsoil from a newly cleared well pad in the same geographic area with similar slope and soil characteristics.

13. Full site restoration would require protection of vegetation until herbivory by wildlife and livestock can be sustained.

14. Access road(s) leading to the fully restored well pad would be reclaimed to conform to the original corridor contours.

15. Access road(s) leading to the fully restored well pad would be revegetated to the same levels required on fully reclaimed well pads.

16. Vehicular access on the reclaimed, revegetated road(s) would be on two-tracks established during road revegetation. Two-track access would be sufficient for use by only one vehicle at a time.

17. Pipeline corridor(s) leading from the fully restored well pad would be reclaimed to conform to the original corridor contours.

18. Pipeline corridor(s) leading from the fully restored well pad would be revegetated to the same levels required on fully reclaimed well pads.

19. Vehicular access on the reclaimed, revegetated pipeline corridors would be on two-tracks only if there is no adjacent road. No vehicular access would be allowed along reclaimed, revegetated pipeline corridors. Two-track access, if allowed, would be sufficient for use by only one vehicle at a time.

Reclamation Monitoring

Monitoring Responsibilities

20. It is the responsibility of the Operator to monitor reclaimed areas, determine if reclamation criteria are being met, develop and implement remedial actions if success standards are not being met, provide resulting data to the BLM annually, and request concurrence from BLM that success standards have been met and monitoring is no longer required.

21. It is the responsibility of the BLM to evaluate the annual monitoring reports, provide concurrence (or not) with the reclamation assessments as to whether or not success standards are being met and the rationale for the determination.

22. It is the responsibility of the BLM to provide Operators with remedial actions when reclamation success criteria are not being met. The remedial actions may include such things as soil testing, soil amendments, irrigation, and seeding.

Monitoring Methods

23. Monitoring methods provide the basis for consistent, uniform, and standard vegetation attribute sampling that is economical, repeatable, statistically reliable, and technically adequate. Vegetative monitoring would be conducted using BLM approved monitoring methods. The following guidelines would be used to determine if the site has met final reclamation criteria. Specific guidelines can be found at the BLM Library Sampling Vegetation Attributes, Interagency Technical Reference 1734-4, 1996 http://www.blm.gov/nstc/library/techref.htm

    a. Location of data collection:
        i. A sample representation of the vegetative population would be used to collect the vegetative data on the reclamation and reference sites.
        ii. The reference site location would represent the ecological characteristics described in the reclamation criteria.

iii. The sites would be permanently marked with a GPS unit for accuracy of future analysis. Precise locations of the site would be noted on a detailed map or aerial photo. The exact location of the study site and the directions for relocating it would also be noted.
iv. See Sampling Vegetation Attributes, Study Design and Analysis for statistical considerations to be used.

b. Timing of data collection.
   i. If at all possible, baseline data should be collected prior to disturbance.
   ii. Monitoring will occur during the growing season post seeding to determine if seeds have germinated. It is crucial to understand if a viable seed source exists on the reclamation site. If seeds germinate but seedlings do not survive due to weather conditions, the site must be reseeded.
   iii. Monitoring may require multiple visits to a site within a given year to capture presence of species (especially forbs) that grow at various times during the growing season. In general, most plants are at their peak in June.

24. Data Collection Methods: For accuracy and time effectiveness, systematic sampling would be used to decrease personal bias. A standard procedure would be identified and used in all data collection methods.

    a. Ground cover and species composition would be evaluated using line-point intercept by plant species method. At a minimum, 200 data points should be collected on each site.
    b. Line-point intercept techniques result in smaller non-sampling errors than the use of quadrants.
    c. Nested Frequency Quadrants would be used to measure frequency. At a minimum, 200 frame plots on each site should be used to calculate data.
    d. The density method as described in Sampling Vegetation Attributes Interagency Technical Reference would be used to measure density. At a minimum, 200 frame plots on each site should be used to calculate data.
    e. Production measurements would be made using the double sampling method. Data should be collected from a minimum of 20 plots on each site.
    f. To measure erosion control, a soil surface factor of 1 to 20 percent must be achieved.

25. Photo Points. Permanent photo points would be established on both the pre-disturbed site and the reference site. Photo points should be permanently marked with a GPS. Photos should be taken yearly (preferably in June) as close to the same time of year previous photos were taken to reduce difference in plant growth characteristics.

    a. Close-up pictures show the soil surface characteristics and the amount of ground surface covered by vegetation and litter. Close-ups would be taken at permanently located photo plots. A 1-meter x 1-meter photo plot is recommended.
    b. General view pictures present a broad view of a site. Pictures depicting north, south, east, and west would also be established and monitored.

26. Stages of reclamation. After evaluating the monitoring data, each site would be categorized into one of four stages to determine landscape trends and reclamation status of the PAPA.

    a. Contouring, soil preparation, seeding (may be different between grasses and forbs/shrubs)

b. Preliminary evaluation in 1 to 3 years – some criteria could be developed to aid in determining whether or not the seeding is successful so a determination can be made as to whether or not to reseed.
c. Criteria met or not met – identification of potential plant community in early successional stage that is specific to range site (number of shrubs and forbs important here).
d. Final Reclamation and bond release – similar composition as above but with greater structure and shrub abundance.

Limitation of Human Presence

27. During the period when an existing well pad is not being fully developed and is subject to temporary site stabilization measures, all existing producing wells on the pad would be connected to the Operator's liquid gathering system.

28. During the period when an existing well pad is not being fully developed and is subject to Temporary Site Stabilization measures, all existing producing wells on the pad would be connected to the Operators' remote telemetry monitoring system to track wellhead production information and downtime alarms from wells.

29. Operators would minimize traffic to the maximum extent possible:

30. Operators would require all well maintenance personnel to maintain a daily travel log of visits to each production well for 1 year following installation of the liquids gathering system and remote telemetry monitoring system for all producing wells on each existing well pad. The logs would be submitted to BLM at the end of the 1-year period along with a summary account of recorded visits.

31. Motor vehicle traffic in Operators' leaseholds would be limited to BLM approved roads and trails during all times of year.

32. Operators would limit all noise associated with production activities to less than 10 decibels above background noise levels, measured 250 feet from the outer edge of each well pad.

33. Operators would utilize flareless completions for all wells within their leasehold unless proven on a case-by-case basis that flareless completions would be unsafe.

34. Operators would require all vehicles used, including those of all sub-contractors and vendors, to have fully functional hospital-grade mufflers.

35. Operators would remove all unnecessary aboveground structures from well pads, principally liquids storage tanks, within 3 months after installing liquids gathering systems.

Citation

United States Department of the Interior and United States Department of Agriculture. 2006. Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development. BLM/WO/ST-06/021+3071. Bureau of Land Management. Denver, Colorado. 84 pp.

APPENDIX F

Comparison of Impact for all Alternatives

Table 1
Comparison of Impacts for all Alternatives

Resource	No Action 2011	Proposed Action 2011	Alternative C 2011	Proposed Action 2023	Alternative C 2023
Environmental Justice					
Susceptible Populations	No impact to minority populations, low income populations, or Indian Tribes	No impact - similar to No Action 2011	No impact - similar to No Action	No impact - similar to No Action	No impact - similar to No Action
Socioeconomic Resources					
Workforce	Locally hired workers are 40% of drilling crew, 100% of production crew. Drilling crew averages 4,317 local workers from 2007-2011. All local production crew averages 1,333 workers from 2007-2011	Impact similar to No Action but local drilling workers averaging 5,507 from 2007-2011. All local production crew averages 1,640 workers from 2007-2011	Impact similar to the Proposed Action 2011	Impact similar to Proposed Action 2011 with local drilling workers averaging 4,388 from 2007-2025. All-local production crew averages 1,038 workers from 2007-2025	Impact similar to Proposed Action 2023.
Housing	Locally hired drilling and production workers exert pressure on a tight temporary and permanent housing market	Impact similar to No Action	Impact similar to No Action	Over the medium-term time horizon 2007-2025, it is likely that the market would accommodate ongoing demand pressure for temporary housing	Impact similar to Proposed Action 2023.
Population	Population estimate for Lincoln, Sublette, and Sweetwater County in 2011 is 63,728	No impact - similar to No Action	No impact - similar to No Action	Population estimate for Lincoln, Sublette, and Sweetwater County in 2020 is 68,413	No impact - similar to Proposed Action 2023
Local Demands	Local infrastructure, services, and facilities demand being met	Impact similar to No Action	Impact similar to No Action	Impact similar to No Action	Impact similar to No Action
Economic Benefit	Direct, indirect, and induced economic benefits from drilling total $5,535,861 per well	Impact similar to No Action	Impact similar to No Action	Impact similar to No Action	Impact similar to No Action
	The net present value of earnings from drilling, 2007-2011, is $2,275,127,060	The net present value of earnings from drilling, 2007-2011, is $2,890,368,935	Impact similar to Proposed Action 2011	The net present value of earnings from drilling, 2007-2025, is $6,393,270,699	Impact similar to Proposed Action 2023
	Direct, indirect, and induced economic benefits from production total $651,327.50 per well	Impact similar to No Action 2011	Impact similar to No Action	Impact similar to No Action	Impact similar to No Action
Mineral Royalties	The net present value of the federal mineral royalties from the PAPA, 2007-2011, is $1,217,144,300	The net present value of the federal mineral royalties from the PAPA, 2007-2011, is $1,483,924,440	Impact similar to Proposed Action 2011	The net present value of federal mineral royalties from the PAPA, 2007-2025, is $4,115,473,668	Impact similar to Proposed Action 2023
Ad Valorem Tax	The net present value of the distribution of Ad Valorem Tax to Sublette County, 2007-2011, is $778,972,352	The net present value of the distribution of Ad Valorem Tax to Sublette County, 2007-2011, is $949,711,642	Impact similar to Proposed Action 2011	The net present value of the distribution of Ad Valorem Tax to Sublette County, 2007-2025, is $2,633,903,147	Impact similar to Proposed Action 2023
Transportation					
Road Construction	More vehicles on the PAPA due to increased construction of ≈108 miles of new road	Impact similar to No Action 2011 but fewer new roads constructed (≈89 miles)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but more new roads constructed (≈121 miles).	Impact similar to Proposed Action 2023
Summer Traffic	Increased wellfield traffic during summer	Impact similar to No Action 2011	Impact similar to Proposed Action 2011	Impact similar to No Action 2011	Impact similar to Proposed Action 2023
Winter Traffic	Increased wellfield traffic during winter with limited installation of liquid gathering system	Production related winter traffic less than the No Action (because of liquid gathering system) but drilling-related traffic more than the No Action in CDAs 1, 2 and 3	Impact similar to Proposed Action 2011 but drilling related traffic more than No Action in DAs 1, 2 and 4	Production related winter traffic less than the No Action (because of liquids gathering system) but drilling related traffic may or may not be more than the No Action in CDAs 1, 2 and 3	Impact similar to Proposed Action 2023 but drilling related traffic may or may not be more than the No Action in DAs 1, 3 and 4
Road Maintenance	Increased arterial road maintenance cost to WDOT due to increased traffic volumes	Impact similar to No Action 2011	Impact similar to Proposed Action 2011	Impact similar to No Action 2011	Impact similar to Proposed Action 2023
Vehicular Accidents	Increased vehicular accident rates due to increased traffic volumes	Impact similar to No Action 2011	Impact similar to Proposed Action 2011	Impact similar to No Action 2011	Impact similar to Proposed Action 2023
Land Use and Residential Areas					
Existing Land Use Categories	Change of existing land use categories to a predominant industrial landscape by ≈4,500 acres of additional surface disturbance	Impact similar to No Action but increased to ≈6,850 acres of new surface disturbance	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased to ≈12,270 acres of new surface disturbance	Impact similar to Proposed Action 2023
Sublette County Resource Conservation Zoning District	New surface disturbance of ≈3,550 acres in conflict with Sublette County Resource Conservation Zoning District	Impact similar to No Action but increased to 5,540 to 5,700 acres of new surface disturbance in County Resource Conservation Zoning District.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased to 9,800 to 10,000 acres of new surface disturbance in County Resource Conservation Zoning District.	Impact similar to Proposed Action 2023
Residential SRMZ	No new wellfield development conflicting with any Sublette County residential zoning districts but ≈50 acres disturbed within 0.25-mile residential buffer and ≈100 acres disturbed within the Residential SRMZ	No new wellfield development conflicting with any Sublette County residential zoning districts but 100 to 180 acres disturbed within 0.25-mile residential buffer and 150 to 230 acres disturbed within the Residential SRMZ	Impact similar to Proposed Action 2011	No new wellfield development conflicting with any Sublette County residential zoning districts but 200 to 250 acres disturbed within 0.25-mile residential buffer and 250 to 300 acres disturbed within the Residential SRMZ	Impact similar to Proposed Action 2023

Resource	No Action 2011	Proposed Action 2011	Alternative C 2011	Proposed Action 2023	Alternative C 2023
Recreation Resources					
Dispersed Recreation	Decreased recreational use of three OHV areas in PAPA by ≈3,800 acres of additional surface disturbance	Impact similar to No Action but increased by 5,900 to 6,100 acres of new surface disturbance in OHV areas in PAPA	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased by 10,500 to 10,800 acres of new surface disturbance in ORV areas on PAPA.	Impact similar to Proposed Action 2023
	Decreased hunting opportunities in PAPA with decreased abundance of big game and upland game birds from increased density of wellfield development and ≈4,500 acres of new surface disturbance	Impact similar to No Action but increased by ≈6,850 acres of new surface disturbance.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased by ≈12,270 acres of new surface disturbance	Impact similar to Proposed Action 2023
Visual Resources					
Visual Resource Management Classes	Wellfield development becomes a locally dominant feature in VRM II class with ≈260 acres of new surface disturbance	Impact similar to No Action but increased by 285 to 340 acres of new surface disturbance in VRM II class.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased by 740 to 860 acres of new surface disturbance in VRM Class II.	Impact similar to Proposed Action 2023
	Wellfield development becomes a locally dominant feature in VRM III class with ≈960 acres of new surface disturbance.	Impact similar to No Action but increased by 1,075 to 1,250 acres of new surface disturbance in VRM III class.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased by 1,960 to 2,200 acres of new surface disturbance in VRM Class III.	Impact similar to Proposed Action 2023
Sensitive Viewshed SRMZ	Local industrialized appearance in the Sensitive Viewshed SRMZ with ≈300 acres of new surface disturbance	Impact similar to No Action but increased by 200 to 250 acres of new surface disturbance in the Sensitive Viewshed SRMZ.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011but increased by ≈ 900 to 1,000 acres of new surface disturbance in the Sensitive Viewshed SRMZ.	Impact similar to Proposed Action 2023
Cultural Resources					
Unexpected Discoveries	Destruction and/or unexpected discoveries of archaeological resources by 4,485 acres of new surface disturbance in the PAPA	Impact similar to No Action by ≈6,850 acres of new surface disturbance	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased by ≈12,300 acres of new surface disturbance	Impact similar to Proposed Action 2023
	Increased disturbance to areas with high potential for major finds (sandy bluffs north of New Fork River, not in Mesa Breaks)	Increased disturbance to areas with high potential for major finds (sandy bluffs north of New Fork River and Mesa Breaks)	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011	Impact similar to Proposed Action 2023
	No new surface disturbance in frozen soils and with limited or no destruction of archaeological resources	Potential destruction of archaeological resources from new surface disturbance in frozen soils	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased by more surface disturbance	Impact similar to Proposed Action 2023
Lander Trail	Potential surface disturbances (≈23 acres) in the 0.25-mile buffer of the Lander Trail	Impact similar to No Action but increased by potential surface disturbances (≈65 to 75 acres) in the 0.25-mile buffer of the Lander Trail	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased by potential surface disturbance (≈120 to 215 acres) in the 0.25-mile buffer of the Lander Trail	Impact similar to Proposed Action 2023
	Decreased visual integrity within the Lander Trail SRMZ by 520 acres of surface disturbance	Impact similar to No Action but increased by potential surface disturbance (700 to 800 acres) within the Lander Trail SRMZ	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased by potential surface disturbance (1,580 to 1,670 acres) within the Lander Trail SRMZ	Impact similar to Proposed Action 2023
Air Quality see Table 2					
Noise					
Noise-Sensitive Sites	Drilling and completion at some of the 1,139 new wells would increase noise above 10 dBA at noise-sensitive sites (residences, greater sage-grouse leks).up to 2,800 feet away	Impact similar to No Action by some of the 1,453 new wells drilled and completed	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 by some of the 4,399 new wells drilled and completed	Impact similar to Proposed Action 2023
Geology and Geologic Hazards					
High Erosion Potential	Increased erosion and slope instability by disturbance to soils on slopes ≥ 15% with high erosion potential ≈180 acres and disturbance of ≈540 to soils with high erosion potential	Impact similar to No Action with increased surface disturbance in 400 to 450 acres on slopes ≥ 15% and increased surface disturbance in 730 to 980 acres of soils with high erosion potential	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance in 700 to 750 acres on slopes ≥ 15% and increased surface disturbance in 1,400 to 1,500 acres of soils with high erosion potential	Impact similar to Proposed Action 2023
Mineral Depletion	Depletion of the natural gas resource by drilling 1,139 new wells	Impact similar to No Action with 1,453 new wells drilled	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with 4,399 new wells drilled	Impact similar to Proposed Action 2023
Paleontological Resources					
Blue Rim Area	Loss, damage, or destruction of fossils in the Blue Rim Area by additional surface disturbance of ≈540 acres	Impact similar to No Action with additional surface disturbance in the Blue Rim Area of 730 to 980 acres	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with additional surface disturbances in the Blue Rim Area of 1,400 to 1,500 acres	Impact similar to Proposed Action 2023

Resource	No Action 2011	Proposed Action 2011	Alternative C 2011	Proposed Action 2023	Alternative C 2023
Groundwater Resources					
Aquifer Depletion	Removal of 2,280 acre-feet of water to drill 1,139 wells could lead to temporary depletion of the Wasatch aquifer.	Impact similar to No Action 2011 with 2,900 acre-feet of water required to drill 1,453 wells.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with 8,800 acre-feet of water required to drill 4,399 wells.	Impact similar to Proposed Action 2023
Surface Water					
Sediment Yield	The amount of surface disturbance in six hydrologic basins will at least double with increased annual sediment yields by 10 percent above current conditions	Impact similar to No Action with increased surface disturbances in basins with increased annual sediment yields by 8 percent above current conditions	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance with increased annual sediment yields by 20 percent above current conditions	Impact similar to Proposed Action 2023
Soil Resources					
High Erosion Potential	Disturbance to sensitive soils with high erosion potential and low revegetation capabilities of ≈540 acres	Impact similar to No Action with increased surface disturbance in 730 to 980 acres of sensitive soils	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance in 1,400 to 1,500 acres of sensitive soils	Impact similar to Proposed Action 2023
Steep Slopes	Disturbances to soils on slopes ≥ 15% with high erosion potential ≈180 acres	Impact similar to No Action 2011 with increased surface disturbance in 400 to 450 acres on slopes ≥ 15%	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance in 700 to 750 acres on slopes ≥ 15%	Impact similar to Proposed Action 2023
Sedimentation	Increased soil erosion and sedimentation in aquatic habitats (up to 10 percent over current conditions)	Impact similar to No Action 2011 with erosion and sedimentation up to 10 percent over current conditions	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with erosion and sedimentation up to 20 percent over current conditions	Impact similar to Proposed Action 2023
Vegetation Resources					
Native Vegetation	Removal of existing native vegetation ≈ 4,100 acres of surface disturbance in native vegetation	Impact similar to No Action with increased surface disturbance of 6,240 to 6,370 acres in native vegetation	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance of 11,450 to 11,600 acres in native vegetation	Impact similar to the Proposed Action 2023
Shrub and Tree Dominated Vegetation	Surface disturbance in native vegetation dominated by shrubs and trees would be converted to herbaceous vegetation (≈3,300 acres of sagebrush steppe, 84 acres of greasewood, 260 acres of desert shrub, 75 acres of riparian forest and shrub).	Impact similar to No Action with increased surface disturbance in vegetation dominated by shrubs and trees (4,870 to 5,000 acres of sagebrush steppe, 70 to 80 acres of greasewood, 450 to 600 acres of desert shrub, 60 to 85 acres of riparian forest and shrub)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance in vegetation dominated by shrubs and trees (≈9,000 acres of sagebrush steppe, 230 acres of greasewood, 930 to 980 acres of desert shrub, 270 to 280 acres of riparian forest and shrub)	Impact similar to the Proposed Action 2023
Nonnative Invasive Species	Unsuccessful revegetation with increased presence of noxious weeds (Canada thistle, perennial pepperweed) on un-reclaimed bare ground (≈4,500 acres)	Impact similar to No Action with increased surface disturbance and potentially more un-reclaimed bare ground (6,840 to 6,860 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance and potentially more un-reclaimed bare ground (12,270 to 12,280 acres)	Impact similar to the Proposed Action 2023
Grazing Resources					
Grazing Capacity	Loss of livestock grazing capacity (AUMs) by removal of existing native vegetation ≈ 4,100 acres (≈390 AUMs) in the PAPA	Impact similar to No Action with increased surface disturbance in 6,240 to 6,370 acres of native vegetation, loss of 590 to 605 AUMs in the PAPA.	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance in 11,450 to 11,600 acres of native vegetation, loss of 1,090 to 1,100 AUMs in the PAPA.	Impact similar to the Proposed Action 2023
Nonnative Invasive Species	Decreased grazing capacity with increased presence of noxious weeds (Canada thistle, perennial pepperweed) on un-reclaimed bare ground (≈4,500 acres)	Impact similar to No Action with increased surface disturbance and potentially more un-reclaimed bare ground (6,840 to 6,860 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased surface disturbance and potentially more un-reclaimed bare ground (12,270 to 12,280 acres)	Impact similar to the Proposed Action 2023
Wetlands, Riparian Resources and Flood Plains					
Wetlands	Loss of wetlands and/or wetland function due to surface disturbance in wetlands (≈ 168 acres) and surface disturbance in the Wetland SRMZ (≈ 228 acres)	Impact similar to No Action but increased surface disturbance of 180 to 223 acres in wetlands and 355 to 380 acres in the Wetland SRMZ	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 with increased surface disturbance of 430 to 470 acres in wetlands and 690 to 740 acres in the Wetland SRMZ	Impact similar to the Proposed Action 2023
Riparian Resources	Increased sedimentation in aquatic habitats with loss of ≈75 acres of forest-dominated riparian and shrub vegetation	Impact similar to No Action but increased surface disturbance of ≈ 60 to 85 acres in forest-dominated riparian and shrub vegetation	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 with loss of ≈ 270 to 280 acres of forest-dominated riparian and shrub vegetation	Impact similar to the Proposed Action 2023
Flood Plains	Surface disturbance within 100-year flood plain ≈ 198 acres with potential loss of flood plain function	Impact similar to No Action but increased surface disturbance of ≈ 245 to 300 acres in 100-year flood plain	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance of ≈ 600 acres in 100-year flood plain	Impact similar to the Proposed Action 2023
Threatened, Endangered Species and Special Status Species					
Bald Eagle Nesting Habitat within 1 mile of Nest Sites	Surface disturbance and potential associated human presence to nesting eagles - additional surface disturbance less than 5 acres	Impact similar to No Action – additional surface disturbance less than 5 acres	Impact similar to No Action – additional surface disturbance less than 5 acres	Impacts similar to No Action but increased – additional surface disturbance 10 to 40 acres	Impact similar to No Action but increased – additional surface disturbance 10 to 40 acres

Resource	No Action 2011	Proposed Action 2011	Alternative C 2011	Proposed Action 2023	Alternative C 2023
Bald Eagle Wintering-Feeding-Sheltering Habitat	Surface disturbance and associated human presence within 1 mile of the New Fork Riparian zone (740 to 1,000 acres) and potential affects to forested-dominated riparian habitat (75 to 85 acres)	Impact similar to No Action	Impact similar to No Action 2011	Impacts similar to No Action but increased – 1,850 to 2,100 additional acres within 1 mile of the New Fork Riparian zone and 270 to 280 acres within forested-dominated riparian habitat	Impact similar to Proposed Action 2023
Endangered Colorado River Fish	Groundwater withdrawals for drilling and produced water discharge, possible average annual depletion of 458.4 acre-feet and possible contribution of 705.7 acre-feet from Colorado River System	Impact similar to No Action but increased average annual depletion of 586.1 acre-feet from Colorado River System	Impact similar to Proposed Action 2011	Impact similar to No Action but decreased average annual depletion of 519.4 acre-feet from Colorado River System	Impact similar to Proposed Action 2023
Special Status Wildlife Species	Direct effects to species depending on upland habitats (sagebrush steppe, mixed grass prairie, greasewood and desert shrub) (4,100 acres) as well as forest-dominated riparian habitats (potentially 75 acres) and wetland habitats (228 acres)	Impact similar to No Action but increased – disturbance to upland habitat of 6,100 to 6,300 acres, forest-dominated riparian habitats of 60 to 85 acres and wetland habitat of 350 to 380 acres	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased - disturbance to upland habitat of 11,050 to 11,175 acres, forest-dominated habitats of 260 to 280 acres and wetland habitats (690 to 740 acres)	Impact similar to Proposed Action 2023
Special Status Fish Species	Increased sedimentation in aquatic habitats (up to 10 percent over current conditions)	Impact similar to No Action - up to 10 percent increase in sedimentation in aquatic habitats	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 – but increased - up to 20 percent increase in sedimentation to aquatic habitats	Impact similar to Proposed Action 2023
Special Status Plants	Direct effects to existing populations by surface disturbance in Blue Rim Area – surface disturbance of 540 acres	Impact similar to No Action but increased – surface disturbance of 730 to 980 acres	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased – 1,415 to 1,490 acres	Impact similar to Proposed Action 2023
Wildlife and Aquatic Resources					
All terrestrial wildlife species	Creation of barriers to movement, edges, and patches within former contiguous habitats. The total pad perimeter ≈ 104 miles due to 245 new pads, and associated linear facilities (roads and pipelines) with perimeter ≈ 258 miles	Impact similar to No Action but increased - pad perimeter of 111 miles due to 179 new well pads, linear facility (roads and pipelines) perimeter of 473 miles	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 - but increased , well pad perimeter of 222 miles due to 250 new pads, linear facility (roads and pipelines) perimeter of 594 miles	Impact similar to Proposed Action 2023
	Direct effects to species depending on upland habitats (sagebrush steppe, mixed grass prairie, greasewood and desert shrub of ≈ 4,100 acres) as well as forest-dominated riparian habitats (potentially 75 acres) and wetland habitats (228 acres)	Impact similar to No Action but increased – disturbance to upland habitats of 6,100 to 6,300 acres, forest-dominated riparian habitats of 60 to 85 acres and wetland habitat of 350 to 380 acres	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased - disturbance to upland habitat of 11,050 to 11,175 acres, forest-dominated habitats of 260 to 280 acres and wetland habitats (690 to 740 acres)	Impact similar to Proposed Action 2023
Pronghorn	Direct loss of crucial winter range by surface disturbance (1,500 acres)	Impact similar to No Action but increased surface disturbance (2,400 to 2,600 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (4,000 to 4,400 acres)	Impact similar to Proposed Action 2023
	Direct loss of spring/summer/fall range by surface disturbance (2,950 acres)	Impact similar to No Action but increased surface disturbance (4,200 to 4,400 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (7,900 to 8,100 acres)	Impact similar to Proposed Action 2023
	Decreased habitat function near roads and well pads due to human presence – 245 well pads and 108 miles of road	Impact similar to No Action but decreased – 179 well pads and 89 miles or road	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased – 250 well pads and 121 miles of road	Impact similar to Proposed Action 2023
	No drilling on crucial winter range during winter	Drilling on crucial winter ranges during winter north and south of the New Fork River in CDAs 1, 2, and 3.	Drilling on crucial winter ranges during winter north of the New Fork River in DA 2; no winter drilling in DA 3 (crucial winter range south of the New Fork) until DA 2 is complete – Federal lands/minerals only.	Drilling on crucial winter ranges during winter north and south of the New Fork River may or may not occur by 2023.	Drilling on crucial winter ranges during winter south of the New Fork River in DA 3 may or may not occur. No winter drilling in would occur in DA 2 (crucial winter range north of the New Fork) by 2023 – Federal lands/minerals only.

Resource	No Action 2011	Proposed Action 2011	Alternative C 2011	Proposed Action 2023	Alternative C 2023
Mule Deer	Direct loss of crucial winter range by surface disturbance (1,090 acres)	Impact similar to No Action but increased surface disturbance (2,000 to 2,200 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (3,400 to 3,600 acres)	Impact similar to Proposed Action 2023
	Direct loss of non-crucial winter range by surface disturbance (1,090 acres)	Impact similar to No Action but increased surface disturbance (1,600 to 1,800)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (2,300 to 2,800 acres)	Impact similar to Proposed Action 2023
	Decreased habitat function near roads and well pads due to human activity – 245 well pads and 108 miles of road	Impact similar to No Action but decreased – 179 well pads and 89 miles of road	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased – 250 well pads and 121 miles of road	Impact similar to Proposed Action 2023
	No drilling on crucial winter range during winter	Drilling on crucial winter ranges during winter in CDAs 1 and 2	Drilling on crucial winter ranges during winter in the most southern end of DA 1; no winter drilling in the central and northern portion of DA 1 (also crucial winter range) until southern end of DA 1 is complete – Federal lands/minerals only.	Drilling on crucial winter ranges during winter in CDAs 1 and 2 may or may not occur by 2023.	Drilling on crucial winter ranges during winter in the most northern end of DA 1 may or may not occur; no winter drilling in the central and southern portion of DA 1 (also crucial winter range) by 2023 – Federal lands/minerals only.
Moose	Direct loss of crucial winter/yearlong range by surface disturbance (250 acres)	Impact similar to No Action but increased surface disturbance (240 to 290 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (640 to 760 acres)	Impact similar to Proposed Action 2023
	Continued drilling on crucial winter range on non-federal lands/minerals during winter	Impact similar to No Action	Impact similar to Proposed Action	Impact similar to No Action	Impact similar to Proposed Action
Greater Sage-Grouse	Decreased habitat function at leks by surface disturbance and potential human presence within 0.25 mile of leks during breeding (26 acres)	Impact similar to No Action but increased surface disturbance (90 to 95 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (195 to 205 acres)	Impact similar to Proposed Action 2023
	Decreased habitat function at leks and within 2 miles in nesting and brood-rearing habitat by surface disturbance (3,290 acres) and human activity	Impact similar to No Action but increased surface disturbance (5,000 to 5,100 acres)	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (9,300 to 9,700 acres)	Impact similar to Proposed Action 2023
	Decreased habitat function near roads and well pads due to human activity – 245 well pads and 108 miles of road	Impact similar to No Action but decreased – 179 well pads and 89 miles of road	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased – 250 well pads and 121 miles of road	Impact similar to Proposed Action 2023
	Fragmentation and loss of contiguous sagebrush steppe habitat by surface disturbance (3,300 acres)	Impact similar to No Action but increased surface disturbance (4,800 to 5,000 acres) in sagebrush steppe	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (8,900 to 9,100 acres) in sagebrush steppe	Impact similar to Proposed Action 2023
	No drilling within 2 miles of occupied greater sage-grouse leks from March 1 through July 31 – federal lands/minerals only.	Drilling within 2 miles of occupied greater sage-grouse leks from March 1 through July 31 only within CDAs 1, 2, and 3.	Drilling within 2 miles of occupied greater sage-grouse leks from March 1 through July 31 within DAs 1, 2, and 4, not in DAs 3 and 5 - federal lands/minerals only.	Drilling within 2 miles of occupied greater sage-grouse leks may or may not occur from March 1 through July 31 only within CDAs 1, 2, and 3.	Drilling within 2 miles of occupied greater sage-grouse leks may or may not occur from March 1 through July 31 within DAs 1, 3, and 4, not in DAs 2 and 5 - federal lands/minerals only.
Small Game and Fur-Bearing Mammals	Fragmentation and direct loss of native habitats by surface disturbance (4,150 acres)	Impact similar to No Action but increased surface disturbance (6,300 to 6,450 acres)	Impact similar to Proposed Action 2011	Impact similar to the Proposed Action 2011 but increased surface disturbance (11,500 to 11,700 acres)	Impact similar to Proposed Action 2023
Migratory Birds	Decreased habitat function in fragmented habitats and along edges of well pad perimeters ≈ 104 miles for 245 pads.	Impact similar to No Action but increased pad perimeter ≈ 111 to 112 miles for 179 pads	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased pad perimeter ≈ 221-223 miles for 250 pads	Impact similar to Proposed Action 2023
	Decreased habitat function near roads due to edges and human activity ≈ 108 miles of road and ≈ 150 miles of pipeline corridor	Impact similar to the No Action with decreased edge ≈ 89 miles of road but increased edge ≈ 383 to 384 miles of pipeline corridor	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased edge ≈ 121 miles of road and ≈ 473-474 miles of pipeline corridor	Impact similar to Proposed Action 2023
	Fragmentation and loss of contiguous sagebrush steppe habitat by surface disturbance (3,300 acres) in habitats used by sagebrush-obligate species	Impact similar to the No Action but increased surface disturbance (4,800 to 5,000 acres) in sagebrush steppe	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (8,900 to 9,100 acres) in sagebrush steppe	Impact similar to Proposed Action 2023
	Decreased raptor nesting habitat effectiveness with ≈ 75 acres of surface disturbance within forest-dominated riparian vegetation and ≈ 740 acres disturbed within 1 mile of New Fork riparian zone	Impact similar to the No Action but increased surface disturbance (60 to 85 acres) in forest-dominated riparian vegetation and 860 to 985 acres disturbed within 1 mile of New Fork riparian zone	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 but increased surface disturbance (270 to 280 acres) in forest-dominated riparian vegetation and 1,800 to 2,100 acres disturbed within 1 mile of New Fork riparian zone	Impact similar to Proposed Action 2023
Aquatic Resources	Decreased reproductive success in spring-spawning native salmonid species from increased sedimentation in aquatic habitats (up to 10 percent over current conditions) and loss of ≈ 75 acres of forest-dominated riparian forest and shrub vegetation	Impact similar to No Action with increased sedimentation up to 10 percent over current conditions and loss of ≈ 60 to 85 acres of riparian forest and shrub vegetation	Impact similar to Proposed Action 2011	Impact similar to Proposed Action 2011 with increased sedimentation up to 20 percent over current conditions and increased loss of ≈ 270 to 280 acres of forest-dominated riparian and shrub vegetation	Impact similar to Proposed Action 2023

Table 2
Summary of Direct Project Air Quality Impacts by Alternative

Potential Air Quality Impact	No Action Alternative (Alternative A)	Proposed Action Alternative (Alternative B)	Alternative C (Mitigation to Year 2005 Emissions Levels)	Alternative C (Mitigation to Year 2005 Emissions Levels and Additional 80 Percent Drill Rig Mitigation)
Increased concentrations of criteria pollutants CO, NO_2, SO_2, PM_{10},and $PM_{2.5}$ at near-field and in-field locations	Predicted concentrations are in compliance with applicable NAAQS and WAAQS; predicted concentrations are above the applicable Class II PSD 24-hour PM_{10} increment[1], and the annual NO_2 increment; and below the PSD annual PM_{10} increment and increments for SO_2.	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations of NO_2 are above the applicable Class II PSD annual NO_2 increment[1], and below the PSD increments for SO_2 and PM_{10}.	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations of NO_2 are above the applicable Class II PSD annual NO_2 increment[1], and below the PSD increments for SO_2 and PM_{10}.	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations are below the applicable PSD increments[1] for NO_2, SO_2 and PM_{10}.
Increased concentrations of criteria pollutants NO_2, SO_2, PM_{10},and $PM_{2.5}$ at (far-field) PSD Class I and sensitive PSD Class II area	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations are below PSD increments[1].	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations are below PSD increments[1].	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations are below PSD increments[1].	Predicted concentrations are in compliance with applicable NAAQS and WAAQS at all locations; predicted concentrations are below PSD increments[1].
Increased visibility (regional haze) impacts at (far-field) PSD Class I and sensitive PSD Class II areas	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 62 days per year at the Bridger Wilderness, 8 days at the Fitzpatrick Wilderness, 2 days at Grand Teton National Park, 6 days at the Gros Ventre Wilderness, 12 days at the Popo Agie Wilderness, 1 day at the Teton Wilderness, 2 days at the Washakie Wilderness, 9 days at the Wind River Roadless Area, and below 1.0 dv at all other sensitive areas.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 67 days per year at the Bridger Wilderness, 10 days at the Fitzpatrick Wilderness, 3 days at Grand Teton National Park, 8 days at the Gros Ventre Wilderness, 14 days at the Popo Agie Wilderness, 1 day at the Teton Wilderness, 2 days at the Washakie Wilderness, 10 days at the Wind River Roadless Area, and below 1.0 dv at all other sensitive areas.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 40 days per year at the Bridger Wilderness, 5 days at the Fitzpatrick Wilderness, 1 day at Grand Teton National Park, 2 days at the Gros Ventre Wilderness, 6 days at the Popo Agie Wilderness, 5 days at the Wind River Roadless Area, and below 1.0 dv at all other sensitive areas.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 10 days per year at the Bridger Wilderness, 1 day at the Fitzpatrick Wilderness, 1 day at the Gros Ventre Wilderness, 1 day at the Wind River Roadless Area, and below 1.0 dv at all other sensitive areas.
Increased visibility (regional haze) impacts at (mid-field) regional communities	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 126 days per year at Boulder, 89 days at Pinedale, and 58 days at Cora.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 138 days per year at Boulder, 91 days at Pinedale, and 62 days at Cora.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 107 days per year at Boulder, 70 days at Pinedale, and 47 days at Cora.	Predicted visibility impacts are greater than the 1.0 dv threshold for a maximum of 45 days per year at Boulder, 25 days at Pinedale, and 12 days at Cora.
Increased atmospheric/terrestrial deposition	Predicted impacts from sulfur and nitrogen deposition are less than the total deposition LOC at all analyzed areas.	Predicted impacts from sulfur and nitrogen deposition are less than the total deposition LOC at all analyzed areas.	Predicted impacts from sulfur and nitrogen deposition are less than the total deposition LOC at all analyzed areas.	Predicted impacts from sulfur and nitrogen deposition are less than the total deposition LOC at all analyzed areas.
Increased sensitive lake ANC	Predicted impacts resulted in less than the LAC at all acid sensitive lakes.	Predicted impacts resulted in less than the LAC at all acid sensitive lakes.	Predicted impacts resulted in less than the LAC at all acid sensitive lakes.	Predicted impacts resulted in less than the LAC at all acid sensitive lakes.

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

APPENDIX G

Wyoming Protocol Agreement

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PROGRAMMATIC AGREEMENT AMONG THE BUREAU OF LAND MANAGEMENT ADVISORY COUNCIL ON HISTORIC PRESERVATION, AND THE NATIONAL CONFERENCE OF STATE HISTORIC PRESERVATION OFFICERS REGARDING THE MANNER IN WHICH BLM WILL MEET ITS RESPONSIBILITIES UNDER THE NATIONAL HISTORIC PRESERVATION ACT

STATE PROTOCOL
Between
The Wyoming Bureau of Land Management State Director
and
The Wyoming State Historic Preservation Officer

This Protocol supplements the above referenced national Programmatic Agreement (PA). It describes the manner in which the Wyoming State Historic Preservation Officer (SHPO) and the Wyoming Bureau of Land Management (BLM) will interact and cooperate under the national Programmatic Agreement. As a condition of the national PA, the BLM, the Advisory Council on Historic Preservation (ACHP) and the National Conference of SHPOs (NCSHPO) mutually agreed that the BLM, after revising and updating it's 8100 Manual Series, will meet its responsibilities under Sections 106, 110 (f) and 111 (a) of the National Historic Preservation Act (NHPA) through the implementation of the mechanisms agreed to in the national PA rather than by following the procedure set forth in the ACHP's regulations (36 CFR Part 800). The goal of the national Programmatic Agreement and this Protocol is to forge a more meaningful and productive historic preservation partnership between BLM and SHPO that will enhance the management of historic properties under the BLM's jurisdiction.

I. RELATIONSHIP TO OTHER AGREEMENTS

Other PAs and Memoranda of Agreement (MOA) may be developed when specific agreement documents are needed to define procedures that are not covered under the national PA or this Protocol. Agreement documents still in effect and negotiated under the previous Protocol are listed in *Appendix A*. Agreement documents negotiated under this Protocol will be added to *Appendix A* when signed. When more than one Federal agency is involved in an undertaking and BLM accepts lead responsibility for Section 106 compliance, the BLM and SHPO agree to follow the procedures of the national PA and this Protocol instead of developing a separate agreement document as long as the other agencies agree. BLM will provide SHPO with documentation that the other agencies have agreed to follow the Protocol.

II. ADMINISTRATIVE INTERACTION AND REPORTING REQUIREMENTS

The BLM's Cultural Resource Management (CRM) Program Annual Report that is submitted to the Washington Office for the Secretary of the Interior's "Report to Congress on Federal Archaeological Activities" shall serve as the BLM's Annual Report to SHPO. Submission of the report to SHPO will coincide with the date the report is submitted to the Washington Office.

Two meetings will be held annually within the first quarter of the calendar year to discuss issues related to this Protocol. The first meeting will include BLM field office cultural resource staff and managers, and State Office personnel. BLM will develop an agenda that includes SHPO input and SHPO will participate. A primary purpose of this meeting will be to prepare briefing papers, summaries, and recommendations for the BLM and SHPO executive management meeting to follow.

The second meeting will be an executive management meeting to be held following the annual field office cultural resource meeting. This meeting will specifically discuss procedures, policies, amendments to the Protocol, or other matters as warranted. BLM and SHPO executive management will determine time, place, agenda, and representation at this meeting.

III. CONSULTATION

A. BLM Project Planning

To facilitate broader and more proactive participation by SHPO in BLM's management activities relating to cultural resources, the BLM will provide the following opportunities:

Each Field Office is responsible for preparing planning and National Environmental Policy Act (NEPA) documents such as Resource Management Plans (RMP), RMP amendments, RMP revisions, high level Environmental Assessments (EAs), or cultural resource activity plans at the regional or local level. Field Offices will, when beginning a planning effort, invite the SHPO to participate in scoping for the purpose of identifying issues that should be addressed in the plan. The BLM will formally invite the SHPO to comment on any historic properties use allocations, whether they are made in regional, local, or project plans. Field Offices will send all draft and final land use plans and historic properties project plans to the SHPO in electronic format or will provide paper copies upon request.

In preparing planning documents, BLM will utilize all relevant information tools including the SHPO web site, BLM Government Land Office (GLO) documents, municipal and county records, and other electronic databases.

B. General Consultation

1. Project Notification: Field Managers have the responsibility to provide written notification to the SHPO about upcoming projects likely to adversely affect known historic properties, or known resources that are unevaluated but are likely to be eligible for inclusion in the National Register of Historic Places. The preferred method of notification is by e-mail and should occur as early as possible in the planning process. Field Managers should use their best judgment in determining what projects should be brought to the SHPO's attention early in the process.

2. Other Meetings and Informal Discussions: The SHPO is encouraged to meet with the Wyoming BLM State Office or a Field Manager and/or staff at any time to discuss annual work plans, specific undertakings, outreach efforts, or other issues related to the BLM's management of cultural resources. The BLM will make every effort to arrange such meetings in a timely manner and to provide information requested by SHPO. The SHPO and Field Office personnel may informally discuss specific undertakings or any aspect of BLM's cultural resource management program. Any meetings specifically designed to discuss agreement documents must be coordinated with the State Office BLM/SHPO liaison.

3. Special Conditions: Under special conditions, such as staffing shortages, unforeseen events, or non-discretionary actions, specified time frames for SHPO review may be extended or shortened through consultation between SHPO and a BLM Field Office or the BLM State Office.

4. Project Segmentation: The BLM may determine that some very large projects (e.g., linear rights-of-way that cross more than one BLM Field Office) can be more efficiently completed if segmented. If a project is to be segmented, the SHPO shall be notified by letter in advance. The notification letter will include a brief description of the overall project. SHPO and BLM tracking numbers shall be referenced by the BLM and SHPO in all subsequent documentation relating to all segments of the project. Geophysical exploration projects do not require advance notification of segmentation.

5. Field Tours: BLM Field Offices will notify the SHPO, by e-mail, of all formal field tours relating to planning and NEPA efforts that may affect historic properties, particularly when the project proponent, the public, or interested parties are invited to participate. Field tours do not include routine on-site inspections pursuant to *Onshore Oil and Gas Order No. 1 (BLM, 43CFR 3160, Federal Register/Vol. 48, No. 205).*

C. Formal Consultations

Formal consultation shall occur in writing between the SHPO and the BLM as outlined in the procedures in Sections V through VIII of this document. Unless otherwise specified, all consultation shall be with the SHPO's Cheyenne office. Circumstances in which documentation should be submitted directly to the SHPO's Wyoming Cultural Records Office (WYCRO) in Laramie are specified in the appropriate sections of this Protocol.

D. Undertakings Requiring Consultation

At a minimum, the BLM will consult with SHPO and request comments on eligibility and effect in the following situations:

1. Non-routine interstate and/or interagency projects or programs that necessitate agreements among affected agencies to clarify roles and responsibilities

2. Undertakings adversely affecting National Historic Landmarks or National Register-eligible properties

3. Land exchanges or land sales affecting historic properties which will no longer be under BLM ownership or management

4. Undertakings that are determined by the BLM or the SHPO to be subject to unusual public attention or involve strongly opposing view points

E. Native American Participation

The BLM will consider the effects of its undertakings on historic properties significant to Native Americans because of an association with tribal history or because of a property's traditional religious or cultural importance to a tribe. In consulting with Indian tribes or authorized tribal representatives, the BLM will be guided by the following:

• BLM Manual 8120, *Tribal Consultation under Cultural Resource Authorities*
• BLM Handbook H-8120-1, *Guidelines for Conducting Tribal Consultation*
• Executive Order No. 13007, Indian Sacred Sites
• National Register Bulletin 38: Guidelines for Evaluating and Documenting Traditional Cultural Properties

Additionally, if Native American human remains, funerary objects, sacred objects, or objects of cultural patrimony are encountered as a result of a BLM undertaking, the BLM will comply with Section 3 of the Native American Graves Protection and Repatriation Act (NAGPRA) and its implementing regulations at 43 CFR Part 10, Subpart B. These situations will also be treated as archaeological discoveries and appropriate discovery procedures, as defined in the BLM Handbook or other guidance developed jointly between the BLM and the SHPO, will be followed.

F. Public Participation

The BLM will seek and consider the views of the public when carrying out actions under the terms of this Protocol. The BLM will solicit such input through the public participation opportunities afforded by BLM's land use planning and environmental review processes established under the National Environmental Policy Act (NEPA) of 1969 and the Federal Land Policy and Management Act (FLPMA) of 1976, and in accordance with regulations at 43 CFR Part 1610.3. Interested parties shall be invited to participate in the Section 106 consultation process (Sections V through VIII below) if they have a demonstrated interest in a BLM undertaking or action on historic properties. Such interested parties may include, but are not limited to, local governments, grantees, permittees, owners of affected lands or land surfaces, Indian tribes, and other interested parties determined jointly by BLM and SHPO.

In making determinations of effect, BLM may request comments of interested parties. When BLM makes a determination of adverse effect, they will request comments of interested parties. BLM will maintain lists of interested parties based on their identified interests.

BLM and SHPO will consult to identify ***invited*** concurring parties based on their demonstrated interest and level of participation. ***Invited*** concurring parties will be provided the opportunity to sign a Memorandum of Agreement or Programmatic Agreement. Refusal by an ***invited*** concurring party to sign an agreement will not invalidate the agreement.

IV. IDENTIFICATION

A. Exemptions

Undertakings that have no potential to affect historic properties, for which no inventory is necessary, are identified in *Appendix B*, subject to the following:

1. The BLM cultural resource specialist will, after reviewing a proposed undertaking, determine if

specific projects or activities have no potential to affect historic properties as described in *Appendix B*.

2. BLM and SHPO may agree that other classes of exempted actions may be added to *Appendix B*.

3. The BLM will report any undertakings exempt from inventory by entering the action in CRMtracker and will proceed with the undertaking.

B. Area of Potential Effect

The area of potential effect (APE) means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking [36 CFR 800.16(d)].

Until such time as the appropriate size of APEs for specific types of projects has been defined in the BLM Handbook or other guidance developed jointly between the BLM and the SHPO, BLM cultural resource specialists will determine that portion of the APE subject to inventory. In defining the APE, the BLM will consider potential direct, indirect, and cumulative effects to historic properties and their associated settings as applicable. The APE shall include historic properties and their associated setting where setting is an important aspect of integrity (see *Appendix C*). The size of the survey area outside of an APE shall be at the approval of the BLM manager, taking into account the recommendations of the cultural resource specialist.

C. Determine Information Needs

The BLM will, during the earliest feasible planning stage of any undertaking, determine the information needed to identify historic properties situated within the APE. Such determinations may be based on a file search of the SHPO/BLM cultural resource records, aerial photographs, GLO records, BLM land records, resource management plan, project-specific NEPA documents of the proposed project area and on information sought and obtained from the SHPO and from interested parties.

1. Previous Adequate Inventory: The BLM cultural resource specialist will determine whether the APE has been adequately inventoried for historic properties. If an adequate Class III inventory (*see BLM Manual 8110.21.c*) has been completed in accordance with current field methods, and BLM and SHPO have previously agreed that no historic properties will be affected, the BLM shall document the undertaking through CRMtracker and proceed. A record of these determinations shall be retained in field office files.

2. Level of Inventory: If the BLM determines that a Class III inventory of the APE is necessary, the BLM need not seek the SHPO's views on identification efforts. If the BLM determines to conduct an inventory at less than a Class III level (except as specified in Section IV.E.1 and 2 below) BLM will consult, in writing, with the SHPO on the adequacy of the inventory design prior to initiating the inventory or authorizing the proposed undertaking. SHPO will comment in 15 days of receipt of the documentation. Any disputes over the adequacy of the proposed inventory efforts shall be resolved in accordance with the dispute resolution clause in Section XI.A of this Protocol.

a. Geophysical Exploration Projects: BLM's obligations to identify National Register-eligible or listed historic properties often include non-Federal lands which are directly or indirectly affected by the Federally permitted seismic project. BLM will make a reasonable and good faith effort to identify such

properties on non-Federal lands for geophysical exploration projects through examination of existing records, or through on-the-ground inventory only at the request of the non-Federal landowner. The BLM will ensure the geophysical operator will inform non-Federal landowners of their right to request a cultural resources inventory. BLM will also ensure that historic properties are not adversely affected by the geophysical project activities.

b. Fuels Reduction or Prescribed Burns: Fuels reduction or prescribed burns that require no surface disturbance (i.e. hand thinning, hand piling, or chemical treatment) require only a reconnaissance survey to determine if rock art, rock shelters, or other types of fire sensitive or chemical-sensitive historic properties exist. The BLM fuels reduction program coordinators will consult with the BLM cultural resource specialist on all fuels reduction projects. The BLM may require special conditions as necessary to protect historic properties. If fire sensitive historic properties exist within the area of the prescribed burn, a protection plan must be submitted to SHPO. SHPO will provide comment within 30 days of receipt of the documentation. If the BLM cultural resource specialist determines that fire sensitive properties do not exist within the proposed area of the prescribed burn, BLM may notify and proceed.

D. Disturbed Areas

If the proposed undertaking is not listed in the exemptions found in *Appendix B*, the BLM cultural resource specialist will determine whether previous ground disturbance has modified the surface so extensively that the probability of finding intact cultural properties is negligible. If such disturbance has occurred in the APE, the BLM may proceed with the undertaking.

E. Areas of Low Potential for Historic Properties

The BLM may determine specific areas do not need to be inventoried because current information suggests the area has little or no potential to contain historic properties. Determinations regarding the applicability of low probability indicators may be made only by BLM cultural resource specialists following any consultation requirements discussed below:

1. Low Probability Areas: Indicators of low probability for historic properties may include steep slopes with no potential for sites such as rock art or rock shelters. Other indicators may be agreed upon as developed and included in the BLM Handbook. When BLM determines that areas are exempted from inventory because one or more of these situations applies, BLM will notify SHPO through CRMtracker and proceed with the undertaking.

2. Project-Specific: When IV.E.1 above does not apply, the BLM will request concurrence in writing from the SHPO on project-specific exemptions due to low probability for historic properties. The SHPO will be provided 15 days to comment.

3. Supplemental Protocol Agreements: Low probability for historic properties due to environmental factors or other conditions may allow large blocks of land to be exempted through a Supplemental Protocol Agreement (SPA). SPAs will be negotiated between BLM and SHPO resulting in an MOA. Executed SPAs are listed in *Appendix A* of this Protocol.

V. DETERMINATION OF ELIGIBILITY

BLM will determine if there are historic properties within the APE by applying the criteria for evaluation found in 36 CFR Part 60.4.

A. No Historic Properties

1. No Cultural Resources Identified: When no cultural resources of any kind are identified by inventory, or only those described in *Appendix D* are encountered, BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *Wyoming State Historic Preservation Office Format, Guidelines, and Standards for Class II and III Reports (WY Report Standards)* to the Wyoming SHPO Cultural Records Office (WYCRO). The BLM will submit the project report to WYCRO within 30 days after determining the report meets standards. Submission of the project report will include a standard signed notification *(see Appendix E)*. The BLM will notify interested parties and proceed with the undertaking (see III.F of this Protocol).

2. No Historic Properties Identified: If the inventory results in no historic properties (only ineligible sites and isolated resources found) then the BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the WYCRO. The BLM will submit the project report and Wyoming Cultural Property Forms (WYCPF) and/or Wyoming Isolated Resource Forms (WYIRF) to WYCRO within 30 days after determining the report meets standards and completing determinations of eligibility. Submission of the project report will include a standard signed notification *(see Appendix E)* containing BLM's determinations of eligibility. The BLM will notify interested parties and proceed with the undertaking.

B. Historic Properties Present

If historic properties are identified, the BLM will submit the electronic record to SHPO through the CRMtracker database. BLM will ensure the project report and associated forms (WYCPF and WYIRF) meet the *WY Report Standards* and will submit all documentation to either the WYCRO office or the Wyoming SHPO office in Cheyenne, for review and comment, depending upon the determination of effect (see Section VI). A discussion on the integrity of location, setting, design, materials, workmanship, feeling, and association must be included in project documentation for all historic properties.

C. Geophysical Projects

Cultural resource inventories conducted specifically for geophysical exploration projects will not be required to evaluate identified properties provided the properties are avoided by an appropriate distance as defined in BLM Handbook H-3150. Proper avoidance will be regarded as a **"no effect"** situation. The BLM will submit the report to the SHPO per Section VI.A and proceed with the undertaking.

VI. DETERMINATION OF EFFECT

Standard measures for reducing effects (see Appendix C, II.D.2) for reducing effects are to be considered part of the project design. Determination of effect must be made after standard treatment measures have been integrated into the project design. The final project design must incorporate all agreed upon treatment measures and be included in the Conditions of Approval or components of the Surface Use Plan, Plan of Operations, or Plan of Development.

A. No Historic Properties Affected

1. If there are no historic properties present, or if they are present but will not be affected by the undertaking, then a determination of "No Effect" is appropriate. The BLM will submit the electronic

record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the WYCRO within 30 days after determining the report meets standards and completing determinations of eligibility and effect. Submission of the project report will include a standard signed notification *(see Appendix E)* containing BLM's determinations of eligibility and effect. The BLM will notify interested parties and proceed with the undertaking.

2. The SHPO will randomly review the BLM's determinations of "No Effect." If SHPO believes there is a pattern of inappropriate or inadequate eligibility determinations, they will begin consultation with the BLM following dispute resolution procedures in Section XI.A of this Protocol.

3. If any of the elements contributing to the defining characteristics that make the property eligible for inclusion in the National Register, including the integrity of location, setting, design, materials, workmanship, feeling and association, will be affected, then a determination of "No Effect" is not appropriate.

4. For geophysical projects appropriate avoidance of unevaluated sites or historic properties will be regarded as "No Effect." The BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the WYCRO within 30 days after determining the report meets standards and completing determinations of eligibility and effect. Submission of the project report will include a standard signed notification *(see Appendix E)* containing BLM's determinations of eligibility and effect. The BLM will notify interested parties and proceed with the undertaking.

5. If a proposed project will not be visible from the historic property and there is no contrast between the project and the setting (*see Appendix C* of this Protocol), then a determination of "No Effect" is appropriate. The BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the WYCRO within 30 days after determining the report meets standards and completing determinations of eligibility and effect. Submission of the project report will include a standard signed notification *(see Appendix E)* containing BLM's determinations of eligibility and effect. The BLM will notify interested parties and proceed with the undertaking.

B. No Adverse Effect

1. If a proposed project will cause effects to a historic property, but the effects will not diminish the aspects of integrity nor the characteristics that make the property eligible for listing in the National Register of Historic Places, then a determination of "No Adverse Effect" is appropriate as defined in 36CFR800.5(b). If undertakings involve sites eligible under Criterion A, B, or C, the BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the SHPO in Cheyenne within 30 days after determining the report meets standards and completing determinations of eligibility and effect. SHPO will review and comment on the effect within 15 days of receipt of the documentation. If SHPO does not respond within 15 days, BLM may assume concurrence with determinations of eligibility and effect and proceed with the undertaking.

2. If a proposed project will cause effects to a historic property, but the effects will not diminish the aspects of integrity nor the characteristics that make the property eligible for listing in the National Register of Historic Places, then a determination of "No Adverse Effect" is appropriate as defined in 36CFR800.5(b). If undertakings involve sites eligible only under Criterion D, BLM will submit the

electronic record to SHPO through the CRMtracker database and will submit the project report, meeting the *WY Report Standards* to the WYCRO within 30 days after determining the report meets standards and completing determinations of eligibility and effect. The SHPO will randomly review the BLM's determinations of "No Adverse Effect" for Criterion D properties. If SHPO believes there is a pattern of inappropriate or inadequate eligibility determinations, they will begin consultation with the BLM following dispute resolution procedures in Section XI.A of this Protocol.

3. If it can be demonstrated only noncontributing portions of historic properties will be affected, then a determination of "No Adverse Effect" is appropriate. Justification of a noncontributing portion must be documented on a WYCPF and discussed in the project report.

4. If a proposed project will be visible, but there is weak contrast, a determination of "No Adverse Effect" is appropriate. A "Weak Contrast" occurs when the proposed project elements, or portions of the elements, can be seen but will not dominate the setting or attract the attention of the casual observer because the basic elements of form, line, color and texture found in the setting are repeated in the project's physical elements (see *Appendix C* of this Protocol). In this case, a determination of "No Adverse Effect" is appropriate.

5. If setting is an important aspect of integrity for a historic property and the project will cause a weak contrast, the BLM will submit the electronic record to SHPO through the CRMtracker database and will submit the project report meeting the *WY Report Standards* within 30 days after determining the report meets standards, and completing determinations of eligibility and effect, to the Wyoming SHPO office in Cheyenne. SHPO will review and comment on the effect within 30 days of receipt of the documentation. If SHPO does not respond within 30 days, BLM may assume concurrence with determinations of eligibility and effect and proceed with the undertaking.

C. Adverse Effect

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Consideration shall be given to all qualifying characteristics of a historic property, including those that may have been identified subsequent to the original evaluation of the property's eligibility for the National Register. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative [CFR 800.5(a)(1)].

1. <u>Data Recovery Plan:</u> If the historic property is eligible for inclusion in the National Register under Criterion D only, and the adverse effect will be minimized by data recovery, then the BLM will prepare a data recovery plan and follow the procedures in Section VII.A of this Protocol. A Memorandum of Agreement is not required to implement the data recovery plan.

2. <u>Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER)</u>: In consultation with the SHPO, the BLM will identify any historic property eligible for inclusion in the National Register where an adverse effect can be minimized by completing a HABS/HAER document. All HABS/HAER projects must be coordinated with the National Park Service prior to initiation of the project in order to ensure that the appropriate level of documentation is completed. The BLM will develop and submit to SHPO a project report and follow the procedures in Section VII.B of this Protocol. A Memorandum of Agreement is not required to implement a HABS/HAER.

3. Memorandum of Agreement: If there are historic properties within the APE that will be adversely affected and are eligible under National Register Criterion A, B or C, BLM will submit the project report to SHPO for review and comment. If the project involves stabilization, the BLM will submit a stabilization plan to SHPO for comment. Upon concurrence with the project report or stabilization plan, BLM will consult with SHPO to develop a Memorandum of Agreement (MOA) and follow the procedures in Section VII.D of this agreement.

If a proposed project will be visible and there is moderate or strong contrast a determination of "Adverse Effect" is appropriate. A "Moderate Contrast" occurs when the proposed project elements, or portions of the elements, begin to attract attention and begin to dominate the characteristic landscape. A "Strong Contrast" occurs when the proposed project elements, or portions of the elements, demand attention, cannot be overlooked, and are dominant on the landscape (see Appendix C of this Protocol). In this case, a determination of "Adverse Effect" is appropriate. In these cases, BLM will consult with SHPO to develop a Memorandum of Agreement (MOA) and follow the procedures in Section VII.D of this agreement.

VII. RESOLUTION OF ADVERSE EFFECTS

A. Data Recovery

1. Data Recovery Plan Documentation and Consultation Needs: Data Recovery plans will be consistent with the *Secretary of Interior's Standards and Guidelines for Archeological Documentation* (48 FR 44734-37). The plan will include, at a minimum, the items in BLM Manual 8140.26A-I. Compliance with the approved data recovery plan will be included in the project Conditions of Approval. Objection to or failure to comply with the approved data recovery plan by the project proponent will require consultation with SHPO and negotiation of a MOA.

2. Data Recovery Plan Review: The BLM will submit the project report meeting the *WY Report Standards* and the data recovery plan to the Wyoming SHPO office in Cheyenne. SHPO will review and comment on the effect and the plan within 30 days of receipt of the documentation. The BLM will concurrently submit the documentation through CRMtracker database for inclusion in the master inventory. If the SHPO has no comment, and no other consulting party objects, the BLM may assume SHPO concurrence with the plan. The BLM may proceed without a Memorandum of Agreement provided there are no other historic properties eligible under Criterion A, B, or C within the APE that may be affected by the undertaking.

3. Data Recovery Report: Data recovery reports must be consistent with the *Secretary of Interior's Standards and Guidelines for Archeological Documentation* (48 FR 44734-37). The Data Recovery Report will include, at a minimum, the items at BLM Manual 8140.27A-F. Final data recovery reports will be provided to the SHPO within 30 days of BLM review and acceptance. The BLM will concurrently submit the documentation through CRMtracker database for inclusion in the master inventory. SHPO may review the final data recovery report and provide courtesy comments to the BLM.

B. HABS/HAER

The BLM will submit the project report meeting the *WY Report Standards* and the recommendations for HABS/HAER documentation to the Wyoming SHPO office in Cheyenne and SHPO will review and comment on the effect within 30 days of receipt of the documentation. The BLM will concurrently

submit the documentation through CRMtracker database for inclusion in the master inventory. The BLM will submit resulting documentation to the National Park Service (NPS) and SHPO within 30 days of completion. SHPO will review the final HABS/HAER documentation and provide comments to the BLM within 30 days receipt of the documentation. The project may not proceed until acceptance of adequate HABS/HAER documentation by the NPS. Compliance with the approved HABS/HAER documentation requirement will be included in the project Conditions of Approval. Objection to or failure to comply with the approved HABS/HAER plan by the project proponent will require consultation with SHPO and negotiation of a MOA.

C. Compensatory Mitigation

Compensatory mitigation, or compensating for an impact by replacement or providing substitute resources or environments, will be considered after application of other forms of onsite mitigation, including best management practices, has been exhausted. Compensatory mitigation can occur immediately adjacent to the area impacted but can also be located anywhere in the same general geographic area or, in the case of linear properties (e.g. National Historic Trails), at other places along that specific resource. Any compensatory mitigation must result from consultation among BLM, SHPO, ACHP (if participating), the project proponent, and other interested parties. Compensatory mitigation must provide a public benefit and be appropriate to the scope of the effect being mitigated. Field offices shall notify the BLM Deputy Preservation Officer as soon as it is recognized that a proposed undertaking may require consideration of compensatory mitigation. The BLM Deputy Preservation Officer will monitor the use of compensatory mitigation for consistency of application by the BLM statewide.

The following procedures are not appropriate as compensatory mitigation measures:

1. Payment of money by the project proponent directly to BLM or SHPO
2. Data recovery at historic properties other than historic properties that will be adversely affected by an undertaking
3. Acquisition of land or a historic property, through exchange or another process, that offers no public access
4. Signage or markers where there is no public access

D. Memorandum of Agreement

1. Consulting Parties: Consulting parties are the BLM, the SHPO, the ACHP (if participating), the project proponent and any other party who assumes responsibilities stipulated in the MOA. The agency official may invite other interested parties to concur. An interested party ***invited*** to concur has no responsibility under the agreement, but may be invited to sign the agreement. The refusal of any party ***invited*** to sign the MOA does not invalidate the MOA.

Unless otherwise agreed, the BLM is responsible for preparing the MOA. Stipulations included in the MOA should come from consultation among the consulting and ***invited*** concurring parties and BLM's conditions of approval.

2. Memorandum of Agreement Process:

Preparation of a MOA follows consultation between BLM, SHPO, the project proponent and ***invited*** concurring parties. Generally the MOA will be drafted by the responsible Field Office.

a. The BLM State Office will provide the SHPO with an electronic draft of the MOA for their comment. The BLM will concurrently request comments from the ACHP (if participating), and any other party to which a role has been assigned within the document.

b. The SHPO shall ensure a timely response to the request for comment and SHPO comment will be sent electronically to the BLM State Office.

c. After receiving all comments, BLM will make necessary revisions to the draft MOA or continue negotiations with parties as necessary to resolve differences. Unresolved differences should follow the dispute resolution process in Section XI of this Protocol.

d. The BLM State Office will provide the SHPO with electronic revised drafts for review. The BLM will distribute revised drafts to any other party to which a role has been assigned within the document.

e. The MOA shall not be finalized until the BLM has made efforts to accommodate all comments from consulting parties and all parties have notified the BLM State Office that the draft is acceptable.

f. When the BLM State Office receives notification from SHPO and other consulting parties of satisfaction with a draft, the BLM will prepare the final the document.

g. The BLM Field Manager will sign the final MOA and submit it to the project proponent and signatories other than SHPO and ACHP. When these signatures are affixed, the Field Office will send the signed MOA to the BLM State Office for signature by the Deputy State Director for Resources Policy and Management. Then the BLM State Office will submit it to the SHPO office in Cheyenne for signature by the SHPO. When the MOA has been executed through signature of all consulting parties, the consultation will be concluded and the MOA will be implemented.

h. The BLM will provide a copy of the MOA with original signatures to the SHPO, the BLM Field Offices and consulting parties.

VIII. DISCOVERY SITUATIONS

A. Planning For Discoveries

The BLM will encourage applicant development of discovery plans for large and complex undertakings and those involving land disturbance in areas known to contain buried sites. Copies of such discovery plans will be forwarded to the SHPO for review along with BLM's determination of effect for the project. When a discovery plan has been accepted by BLM and SHPO, the BLM can meet its Section 106 requirements by following the plan when cultural properties are discovered during implementation of an undertaking. The BLM shall take prudent and feasible steps to ensure that the undertaking does not harm the property until treatment is completed in accordance with the discovery plan. BLM and SHPO may agree upon a standard discovery plan for inclusion in the BLM Handbook. A field office may follow that discovery plan without additional consultation with SHPO on the discovery plan. Until such a plan is developed for inclusion in the BLM Handbook, BLM will follow procedures outlined in Section VIII.B of this Protocol.

B. Unplanned Discoveries

If the BLM determines, after completion of the review process outlined in this Protocol, an undertaking

may affect or has affected a previously unidentified property that may be eligible for the National Register, the BLM will be required to follow appropriate discovery procedures defined in the BLM Handbook or other guidance developed jointly between the BLM and the SHPO. Until the BLM Handbook procedures are developed, the BLM will make a reasonable effort to avoid or minimize harm to a discovered property until (1) the property has been assessed in terms of National Register eligibility, and (2) if the property is determined eligible, an appropriate treatment plan has been prepared. The SHPO will be provided 15 days of receipt of the documentation to comment on the treatment plan. Since implementation of the treatment plan is not covered by the land user's Conditions of Approval, implementation of the treatment plan will require a MOA among the BLM, the SHPO, and the land user.

IX. STAFFING AND OBTAINING SPECIALIZED CAPABILITIES

A. Staffing

The BLM will allow identification and evaluation of cultural resources only by specialists who meet the qualifications and are classified in the appropriate professional series by the Office of Personnel Management (e.g., Series 193 for archaeologists). Specialists at the GS-5 and GS-7 levels are considered to be performing duties in a trainee or developmental capacity. Reports prepared by GS-5 and GS-7 specialists, or any cultural resource consultant, must be reviewed and submitted to the SHPO by a GS-9 or higher-grade cultural resource specialist. New specialists at a GS-9 grade or higher who have not received training on this Protocol must follow the procedures required of a GS-7 cultural resource specialist.

When new managers (Field Managers, Assistant Field Managers, Supervisory Natural Resource Specialists, or Deputy State Director for Resources) or cultural resource specialists are hired, the BLM will ensure that the new managers or cultural resource specialists receive orientation, within 90 days in accordance with Section X.D of this Protocol. It shall be the responsibility of the BLM Deputy Preservation Officer (DPO) to provide appropriate orientation to new managers and cultural resource specialists. Once the orientation is completed, the DPO will notify the SHPO and the Field Office will be allowed to follow the procedures of this Protocol. If the SHPO documents persistent problems in complying with the terms of this Protocol, the Dispute Resolution Procedures at Section XI.A of the Protocol will be followed.

The Wyoming SHPO will ensure all new historic preservation specialists hired to conduct Federal Section 106 review receive training in Section 106 compliance and this Protocol within 90 days of being hired.

B. Specialized Capabilities

When the BLM is involved in an undertaking requiring expertise not possessed by available BLM staff (i.e., architectural history), it will obtain that expertise for the purpose of determining National Register eligibility, effects, and treatment for the cultural properties in question. The BLM may request the assistance of SHPO staff in such cases or may obtain the necessary expertise through contracts, BLM personnel from other states, or cooperative arrangements with other agencies.

X. SUPPORTING PROGRAMS AND ACTIVITIES

The BLM and the SHPO recognize the advantages of working together on a wide range of heritage preservation activities and will cooperatively pursue the following efforts:

A. Data Sharing and Information Management

1. Reporting Standards: BLM and SHPO will collaborate on the development of standards for preparing inventory and treatment reports, and jointly develop isolated resource and *Wyoming Cultural Properties Forms (WYCPF)*. All BLM inventory reports submitted to SHPO will follow *WY Report Standards*. All site data will be reported on Wyoming Cultural Property Forms or Wyoming Isolated Resource Forms as appropriate. Any revisions to the standards will be jointly developed by BLM and SHPO.

2. Data System Management: BLM and SHPO will maintain a Statewide automated cultural records database that is accessible from all BLM Field Offices. The BLM and SHPO will continue to collaborate on ways to synthesize and use the automated cultural data to develop Geographic Information System (GIS) capabilities. BLM and SHPO will continue to cooperate in this endeavor by providing financial, personnel, hardware and software resources as funding becomes available. If SHPO or a BLM Field Office are aware of specific backlog documentation held in either office, they should work cooperatively to provide the documentation to the office requesting it.

3. Electronic Records Submission and Project Tracking: BLM and SHPO will jointly work to implement the electronic submission of records for tracking agency actions through the use of CRMtracker. BLM and SHPO will work to insure the program meets agency and SHPO needs. The use of this program greatly increases the efficiency of data management, review, and annual reporting.

B. State BLM Handbook Supplement

BLM field procedures will be detailed in a Wyoming State BLM Handbook as a supplement to bureau-wide BLM Manual procedures. BLM and SHPO will collaborate on development of the handbook and set a goal of finalizing the handbook within one year of signature of this Protocol. The BLM and SHPO, in consultation with contractors permitted by the BLM to work in the state of Wyoming, will collaborate on development of a supplemental contractor handbook. Disagreement between BLM and SHPO regarding either development or implementation of Handbook procedures will be resolved in accordance with the dispute resolution procedures at Section X of this Protocol. All future changes or amendments to the Handbook procedures will be made in cooperation with the SHPO.

C. Public Outreach and Heritage Education

The BLM and the SHPO will work cooperatively to promote and enhance public education and outreach in historic preservation and cultural resource management through the following programs:

1. Archaeology Awareness Month: The BLM and the SHPO will participate in and support financially, as funding permits, Archaeology Awareness Month activities, including public presentations, field tours and excavations, exhibits, archaeology fairs, posters, brochures, and educational activities.

2. Project Archaeology: The BLM and SHPO will support Project Archaeology as a component of BLM's Heritage Education Program, by encouraging staff archaeologists to be trained and serve as facilitators in the program, with the goal of integrating the teaching of archaeological concepts and preservation ethics in Wyoming schools statewide.

3. Adventures in the Past/Heritage Education: The BLM and SHPO may, as funding permits, cooperatively work on the development of interpretation of cultural resources through a variety of media

including, but not limited to, exhibits, brochures, lectures, radio and television promotions, Internet web pages, and interpretive signs.

4. Wyoming Archaeological Society and the Wyoming Historical Society: The BLM and SHPO are encouraged to work cooperatively with the Wyoming Archaeological Society and the Wyoming Historical Society to promote preservation ethics, good science, and professional standards statewide to amateur archaeologists and historians by participating in society meetings, serving as chapter advisors, providing presentations and demonstrations, and other assistance as appropriate.

5. Professional Organizations: The BLM and SHPO cultural resource specialists are encouraged to participate in and work cooperatively with professional historic preservation organizations (e.g., Wyoming Association of Professional Archaeologists and the Wyoming Association of Professional Historians) to promote preservation ethics, good science and good history, professional standards statewide, and open dialogue regarding historic preservation issues .

6. Site Stewardship: The BLM and the SHPO will cooperate, as funding and staff availability permit, to develop a volunteer site stewardship program to recruit and train members of the public to serve as monitors and stewards of Wyoming's cultural resources on public lands, and to assist with educational and other activities involving cultural resources. BLM and SHPO will cooperate in efforts to obtain funding and other resources, such as grants and partnerships, for these activities.

7. Public Dissemination of Information: When appropriate, the BLM, SHPO, or a project proponent will provide funding for development and distribution of brochures, monographs, or other information documents summarizing the results of archaeological investigations for the general public. These can be either part of the Section 106 compliance responsibility or Section 110 research on public lands. Opportunities for public dissemination will especially be sought when research produces information that may be of particular interest to the general public. The BLM and SHPO will develop these materials in cooperation, either by BLM and SHPO staffs or through contracts. BLM and SHPO will cooperate in efforts to obtain funding and other resources, such as grants and partnerships, for these activities.

D. State-Level Historic Preservation Training and Workshops

The BLM and SHPO will cooperate and participate in both the initial training and future on-going training of BLM managers and cultural resource staff, SHPO staff, public land users, and cultural resource contractors relative to the National PA and implementation of this Protocol. Training resources shall include, but are not limited to, Wyoming BLM State Handbook or Manual Supplements, planning documents, and statewide historic context documents. Other training and workshops may include writing and negotiating agreement documents and treatment plans, Visual Contrast Rating (VCR) system, etc. Review of training needs and/or additional workshops will occur on a yearly basis at the annual cultural resource staff meeting. Emphasis will be on professional development training to expand professional skills of BLM and SHPO cultural resource staff. Orientation meetings on this Protocol will be held within six months of signature of this agreement for contractors, developers, and other interested parties.

E. Historic Context Development

Pursuant to the *Letter of Intent Creating a Partnership in Preservation between the State of Wyoming and the Wyoming State Office of the Bureau of Land Management* which was executed on April 23, 2004, increased emphasis will be given to the development of historic contexts. The BLM and the SHPO will cooperatively recommend statewide priorities for historic context development involving BLM lands.

These recommendations shall take into consideration context development priority recommendations made by the Governor's Historic Context Development Steering Committee. Recommendations will be considered in the BLM budget process as a statewide benefiting program. Field Managers may also develop project-specific contexts as their funding allows. In addition, the BLM will cooperate with the SHPO in the pursuit of funding to support the development of historic contexts (e.g., grant proposals). All historic contexts, must be consistent with the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation (48 FR 44716) and the SHPO *Guidelines for the Development of Historic Contexts in Wyoming*. In accordance with Section 101(b)(3) of the NHPA, whereby the SHPO has responsibility for preparing and implementing the State's comprehensive historic preservation plan, the SHPO shall review and provide comments on all BLM historic context documents. Historic contexts which define site eligibility criteria, levels of adequate inventory, site documentation requirements, standards for assessment of effects, and/or appropriate treatment of historic properties shall require SHPO concurrence on those aspects. All jointly developed historic contexts within Wyoming shall be endorsed by all participating parties.

F. Collections Management

BLM and SHPO shall cooperate to support and maintain the collections (artifacts and associated field notes and other documents) at the University of Wyoming Archaeological Repository (UWAR) for curation of Federal archaeological collections. Curation of archaeological materials is supported through a formal Memoradum of Understanding between the University of Wyoming Department of Anthropology and the SHPO's Office of the Wyoming State Archaeologist. Following BLM acceptance and submission of project reports to SHPO, BLM shall continue to track progress of collections from BLM lands. Consultants and BLM shall submit artifacts, field notes, field maps, photographs, and documentation meeting UWAR's "Guidelines and Standards" as required per standard stipulations in BLM permits. UWAR will notify the BLM State Office of receipt of the collection upon arrival at UWAR. After accessioning the collection, UWAR will further notify the BLM State Office of acceptance and curation of the collection. BLM will require through its Cultural Resource Use Permit stipulations that all collections are submitted to UWAR within 60 days of the submission of the project report to BLM. The project report will be date-stamped and that date shall be the beginning of the 60-day period.

XI. DISPUTE RESOLUTION PROCEDURES, AMENDMENTS, AND TERMINATION

A. If the BLM and the SHPO disagree on an issue, they will consult with one another to resolve the issue. If the disagreement is about an action in a BLM Field Office, the Field Office Manager and the SHPO will consult to resolve it.

If the disagreement is with the State Office, or the matter is referred to the State Office by a Field Office Manager or the SHPO, the BLM Deputy Preservation Officer, the SHPO, and the Wyoming State Division of Cultural Resources Administrator will consult to resolve the issue. If the matter is not resolved at this level, the matter will be referred to the BLM Deputy State Director and the Director of the Wyoming State Department of Parks and Cultural Resources.

If the issue is not satisfactorily resolved at this management level, the issue will be forwarded to the Governor and the State Director for final resolution.

Nothing in this section abrogates the signature authority of the SHPO under the NHPA.

B. Amendments to the Protocol

If the BLM or the SHPO wish to amend this Protocol at any time, they will consult to consider requested changes. Amendments will become effective when signed by both parties.

C. Termination of the Protocol

The BLM or the SHPO may terminate this Protocol by providing 90 days notice to the other party, providing that they consult during this period to seek agreement on amendments or other actions that would avoid termination. The BLM DPO may request the assistance of the BLM Preservation Board, the National Conference of State Historic Preservation Officers, or the ACHP in the consultation process. If the Protocol is terminated, the BLM will be required to comply with Section 106 of the NHPA by following the implementing regulations at 36 CFR Part 800.

D. Termination of the National Programmatic Agreement

Should the National Programmatic Agreement be terminated or suspended for any reason, the BLM and the SHPO shall, within 30 days, bring this Protocol to the ACHP and attempt to convert this Protocol into a stand-alone statewide programmatic agreement. If the National Programmatic Agreement is terminated, the BLM will be required to comply with Section 106 of the NHPA by following the implementing regulations at 36 CFR Part 800.

XII. DECERTIFICATION/SUSPENSION FOR CAUSE

If a pattern of failure to comply with the terms of this Protocol can be demonstrated, a Field Office Manager, the DPO, or the SHPO may, upon written notification to the BLM State Director, request a review of a Field Office's status and its capability for carrying out the terms of the national Programmatic Agreement and this Protocol. The BLM State Director may request a review and recommendations from appropriate staff and/or the Preservation Board. The BLM, in consultation with the SHPO, shall develop an action plan to be followed by the Field Office under review in order to bring that office into compliance with this Protocol. After the subject Field Office believes that it has completed all of the actions specified in the plan, it will notify the BLM Deputy Preservation Officer who will review compliance with the action plan with SHPO. Based on the review, the BLM Deputy Preservation Officer will make a recommendation to the State Director.

If the Field Office has failed to comply with the action plan, the State Director may decertify and suspend a Field Office from operating under the terms of this Protocol. Decertification and suspension from this Protocol will require that the affected Field Office comply with Section 106 of the NHPA by following the implementing regulations at 36 CFR Part 800.

Recertification of the affected Field Office, which will allow that office to continue operating under the terms of this Protocol, will occur at the discretion of the BLM State Director after consultation with the

SHPO and/or Governor. The State Director will notify in writing both the Field Office and the SHPO when that Field Office is recertified.

XIII. IMPLEMENTATION

The previous Protocol dated April 15, 1998 will remain in effect until all appropriate staff are trained pursuant to Section IX.A of this Protocol. The terms of this Protocol will not be effective until BLM and SHPO staff has received training on the requirements and procedures herein. Cultural resource permittees will have the opportunity to receive training on Appendix C concurrently with the BLM and SHPO.

XIV. APPENDICES

A. Special Purpose Programmatic Agreements, Memorandums of Agreement and Supplemental Agreements in Effect Under the Protocol
B. Actions Exempt from Case-By-Case Review
C. Guidance on the Assessment of Setting (pending)
D. Defined Non-Sites and Property Types Requiring No Formal Documentation
E. Standard Signed Notification

Glossary

XIV. APPROVALS

BUREAU OF LAND MANAGEMENT

/ signed / 03/08/2006

Robert A. Bennett, Wyoming State Director Date

STATE HISTORIC PRESERVATION OFFICER

/ signed / 03/08/2006

Sara E. Needles, Wyoming State Historic Preservation Officer Date

STATE OF WYOMING

/ signed / 03/08/2006

Honorable Dave Freudenthal, Governor Date

STATE OF WYOMING ATTORNEY GENERAL

/ signed / 03/08/2006

Kyle Smith Date
Signature as to form

APPENDIX H

Programmatic Agreement Shell/Ultra

RECEIVED
15 2004
PINEDALE RESOURCE
AREA OFFICE

Programmatic Agreement

Among the Bureau of Land Management, the Wyoming State Historic Preservation Officer, the Advisory Council on Historic Preservation, Shell Exploration and Production Company and Ultra Resources, Inc., regarding the effects of the Pinedale Anticline Oil and Gas Exploration and Development in Sublette County, Wyoming, on the Lander Road Variant of the California National Historic Trail

WHEREAS, the Bureau of Land Management (BLM) proposes to approve 36 well pads for over 100 Applications for a Permit to Drill (APD) for Shell Exploration and Production Company (Shell) and Ultra Resources, Inc. (Ultra) in the Pinedale Anticline, Sublette County, Wyoming; and

WHEREAS, the BLM's approval of the APD, quality control, reclamation and rehabilitation will be implemented in accord with the Record of Decision for the Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project as ratified in July, 2000; and

WHEREAS, the development of well pads, drilling wells, and construction and use of access roads will have an adverse effect on the integrity of setting of the Lander Road Variant of the California National Historic Trail (Lander Road), designated by Congress as a National Historic Trail and determined eligible for listing on the National Register of Historic Places under Criteria A and C; and

WHEREAS, the BLM has established the area of potential effect (APE), as defined at 36 CFR § 800.16(d), to include the surface area within Township 31 North, Range 108 West, Sections 19, 20, 29, 30, 31, 32, 33, Township 31 North, Range 109 West, Sections 23, 24, 25 26, and the Lander Road between Township 30 North, Range 105 West, Section 22 and Township 31 North, Range110 West, Section 35; and

WHEREAS, a quarter-mile surface protection zone has been established on either side of the Lander Road to comprise a total zone for no surface disturbance of a half-mile; and

WHEREAS, the BLM has a Nationwide Programmatic Agreement and a Wyoming State Protocol Agreement that governs this undertaking with regard to any of its effects on the Lander Road Variant other than those to its integrity of setting, and all other undertakings and effects to historic properties that may occur within the APE; and

WHEREAS, the BLM has consulted with the Wyoming State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (ACHP) pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. § 470f) and 36 CFR § 800.14(b); and

WHEREAS, the BLM has invited Shell and Ultra to participate in consultation and sign this Programmatic Agreement (PA); and

WHEREAS, the BLM has consulted with the Oregon-California Trails Association (OCTA) and the National Historic Trails Administrator, National Park Service (NPS) and both parties may concur with this PA; and

WHEREAS, the BLM has consulted with the Northern Ute and Eastern Shoshone Tribes on the Lander Road and the PA and they did not express any concerns; and

WHEREAS, the State of Wyoming and the SHPO do not waive their sovereign immunity by entering into this PA, and each fully retains all immunities and defenses provided by law with respect to any action based on or occurring as a result of this PA; and

WHEREAS, this PA represents the entire and integrated agreement between the parties and supercedes all prior negotiations, representations and agreements, whether written or oral regarding Section 106 review of the effects of Pinedale Anticline Oil and Gas Exploration and Development Project on the integrity of setting of the Lander Road Variant of the California National Historic Trail.

NOW, THEREFORE, the BLM, SHPO, ACHP, Shell and Ultra agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on the integrity of setting for the Lander Road.

PINEDALE RESOURCE AREA OFFICE 2004

STIPULATIONS

The BLM shall ensure that the following stipulations are implemented.

I. Avoidance

A. Segments of the Lander Road within the APE will be avoided completely within the half-mile surface protection zone. BLM will identify the area to be avoided on the ground.

B. Shell and Ultra Project Managers will instruct all employees, contractors, subcontractors and any additional parties involved in the well pad construction and drilling to keep equipment, trucks and any other gear outside of the surface protection zone.

II. Mitigation

A. Surface ground disturbance and visual intrusions will be minimized by only constructing 36 well pads. Each well pad will average 6.5 acres. The wells will conform to the Wyoming Oil and Gas Commission's Standards for the Pinedale Anticline field development.

B. Shell and Ultra will jointly plan the construction and use of access and transportation roads and pipeline corridors. Both companies will utilize the same roads and pipeline corridors whenever possible which will limit the

number of roads and minimize visual impacts. Placing pipelines adjacent to roads will also limit ground disturbance.

C. Shell and Ultra will use low profile tanks, approximately 10 feet in height. The tanks will be painted to be visually integrated into the landscape by color (e.g. Carlsbad Canyon {2.5Y 6/2} or Shale Green {5Y 4/2}.

D. Visual simulations may be required for problematic well locations. The BLM will decide at the on-site for the well permit if a visual simulation is necessary. The SHPO, ACHP and OCTA will be provided with the data after a visual simulation is completed for review and comment.

E. Ultra will plug and abandon the Pinedale Federal #2 well location, located in Township 31 North, Range 108 West, Section 29. Ultra will remove all surface facilities and subsequently reclaim the site. Plugging, facility removal and reclamation will be completed by July 1, 2005.

F. Shell and Ultra will fund the replacement of a windmill in Township 30, Range 106 West, Section 12. The windmill will be replaced with a submersible pump. If replacement is not feasible, the windmill will be painted with non-reflective and appropriate environmental colors.

III. Reports and Educational Products

A. An Advisory Committee (Committee) is established with this PA to develop educational materials including interpretation of the historic significance of the Lander Road for the public. Representatives from the BLM, SHPO, Ultra, Shell, OCTA and the NPS will comprise the membership. The BLM Pinedale Field Manager will have final approval authority over any educational products.

B. The Committee will meet within three months of the execution of this PA to develop an Interpretive Plan with specific projects and a schedule for completion.

1. Specific educational products to be produced may include, but will not be limited to, an illustrated popular report, augmentation of the existing Trails website, interpretive signs, kiosks, brochures, trail markers, posters, and a traveling exhibit for communities within Wyoming.
2. Photographic documentation may include, but will not be limited to large format black-and-white landscape and specific segments of the Lander Road, black-and-white and color aerial photos, narrated video documentation of the affected segments of the Lander Road and copies of any archival historic photos that may exist in collections.

3. Educational interpretive products may be developed for the segment of the Lander Road between Buckskin Crossing and the Green River.

C. Shell and Ultra will jointly fund the educational products identified in the final Interpretive Plan for a total amount not to exceed $60,000.

D. Implementation of the Interpretive Plan will commence within one year of the execution of this PA.

E. The BLM will prepare an annual report as a specific requirement of this PA. The report will include the number of APD's approved for the calendar year, status of the Interpretive Plan and its' implementation, status of reclamation efforts, and a summary of any mitigation that may have been taken place during construction of the well pad, access roads or an individual APD. The report will be distributed to all signatories by March 31 of each year the PA is in effect.

IV. Dispute Resolution

A. The BLM shall consult with any signatory to this PA if there is an objection by a signatory to the manner in which the terms of this agreement are implemented.
B. If the objection cannot be resolved between the BLM Field Manager and the objecting signatory, the matter shall be referred to the BLM Deputy Preservation Officer (DPO) for resolution.
C. If the objection cannot be resolved with the BLM DPO, then all signatories should consult to resolve the matter.
D. If the objection cannot be resolved among the signatories, the matter shall be referred to the BLM State Director. The matter may be referred to the BLM Preservation Board which will provide recommendations for resolution to the State Director. The final decision for resolution of the objection by any signatory shall be made by the BLM State Director.
E. The BLM Field Manager shall consider non-signatory objections to the manner in which the terms of the agreement are implemented. If the objection cannot be resolved to the satisfaction of BLM and the objecting party, the BLM Field Manager shall request the signatories to provide their opinion on the matter. Prior to making a final decision on the matter, the BLM Field Manager shall take into account all the signatory opinions received within 15 days of the request.

V. Amendment

Any signatory to this PA may request that the other signatories consider amending it if circumstances change over time and warrant revision of the stipulations. Amendments will be executed in the same manner as the original PA.

VI. Termination

A. Any signatory to this PA may initiate consultation for termination by providing 30 business days notice to the other parties of their intent. After notification by the initiating signatory, the remaining signatories will have 60 business days to consult to seek agreement on amendments or any other actions that would address the issues and avoid termination.

B. In the event of termination, the BLM will refer to Wyoming State Protocol Agreement to address any remaining adverse effects to the Lander Road.

VII. Sunset Terms

A. This PA will remain in effect for ten years from the date of execution.

B. If Shell and Ultra have not completed the development of their leaseholds in ten years, the BLM will insure the PA will be reevaluated, revised if necessary to accommodate any changes to the terms, and renewed for another ten years. All signatories will be consulted in the reevaluation of the stipulations.

C. The BLM will ensure the PA will be reevaluated every ten years by all signatories, or until all the wells have been reclaimed and rehabilitated as specified in the BLM Pinedale Field Office Record of Decision for the Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming as ratified in July 2000.

Execution of the Programmatic Agreement and implementation of its terms evidence that BLM has afforded the ACHP an opportunity to comment on the undertakings that will adversely effect the integrity of the setting of the Lander Road.

APPENDIX I

Air Quality Impact Tables Year 2005 Modeling

Table I.1 - Summary of Maximum Modeled NO_2 Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources

Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
0.221	8.22	0.015	8.02	0.006	8.01	0.019	8.02	0.001	8.00

Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
0.046	8.05	0.003	8.00	0.002	8.00	0.033	8.03	0.001	8.00

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 100 $\mu g/m^3$ on an annual basis.

[2] Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.

Table I.2 - Summary of Maximum Modeled SO_2 Concentration ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources

Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
0.80	0.23	0.02	132.8	43.2	9.02	0.19	0.06	0.003	132.2	43.1	9.00	0.08	0.017	0.001	132.1	43.0	9.00	0.17	0.04	0.002	132.2	43.0	9.00	0.03	0.01	0.0003	132.0	43.0	9.00

Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
0.18	0.04	0.01	132.2	43.0	9.01	0.05	0.01	0.001	132.0	43.0	9.00	0.05	0.01	0.001	132.0	43.0	9.00	0.19	0.05	0.01	132.2	43.0	9.01	0.05	0.01	0.0003	132.1	43.0	9.00

[1] Total concentration includes direct modeled impact and background concentration for comparison with NAAQS/WAAQS which are 1,300 $\mu g/m^3$ on a 3-hour basis, 365/260 $\mu g/m^3$ on a 24-hour basis and 80/60 $\mu g/m^3$ on an annual basis. Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.

Table I.3 - Summary of Maximum Modeled PM_{10} Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources

Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
1.80	0.10	33.8	9.10	0.60	0.02	32.6	9.02	0.18	0.01	32.176	9.01	0.36	0.02	32.4	9.02	0.13	0.003	32.134	9.00

Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
0.46	0.04	32.5	9.04	0.13	0.01	32.1	9.01	0.17	0.01	32.2	9.01	0.54	0.03	32.5	9.03	0.12	0.004	32.1	9.00

[1] Total Concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS whaich are 150$\mu g/m^3$ on a 24-hour basis and 50 $\mu g/m^3$ on an annual basis.

Background PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.

Table I.4 - Summary of Maximum Modeled $PM_{2.5}$ Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources

Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
0.72	0.10	15.7	6.10	0.19	0.02	15.2	6.02	0.11	0.01	15.1	6.01	0.15	0.02	15.2	6.02	0.05	0.003	15.0	6.00

Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
0.26	0.04	15.3	6.04	0.06	0.01	15.1	6.01	0.07	0.01	15.1	6.01	0.26	0.03	15.3	6.03	0.06	0.004	15.1	6.00

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 65 $\mu g/m^3$ on an annual basis and 15 $\mu g/m^3$ (revised NAAQS of 35 $\mu g/m3$ effective on Dec 18, 2006) on a 24-hour basis.

[2] Background $PM_{2.5}$ concentration values of 15 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

Table I.5 - Summary of Maximum Modeled NO_2 Concentration Impacts ($\mu g/m^3$) Compared to PSD Increments from Year 2005 Project Sources

Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
0.221	2.5	0.015	2.5	0.006	2.5	0.019	25.0	0.001	2.5

Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
0.046	25.0	0.003	2.5	0.002	2.5	0.033	25.0	0.001	2.5

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

Table I.6 - Summary of Maximum Modeled SO_2 Concentration ($\mu g/m^3$) Compared to PSD Increments from Year 2005 Project Sources[1]

Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
0.80	0.23	0.02	25.0	5.0	2.0	0.19	0.06	0.003	25.0	5.0	2.0	0.08	0.017	0.001	25.0	5.0	2.0	0.17	0.04	0.002	512.0	91.0	20.0	0.03	0.01	0.0003	25.0	5.0	2.0

Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
0.18	0.04	0.01	512.0	91.0	20.0	0.05	0.01	0.001	25.0	5.0	2.0	0.05	0.01	0.001	25.0	5.0	2.0	0.19	0.05	0.01	512.0	91.0	20.0	0.05	0.01	0.0003	25.0	5.0	2.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis .

Table I.7 - Summary of Maximum Modeled PM_{10} Concentration Impacts ($\mu g/m^3$) from Year 2005 Project Sources Compared to PSD Increments[1]

Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
1.80	0.10	8.0	4.0	0.60	0.02	8.0	4.0	0.18	0.01	8.000	4.0	0.36	0.02	30.0	17.0	0.13	0.003	8.000	4.0

Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
0.46	0.04	30.0	17.0	0.13	0.01	8.0	4.0	0.17	0.01	8.0	4.0	0.54	0.03	30.0	17.0	0.12	0.004	8.0	4.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

Table I.8 - Summary of Maximum Modeled In-field Pollutant Concentrations ($\mu g/m^3$) from Year 2005 Project Sources

NO_2				SO_2											
Direct Modeled Impact[1]	PSD Class II Increment[2]	Total Concentration[3]	NAAQS/ WAAQS	Direct Modeled Impact[1]			PSD Class II Increment[2]			Total Concentration[3]			NAAQS/WAAQS		
Annual	Annual	Annual	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
31.6	25.0	39.6	100	76.1	14.9	2.3	512.0	91.0	20.0	208.1	57.9	11.3	1,300	365/260	80/60

PM_{10}								$PM_{2.5}$					
Direct Modeled Impact[1]		PSD Class II Increment[2]		Total Concentration[3]		NAAQS/ WAAQS		Direct Modeled Impact		Total Concentration[3]		NAAQS/ WAAQS	
24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
76.3	20.9	30.0	17.0	108.3	29.9	150	50	15.0	5.4	30.0	11.4	65 (35)[4]	15

1

2 Background concentrations are not added to modeled concentrations for comparison to the PSD increment.
All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

3

Total concentration includes direct modeled impact and background concentration.

Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.

Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.

Background PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.

Background $PM_{2.5}$ concentration values of 15 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

4

Revised NAAQS effective December 18, 2006.

Table I.9 - Summary of Maximum Modeled Visibility Impacts from Year 2005 at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources Using FLAG Background Data - (MVISBK=6)

Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
6.1	45	3.9	5	1.1	1	2.8	2	0.5	0

Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
2.3	6	0.8	0	0.9	0	2.9	6	0.5	0

Note: Δdv = change in deciview.

Table I.10 - Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Community Locations from Year 2005 Project Sources Using Boulder Background Data

Boulder		Cora		Pinedale	
Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)
12.2	108	8.5	36	10.3	55

[1] Δdv = change in deciview.

Table I.11 - Summary of Maximum Modeled Total Nitrogen (N) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources[1]

Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
0.058	1.478	0.007	1.427	0.004	1.294	0.008	1.428	0.003	1.293

Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
0.020	1.440	0.003	1.293	0.003	1.293	0.012	1.432	0.002	1.292

1

2 Nitrogen deposition analysis level of concern for total impacts - 3.00 kg/ha-yr.

3 Includes N deposition value of 1.42 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.
Includes N deposition value of 1.29 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.

Table I.12 - Summary of Maximum Modeled Total Sulfur (S) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Year 2005 Project Sources[1]

Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
0.0098	0.750	0.0015	0.741	0.0006	0.681	0.0013	0.741	0.0004	0.680

Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
0.0042	0.744	0.0005	0.680	0.0006	0.681	0.0026	0.743	0.0004	0.680

1

2 Sulfur deposition analysis level of concern for total impacts = 5.0 kg/ha-y.

3 Includes S deposition value of 0.74 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.
Includes S deposition value of 0.68 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.

Table I.13 - Summary of Maximum Modeled Change in ANC (μeq/L) at Acid Sensitive Lakes from Year 2005 Project Sources

	Black Joe Lake		Deep Lake		Hobbs Lake		Lazy Boy Lake		Lower Saddlebag		Ross Lake		Upper Frozen	
	Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Popo Agie Wilderness Class II		Fitzpatrick Wilderness Class I		Bridger Wilderness Class I	
Alternative	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)
Level of Acceptable Change(μeq/L)	6.71	10%	5.97	10%	6.99	10%	1.00	--	5.52	10%	5.37	10%	1.00	--
Background	67.1	--	59.7	--	69.9	--	10.8	--	55.2	--	53.7	--	6.0	--
Predicted change in ANC	0.18	0.27%	0.20	0.34%	0.10	0.15%	0.06	--	0.19	0.35%	0.05	0.10%	0.22	--

[1] USFS Level of Acceptable Change: 10% change in ANC for lakes with ANC background values greater than 25 μeq/L, 1 μeq/l for lakes with ANC values less than or equal to 25 μeq/L.

APPENDIX J

Erosion Modeling, Sediment Transport Modeling, and Salt Loading

Technical Report

HydroGeo, Inc.
Surface & Groundwater Hydrology

TECHNICAL REPORT

EROSION MODELING, SEDIMENT TRANSPORT MODELING, AND SALT LOADING

PINEDALE ANTICLINE PROJECT SUBLETTE COUNTY, WYOMING

Prepared by

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November 2006

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1. INTRODUCTION

The potential for environmental impacts associated with erosion, sediment transport and salinity has been identified as an issue for further investigation in the Supplemental Environmental Impact Statement (SEIS) for continued development of the Pinedale Anticline Project Area (PAPA). The purpose of this technical report is to describe the conceptual model of the watershed hydrology, summarize the hydrologic transport modeling methods, and to present modeling results that simulate potential impacts resulting from erosion, sedimentation, and salinity.

1.1 Modeling Objectives

The goals of the sediment transport and salinity modeling were to simulate potential erosion and sediment loads entering the Green, New Fork, and Big Sandy rivers and leaving the PAPA boundary and to estimate the potential for salinity loading in the Green and the Big Sandy rivers. The modeling was designed to simulate sediment loading under the following seven conditions:

- Assuming No Disturbance in the PAPA Area (baseline conditions)
- Under the Current Conditions (end of 2006)
- Under the No Action Alternative(end of 2011)
- Under the Proposed Action Alternative (end of 2011)
- Under the Proposed Action Alternative (end of 2023)
- Under Alternative C (end of 2011)
- Under Alternative C (end of 2023)

The results of the watershed modeling for erosion were expressed in soil loss of kilograms per hectare per year. The results of the watershed modeling for sediment transport were expressed in kilograms of sediment per year at the PAPA boundary and in percentage increase over a non-disturbance baseline case and over the current conditions.

1.2 Model Selection

Two different models were chosen to simulate long-term and short-term storm-related erosion and sediment transport for two different spatial scales.

Spatial scale is an important criterion in the selection of a model because the storage characteristics vary at different watershed scales, that is, large watersheds have well developed channel networks and a channel phase, and thus, channel storage is dominant. Such watersheds are less sensitive to short duration, high intensity rainfalls. Alternatively, small watersheds are dominated by the land phase and overland flow, thus they have a relatively less conspicuous channel phase and are highly sensitive to high intensity, short duration rainfalls (Burns et al, 2004).

Storm event watershed modeling was performed using the Kinematic Runoff and Erosion Model (KINEROS2), developed by the U.S. Department of Agriculture (USDA, 2005). KINEROS2 is an event-oriented physically based model that describes the processes of interception, infiltration, surface runoff, and erosion from small agricultural and urban watersheds. KINEROS2 utilizes a network of channels and planes to represent a watershed and the kinematic wave method to route water off the watershed. It is a physically-based model designed to simulate runoff and erosion for single storm events in small watersheds less than approximately 100 km^2 (10,000 hectares or 24,711 acres). Considering this, KINEROS2 was suitable to model the ephemeral drainages within the PAPA, but could not be used to model the large watersheds of the Green River or the New Fork River.

The model program SWAT (Soil and Water Assessment Tool) was used to simulate large patterns of change in erosion on a large scale assessment over a longer period of time for the Green and New Fork rivers watersheds. SWAT is a distributed lumped-parameter model developed by the USDA Agricultural Research Service (ARS) to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large (basin scale) complex watersheds with varying soils and land use and management conditions over long periods of time (> 1 year). SWAT is a continuous-time model, i.e., a long-term yield model, using daily average input values, and is not designed to simulate detailed, single-event flood routing. Major components of the SWAT model include: hydrology, weather generator, sedimentation, soil temperature, and groundwater and lateral flow (Burns et al, 2004).

Both SWAT and KINEROS2 models were implemented using a public domain geographic information system (GIS) interface, the AGWA (Automated Geospatial Watershed Assessment) tool (Burns et al, 2004). This interface operates in ArcView 3.x GIS and performed the automated parameterization for both models for specified watersheds and basins.

Results from both models are presented for the sixth-level sub-watershed within the PAPA. Sixth level sub-watersheds have a 12-digit Hydraulic Unit Code (HUC). A sub-watershed is defined as typically having an area of 10,000 to 40,000 acres.

1.3 Impact Analysis Approach

The following conditions/alternatives were modeled:

- No Disturbance in the PAPA (baseline conditions)
- Current Conditions (end of 2006)
- No Action Alternative (end of 2011)
- Proposed Action Alternative (end of 2011 and 2023)
- Alternative C (end of 2011 and 2023)

Baseline conditions are based on the vegetation / land cover described in the Wyoming Land Cover Gap Analysis (Wyoming Gap Analysis, 1996) and PAPA-specific vegetation data. Current Conditions and Alternatives were modeled by adding disturbances to the 1996 vegetation. The exact locations of the disturbances are not yet determined, but disturbance percentages per quarter section were given. The total amount of disturbance is the same for the Proposed Action Alternative and Alternative C, but the distribution and development time lines differ. Mitigation measures such as engineered retention structures would likely be implemented, but the mitigation effects were not modeled; therefore, the model results are considered conservative.

2 WATERSHEDS AND SOILS

2.1 Watershed Hydrology

Five perennial streams flow partially through the PAPA: Duck Creek, East Fork River, Green River, New Fork River, and Pine Creek. The majority of the PAPA is drained by intermittent and ephemeral drainages. The PAPA is within the Upper Colorado Region and the Upper Green River Basin and is divided into three sub-basins: Upper Green River, New Fork River, and Big Sandy River. Twenty-one sub-watersheds intersect the PAPA. Of these, twelve drain into the New Fork River, which then flows into the Green River. Five sub-watersheds drain either directly into the Green River, or into the Green River via Alkali Creek. Four sub-watersheds drain into the Big Sandy River (Table 1 and Map 1).

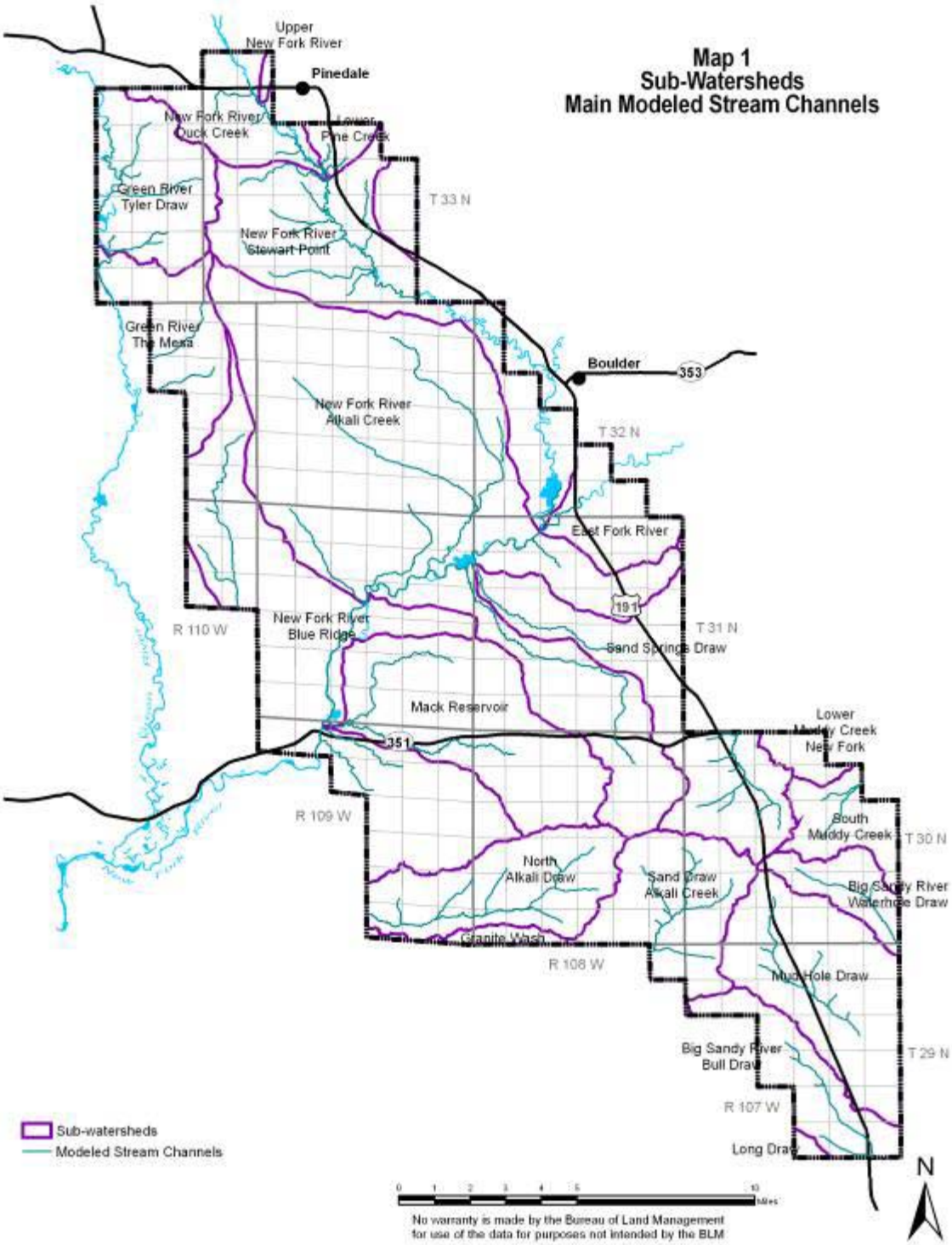
Map 1
Sub-Watersheds
Main Modeled Stream Channels
Upper
New Fork River
Pinedale
New Fork River/
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
T 33 N
New Fork River
Stewart Point
Green River
The Mesa
Boulder
353
New Fork River
Alkali Creek
T 32 N
East Fork River
191
New Fork River
Blue Ridge
R 110 W
T 31 N
Sand Springs Draw
Mack Reservoir
351
Lower
Muddy Creek
New Fork
R 109 W
South
Muddy Creek
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
Granite Wash
R 108 W
Mud Hole Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Long Draw
Sub-watersheds
Modeled Stream Channels
N
No warranty is made by the Bureau of Land Management
for use of the data for purposes not intended by the BLM

Table 1 Watershed Areas

Sub-Watershed	Sub-Basin	Hydrologic Unit Code (HUC)	Surface Area (acres) in PAPA	Total Surface Area (acres)
Big Sandy River – Bull Draw	Big Sandy River	140401040106	5,761	19,768
Big Sandy River - Long Draw	Big Sandy River	140401040109	316	18,529
Big Sandy River – Waterhole Draw	Big Sandy River	140401040105	3,349	23,876
Mud Hole Draw	Big Sandy River	140401040107	12,923	19,619
East Fork River	New Fork	140401020302	4,885	25,005
Hay Gulch	New Fork	140401020105	245	14,668
Lower Muddy Creek – New Fork	New Fork	140401020603	1,492	34,520
Lower Pine Creek	New Fork	140401020203	1,276	25,749
Lower Pole Creek	New Fork	140401020403	1,757	20,119
Mack Reservoir	New Fork	140401020306	15,353	15,353
New Fork River – Alkali Creek	New Fork	140401020303	49,522	49,532
New Fork River – Blue Ridge	New Fork	140401020305	24,909	39,853
New Fork River – Duck Creek	New Fork	140401020102	5,521	37,229
New Fork River – Stewart Point	New Fork	140401020301	17,216	32,670
Sand Springs Draw	New Fork	140401020304	13,207	19,073
South Muddy Creek	New Fork	140401020602	4,121	33,923
Granite Wash	Upper Green River	140401010704	1,091	12,218
Green River – The Mesa	Upper Green River	140401010404	7,293	41,713
Green River –Tyler Draw	Upper Green River	140401010403	8,834	34,761
North Alkali Draw	Upper Green River	140401010705	9,959	15,918
Sand Draw – Alkali Creek	Upper Green River	140401010701	9,004	22,941

2.2 Erosion, Sediment Transport, and Salt Loading

Soils within the PAPA vary in physical and chemical characteristics as determined primarily by geologic, topographic, and climatic factors. Soils on steeper slopes are especially subject to water erosion and are difficult to reclaim (BLM, 1983). Project activities may increase the potential erosion of these soils, due to the proposed surface disturbance. After major storm events, disturbed soils could be eroded and transported into live streams, if unchecked by appropriate erosion control measures (e.g., reclamation, retention structures).

Increased erosion and sediment transport could lead to increased salinity in the Green River and significant precipitation events could move the dissolved salt to these receiving waters. Salt loading is an issue of concern in the Colorado/Green River system; therefore, any salt loading associated with this project could have implications concerning the Colorado River Basin Salinity Control Act (USBR, 1974).

3 MODEL SETUP

3.1 SWAT and KINEROS2

The watershed modeling was performed using the physically based models SWAT and KINEROS2.

KINEROS2 is an event oriented model, i.e. it is meant to model single storm events. It describes the processes of interception, infiltration, surface runoff, and erosion from small agricultural and urban watersheds during a storm event. Watersheds are represented by a cascade of planes and channels. The partial differential equations describing overland flow, channel flow, erosion, and sediment transport are solved by finite difference techniques. The spatial variations of rainfall, infiltration, runoff, and erosion parameters can be accommodated within the program. KINEROS2 may be used to determine the effects of various artificial features--such as urban developments, small detention reservoirs, or lined channels--on flood hydrographs and sediment yield.

The KINEROS2 model was operated using a public-domain GIS interface, called Automated Geospatial Watershed Assessment or AGWA. AGWA was developed by the USDA, Agricultural Research Service, Southwest Watershed Research Center, in cooperation with the U.S. Environmental Protection Agency (EPA) Office of Research and Development (Burns et al. 2004). AGWA operates in ArcView 3.x GIS and was used to perform the automated parameterization of KINEROS2 for a specified watershed.

SWAT is a continuous time model, i.e. a long-term sediment yield model. The model is not designed to simulate detailed, single-event flood routing. For modeling purposes, a watershed may be partitioned into a number of sub-watersheds or sub-basins. The use of sub-basins in a simulation is particularly beneficial when different areas of the watershed are dominated by land uses or soils dissimilar enough in properties to impact hydrology (Neitsch et al. 2002). SWAT was also operated using AGWA.

3.2 Precipitation and Storm Events

For the two different models, two different types of precipitation data had to be used. SWAT required daily rainfall data for a long period of time, while KINEROS2 required total rainfall depth for a discrete storm event.

Precipitation used for the SWAT input was the daily rainfall data from the gage at Pinedale, Wyoming for the 25- year time period 1980 through 2004. Missing data were filled in with data from the gage at the Boulder Rearing Station (NOAA, 2006). Rainfall was assumed to be uniformly distributed over the entire PAPA. Model runs for SWAT were conducted for the complete 25 year period; the results are then averaged by the model to give the average annual erosion data.

Storm runoff events for KINEROS2 were modeled for 24-hour storms having the following recurrence intervals:

- 5-year
- 10-year
- 20-year
- 50-year
- 100-year, and
- 150-year

Precipitation depths for the 2-year through 100-year storm events were obtained from the National Oceanic and Atmospheric Administration (NOAA) Atlas for Western Precipitation Frequency Maps (NOAA 1973). The precipitation depth for the 150-year storm event was extrapolated from the NOAA data using a semi-log plot (Figure 1). Precipitation depths for all storm events are summarized in Table 2.

Figure 1. Storm Magnitude

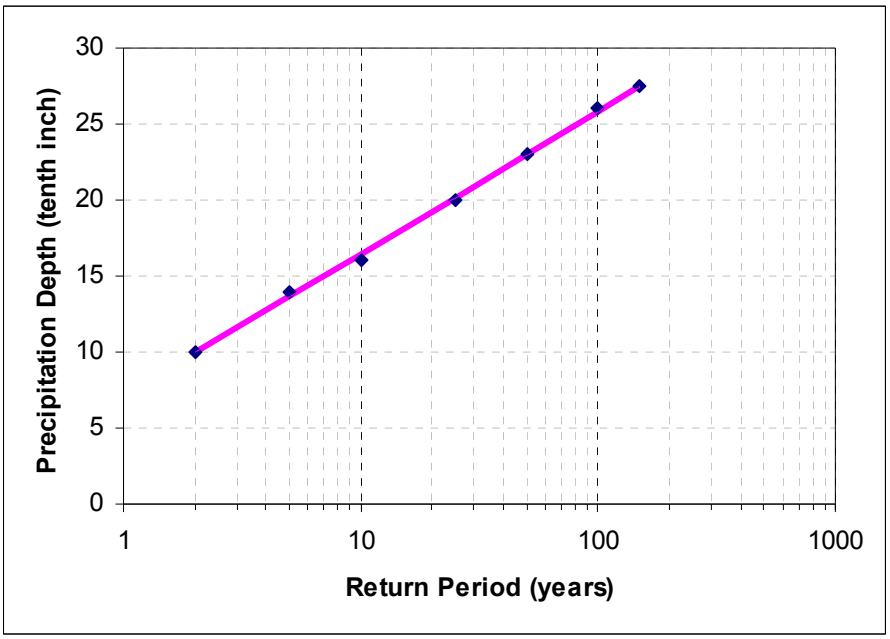

Table 2 Recurrence Interval and Magnitude of 24-hour Precipitation Event

Recurrence Interval T (Years)	Annual Probability	Storm Magnitude x_T (inches)
2	0.5	1.0
5	0.2	1.4
10	0.1	1.6
20	0.04	2.0
50	0.02	2.3
100	0.01	2.6
150	0.0067	2.7

Using AGWA, the precipitation depth is converted to a hyetograph using the Soil Conservation Service (SCS) methodology (SCS 1973) and a type II storm distribution. The precipitation input files for KINEROS2 give the rainfall depth over time, and a sample is shown in Attachment A.

3.3 Elevation Data and Watershed Delineation

The SWAT and KINEROS2 models both calculate flow and erosion in a watershed by assuming each watershed is a connected series of planes and channels. AGWA calculates the planes and channels

necessary for input from digital elevation data. Elevation data from the National Elevation Dataset were downloaded from the U.S. Geological Survey (USGS) EROS Data Center (USGS 2005).

The following elevation data were used: National Elevation Dataset (NED) 1/3 Arc Second, downloaded in ArcGrid NAD 83 Geographic format (vertical datum is GRS 80. For this dataset, the resolution is 10 m. The elevation data were converted to NAD 1983, UTM Zone 12, in meters.

AGWA was then used to delineate the watersheds covering the PAPA and to divide the watersheds into planes and channels for KINEROS2 and SWAT input. This process is described in the AGWA manual (Burns et al. 2004). First, any sinks in the NED data are filled. Sinks are isolated depressions in the elevation surface that can cause flow routing problems. Next, a flow direction grid is created for the entire topographic surface. Then a flow accumulation grid is created. The user then selects a watershed outlet, and the watershed is delineated according to the elevations in the NED file. Ponds or internal gages can be created, but were not used for this project. Lastly, a size for the contributing source area (CSA) of 2.5% or 350 acres, whichever was larger, of the watershed size was selected for all watersheds. CSA is the area that is required before the flow becomes channelized. Smaller numbers result in a larger number of smaller planes and vice versa, so the CSA is a measure of the geometric complexity at which the watershed is delineated. The sub-watershed channels created for input are shown on Map 1.

Discrete channels were created within AGWA, and AGWA-created model channels were generally consistent with the mapped drainage channels. Channel geometry was defined by using the model-default hydraulic geometry relationship options for the channel geometries. These relationships are known as bankfull hydraulic geometry relationships, and they define the bankfull channel width and depth based on watershed size. Bankfull hydraulic geometry relationships are useful in that they define channel topography with minimal input from the user and when actual channel topography is not known or known only for a small portion of actual channels in the watershed (Burns et al. 2004).

3.4 Soils

Properties of the soils in the watersheds can provide estimated input parameters, such as infiltration, water flow, and sediment routing for KINEROS2 and SWAT. The following parameters are estimated for each channel and plane element of each watershed from the soil properties:

Both Models:

- Ks - saturated hydraulic conductivity, in mm/hr

KINEROS2 Parameters:

- CV - Coefficient of variation of Ks
- G - mean capillary drive, in mm (a zero value sets the infiltration rate to a constant value of Ks)
- Distribution - pore size distribution index (or Brooks and Corey Lambda) (This is a parameter used for redistribution of soil moisture during intervals of no flow.)
- Porosity
- Rock - volumetric rock fraction, if any
- Splash - rain splash coefficient (for plane elements only) (0-1)
- Cohesion - cohesion coefficient of bed material, and
- Fractions - list of particle class fractions that must sum to one. Fract_sand: fractional sand content (0-1) ; Fract_silt: fractional silt content (0-1); Fract_clay: fractional clay content (0-1).

SWAT Parameters:

- HydValue - weighted hydrologic group value used to determine the runoff curve number.
- CN - area-weighted runoff curve number based on soil type and land cover

For KINEROS2, the soil parameters are area-weighted by sub-watershed. For SWAT, these values are based on the dominant soil type found in the sub-watershed.

AGWA estimates these parameters from the State Soil Geographic (Statsgo) database (Burns et al., 2004). However, more detailed soil data are available for the PAPA from the Burma Road Soil Survey (ERO Resources Corporation, 1988) and an on-going survey (Vasquez, 2006). Detailed soil data from both reports were used within the PAPA. The extent of each soil survey within the PAPA is shown in Map 2. The data was put in a database format equivalent to the Statsgo data format. Statsgo soils data were added to the new database for areas where other information was not available. The Statsgo data for Wyoming were downloaded from the NRCS website (NRCS 2005). The database tables created from the Burma Road Soil Survey and the new NRCS survey for the PAPA and surrounding Statsgo soils are shown in Attachment B. The newly created database tables were then used within AGWA to estimate the parameters listed above. The range and average of the parameters estimated from the soils data are shown in Table 3 for KINEROS2 and in Table 4 for SWAT.

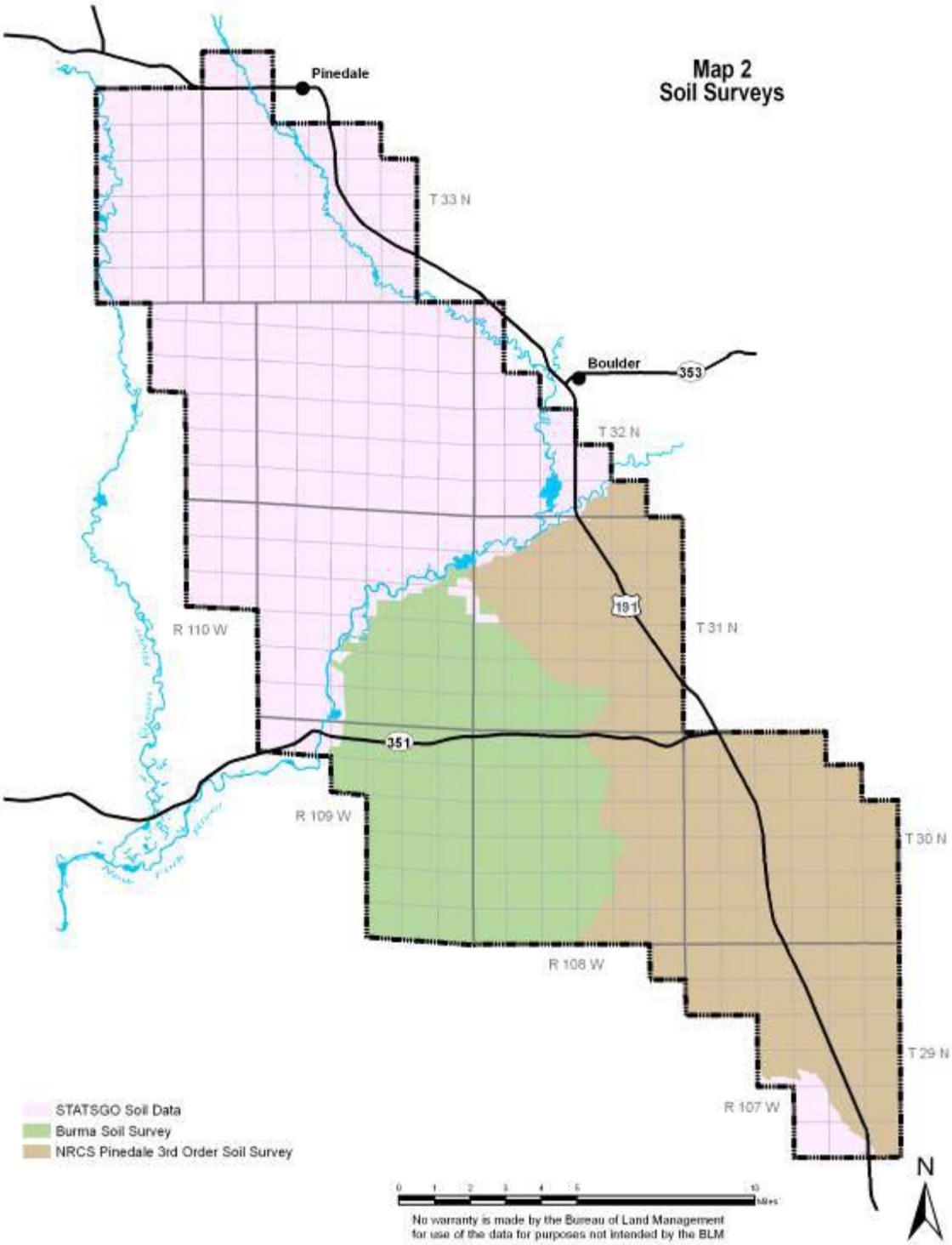
Map 2
Soil Surveys
Pinedale
Boulder
353
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
191
351
STATSGO Soil Data
Burma Soil Survey
NRCS Pinedale 3rd Order Soil Survey
N
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Table 3 KINEROS2 Input Parameters Derived from Soil Properties

	Channel (Constant-AGWA default values)	**Plane Average**	**Plane Minimum**	**Plane Maximum**
Ks (mm/hr)	210	14.84	3.26	36.79
CV	0	1.06	0.53	1.54
G (mm)	101	182.52	88.77	280.98
Distribution	0.545	0.29	0.22	0.32
Porosity	0.44	0.428	0.331	0.465
Rock	0	0.15	0.05	0.48
Splash	--	106.65	73.30	134.40
Cohesion	0.005	0.006	0.004	0.008
Sand Fraction	0.9	0.51	0.37	0.69
Silt Fraction	0.05	0.27	0.15	0.40
Clay Fraction	0.05	0.22	0.12	0.34

Table 4 SWAT Input Parameters Derived from Soil Properties

	Average	**Minimum**	**Maximum**
Ks (mm/hr)	23.90	12.01	41.58
HydValue	1.32	0.98	2.26

3.5 Land Cover

Land cover and vegetation can be used to estimate infiltration parameters and the Manning roughness for KINEROS2 and SWAT. The following parameters have to be estimated for each plane element of each watershed for KINEROS2:

Both Models:

- Manning - Manning roughness coefficient (for plane and channel elements)

KINEROS2 Parameters:

- Canopy - fraction of surface covered by intercepting cover (rainfall intensity is reduced by this fraction until the specified interception depth has accumulated)
- Interception - interception depth in mm or inches, and

SWAT Parameters:

- CN: area-weighted runoff curve number based on soil type and land cover
- Cover: fraction of surface covered by intercepting cover – rainfall intensity is reduced by this fraction until the specified interception depth has been accumulated (0-1)

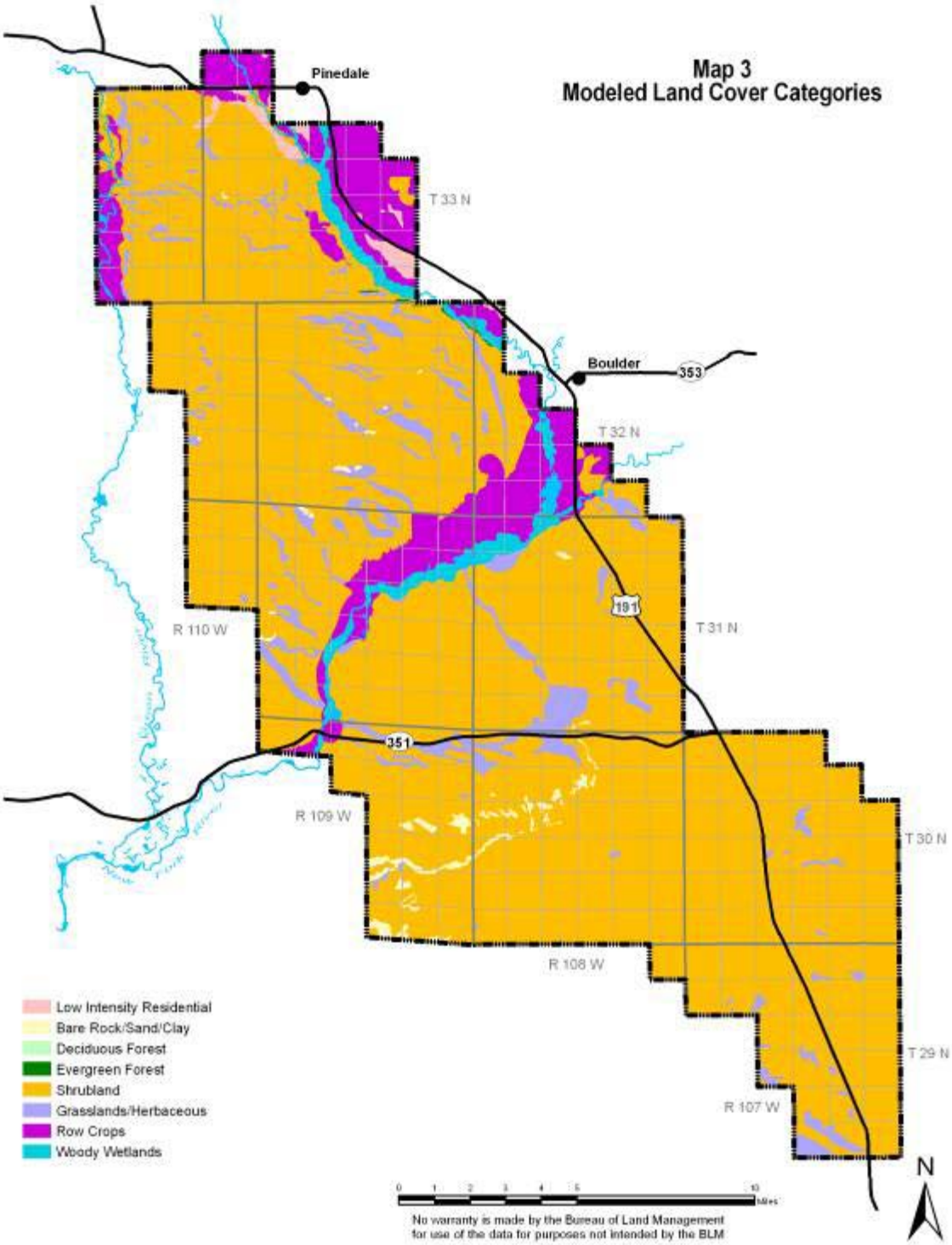
AGWA can estimate these parameters from the Multi-Resolution Land Characteristics (MRLC) Consortium National Land Cover Data (NLCD).

Two sources were used to obtain the land cover data. For the PAPA, detailed specific vegetation data were developed as grid files. Outside the PAPA, Wyoming GAP land cover data from a map at 1:100,000-scale (http://www.sdvc.uwyo.edu/clearinghouse/metadata/landcov.html) were added to the map. Vegetation types were converted to the closest land cover type defined in the NLCD land cover database. The resulting land cover classification is shown in Map 3. In order to use the AGWA parameter estimation routine, an ID was assigned to each vegetation type according to the NLCD land cover class. Thus, the AGWA lookup table could be used to convert land cover information to modeling parameters. The AGWA look-up table for vegetation data is shown in Attachment C.

The ranges and average of the parameters estimated from land cover data for KINEROS2 are shown in Table 5, and for SWAT in Table 6.

Table 5 KINEROS2 Input Parameters Derived from Land Cover Properties

	Channel (Constant)	**Plane Average**	**Plane Minimum**	**Plane Maximum**
Canopy (no disturbance case)	--	0.31	0.10	0.70
Interception (no disturbance case)	--	2.54	0.72	3.00
Manning (no disturbance case)	0.035	0.053	0.025	0.104
Canopy (disturbance cases)	--	0.25	0.07	0.70
Interception (disturbance cases)	--	1.98	0.23	3.00
Manning (disturbance cases)	0.035	0.044	0.004	0.158


Map 3
Modeled Land Cover Categories
Pinedale
Boulder
353
191
351
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
Low Intensity Residential
Bare Rock/Sand/Clay
Deciduous Forest
Evergreen Forest
Shrubland
Grasslands/Herbaceous
Row Crops
Woody Wetlands
0 1 2 3 4 5 10
Miles
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N

Table 6 SWAT Input Parameters Derived from Land Cover Properties

	Channel (Constant)	Plane Average	Plane Minimum	Plane Maximum
CN (no disturbance case)	--	86.43	81.12	91.23
Cover (no disturbance case)	--	28.78	20.60	63.80
Manning (no disturbance case)	0.030	0.050	0.050	0.050
CN (disturbance cases)	--	87.77	81.12	94.00
Cover (disturbance cases)	--	25.32	6.93	61.00
Manning (disturbance cases)	0.030	0.050	0.050	0.050

3.6 Disturbance

Disturbances from PAPA developments were simulated for modeling purposes by assuming the land cover changes to equal bare ground, a conservative assumption. Disturbance percentages were given by quarter section for each of the modeled alternatives. The disturbance percentages for each modeled scenario are given in Attachment D. Land cover parameters for each quarter section were changed to simulate the appropriate percentage of disturbance.

3.7 Salt Loading

In the Burma Road Soil Survey (ERO Resources Corporation 1988), chemical analyses of seven soil profiles were performed. The chemical properties of the top layer of saturated soil are summarized in Table 7. The median measured electric conductivity for the 1988 analyzed profiles using the saturated paste method is 0.4 dS/m.

Table 7 Soil Profile Chemical Analysis (ERO Resources Corporation 1988)

Soil Name	Depth (inches)	Electric Conductivity (dS/m)	Ca (meq/l)	Mg (meq/l)	Na (meq/l)	Sodium Adsorption Ratio
Fraddle	0-4	0.3	1.4	0.7	0.3	0.3
Quard Variant	0-4	0.5	1.2	0.7	3.2	3.3
Dines	0-4	0.4	1.0	0.4	3.0	3.5
Fluvent, Saline-Sodic	0-4	2.5	4.3	1.1	22.4	13.6
Vermillion Variant	0-3	0.3	1.4	1.1	0.3	0.3
Baston	0-3	0.5	0.8	0.5	4.7	6.0
Langspring Variant	0-3	0.4	4.4	1.1	0.3	0.2

Electric conductivity was measured with the saturation extract method or saturated paste method. In this method, water is added to the soil until the soil is saturated and just reaches the flow point. This condition is referred to as a saturated paste. The saturated paste is allowed to sit for approximately two hours to reach equilibrium. At that time, the water present in the paste is extracted. This extract is referred to as the saturation extract. The electrical conductivity of this extract is then measured. The higher the salt concentration in a specific soil, the higher the conductivity of the saturation extract.

In ERO Resources Corporation (1988), an estimated electric conductivity is given for all soils in the study area for this report (see also BLM 2005). The estimated average electric conductivity for each soil series and the derived electric conductivity for each soil complex or map unit are shown in Attachment E.

The estimated electric conductivities are given as a range or maximum. The estimated electric conductivity for all watersheds within the PAPA and covered by the Burma Soil Survey is less than 2 dS/m.

The NRCS Pinedale Third Order Soil Survey (Vazquez, 2006) also provides estimates for electric conductivity for all soil types. With the exception of the Havermom-Tismid-Giarch complex, all soils are considered non-saline, with an electric conductivity less than 2 dS/m. In the Havermom-Tismid-Giarch complex salinity ranges from 8 – 32 dS/m for the top nine inches of Havermon, from 0 to 16 dS/m for the top nine inches of Tismid, and 2 – 25 dS/m for the top nine inches of eroded Girarch. This complex is found in a narrow band along Sand Spring Draw.

Electric conductivity, which is closely related to total dissolved solids (TDS), can be used as a general measure of salinity. A commonly used conversion states that the TDS in mg/L is roughly equal to 0.67 times the electric conductivity in µS/cm (Hem, 1989); thus, the average salinity as expressed in TDS for soil water extract is about 268 mg/L for the measured profile average and a maximum of 1,340 mg/L for the estimated salinity range.

4 MODEL RESULTS

Two separate models were used to estimate the average annual erosion in the PAPA, and the sediment transport in channels during storm events. SWAT was used to estimate average annual erosion, and KINEROS2 was used to estimate sediment transport to the PAPA boundary and to the New Fork River within the PAPA.

The same seven scenarios described above were modeled: No Disturbance (Baseline Conditions), Current Conditions (end of 2006), the No-Action Alternative through 2011, Proposed Action Alternative through 2011 and 2023, and Alternative C through 2011 and 2023. For all development scenarios it was assumed that no erosion or sediment control measures would be in place, a conservative assumption.

Of the seven scenarios modeled it was found that the Proposed Action Alternative and Alternative C would cause equal amounts of erosion and sediment loss, both in 2011 and 2023. Thus, even though both of these Alternatives were modeled individually, the discussion of the results from those two alternatives was combined in the following sections.

4.1 Average Annual Erosion (Sediment Loss)

Water-caused erosion (sediment loss) in the PAPA was modeled for 15 of the 21 sub-watersheds intersecting the PAPA. The sub-watersheds modeled were Lower Pine Creek, New Fork River –Duck Creek, New Fork River – Stewart Point, New Fork River – Alkali Creek, East Fork River, Sand Springs Draw, Mack Reservoir, New Fork River – Blue Ridge, Green River –Tyler Draw, Green River – The Mesa, North Alkali Draw, Sand Draw – Alkali Creek, Big Sandy River – Waterhole Draw, Mud Hole Draw, and Big Sandy River – Bull Draw. Of the remaining six watersheds, five, Hay Gulch, Lower Pole Creek, Lower Muddy Creek – New Fork, Long Draw, and Granite Wash, had areas inside the PAPA that were too small to model. South Muddy Creek has a slightly larger area inside the PAPA, but does not contain any disturbance under any of the scenarios, and thus was also excluded from modeling.

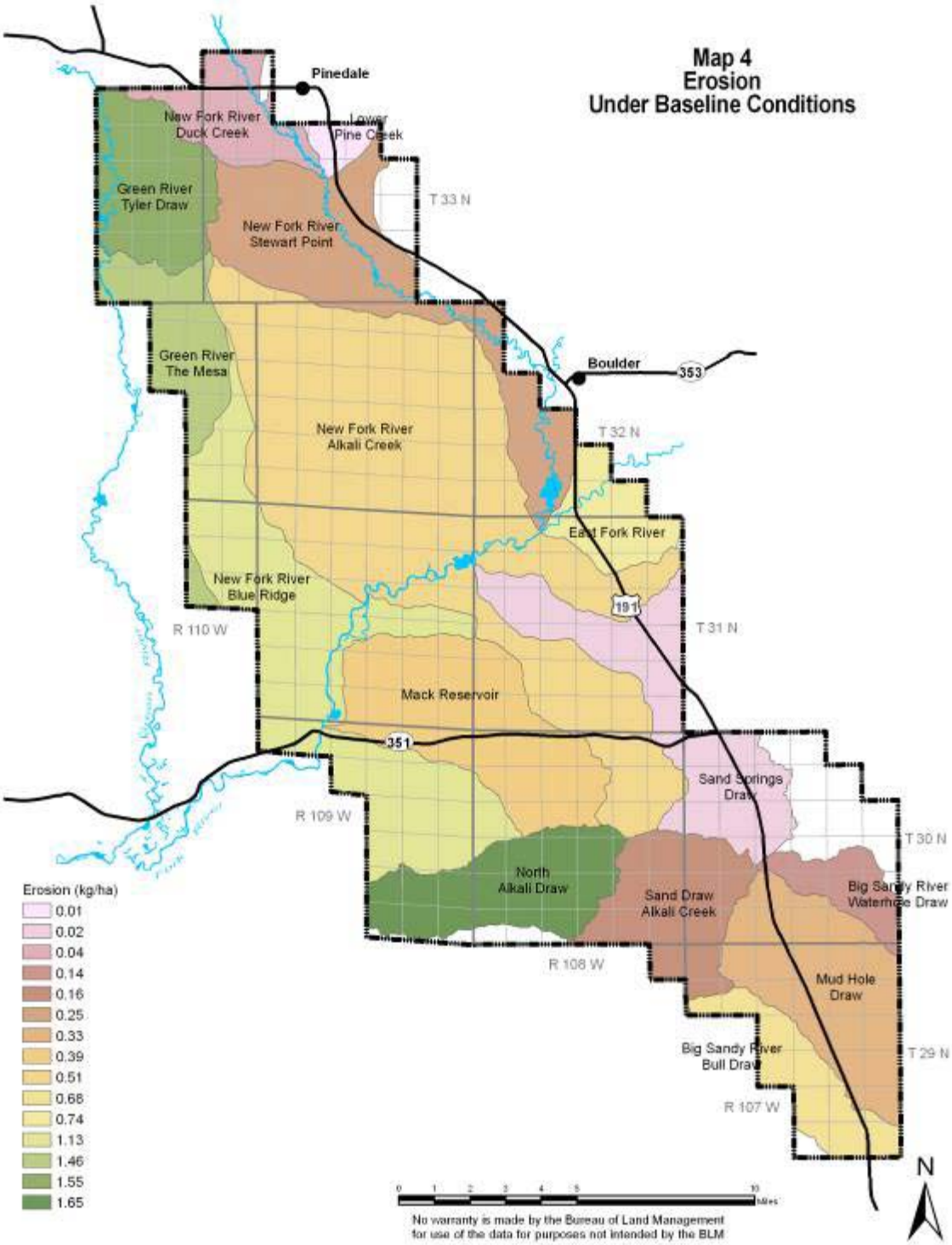
Water-caused erosion is generally low in the PAPA due to low average annual precipitation and low angle slopes. The baseline average sediment loss ranges from less than 0.02 kg/hectare on low angle slopes to approximately 1.5 kg/hectare per year on steeper slopes in the PAPA. A summary of the modeled average annual sediment loss for the 15 sub-watersheds in the PAPA area for baseline conditions and the modeled alternatives is presented in Table 8 and Maps 4, and 5A, 6A, 7A, and 8A. The percent increase in sediment loss compared to baseline conditions is given in Table 9 and Maps 5B, 6B, 7B, and 8B. The percent increase in sediment loss compared to current conditions is given in Table 10

Table 8. Average Annual Sediment Loss.

Sub-watershed	Sediment Loss (kg/ha)				
	Baseline (Map 4)	**Current Conditions (2006) (Map 5A)**	**No Action Alternative (2011) (Map 6A))**	**Proposed Action Alternative and Alternative C (2011) (Map 7A)**	**Proposed Action Alternative and Alternative C (2023) (Map 8A)**
Big Sandy River - Bull Draw	0.68	0.70	0.70	0.70	0.70
Big Sandy River - Waterhole Draw	0.14	0.15	0.15	0.15	0.15
East Fork River	0.74	0.74	0.74	0.74	0.74
Green River - The Mesa	1.46	1.46	1.46	1.46	1.46
Green River - Tyler Draw	1.55	1.55	1.57	1.57	1.57
Lower Pine Creek	0.01	0.01	0.01	0.01	0.01
Mack Reservoir	0.39	0.44	0.71	0.56	0.89
Mud Hole Draw	0.33	0.39	0.40	0.41	0.41
New Fork River - Alkali Creek	0.51	0.67	0.95	0.99	1.16
New Fork River - Blue Ridge	1.13	1.13	1.16	1.14	1.28
New Fork River - Duck Creek	0.04	0.04	0.04	0.04	0.04
New Fork River - Stewart Point	0.25	0.33	0.35	0.34	0.47
North Alkali Draw	1.65	2.05	2.49	2.62	2.70
Sand Draw - Alkali Creek	0.16	0.19	0.21	0.20	0.24
Sand Springs Draw	0.02	0.02	0.02	0.02	0.02
PAPA Average	**0.60**	**0.66**	**0.73**	**0.73**	**0.79**

Table 9. Average Annual Sediment Loss Increase above Baseline Conditions.

Sub-watershed	**Sediment Loss Increase over Baseline Conditions**			
	Current Conditions (2006) (Map 5B)	**No Action Alternative (2011) (Map 6B)**	**Proposed Action Alternative and Alternative C (2011) (Map 7B)**	**Proposed Action Alternative and Alternative C (2023) (Map 8B)**
Big Sandy River - Bull Draw	3%	3%	3%	3%
Big Sandy River - Waterhole Draw	8%	8%	8%	8%
East Fork River	0%	0%	0%	0%
Green River - The Mesa	0%	0%	0%	0%
Green River - Tyler Draw	0%	1%	1%	1%
Lower Pine Creek	0%	0%	0%	0%
Mack Reservoir	13%	83%	44%	130%
Mud Hole Draw	17%	20%	23%	24%
New Fork River - Alkali Creek	32%	87%	96%	128%
New Fork River - Blue Ridge	1%	3%	1%	14%
New Fork River - Duck Creek	0%	0%	0%	0%
New Fork River - Stewart Point	33%	40%	37%	87%
North Alkali Draw	24%	51%	59%	64%
Sand Draw - Alkali Creek	17%	28%	25%	51%
Sand Springs Draw	0%	0%	0%	0%
PAPA Average	**9%**	**21%**	**21%**	**31%**


Map 4
Erosion
Under Baseline Conditions
Pinedale
Boulder
353
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
T 33 N
Green River
The Mesa
New Fork River
Alkali Creek
T 32 N
East Fork River
New Fork River
Blue Ridge
191
R 110 W
T 31 N
Mack Reservoir
351
Sand Springs
Draw
R 109 W
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
R 108 W
Mud Hole
Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Erosion (kg/ha)
0.01
0.02
0.04
0.14
0.16
0.25
0.33
0.39
0.51
0.68
0.74
1.13
1.46
1.55
1.65
N
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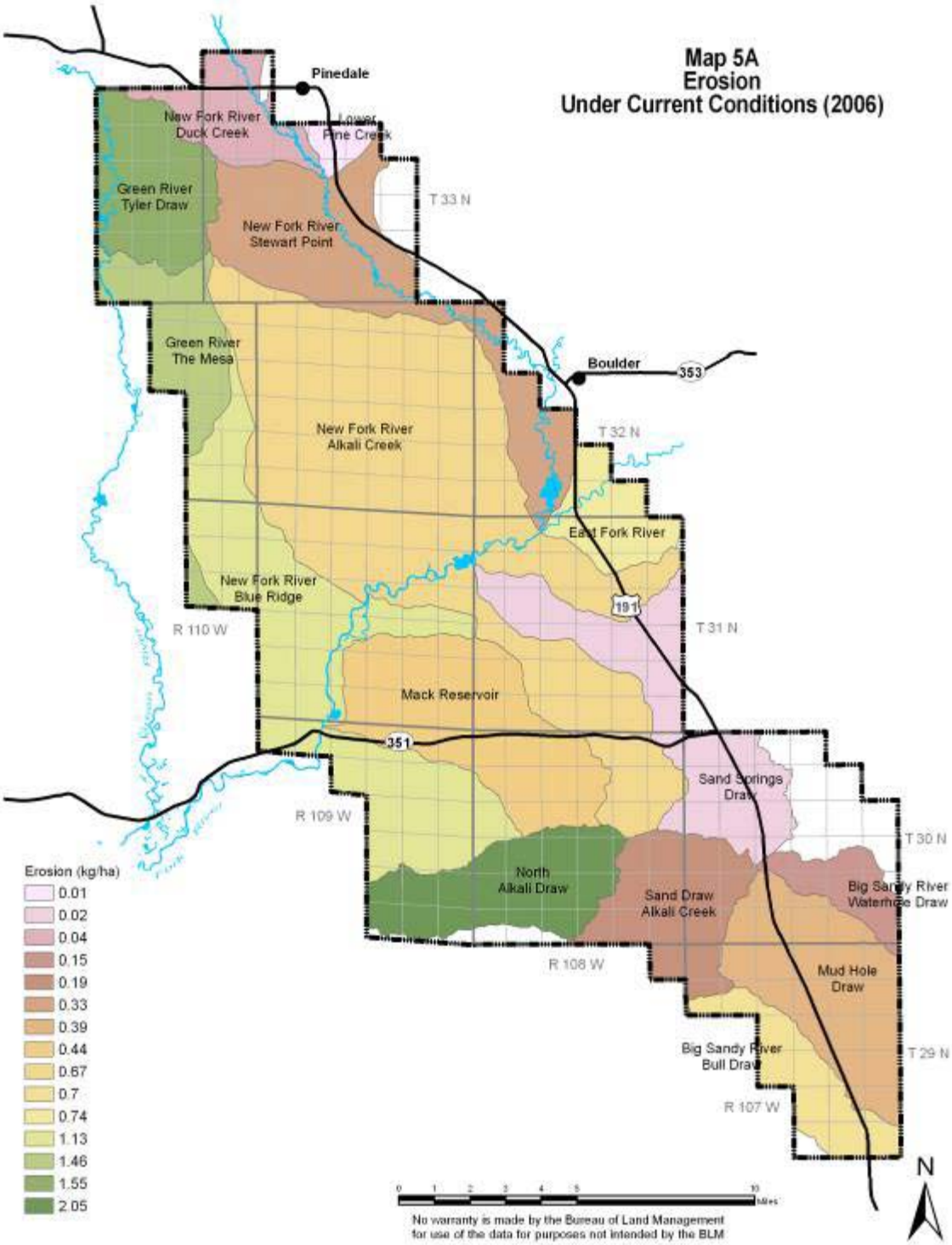
Map 5A
Erosion
Under Current Conditions (2006)
Pinedale
Boulder
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
Green River
The Mesa
New Fork River
Alkali Creek
East Fork River
New Fork River
Blue Ridge
Mack Reservoir
Sand Springs
Draw
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
Mud Hole
Draw
Big Sandy River
Bull Draw
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
353
191
351
Erosion (kg/ha)
0.01
0.02
0.04
0.15
0.19
0.33
0.39
0.44
0.67
0.7
0.74
1.13
1.46
1.55
2.05
N
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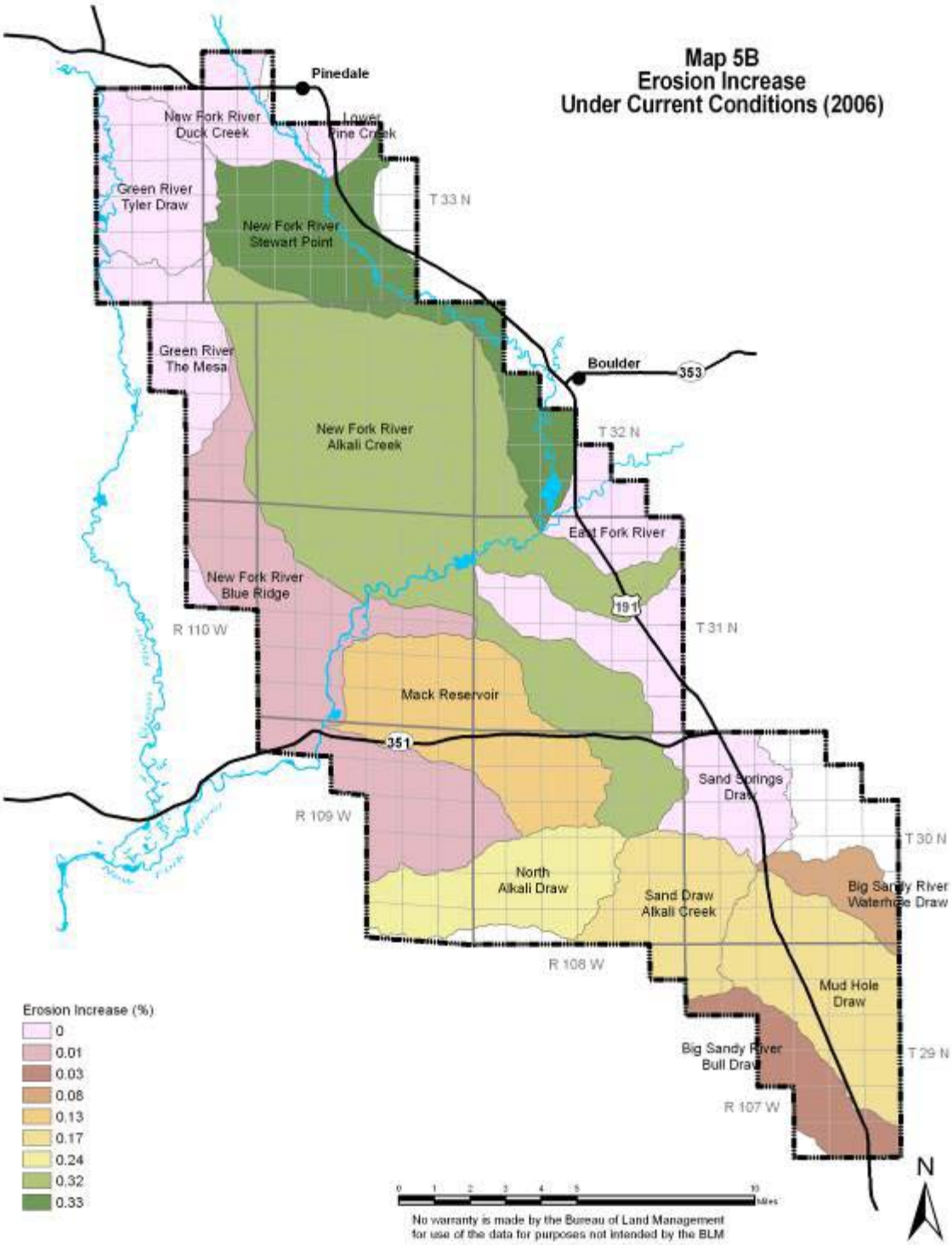
Map 5B
Erosion Increase
Under Current Conditions (2006)
Pinedale
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
T 33 N
Green River
The Mesa
Boulder
353
New Fork River
Alkali Creek
T 32 N
East Fork River
New Fork River
Blue Ridge
191
R 110 W
T 31 N
Mack Reservoir
351
Sand Springs
Draw
R 109 W
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
R 108 W
Mud Hole
Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Erosion Increase (%)
0
0.01
0.03
0.08
0.13
0.17
0.24
0.32
0.33
0 1 2 3 4 5 10
Miles
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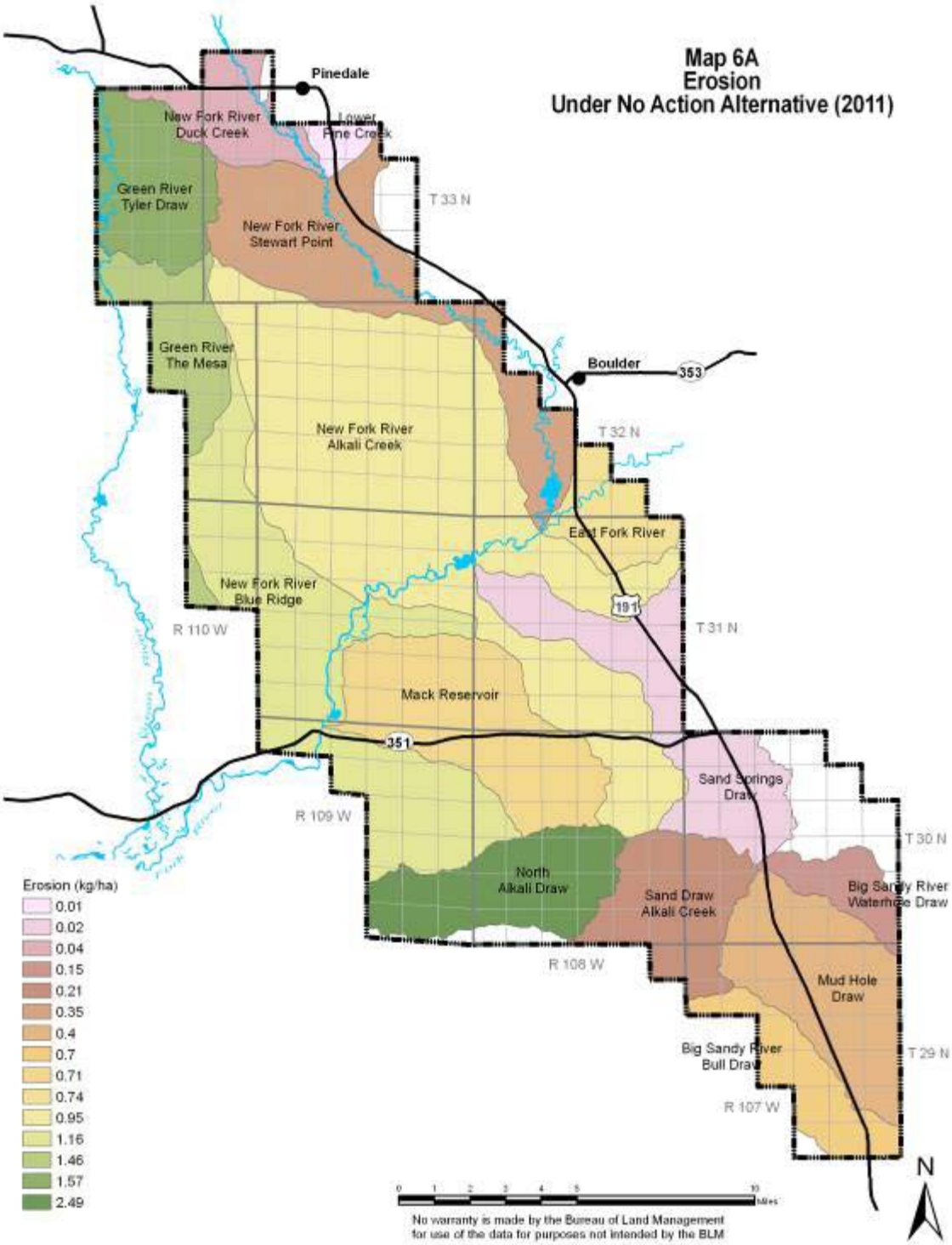
Map 6A
Erosion
Under No Action Alternative (2011)
Pinedale
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
T 33 N
Green River
The Mesa
Boulder
353
New Fork River
Alkali Creek
T 32 N
East Fork River
New Fork River
Blue Ridge
191
R 110 W
T 31 N
Mack Reservoir
351
Sand Springs
Draw
R 109 W
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
R 108 W
Mud Hole
Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Erosion (kg/ha)
0.01
0.02
0.04
0.15
0.21
0.35
0.4
0.7
0.71
0.74
0.95
1.16
1.46
1.57
2.49
N
No warranty is made by the Bureau of Land Management
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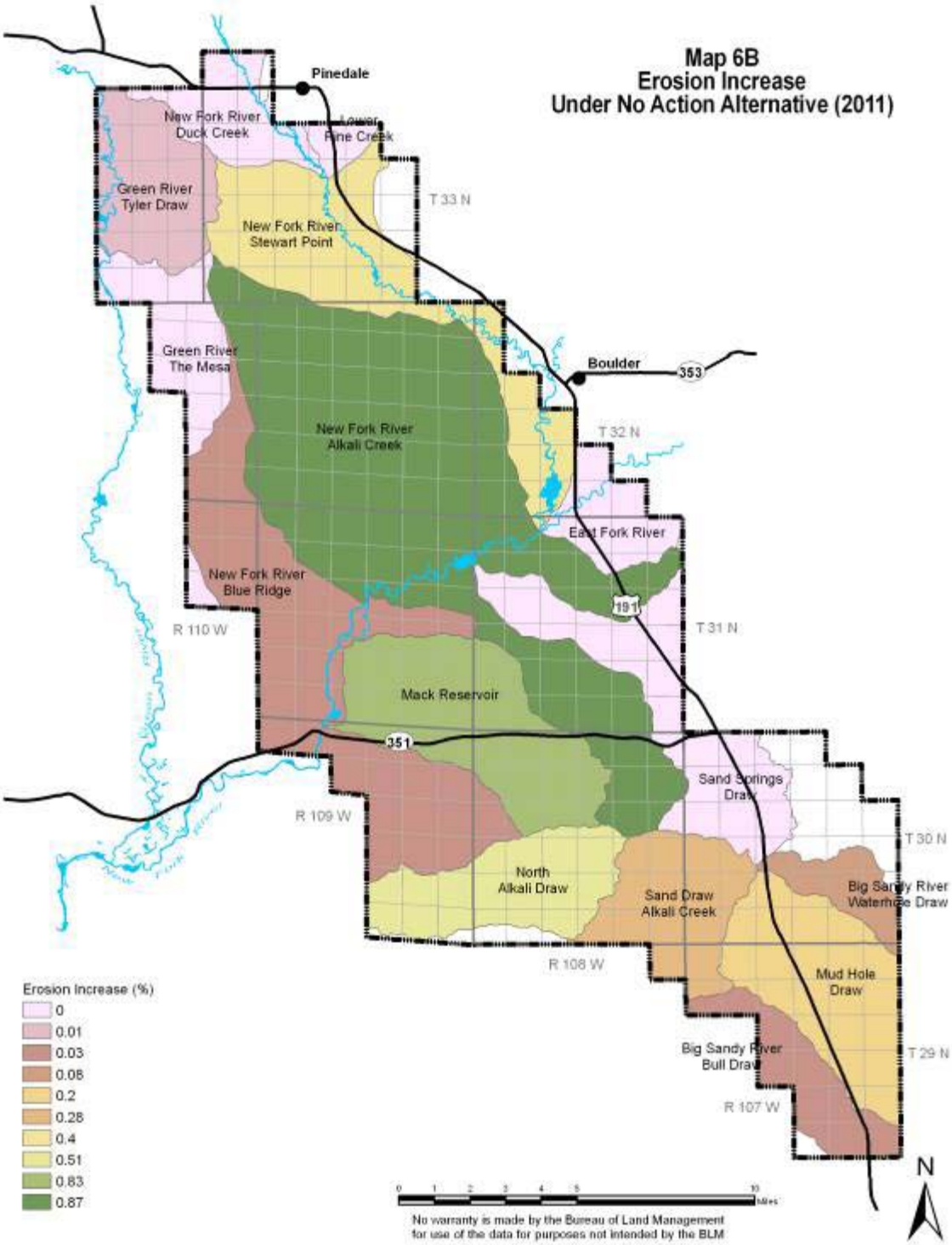
Map 6B
Erosion Increase
Under No Action Alternative (2011)
Pinedale
Boulder
353
351
191
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
Green River
The Mesa
New Fork River
Alkali Creek
East Fork River
New Fork River
Blue Ridge
Mack Reservoir
Sand Springs
Draw
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
Mud Hole
Draw
Big Sandy River
Bull Draw
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
Erosion Increase (%)
0
0.01
0.03
0.08
0.2
0.28
0.4
0.51
0.83
0.87
0 1 2 3 4 5 10
Miles
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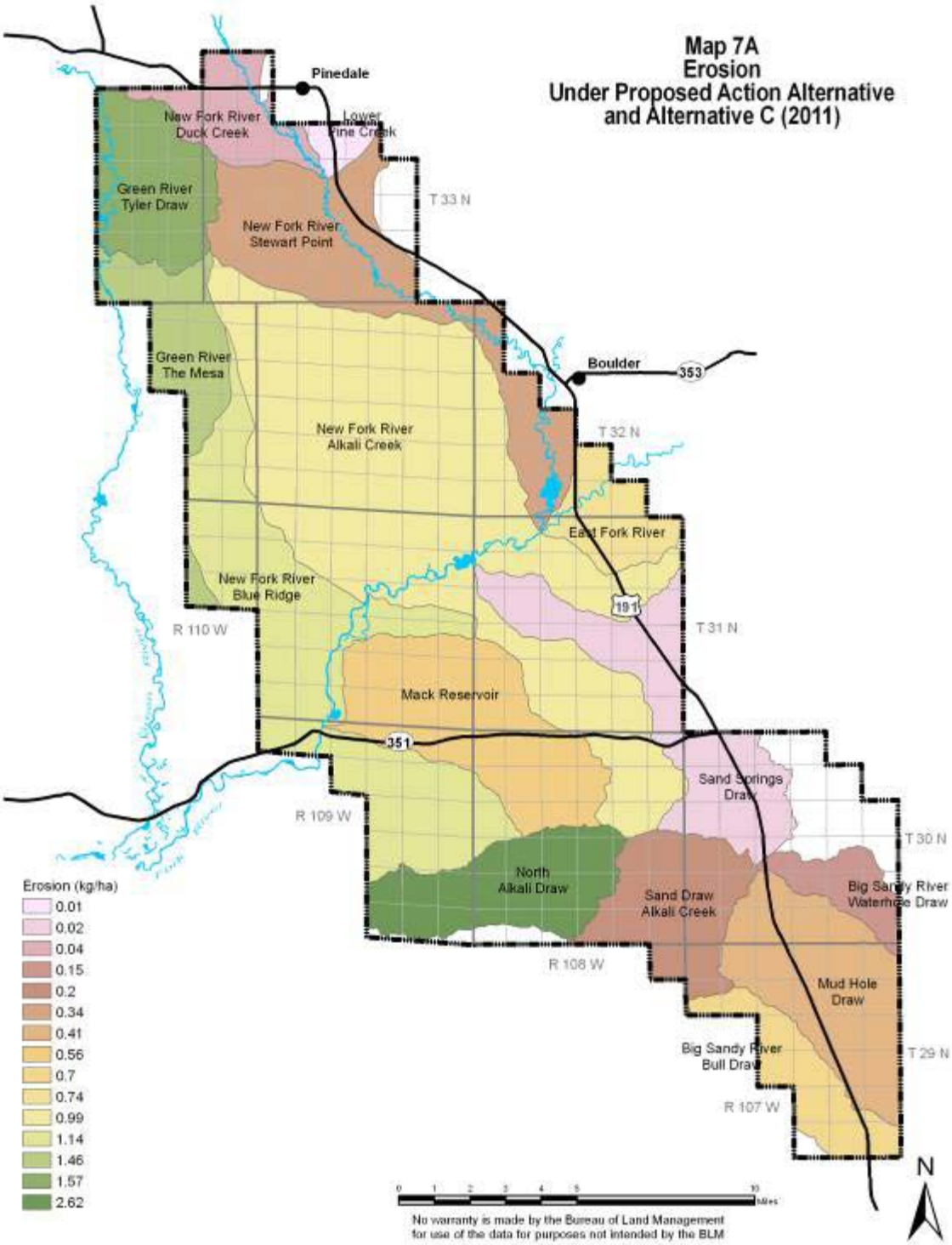
N


Map 7A
Erosion
Under Proposed Action Alternative
and Alternative C (2011)
Pinedale
Boulder
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
Green River
The Mesa
New Fork River
Alkali Creek
East Fork River
New Fork River
Blue Ridge
Mack Reservoir
Sand Springs
Draw
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
Mud Hole
Draw
Big Sandy River
Bull Draw
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
353
191
351
Erosion (kg/ha)
0.01
0.02
0.04
0.15
0.2
0.34
0.41
0.56
0.7
0.74
0.99
1.14
1.46
1.57
2.62
N
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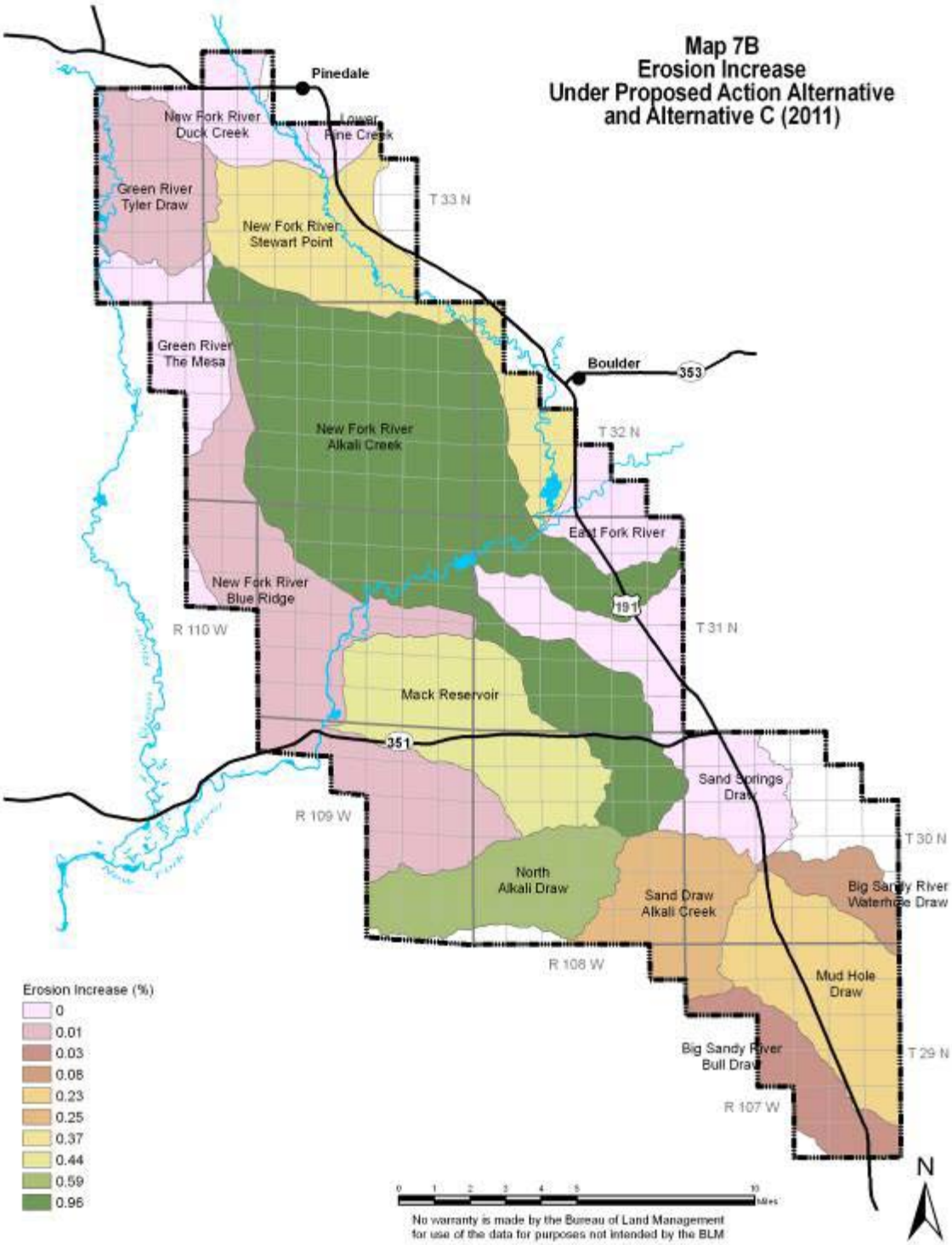
Map 7B
Erosion Increase
Under Proposed Action Alternative
and Alternative C (2011)
Pinedale
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
T 33 N
Green River
The Mesa
Boulder
353
New Fork River
Alkali Creek
T 32 N
East Fork River
New Fork River
Blue Ridge
191
R 110 W
T 31 N
Mack Reservoir
351
Sand Springs
Draw
R 109 W
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
R 108 W
Mud Hole
Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Erosion Increase (%)
0
0.01
0.03
0.08
0.23
0.25
0.37
0.44
0.59
0.96
0 1 2 3 4 5 10
Miles
No warranty is made by the Bureau of Land Management
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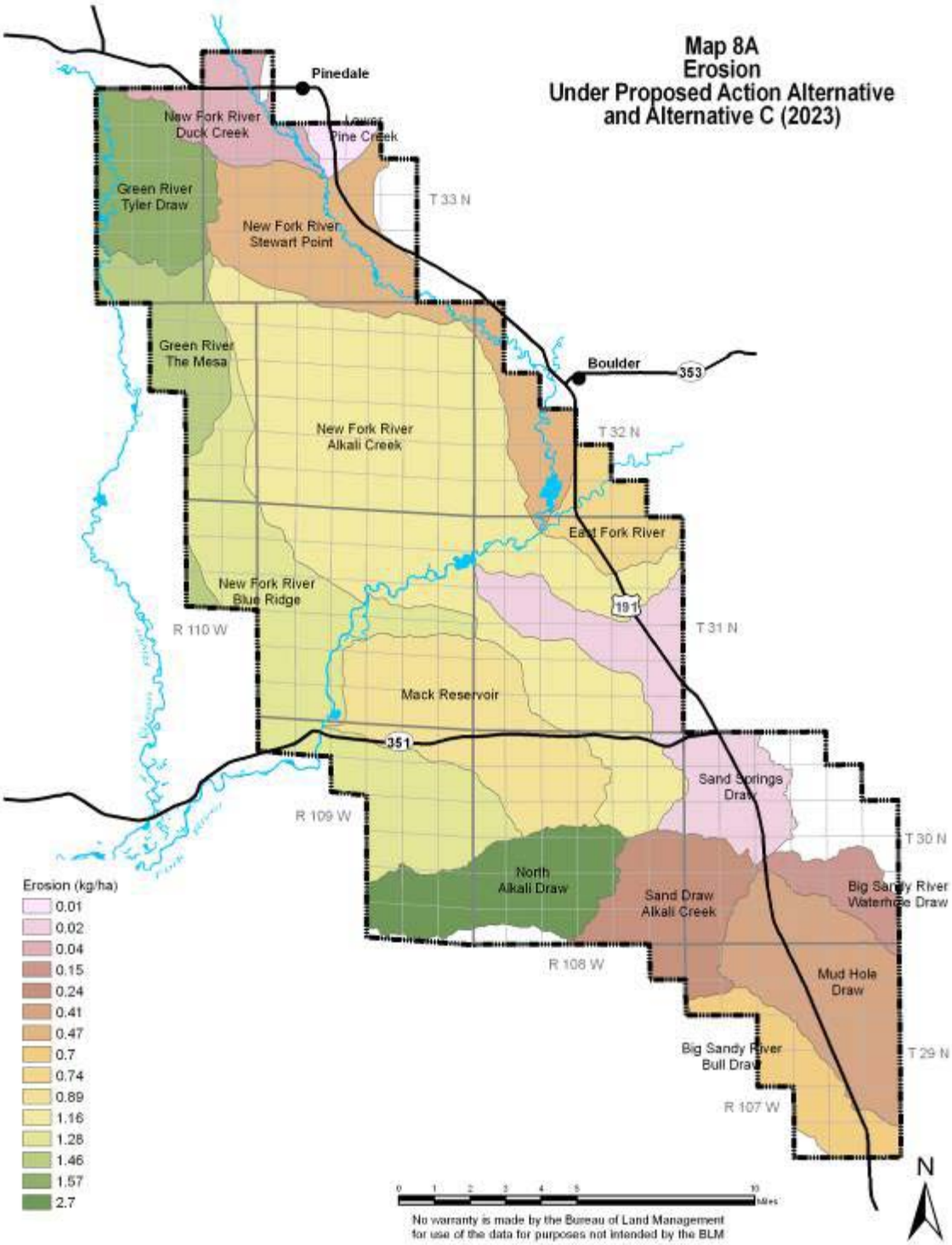
N


Map 8A
Erosion
Under Proposed Action Alternative
and Alternative C (2023)
Pinedale
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
T 33 N
Green River
The Mesa
Boulder
353
New Fork River
Alkali Creek
T 32 N
East Fork River
New Fork River
Blue Ridge
191
R 110 W
T 31 N
Mack Reservoir
351
Sand Springs
Draw
R 109 W
T 30 N
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
R 108 W
Mud Hole
Draw
Big Sandy River
Bull Draw
T 29 N
R 107 W
Erosion (kg/ha)
0.01
0.02
0.04
0.15
0.24
0.41
0.47
0.7
0.74
0.89
1.16
1.28
1.46
1.57
2.7
N
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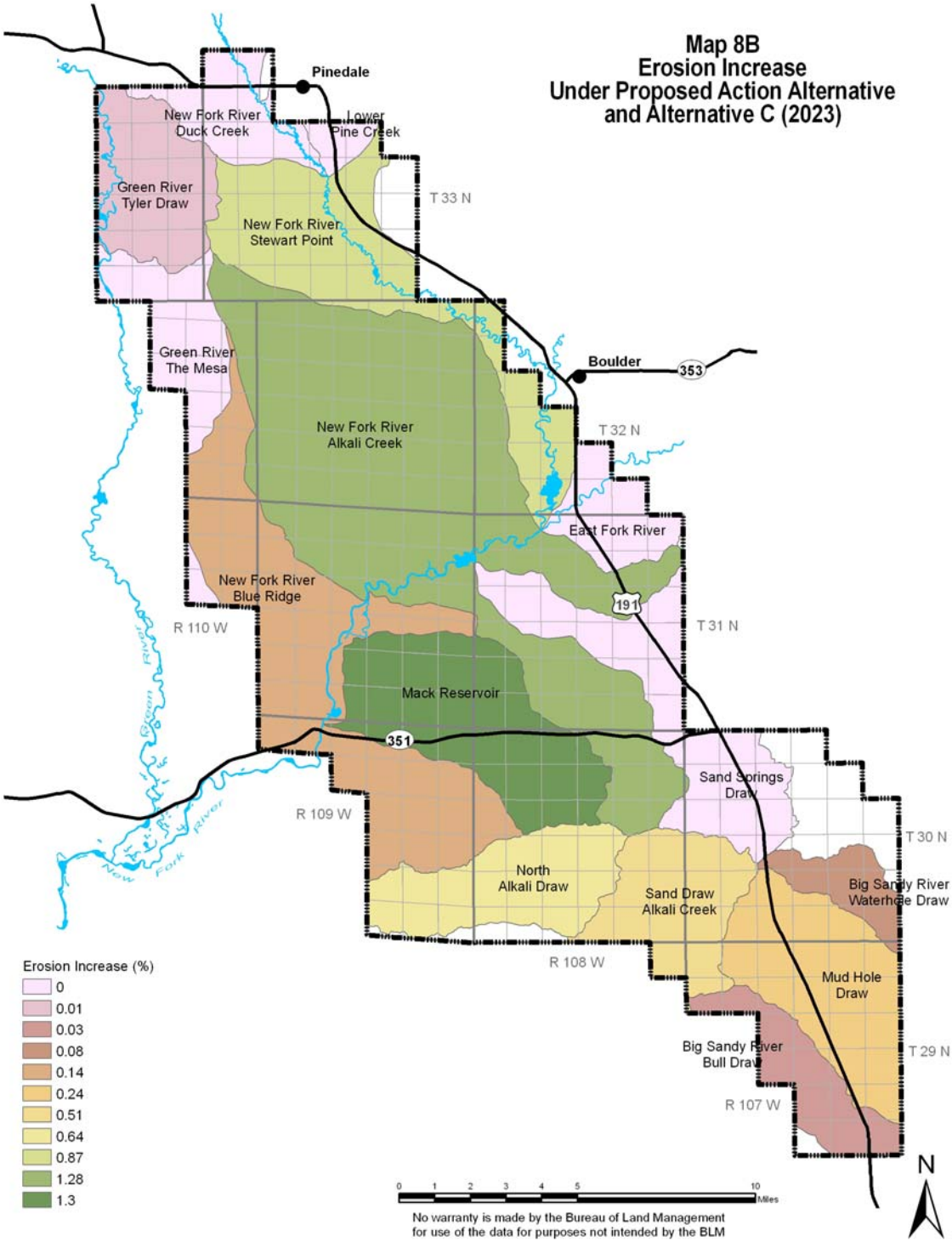
Map 8B
Erosion Increase
Under Proposed Action Alternative
and Alternative C (2023)
Pinedale
Boulder
353
191
351
New Fork River
Duck Creek
Lower
Pine Creek
Green River
Tyler Draw
New Fork River
Stewart Point
Green River
The Mesa
New Fork River
Alkali Creek
East Fork River
New Fork River
Blue Ridge
Mack Reservoir
Sand Springs
Draw
North
Alkali Draw
Sand Draw
Alkali Creek
Big Sandy River
Waterhole Draw
Mud Hole
Draw
Big Sandy River
Bull Draw
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
Green River
New Fork River
Erosion Increase (%)
0
0.01
0.03
0.08
0.14
0.24
0.51
0.64
0.87
1.28
1.3
0 1 2 3 4 5 10
Miles
No warranty is made by the Bureau of Land Management
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N

Table 10. Average Annual Sediment Loss Increase above Current Conditions (end of 2006).

Watershed	**Sediment Loss Increase over Current Conditions**		
	No Action Alternative (2011)	**Proposed Action Alternative and Alternative C (2011)**	**Proposed Action Alternative and Alternative C (2023)**
Big Sandy River - Bull Draw	0%	0%	0%
Big Sandy River - Waterhole Draw	0%	0%	0%
East Fork River	0%	0%	0%
Green River - The Mesa	0%	0%	0%
Green River - Tyler Draw	1%	1%	1%
Lower Pine Creek	0%	0%	0%
Mack Reservoir	62%	36%	103%
Mud Hole Draw	2%	5%	6%
New Fork River - Alkali Creek	42%	48%	73%
New Fork River - Blue Ridge	2%	1%	13%
New Fork River - Duck Creek	0%	0%	0%
New Fork River - Stewart Point	5%	3%	40%
North Alkali Draw	22%	28%	31%
Sand Draw - Alkali Creek	9%	6%	29%
Sand Springs Draw	0%	0%	0%
PAPA Average	**11%**	**11%**	**20%**

Overall, the projected average increase in sediment loss is 20% for the PAPA, from 0.66 kg/hectare per year for Current Conditions to 0.79 kg/hectare for the Proposed Action Alternative and Alternative C disturbance in 2023. The largest increases in erosion are projected for Mack Reservoir and the New Fork River – Alkali Creek sub-watersheds. Both sub-watersheds contain a large part of the Anticline Crest inside the PAPA. The projected erosion is largest for the largest disturbance, which is projected for the Proposed Action Alternatives and Alternative C in 2023. Of the modeled sub-watersheds, for eight there is no predicted increase or an increase of only 1% in erosion above Current Conditions. These sub-watersheds are the Big-Sandy River – Bull Draw, Big Sandy River – Waterhole Draw, East Fork River, Green River – The Mesa, Green River – Tyler Draw, Lower Pine Creek, New Fork River-Duck Creek, and

Sand Springs Draw. All of these watersheds skirt around the core-development area inside the PAPA, and thus, have less projected disturbances and little projected erosion. In the Mack Reservoir sub-watershed, the total disturbance under the No-Action condition is smaller than the disturbance under the Proposed Action Alternative and Alternative C for 2011; however, the predicted erosion is larger under the No-Action Alternative. This can be explained by noting that the distribution of the disturbed areas is quite different for both alternatives. Under the No Action Alternative, most of the disturbed area is located along the south-east boundary of the sub-watershed. The southeast boundary of the Mack Reservoir sub-watershed has the steepest slopes within the sub-watershed, and is thus much more susceptible to erosion than other less steep areas. The same is true for the sub-watersheds New Fork River - Blue Ridge, and New Fork River - Stewart Point. Sand Draw - Alkali Creek actually has more disturbances under No Action Alternative than under Proposed Action Alternative and Alternative C. Under the Proposed Action Alternative and Alternative C, disturbances are more distributed throughout the watershed, and impact less acreage along the southeast boundary of the watershed. Thus, the impact of erosion is less under the Proposed Action Alternative and Alternative C.

4.2 Sediment Transport during Storms

Based on the results of the erosion modeling, seven sub-watersheds were selected for additional erosion and sediment transport modeling. These watersheds are the New Fork River – Stewart Point, New Fork River – Alkali Creek, Mack Reservoir, New Fork River – Blue Ridge, North Alkali Draw, Sand Draw – Alkali Creek, and Mud Hole Draw.

Of the seven sub-watersheds selected for additional modeling, four are ephemeral sub-watersheds inside the PAPA: Mack Reservoir, Mud Hole Draw, North Alkali Creek, and Sand Draw - Alkali Creek sub-watersheds.

Due to the general low angle slopes in the PAPA, runoff from ephemeral drainages inside the PAPA occurs primarily during large storm events. Most ephemeral drainages do not flow during 5 and 10 year storm events, and thus sediment transport to the New Fork River or the PAPA boundary does not increase during small storms. Erosion and sediment transport may occur on a small scale, but sediment does not travel longer distances to the watershed boundary. Large increases in sediment transport occur only during 25-year or larger storms events. During larger storms, vegetation disturbance (conversion to bare ground) increases the sediment transport significantly. When compared to the No Disturbance (baseline case), sediment transport increases the most for the Proposed Action Alternative and Alternative C in 2023 and the least for the Current Conditions (end of 2006).

The Mack Reservoir sub-watershed drains directly into the New Fork River inside the PAPA. Modeling indicated that flow from Mack Reservoir drainages would not reach the New Fork River until at least a 50-year storm event takes place. Sediment transport would be largest under a 150 year storm (Table 11), but relative increase over baseline or current condition would be largest under a 50 year storm. Sediment transport would increase approximately 4 times over baseline conditions (Table 12), and 1.5 times over current conditions under a 50-year storm (Table 13).

Mud Hole Draw drains into Big Sandy River, and North Alkali Draw and Sand Draw drain into the Green River via Alkali Creek. Sediment transport to the PAPA boundary was modeled for all three sub-watersheds. For all three sub-watersheds, sediment transport would be largest under a 150 year storm (Table 14, Table 17, and Table 20). For Mud Hole Draw, relative sediment transport increase over baseline or current condition would be largest under a 50 year storm. Sediment transport would increase approximately 70% over baseline conditions (Table 15), and 30% over current conditions (Table 16). For North Alkali Draw, relative sediment transport increase over baseline or current condition would be largest under a 150 year storm. Sediment transport would increase approximately 20% over baseline conditions (Table 18), and 10% over current conditions (Table 19).). For Sand Draw, relative sediment transport

increase over baseline or current condition would be largest under a 25 year storm. Sediment transport would increase approximately 20 times over baseline conditions (Table 21), and 4 times over current conditions (Table 22).

Table 11. Sediment Yield for Mack Reservoir Sub-Watershed at Confluence with New Fork River.

Storm Return Period (years)	Sediment Yield (Total kg)				
	No Disturbance (Baseline)	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	No Flow				
50	381	747	1,607	1,554	1,998
100	27,473	28,880	32,021	31,244	37,856
150	50,975	53,486	59,455	58,456	70,148

Table 12. Sediment Yield Increase above Baseline Conditions for Mack Reservoir Sub-Watershed at Confluence with New Fork River.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	No flow			
50	96%	322%	308%	425%
100	5%	17%	14%	38%
150	5%	17%	15%	38%

Table 13. Sediment Yield Increase above Current Conditions for Mack Reservoir Sub-Watershed at Confluence with New Fork River.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25			
50	115%	108%	168%
100	11%	8%	31%
150	11%	9%	31%

Table 14. Sediment Yield for Mud Hole Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Yield (Total kg)				
	No Disturbance (Baseline)	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C(2023)
25	6,779	8,678	8,684	8,689	8,724
50	82,266	108,039	119,214	111,660	139,847
100	545,335	667,780	729,301	691,107	822,662
150	853,177	1,043,763	1,133,487	1,078,959	1,252,908

Table 15. Sediment Yield Increase above Baseline Conditions for Mud Hole Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	28%	28%	28%	29%
50	31%	45%	36%	70%
100	22%	34%	27%	51%
150	22%	33%	26%	47%

Table 16. Sediment Yield Increase above Current Conditions for Mud Hole Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	0%	0%	1%
50	10%	3%	29%
100	9%	3%	23%
150	9%	3%	20%

Table 17. Sediment Yield for North Alkali Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Yield (Total kg)				
	No Disturbance (Baseline)	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	68	71	71	71	71
50	64,311	68,467	68,455	68,466	68,444
100	456,721	485,648	515,055	498,794	540,375
150	831,366	897,502	952,010	930,110	1,006,912

Table 18. Sediment Yield Increase above Baseline Conditions for North Alkali Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	5%	5%	5%	5%
50	6%	6%	6%	6%
100	6%	13%	9%	18%
150	8%	15%	12%	21%

Table 19. Sediment Yield Increase above Current Conditions for the North Alkali Draw Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	0%	0%	0%
50	0%	0%	0%
100	6%	3%	11%
150	6%	4%	12%

Table 20. Sediment Yield for Sand Draw – Alkali Creek Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Yield (Total kg)				
	No Disturbance (Baseline)	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	4,681	20,422	60,588	33,894	97,815
50	120,463	169,956	367,896	231,546	522,198
100	522,994	672,812	1,007,203	801,065	1,262,716
150	725,829	881,771	1,253,574	1,033,624	1,563,012

Table 21. Sediment Yield Increase above Baseline Conditions for Sand Draw – Alkali Creek Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	336%	1194%	624%	1989%
50	41%	205%	92%	333%
100	29%	93%	53%	141%
150	21%	73%	42%	115%

Table 22. Sediment Yield Increase above Current Conditions for Sand Draw – Alkali Creek Sub-Watershed at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	197%	66%	379%
50	116%	36%	207%
100	50%	19%	88%
150	42%	17%	77%

Sediment is transported to and within the New Fork River. Three large sub-watersheds of the New Fork River are within the PAPA, New Fork River - Stewart Point, New Fork River - Alkali Creek, and New Fork River - Blue Ridge. Under the Proposed Action Alternative and Alternative C, all three sub-watersheds would experience increased sediment transport in the New Fork River, caused by flow from ephemeral drainages into the New Fork River as well as from direct sediment washing into the stream. Each sub-watershed of the New Fork River is larger than can be modeled with KINEROS2. KINEROS2 is designed to simulate runoff and erosion for single storm events in small watersheds less than approximately 100 km^2 (~25,000 acres). Stewart Point sub-watershed contains over 32,000 acres, Blue Ridge contains almost 40,000 acres, and Alkali Creek contains almost 50,000 acres. In addition, the three sub-watersheds cannot be considered independently of each other, and should be modeled together, because changes in the upstream flow regime of the New Fork River will influence the downstream flow in the lower sub-watersheds. Increases in sediment load were estimated for the New Fork River; however, it has to be noted that these are very rough estimates, calculated by assuming the different sections of the New Fork River can be considered independently. Estimates for sediment yield increases for the New Fork River are given in below (Table 22, Table 23, Table 24, Table 25, Table 26, Table 27, and Table 28.)

Table 23. Sediment Yield Increase above Baseline Conditions for New Fork River – Stewart Point.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	20%	20%	30%	70%
50	10%	20%	20%	50%
100	10%	20%	20%	50%
150	10%	20%	20%	50%

Table 24. Sediment Yield Increase above Current Conditions for the New Fork River – Stewart Point.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative C (2023)
25	10%	10%	50%
50	10%	10%	30%
100	10%	10%	30%
150	10%	10%	30%

Table 25. Sediment Yield Increase above Baseline Conditions for New Fork River – Alkali Creek.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	0%	10%	0%	10%
50	10%	60%	40%	130%
100	50%	220%	210%	330%
150	50%	180%	180%	270%

Table 26. Sediment Yield Increase above Current Conditions for the New Fork River – Alkali Creek.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	10%	0%	10%
50	50%	30%	110%
100	110%	110%	180%
150	80%	80%	140%

Table 27. Sediment Yield Increase above Baseline Conditions for the New Fork River – Blue Ridge at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Baseline Conditions			
	Current Conditions (2006)	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative and Alternative C (2023)
25	0%	10%	0%	20%
50	0%	20%	20%	50%
100	20%	70%	70%	120%
150	30%	80%	80%	130%

Table 28. Sediment Yield Increase above Current Conditions for the New Fork River – Blue Ridge at PAPA Boundary.

Storm Return Period (years)	Sediment Increase over Current Conditions		
	No Action Alternative (2011)	Proposed Action Alternative and Alternative C (2011)	Proposed Action Alternative C (2023)
25	10%	0%	10%
50	20%	10%	40%
100	50%	50%	80%
150	40%	40%	70%

All modeling is based on assumptions and many simplifications are inherent when creating input parameters for SWAT and KINEROS2. Thus, the actual values of sediment transported should be considered with caution. However, the differences in model-derived sediment transport volumes among the analyzed conditions/alternatives and among precipitation events provide approximate values suitable for comparison. Specific monitoring and sampling in the PAPA channels would provide more accurate data of environmental conditions, and if conducted, these data could be compared with the model results presented herein for verification.

4.3 Salt Loading to Green River

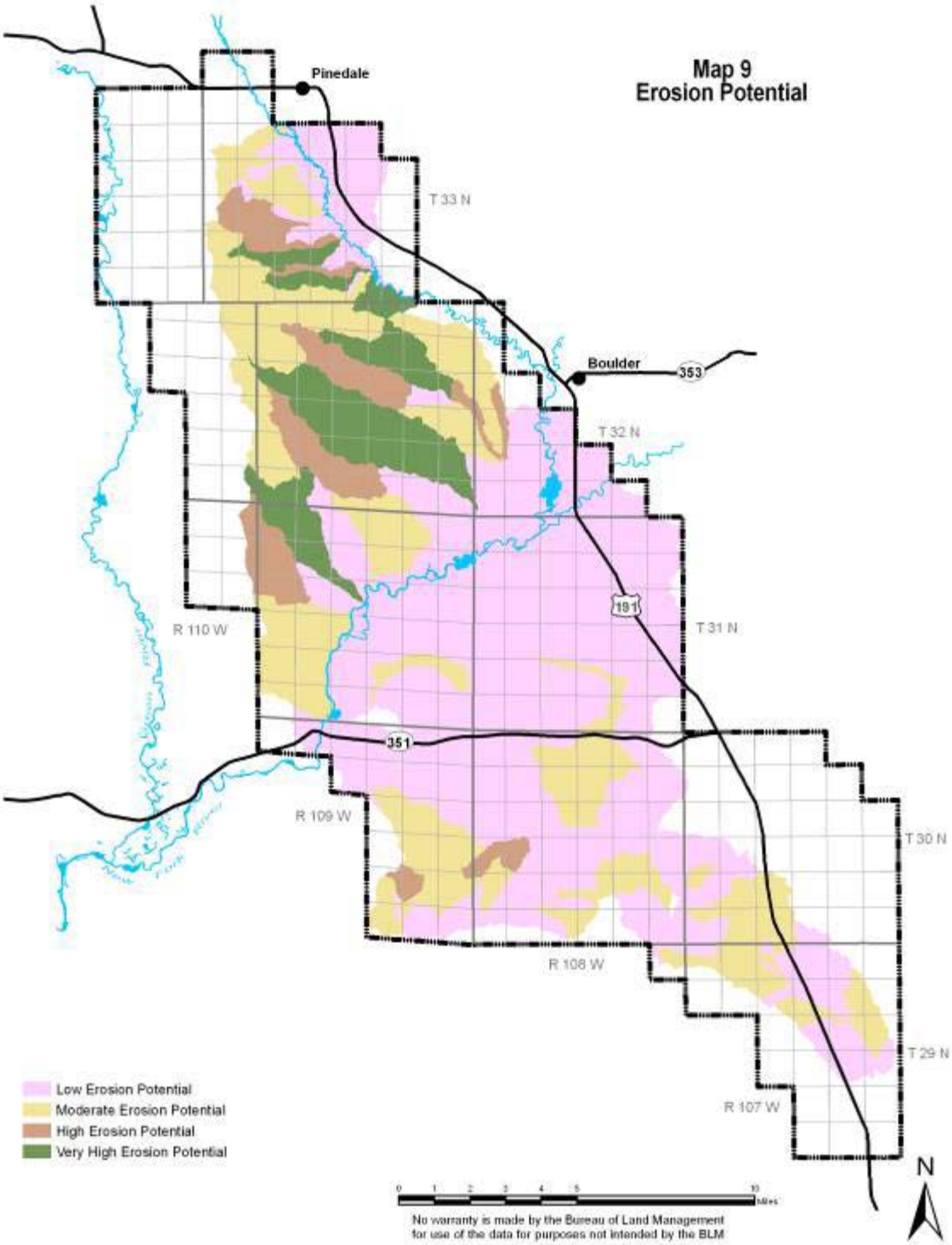
Salinity in all waters leaving the PAPA was estimated as ranging from approximately 300 to 1,300 mg/L as total dissolved solids (TDS). Salinity at the PAPA boundary can be estimated from the measured soil saturation extract salinity or electric conductivity. The saturation extract salinity is assumed to be the maximum salinity of water in contact with sediment. Actual salinity may be lower, if the contact time between water and sediment is not long enough to reach equilibrium or if only a portion of the water volume is in contact with the sediment; both of these conditions are likely during most storm events. Saturation extract salinity has been measured for only seven of the various soil series within the PAPA and was estimated for the other soil series, so only a rough estimate for the maximum salinity for all sub-watersheds can be provided.

Measured salinity in the New Fork River near Big Piney (USGS, 2006) ranges from 40 mg/L TDS (0.06 dS/m) to 280 mg/L TDS (0.42 dS/m), with an average of 130 mg/l TDS (0.19 dS/m), based on 283 USGS measurements of specific conductance between 1965 and 1986. Storm runoff from the PAPA is likely higher in salinity, and even under undisturbed conditions would add additional salt loading to the New Fork, and thus the Green River. Increased sediment load from increased disturbances would increase the salinity added to the New Fork and the Green River. Field measurements of salinity in flowing streams could quantify the salt loading under current conditions.

4.4 Areas Most Susceptible to Erosion

Erosion potential depends on slope, soil type, and vegetation cover. Since most of the development within the PAPA will take place on the Anticline Crest, erosion potential for the Anticline Crest was analyzed for this study. To delineate areas within the Anticline Crest with the greatest potential for erosion, sub-watersheds were subdivided into smaller sections and were analyzed for their sediment yield under the No Disturbance (baseline conditions) scenario for a 150-year storm. However, the ranking of the sub-watersheds across alternatives with respect to erosion potential would not change under any other rainfall scenario.

Areas (sub-watersheds) along the steeper ridges within the PAPA have the greatest potential for erosion after disturbance. Map 9 illustrates the potential for erosion in the PAPA. The erosion potential is given as “low”, “moderate” “high”, and “very high”. This is a relative classification scheme based on the overall erosion potential inside the PAPA. Areas with “low” erosion potential have erosion potential less than the mean erosion potential inside the PAPA, “moderate” erosion potential signifies the mean erosion potential inside PAPA (erosion potential ranges from mean to mean plus one standard deviation), “high” signifies the erosion potential ranges from mean plus one standard deviation to mean plus two standard deviations, and “very high” signifies erosion potential is higher than mean PAPA erosion potential plus two standard deviations.


Map 9
Erosion Potential
Pinedale
Boulder
353
191
351
T 33 N
T 32 N
T 31 N
T 30 N
T 29 N
R 110 W
R 109 W
R 108 W
R 107 W
Low Erosion Potential
Moderate Erosion Potential
High Erosion Potential
Very High Erosion Potential
N
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5 CONCLUSIONS

All model alternatives increase erosion and sediment transport into and from the PAPA. Modeled erosion and sediment transport is largest for the Proposed Action Alternative and Alternative C in 2023. Erosion and sediment transport also increase with rainfall intensity. The New Fork River flows directly through the PAPA and additional sediment from erosion would flow into the New Fork River and, thus, also reach the Green River. The modeling assumed that no measures were taken to prevent erosion and sediment transport. However, due to the proximity of the New Fork River and Green River, best management practices (e.g., revegetation, sediment control structures) would have to be used to prevent erosion and minimize sediment transport. Areas and sub-watersheds that are most susceptible to erosion, and create the largest amount of sediment have been identified, and these areas are recommended to receive the most aggressive monitoring (e.g., photo-point, vegetation, channel cross section, first flush) and soil erosion control measures/treatments.

Impact Summary for Proposed Action Alternative and Alternative C:

- Average annual water-caused erosion in the PAPA area would increase above current conditions. The increase would be 11% for disturbances expected in the year 2011 and 20% for disturbances in the year 2023. This assumes no erosion control measures, mitigation or reclamation takes place.
- Sediment transport from ephemeral drainages into the New Fork River would increase significantly during 25-year and larger storm events. From the Mack Reservoir sub-watershed, sediment transport into the New Fork River would increase approximately 1.5 times during a 50-year storm over a 50-year storm occurring under current conditions.
- Sediment transport from ephemeral drainages to the PAPA boundary would increase significantly during 25-year and larger storm events. Most affected would be the Sand Draw sub-watershed. Sediment transport to the PAPA boundary would increase approximately 4 times during a 25-year storm over a 25-year storm occurring under current conditions.
- Salinity in runoff from disturbed areas would increase and could potentially increase salt loading in the Green River.
- All statements above assume no erosion control measures, mitigation or reclamation takes place.

6 REFERENCES

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ATTACHMENT A: KINEROS2 PRECIPITATION INPUT FILE

Only a sample input file for 5-year storm is presented here.

```
! Design storm computed from the AGWA database dsgnstrm.dbf using the SCS
methodology with a type II distribution
! Storm generated for the w2kin watershed using the design storm for Jonah
"! Return Period (frequency) = 5 years, Duration = 24.00 hours."
! ** Return period depth has NOT been reduced for watershed area.


BEGIN RG1
N = 145

   TIME DEPTH  TIME DEPTH  TIME DEPTH  TIME DEPTH  TIME DEPTH
!  (min) (mm)  (min) (mm)  (min) (mm)  (min) (mm)  (min) (mm)
   0     0.00   310  2.35   620   7.01   930 30.81  1240   34.16
   10    0.06   320  2.45   630   7.30   940 30.96  1250   34.24
   20    0.13   330  2.54   640   7.62   950 31.11  1260   34.32
   30    0.19   340  2.64   650   7.97   960 31.26  1270   34.40
   40    0.25   350  2.74   660   8.36   970 31.40  1280   34.47
   50    0.32   360  2.85   670   8.80   980 31.53  1290   34.55
   60    0.38   370  2.95   680   9.33   990 31.66  1300   34.62
   70    0.45   380  3.06   690   9.97  1000 31.79  1310   34.69
   80    0.52   390  3.17   700  10.82  1010 31.92  1320   34.76
   90    0.59   400  3.29   710  12.17  1020 32.04  1330   34.83
   100   0.66   410  3.40   720  17.78  1030 32.16  1340   34.90
   110   0.73   420  3.52   730  23.39  1040 32.27  1350   34.97
   120   0.80   430  3.64   740  24.74  1050 32.39  1360   35.04
   130   0.87   440  3.77   750  25.59  1060 32.50  1370   35.11
   140   0.94   450  3.90   760  26.23  1070 32.61  1380   35.18
   150   1.01   460  4.03   770  26.76  1080 32.71  1390   35.24
   160   1.09   470  4.16   780  27.20  1090 32.82  1400   35.31
   170   1.16   480  4.30   790  27.59  1100 32.92  1410   35.37
   180   1.24   490  4.45   800  27.94  1110 33.02  1420   35.43
   190   1.32   500  4.60   810  28.26  1120 33.11  1430   35.50
   200   1.40   510  4.75   820  28.55  1130 33.21  1440   35.56
   210   1.48   520  4.91   830  28.82  1140 33.30   SA = 0.2
   220   1.56   530  5.08   840  29.07  1150 33.40   END
   230   1.64   540  5.25   850  29.30  1160 33.49  !duration: 1440
   240   1.72   550  5.44   860  29.53  1170 33.58
   250   1.81   560  5.63   870  29.74  1180 33.66
   260   1.90   570  5.82   880  29.93  1190 33.75
   270   1.98   580  6.03   890  30.12  1200 33.84
   280   2.07   590  6.26   900  30.31  1210 33.92
   290   2.16   600  6.49   910  30.48  1220 34.00
   300   2.26   610  6.74   920  30.65  1230 34.08
```

ATTACHMENT B: SOIL DATABASE TABLES

Soil data from the Burma Soil Survey (ERO 1988) and the new NRCS survey for the PAPA were put into Statsgo format, in order to allow AGWA to read the data and use it to estimate the infiltration, runoff, and sediment transport parameters. The first soil database table from the Statsgo data which AGWA reads is called comp.dbf. This file contains the following fields:

STSSAID	State Soil Survey Area ID
MUID	Map Unit Identification
SEQNUM	Sequence Number
MUSYM	Map Unit Symbol
COMPNAME	Component Name
S5ID	Soil Interpretations Record Number
COMPPCT	Component Percent
SLOPEL	Soil Slope (Minimum)
SLOPEH	Soil Slope (Maximum)
SURFTEX	Surface Soil Texture
OTHERPH	Phase Class (other than slope or texture)
COMPKIND	Kind of Component (S=Series, F=Family, V=Variant, M=Miscellaneous)
COMPACRE	Component Acres
CLASCODE	Taxonomic Classification Code
ANFLOOD	Annual Flooding Frequency (Descriptive)
ANFLODUR	Flood Duration Class (Descriptive)
ANFLOBEG	Month in which annual flooding begins in a normal year
ANFLOEND	Month in which annual flooding ends in a normal year
GSFLOOD	Growing Season Flooding (Descriptive)
GSFLODUR	Growing Season Flood Duration (Descriptive)
GSFLOBEG	Month in which annual flooding begins during growing season
GSFLOEND	Month in which annual flooding ends during growing season
WTDEPL	Depth to high Water Table (Minimum)
WTDEPH	Depth to high Water Table (Maximum)
WTKIND	Water Table Kind (Artesian, Perched, Apparent)
WTBEG	Month in which seasonal water table occurs at the depth specified in a normal year
WTEND	Month in which seasonal water table subsides below the normal year depth
PNDDEPL	Ponding Depth (Minimum)
PNDDEPH	Ponding Depth (Maximum)
PNDDUR	Ponding Duration
PNDBEG	
PNDEND	
ROCKDEPL	Depth to Bedrock (Minimum) Inches
ROCKDEPH	Depth to Bedrock (Maximum) Inches
ROCKHARD	Bedrock Hardness (Descriptive)
PANDEPL	Depth to Cemented Pan (Minimum) Inches
PANDEPH	Depth to Cemented Pan (Maximum) Inches
PANHARD	Cemented Pan Thickness (Descriptive)
SUBINITL	Min. value in initial subsidence when drained, in inches (organic soils only)
SUBINITH	Max. value in initial subsidence when drained, in inches (organic soils only)

SUBTOTL	Min. value in total subsidence when drained, in inches (organic soils only)
SUBTOTH	Max. value in total subsidence when drained, in inches (organic soils only)
HYDGRP	Hydrologic Group
FROSTACT	Potential Frost Action (Descriptive)
DRAINAGE	Code identifying the natural soil drainage condition. Example: Well Drained (W); Excessive (E); Moderately Well (MW); Poorly (P); Somewhat Excessively (SE); Somewhat Poorly (SP)
HYDRIC	Hydric Soil Rating
CORCON	A rating of concrete susceptibility to corrosion when in contact with the soil
CORSTEEL	A rating of the uncoated steel susceptibility to corrosion when in contact with soil
CLNIRR	A rating of the soil for nonirrigated agricultural use
CLIRR	Irrigated Capability Class
SCLNIRR	Irrigated Capability Subclass
SCLIRR	Irrigated Capability Subclass
PRIMFML	Prime Farmland Classification

From this table, AGWA reads the composition percentages and surface texture for each soil. Table B-1 presents the part of the comp.dbf table read by AGWA and populated with data from the Burma Soil Survey and the new NRCS survey for the PAPA. MUID numbers between PD100 and PD129 indicate soil data from the Burma Survey, MUID numbers higher than PD400 indicate soil data from the NRCS survey.

Table B-1: Composition percentages and Textures for PAPA Soils

MUID	SEQNUM	COMPNAME	COMPPCT	SURFTEX
PD100	1	Horsley	40	L
PD100	2	BADLAND	33	UWB
PD100	3	Boltus	27	CL
PD102	1	Langspring Variant	72	L
PD102	2	Langspring	28	L
PD103	1	Terada	44	FSL
PD103	2	Huguston	37	SL
PD103	3	Fraddle	19	SL
PD104	1	Chrisman	100	SiC
PD105	1	FLUVENTS	100	VAR
PD106	1	Monte	67	L
PD106	2	Leckman	33	L
PD107	1	Leckman	100	SL
PD108	1	Dines	45	L
PD108	2	Clowers	33	L
PD108	3	Quealman	22	L
PD109	1	FLUVENTS	100	VAR
PD110	1	Fraddle	72	L
PD110	2	Tresano	28	L
PD111	1	Fraddle	50	SL
PD111	2	SPACE CITY	28	LS
PD111	3	KOONICH	22	LS
PD112	1	KOONICH	100	LS
PD113	1	Haterton	53	L

PD113	2	Garsid	47	L
PD114	1	Ouard	35	L
PD114	2	Ouard Variant	35	C
PD114	3	Boltus	30	Sh
PD116	1	Huguston	44	L
PD116	2	Horsley	39	Sh
PD116	3	Terada	17	L
PD117	1	Huguston	53	SL
PD117	2	ROCK OUTCROP	23	UWB
PD117	3	Boltus	24	CL
PD119	1	Garsid	53	L
PD119	2	Monte	47	L
PD120	1	KANDALY	50	LS
PD120	2	Terada	28	FSL
PD120	3	Huguston	22	SL
PD121	1	Garsid	47	L
PD121	2	Terada	29	L
PD121	3	Langspring Variant	24	L
PD122	1	Baston	44	C
PD122	2	Boltus	31	Sh
PD122	3	Chrisman	25	C
PD123	1	Spool Variant	41	S
PD123	2	Ouard Variant	41	C
PD123	3	San Arcacio Variant	18	L
PD124	1	Fraddle	35	L
PD124	2	Ouard	35	L
PD124	3	San Arcacio Variant	30	L
PD125	1	San Arcacio	56	LS
PD125	2	Saguache	44	SL
PD127	1	Vermillion Variant	39	L
PD127	2	Seedskadee	39	L
PD127	3	Fraddle	22	L
PD128	1	Fraddle	56	L
PD128	2	Ouard	22	L
PD128	3	San Arcacio Variant	22	L
PD129	1	Dunul Variant	47	GRV-SL
PD129	2	Garsid	30	CL
PD129	3	Boltus	23	CL
PD401	1	Havermon	53	CL
PD401	2	Tismid	27	SL
PD401	3	Giarch, eroded	20	SCL
PD425	1	Maysprings	43	SL
PD425	2	Ryark	40	LCOS
PD425	3	Comer	17	COSL
PD427	1	Ryark	50	COSL
PD427	2	Hawkstone	25	COSL
PD427	3	Cotha	15	COSL
PD427	4	Maysprings	10	GR-COSL
PD432	1	Pinelli	100	L
PD435	1	Hawkstone	37	LCOS
PD435	2	Ryark	63	SL

PD437	1	Almy	72	SL
PD437	2	Bluerim	28	SL
PD438	1	Almy	30	SL
PD438	2	Bluerim	25	SL
PD438	3	Cotha	20	COSL
PD438	4	Milren	15	COSL
PD438	5	Comer	10	SCL
PD451	1	Kandaly	32	LFS
PD451	2	Maysprings	42	FSL
PD451	3	Ryark	26	FS
PD522	1	Bluerim	45	COSL
PD522	2	Zagspeed	35	COSL
PD522	3	Cotha	10	COSL
PD522	4	Elk Mountain	5	SL
PD522	5	Milren	5	SL
PD533	1	Bluerim	59	SL
PD533	2	Rock River	41	GR-COSL
PD536	1	Bluerim	44	GR-COSL
PD536	2	Forelle	39	SL
PD536	3	Diamondville	17	SL
PD543	1	Toney	47	GR-SL
PD543	2	Forelle	29	GR-SL
PD543	3	Bluerim	24	SL
PD550	1	Bluerim	40	SL
PD550	2	Maysprings	25	SL
PD550	3	Tigon	20	SL
PD550	4	Diamondville	15	GR-SL
PD562	1	Bluerim	62	SL
PD562	2	Forelle	38	COSL
PD565	1	Zagpeed	31	SL
PD565	2	Bluerim	45	SL
PD565	3	Boettcher	19	L
PD565	4	Rock Outcrop	5	UWB
PD568	1	Forelle	44	SL
PD568	2	Bluerim	39	SL
PD568	3	Zagpeed	17	L
PD569	1	Forelle	40	SL
PD569	2	Bluerim	27	SL
PD569	3	Tigon	20	SL
PD569	4	Byrnie	13	LCOS
PD581	1	Worfka	50	GR-C
PD581	2	Kemmerer	25	CL
PD581	3	Glassner	20	C
PD581	4	BADLAND	5	UWB
PD584	1	Forelle	36	COSL
PD584	2	Bluerim	27	CB-SL
PD584	3	Manburn	16	L
PD584	4	Blackhall	16	LCOS
PD584	5	Rock Outcrop	5	UWB
PD587	1	Bluerim	76	L
PD587	2	Cotha	19	GR-SL

PD587	3	Rock Outcrop	5	UWB
PD615	1	Bluerim	40	SL
PD615	2	Tigon	25	GR-COSL
PD615	3	Zagpeed	25	COSL
PD615	4	BADLAND	5	UWL
PD615	5	Rock Outcrop	5	UWL
PD701	1	Manburn	39	GR-LCOS
PD701	2	Bluerim	23	LCOS
PD701	3	Zagpeed	23	COSL
PD701	4	BADLAND	15	UWL
PD702	1	Forelle	38	SCL
PD702	2	Cushool	31	L
PD702	3	Forelle, 40	31	CNV-SCL
PDBL	1	BADLAND	100	UWB
PDW	1	WATER	100	L

The second soil database table from the Statsgo data, which AGWA reads in order to estimate the infiltration, runoff, and sediment transport parameters, is called layer.dbf. This file contains the following fields:

STSSAID State Soil Survey Area ID
MUID Map Unit Identification
SEQNUM Sequence Number
S5ID Soil Interpretations Record Number
LAYERNUM Layer Number
LAYERID convention to identify the original layers on the Number SOI-5 record. Example: layerid 11 for the first surface of a multisurface record, 12 for the second surface layer, 2 through 9 for subsurface layers
LAYDEPL depth to upper boundary of soil layer, inches
LAYDEPH depth to lower boundary of soil layer, inches
TEXTURE1
TEXTURE2
TEXTURE3
KFACT Soil Erodibility Factor, includes adjustment for rock fragments
KFFACT Soil Erodibility Factor, without adjustment for rock fragments Used in SWAT
TFACT Soil loss tolerance factor.
WEG Wind Erodibility Group
INCH10L weight of the rock fragments greater than 10 inches size, in percent (minimum)
INCH10H weight of the rock fragments greater than 10 inches size, in percent (maximum)
INCH3L weight of the rock fragments 3 to 10 inches size, in percent (minimum)
INCH3H weight of the rock fragments 3 to 10 inches size, in percent (maximum)
NO4L Percent Passing Sieve Number 4 (Minimum)
NO4H Percent Passing Sieve Number 4 (Maximum)
NO10L Percent Passing Sieve Number 10 (Minimum)
NO10H Percent Passing Sieve Number 10 (Maximum)
NO40L Percent Passing Sieve Number 40 (Minimum)
NO40H Percent Passing Sieve Number 40 (Maximum)
NO200L Percent Passing Sieve Number 200 (Minimum)
NO200H Percent Passing Sieve Number 200 (Maximum)

CLAYL	Clay Content of Material less than 2 mm in size (Minimum)
CLAYH	Clay Content of Material less than 2 mm in size (Maximum)
LLL	Liquid Limit in percent moisture by weight (Minimum)
LLH	Liquid Limit in percent moisture by weight (Minimum)
PIL	Plasticity Index (Minimum)
PIH	Plasticity Index (Maximum)
UNIFIED1	Unified Soil Classification (engineering)
UNIFIED2	Unified Soil Classification (engineering)
UNIFIED3	Unified Soil Classification (engineering)
UNIFIED4	Unified Soil Classification (engineering)
AASHTO1	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO2	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO3	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHTO4	AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group classification
AASHIND	A AASHTO (American Assoc. of State Highway Classification and Transportation Officials) group index
AWCL	Available Water Capacity (Minimum)
AWCH	Available Water Capacity (Maximum)
BDL	Bulk Density (Minimum)
BDH	Bulk Density (Maximum)
OML	Organic Matter, percent by weight (Minimum)
OMH	Organic Matter, percent by weight (Maximum)
PHL	Soil Reaction (pH) (Minimum)
PHH	Soil Reaction (pH) (Maximum)
SALINL	Salinity (Minimum)
SALINH	Salinity (Maximum)
SARL	Sodium Absorption Ratio (Minimum)
SARH	Sodium Absorption Ratio (Maximum)
CECL	Cation Exchange Capacity (Minimum)
CECH	Cation Exchange Capacity (Maximum)
CACO3L	Carbonate as CaCO3, percent (Minimum)
CACO3H	Carbonate as CaCO3, percent (Maximum)
GYPSUML	Sulfates as CaSO4 (gypsum), percent (Maximum)
GYPSUMH	Sulfates as CaSO4 (gypsum), percent (Minimum)
PERML	Permeability Rate inches/hour (Minimum)
PERMH	Permeability Rate inches/hour (Minimum)
SHRINKSW	Shrink-Swell Potential

This file, showing only the populated fields for the soils of the PAPA project, is in shown in Table B-2.

Table B-2: Layer Composition for PAPA Soils

MUID	SEQNUM	LAYERNUM	LAYDEPL	LAYDEPH	TEXTURE1	TEXTURE 2	TEXTURE3	KFACT	KFFACT	INCH10L	INCH10H	INCH3L	INCH3H	NO4L	NO4H	NO10L	NO10H	NO40L	NO40H	NO200L	NO200H	CLAYL	CLAYH	AWCL	AWCH	BDL	BDH	OML	OMH	PERML	PERMH
PD100	1	1	0	3	L			0.15	0.15	0	0	0	0	50	75	50	75	45	65	35	50	18	27	0.11	0.15	1.30	1.40	0.0	1.0	0.60	2.00
PD100	1	2	3	9	L	CL	SCL	0.37	0.37	0	0	0	0	90	100	75	100	60	80	50	60	18	35	0.15	0.20	1.30	1.40	0.0	1.0	0.60	2.00
PD100	2	1	0	9	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	1.30	1.40	0.0	0.0	0.00	0.00
PD100	3	1	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD100	3	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD102	1	1	0	3	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	34	0.14	0.17	1.30	1.40	2.3	2.3	0.60	2.00
PD102	1	2	3	22	CL	SCL	L	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	18	34	0.13	0.16	1.30	1.40	2.8	2.8	0.60	2.00
PD102	2	1	0	4	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	27	0.14	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD102	2	2	4	9	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	27	0.14	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD102	2	3	9	40	SCL	L	SL	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	15	27	0.13	0.16	1.30	1.40	0.0	1.0	0.20	0.60
PD103	1	1	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD103	1	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD103	2	1	0	2	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD103	2	2	2	9	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD103	3	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD103	3	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD104	1	1	0	2	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	0.15	0.17	1.30	1.40	0.0	1.0	0.00	0.06
PD104	1	2	2	60	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	0.10	0.15	1.30	1.40	0.0	1.0	0.00	0.06
PD105	1	1	0	9	VAR			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	1.30	1.40	0.0	0.0	0.60	20.00
PD106	1	1	0	2	L			0.24	0.24	0	0	0	10	95	100	90	100	75	95	55	75	15	25	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD106	1	2	2	60	CL	L	SL	0.24	0.24	0	0	0	10	95	100	90	100	65	95	45	75	15	34	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD106	2	1	0	3	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD106	2	2	3	60	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD107	1	1	0	3	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD107	1	2	3	60	FSL	VFSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	10	20	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD108	1	1	0	4	SIL			0.37	0.37	0	0	0	0	100	100	100	100	95	100	80	100	18	27	0.09	0.11	1.30	1.40	1.1	1.1	0.20	0.60
PD108	1	2	4	60	SIL	SICL		0.37	0.37	0	0	0	0	100	100	100	100	95	100	80	100	37	35	0.09	0.16	1.30	1.40	1.1	1.1	0.20	0.60
PD108	2	1	0	1	L			0.37	0.37	0	0	0	5	80	100	80	100	80	90	60	75	18	28	0.12	0.14	1.30	1.40	0.0	1.0	0.60	2.00
PD108	2	2	1	60	CL			0.49	0.49	0	0	0	5	80	100	75	100	65	90	50	75	20	40	0.12	0.14	1.30	1.40	0.0	1.0	0.60	2.00
PD108	3	1	0	2	FSL	L	CL	0.32	0.32	0	0	0	0	75	100	75	100	50	75	25	50	10	34	0.11	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD108	3	2	2	60	SR-LS	L	FSL	0.37	0.37	0	0	0	0	90	100	80	100	40	75	20	35	10	34	0.10	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD109	1	1	0	9	VAR			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	1.30	1.40	0.0	0.0	0.60	20.00
PD110	1	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD110	1	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD110	2	1	0	2	SL			0.24	0.24	0	0	0	0	80	100	75	90	50	60	25	35	10	20	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD110	2	2	2	16	SCL			0.28	0.28	0	0	0	0	80	100	75	90	60	80	35	50	20	30	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD111	1	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD111	1	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD111	2	1	0	2	LFS	LS		0.15	0.15	0	0	0	0	100	100	95	100	80	95	20	40	4	8	0.07	0.10	1.30	1.40	0.0	1.0	6.00	20.00
PD111	2	2	2	34	LFS	LS		0.15	0.15	0	0	0	0	100	100	95	100	80	95	20	40	4	8	0.07	0.10	1.30	1.40	0.0	1.0	6.00	20.00
PD111	3	1	0	3	SL			0.20	0.20	0	0	10	16	75	90	75	90	50	60	23	35	10	16	0.11	0.13	1.30	1.40	0.0	1.0	6.00	20.00
PD111	3	2	3	18	SL			0.20	0.20	0	0	10	16	75	90	75	90	50	60	23	35	10	16	0.11	0.13	1.30	1.40	0.0	1.0	6.00	20.00
PD112	1	1	0	3	SL			0.20	0.20	0	0	10	16	75	90	75	90	50	60	23	35	10	16	0.11	0.13	1.30	1.40	0.0	1.0	6.00	20.00
PD112	1	2	3	18	SL			0.20	0.20	0	0	10	16	75	90	75	90	50	60	23	35	10	16	0.11	0.13	1.30	1.40	0.0	1.0	6.00	20.00
PD113	1	1	0	3	L			0.37	0.37	0	0	0	0	75	100	75	100	70	100	50	70	18	27	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00

PD113	1	2	3	12	L			0.43	0.43	0	0	0	0	75	100	75	100	60	75	50	60	18	27	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD113	2	1	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD113	2	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD114	1	1	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD114	1	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD114	2	1	0	4	CL	L		0.32	0.32	0	0	0	0	95	100	90	100	75	95	55	80	6	25	0.17	0.21	1.30	1.40	1.1	1.1	0.20	0.60
PD114	2	2	4	13	CL	C		0.37	0.37	0	0	0	0	95	100	90	100	90	100	75	95	35	50	0.19	0.21	1.30	1.40	0.9	0.9	0.06	0.20
PD114	3	1	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD114	3	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD116	1	1	0	2	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD116	1	2	2	9	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD116	1	3	9	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0.15	0.00	0.00	0.0	1.0	2.00	6.00
PD116	2	1	0	3	L			0.15	0.15	0	0	0	0	50	75	50	75	45	65	35	50	18	27	0.11	0.15	1.30	1.40	0.0	1.0	0.60	2.00
PD116	2	2	3	9	L	CL	SCL	0.37	0.37	0	0	0	0	90	100	75	100	60	80	50	60	18	35	0.15	0.20	1.30	1.40	0.0	1.0	0.60	2.00
PD116	2	3	9	60	SH			0.37	0.37	0	0	0	0	90	100	75	100	60	80	50	60	18	35	0.15	0.20	1.30	1.40	0.0	1.0	0.60	2.00
PD116	3	1	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD116	3	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD117	1	1	0	2	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD117	1	2	2	9	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD117	2	1	0	9	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	1.0	0.00	0.00
PD117	3	1	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD117	3	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD119	1	1	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD119	1	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD119	2	1	0	2	L			0.24	0.24	0	0	0	10	95	100	90	100	75	95	55	75	15	25	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD119	2	2	2	60	CL	L	SL	0.24	0.24	0	0	0	10	95	100	90	100	65	95	45	75	15	34	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD120	1	1	0	4	LFS	LS		0.32	0.32	0	0	0	0	100	100	100	100	75	95	20	35	0	10	0.08	0.10	1.30	1.40	0.0	1.0	6.00	20.00
PD120	1	2	4	60	FS	LS		0.28	0.28	0	0	0	0	100	100	100	100	75	95	5	30	0	7	0.05	0.07	1.30	1.40	0.0	1.0	6.00	20.00
PD120	2	1	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD120	2	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD120	3	1	0	2	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD120	3	2	2	9	SL	FSL		0.32	0.32	0	0	0	0	75	100	75	100	55	75	30	40	5	12	0.13	0.15	1.30	1.40	0.0	1.0	2.00	6.00
PD121	1	1	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD121	1	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD121	2	1	0	7	VFSL	FSL	SL	0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD121	2	2	7	34	VFSL	FSL		0.32	0.32	0	0	0	0	100	100	100	100	85	95	50	65	5	18	0.15	0.17	1.30	1.40	0.0	1.0	0.60	2.00
PD121	3	1	0	3	L			0.32	0.32	0	0	0	0	95	100	85	100	80	90	65	80	18	34	0.14	0.17	1.30	1.40	2.3	2.3	0.60	2.00
PD121	3	2	3	22	CL	SCL	L	0.32	0.32	0	0	0	0	80	100	75	100	65	85	50	75	18	34	0.13	0.16	1.30	1.40	2.8	2.8	0.60	2.00
PD122	1	1	0	3	FSCL			0.37	0.37	0	0	0	0	90	100	90	100	75	85	35	50	20	35	0.14	0.16	1.30	1.40	1.0	1.0	0.60	2.00
PD122	1	2	3	28	C			0.37	0.37	0	0	0	0	75	100	75	100	70	90	65	90	35	50	0.11	0.13	1.30	1.40	0.9	0.1	0.06	0.60
PD122	2	1	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD122	2	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD122	3	1	0	3	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	0.15	0.17	1.30	1.40	0.0	1.0	0.00	0.06
PD122	3	2	3	60	SIC	C	SICL	0.37	0.37	0	0	0	0	95	100	95	100	95	100	90	100	35	60	0.10	0.15	1.30	1.40	0.0	1.0	0.00	0.06
PD123	1	1	0	6	LFS	GR-SL		0.20	0.20	0	0	0	10	85	100	80	100	65	95	15	30	5	12	0.08	0.11	1.30	1.40	0.0	1.0	2.00	6.00
PD123	1	2	6	12	LFS	CN-LFS	GR-SL	0.28	0.28	0	0	0	10	70	90	65	90	60	90	10	30	5	12	0.06	0.11	1.30	1.40	0.0	1.0	2.00	6.00
PD123	2	1	0	4	CL	L		0.32	0.32	0	0	0	0	95	100	90	100	75	95	55	80	6	25	0.17	0.21	1.30	1.40	1.1	1.1	0.20	0.60
PD123	2	2	4	13	CL	C		0.37	0.37	0	0	0	0	95	100	90	100	90	100	75	95	35	50	0.19	0.21	1.30	1.40	0.9	0.9	0.06	0.20
PD123	3	1	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD123	3	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00

PD124	1	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD124	1	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD124	2	1	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD124	2	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD124	3	1	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD124	3	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD125	1	1	0	3	SL	COSL		0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD125	1	2	3	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD125	2	1	0	6	SL	COSL	GR-SL	0.15	0.15	0	0	0	10	75	100	50	100	40	75	25	45	5	18	0.11	0.18	1.30	1.40	0.0	1.0	2.00	6.00
PD125	2	2	6	19	GRV-S	COSL	GRV-LS	0.05	0.05	0	0	10	40	25	50	25	50	10	30	0	10	0	5	0.03	0.05	1.30	1.40	0.0	1.0	6.00	20.00
PD127	1	1	0	3	L			0.37	0.37	0	0	0	0	95	100	95	100	80	90	60	70	15	30	0.16	0.18	1.30	1.40	1.8	1.8	0.60	2.00
PD127	1	2	3	8	CN-L	CN-CL		0.15	0.15	0	0	0	10	70	85	65	75	55	65	40	50	18	34	0.10	0.13	1.30	1.40	1.8	1.8	0.20	6.00
PD127	1	3	8	27	FLX-L	FLV-CL	FLV-L	0.10	0.10	0	0	45	60	70	85	40	50	30	40	20	30	18	30	0.07	0.09	1.30	1.40	2.4	2.4	0.20	6.00
PD127	2	1	0	2	L			0.24	0.24	0	0	0	10	85	100	70	100	45	90	20	50	18	34	0.10	0.15	1.30	1.40	0.0	1.0	0.60	6.00
PD127	2	2	2	14	SCL	L	SL	0.24	0.24	0	0	0	10	85	100	70	100	45	90	20	50	18	34	0.10	0.15	1.30	1.40	0.0	1.0	0.60	6.00
PD127	3	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD127	3	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD128	1	1	0	4	SL			0.24	0.24	0	0	0	0	90	100	90	100	55	80	30	50	10	20	0.11	0.13	1.30	1.40	1.1	1.1	2.00	6.00
PD128	1	2	4	22	SCL			0.28	0.28	0	0	0	0	90	100	90	100	75	85	35	50	18	34	0.14	0.16	1.30	1.40	0.8	0.8	0.60	2.00
PD128	2	1	0	1	SL	SCL		0.24	0.24	0	0	0	0	100	100	100	100	60	70	30	40	18	34	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD128	2	2	1	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	75	90	35	50	18	34	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD128	3	1	0	4	SL			0.24	0.24	0	0	0	0	80	100	75	95	50	65	25	50	10	20	0.11	0.13	1.30	1.40	0.0	1.0	2.00	6.00
PD128	3	2	4	14	SCL	SL		0.28	0.28	0	0	0	0	80	100	75	95	60	85	35	50	18	35	0.14	0.16	1.30	1.40	0.0	1.0	0.60	2.00
PD129	1	1	0	4	GRV-SL			0.05	0.05	0	0	0	20	35	50	30	45	25	40	10	20	8	18	0.06	0.08	1.30	1.40	0.0	1.0	2.00	6.00
PD129	1	2	4	14	GRX-S			0.02	0.02	0	0	5	30	15	30	10	25	5	20	0	15	3	10	0.03	0.05	1.30	1.40	0.0	1.0	6.00	20.00
PD129	2	1	0	4	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD129	2	2	4	22	L	CL		0.32	0.32	0	0	0	0	75	100	75	100	75	100	55	75	18	35	0.16	0.18	1.30	1.40	0.0	1.0	0.60	2.00
PD129	3	1	0	3	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD129	3	2	3	11	C	CL		0.32	0.32	0	0	0	0	90	100	75	100	75	100	70	100	35	60	0.08	0.10	1.30	1.40	0.0	1.0	0.06	0.20
PD401	1	1	0	2	C	CL		0.37	0.37	0	0	0	0	100	100	100	100	91	100	65	78	24	40	0.13	0.15	1.05	1.15	1.0	2.0	0.60	2.00
PD401	1	2	2	9	SCL	CL		0.32	0.32	0	0	0	0	100	100	100	100	92	100	70	81	34	45	0.01	0.02	1.15	1.30	0.5	1.0	0.06	0.20
PD401	2	1	0	4	SL			0.28	0.28	0	0	0	0	88	100	75	100	66	93	29	43	14	19	0.09	0.11	1.25	1.35	1.0	2.0	2.00	6.00
PD401	2	2	4	6	SCL			0.28	0.28	0	0	0	0	100	100	100	100	88	100	43	57	20	34	0.13	0.15	1.25	1.40	0.5	1.0	0.60	2.00
PD401	2	3	6	12	CL			0.37	0.37	0	0	0	0	100	100	100	100	95	100	65	74	27	36	0.11	0.12	1.25	1.40	0.5	1.0	0.60	2.00
PD401	3	1	0	2	SC	CL	SCL	0.17	0.17	0	0	0	0	100	100	100	100	64	88	29	53	12	36	0.13	0.15	1.15	1.25	1.0	2.0	0.60	2.00
PD401	3	2	2	6	CL	C	SC	0.32	0.32	0	0	0	0	100	100	100	100	90	97	69	76	35	42	0.14	0.16	1.25	1.35	0.5	1.0	0.20	0.60
PD401	3	3	6	8	SCL	C	SC	0.24	0.24	0	0	0	0	100	100	100	100	75	100	39	67	16	44	0.11	0.16	1.30	1.40	0.0	0.5	0.60	2.00
PD401	3	4	8	26	CL	SCL		0.28	0.28	0	0	0	0	100	100	100	100	73	91	52	70	18	36	0.16	0.18	1.35	1.45	0.0	0.5	0.20	0.60
PD425	1	1	0	2	SL	SCL		0.15	0.15	0	0	0	0	76	100	75	100	51	80	19	38	10	22	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD425	1	2	2	3	SL	SCL	GR-SL	0.28	0.28	0	0	0	0	61	100	60	100	47	88	22	47	12	22	0.09	0.13	1.25	1.35	0.5	1.0	2.00	6.00
PD425	1	3	3	8	SCL	SL	L	0.24	0.24	0	0	0	0	83	100	82	100	62	92	30	53	16	32	0.14	0.16	1.31	1.38	0.5	1.0	0.60	2.00
PD425	1	4	8	17	SCL	CL	SL	0.24	0.24	0	0	0	0	91	100	91	100	67	95	32	56	16	37	0.14	0.16	1.31	1.38	0.5	1.0	0.60	2.00
PD425	2	1	0	2	LCOS	GR-LCOS		0.05	0.05	0	0	0	0	69	91	68	91	37	53	13	21	8	12	0.05	0.07	1.32	1.44	1.0	2.0	6.00	20.00
PD425	2	2	2	6	SL	GR-SL		0.20	0.20	0	0	0	0	68	100	66	100	47	76	18	33	10	15	0.10	0.13	1.28	1.34	1.0	2.0	2.00	6.00
PD425	2	3	6	16	SL	GR-SL		0.28	0.28	0	0	0	0	69	100	68	100	52	78	27	42	14	16	0.10	0.13	1.35	1.41	0.5	1.0	2.00	6.00
PD425	3	1	0	1	COSL	LCOS		0.15	0.17	0	0	0	0	91	100	91	100	52	61	25	32	8	12	0.09	0.11	1.30	1.36	1.0	2.0	6.00	20.00

PD425	3	2	1	3	SL			0.24	0.24	0	0	0	0	91	96	90	96	66	74	29	35	10	14	0.11	0.13	1.27	1.33	1.0	2.0	2.00	6.00
PD425	3	3	3	9	SL			0.24	0.24	0	0	0	0	96	100	96	100	71	78	33	38	12	16	0.11	0.13	1.27	1.33	0.0	0.5	2.00	6.00
PD427	1	1	0	2	COSL			0.10	0.10	0	0	0	0	87	97	74	94	49	66	21	31	8	12	0.08	0.11	1.25	1.35	1.0	2.0	6.00	20.00
PD427	1	2	2	9	SL	COSL		0.37	0.37	0	0	0	0	88	100	76	100	63	91	28	45	11	19	0.09	0.11	1.35	1.50	0.5	1.0	2.00	6.00
PD427	2	1	0	2	COSL	SL		0.15	0.15	0	0	0	0	88	100	75	100	46	66	23	34	8	12	0.08	0.11	1.25	1.35	1.0	2.0	6.00	20.00
PD427	2	2	2	6	SL	COSL		0.28	0.28	0	0	0	0	95	100	90	100	74	86	27	34	8	12	0.09	0.11	1.25	1.35	1.0	2.0	6.00	20.00
PD427	2	3	6	12	SL			0.32	0.32	0	0	0	0	96	100	91	100	77	90	33	41	10	15	0.09	0.11	1.35	1.50	0.5	1.0	2.00	6.00
PD427	3	1	0	2	COSL			0.15	0.15	0	0	0	0	91	100	82	100	53	69	24	34	8	12	0.08	0.11	1.25	1.35	1.0	2.0	6.00	20.00
PD427	3	2	2	16	SL			0.24	0.24	0	0	0	0	100	100	100	100	80	86	34	40	12	18	0.09	0.11	1.35	1.50	0.5	1.0	2.00	6.00
PD427	4	1	0	1	GR-COSL			0.15	0.15	0	0	0	0	76	100	75	100	51	80	19	38	8	16	0.11	0.13	1.30	1.40	1.0	2.0	2.00	6.00
PD427	4	2	1	3	GR-SL			0.28	0.28	0	0	0	0	61	100	60	100	47	88	22	47	8	16	0.09	0.13	1.30	1.40	0.5	1.0	2.00	6.00
PD427	4	3	3	6	GR-SCL			0.24	0.24	0	0	0	0	83	100	82	100	62	92	30	53	20	26	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD427	4	4	6	11	GRV-SCL			0.24	0.24	0	0	0	0	91	100	91	100	67	95	32	56	20	26	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD432	1	1	0	1	L	SIL	SICL	0.43	0.43	0	0	0	0	100	100	100	100	86	94	62	70	22	29	0.16	0.18	1.18	1.28	1.0	2.0	0.60	2.00
PD432	1	2	1	2	CL			0.43	0.43	0	0	0	0	100	100	100	100	86	98	65	77	28	32	0.19	0.21	1.20	1.30	1.0	2.0	0.60	2.00
PD432	1	2	2	10	CL			0.32	0.32	0	0	0	0	100	100	100	100	93	99	74	80	36	38	0.18	0.20	1.25	1.35	0.5	1.0	0.20	0.60
PD435	1	1	0	2	GR-LCOS	LCOS	COSL	0.10	0.15	0	0	0	0	63	91	61	91	36	60	14	27	3	10	0.05	0.07	1.35	1.45	1.0	2.0	6.00	20.00
PD435	1	2	2	4	COSL			0.32	0.32	0	0	0	0	88	96	87	96	58	73	33	46	6	15	0.09	0.11	1.30	1.40	1.0	2.0	6.00	20.00
PD435	1	3	4	14	GR-COSL	COSL		0.24	0.28	0	0	0	0	73	96	72	96	49	72	28	44	10	17	0.09	0.11	1.37	1.47	0.5	1.0	6.00	20.00
PD435	2	1	0	1	LCOS	COSL	SL	0.28	0.32	0	0	0	0	75	100	74	100	58	89	29	50	5	15	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD435	2	2	1	4	COSL	SL		0.28	0.32	0	0	0	0	91	100	90	100	71	88	34	48	8	18	0.11	0.13	1.27	1.37	1.0	2.0	2.00	6.00
PD435	2	3	4	11	SL	COSL		0.28	0.32	0	0	0	0	91	100	91	100	71	85	39	50	12	19	0.11	0.13	1.35	1.45	0.5	1.0	2.00	6.00
PD437	1	1	0	2	SL			0.20	0.24	0	0	0	0	83	96	82	96	61	79	28	41	10	18	0.11	0.13	1.34	1.40	1.0	2.0	2.00	6.00
PD437	1	2	2	6	SL			0.28	0.28	0	0	0	0	100	100	100	100	73	81	37	45	10	18	0.11	0.13	1.37	1.44	1.0	2.0	2.00	6.00
PD437	1	3	6	12	SCL	SL	CL	0.28	0.28	0	0	0	0	100	100	100	100	80	94	42	56	16	30	0.14	0.16	1.30	1.36	0.5	1.0	0.60	2.00
PD437	2	1	0	2	COSL	SL		0.15	0.20	0	0	0	0	87	100	87	100	62	76	28	36	12	16	0.11	0.13	1.27	1.33	1.0	2.0	2.00	6.00
PD437	2	2	2	4	SL			0.20	0.20	0	0	0	0	96	100	96	100	72	79	37	42	13	20	0.11	0.13	1.27	1.33	1.0	2.0	2.00	6.00
PD437	2	3	4	7	SC	SCL		0.20	0.20	0	0	0	0	100	100	96	100	70	85	37	50	24	36	0.14	0.16	1.33	1.39	0.5	1.0	0.20	0.60
PD437	2	4	7	25	SCL			0.24	0.24	0	0	0	0	100	100	94	100	73	86	37	47	20	28	0.14	0.16	1.34	1.40	0.5	1.0	0.60	2.00
PD438	1	1	0	2	SL	L		0.24	0.24	0	0	0	0	100	100	100	100	78	92	39	53	12	26	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD438	1	2	2	13	CL	SL	SCL	0.28	0.28	0	0	0	0	100	100	100	100	78	95	42	59	17	34	0.14	0.16	1.28	1.38	0.5	1.0	0.60	2.00
PD438	2	1	0	2	SL			0.20	0.20	0	0	0	0	100	100	90	94	69	76	34	40	14	19	0.09	0.11	1.20	1.35	1.0	2.0	2.00	6.00
PD438	2	2	2	9	SCL			0.28	0.28	0	0	0	0	100	100	100	100	85	93	44	52	20	28	0.14	0.16	1.30	1.30	0.5	1.0	0.60	2.00
PD438	3	1	0	2	SL	COSL		0.15	0.15	0	0	0	0	100	100	94	96	56	62	30	37	10	16	0.09	0.11	1.29	1.39	1.0	2.0	6.00	20.00
PD438	3	2	2	9	SL			0.24	0.24	0	0	0	0	100	100	100	100	75	77	39	41	15	17	0.11	0.13	1.35	1.45	0.5	1.0	2.00	6.00
PD438	4	1	0	2	SL	COSL		0.20	0.20	0	0	0	0	100	100	87	96	56	67	34	43	12	18	0.09	0.11	1.25	1.35	1.0	2.0	2.00	6.00
PD438	4	2	2	9	CL	SCL		0.28	0.28	0	0	0	0	100	100	96	100	86	100	50	66	24	38	0.14	0.16	1.28	1.38	0.5	1.0	0.60	2.00
PD438	5	1	0	2	SCL			0.24	0.24	0	0	0	0	100	100	96	100	82	92	44	52	20	26	0.14	0.16	1.20	1.30	1.0	2.0	0.60	2.00
PD438	5	2	2	17	SL			0.28	0.28	0	0	0	0	100	100	100	100	75	81	37	43	12	18	0.11	0.13	1.25	1.35	0.5	1.0	2.00	6.00
PD451	1	1	0	2	LFS			0.37	0.37	0	0	0	0	100	100	100	100	95	99	34	38	6	10	0.08	0.10	1.35	1.45	1.0	2.0	6.00	20.00
PD451	1	2	2	5	FSL			0.37	0.37	0	0	0	0	100	100	100	100	93	98	37	42	10	15	0.13	0.15	1.35	1.50	0.5	1.0	2.00	6.00
PD451	1	3	5	24	FS	S		0.15	0.15	0	0	0	0	100	100	100	100	91	95	14	18	5	9	0.06	0.08	1.45	1.60	0.0	0.5	6.00	20.00
PD451	2	1	0	2	FSL			0.32	0.32	0	0	0	0	100	100	100	100	91	98	36	43	10	17	0.13	0.15	1.25	1.35	0.0	2.0	2.00	6.00
PD451	2	2	2	11	SCL			0.28	0.28	0	0	0	0	100	100	100	100	87	97	42	52	20	30	0.16	0.18	1.25	1.40	0.5	1.0	0.60	2.00
PD451	3	1	0	2	FS			0.17	0.17	0	0	0	0	100	100	100	100	93	96	16	19	5	8	0.06	0.08	1.35	1.45	1.0	2.0	6.00	20.00
PD451	3	2	2	7	FSL			0.43	0.43	0	0	0	0	100	100	100	100	93	98	40	45	10	15	0.13	0.15	1.35	1.50	0.5	1.0	2.00	6.00

PD451	3	3	7	26	LFS	FS		0.17	0.17	0	0	0	0	100	100	100	100	91	96	14	19	5	10	0.06	0.08	1.45	1.60	0.0	0.5	6.00	20.00
PD522	1	1	0	4	COSL			0.15	0.15	0	0	0	0	100	100	90	100	59	70	31	40	10	15	0.09	0.11	1.20	1.35	1.0	2.0	6.00	20.00
PD522	1	2	4	17	SCL			0.24	0.24	0	0	0	0	100	100	91	100	76	88	37	46	20	25	0.14	0.16	1.25	1.40	0.5	1.0	0.60	2.00
PD522	2	1	0	2	COSL			0.20	0.20	0	0	0	0	100	100	90	96	58	67	29	35	10	15	0.08	0.11	1.23	1.37	1.0	2.0	6.00	20.00
PD522	2	2	2	5	COSL			0.20	0.20	0	0	0	0	100	100	90	98	60	69	31	37	15	19	0.08	0.11	1.23	1.37	0.5	1.0	2.00	6.00
PD522	2	3	5	11	SCL			0.28	0.28	0	0	0	0	100	100	91	100	77	90	38	46	20	24	0.14	0.19	1.27	1.40	0.5	1.0	0.60	2.00
PD522	3	1	0	4	COSL			0.15	0.15	0	0	0	0	91	95	82	90	52	59	26	31	15	17	0.08	0.11	1.23	1.37	1.0	2.0	2.00	6.00
PD522	3	2	4	8	SCL			0.15	0.20	0	0	0	0	88	95	76	91	63	80	31	42	20	25	0.16	0.18	1.27	1.40	0.5	1.0	0.60	2.00
PD522	3	3	8	16	GR-COSL			0.10	0.20	0	0	0	0	84	88	68	75	44	51	22	27	12	16	0.06	0.08	1.37	1.50	0.5	1.0	2.00	6.00
PD522	4	1	0	2	SL			0.28	0.32	0	0	0	0	95	100	90	100	78	90	32	40	10	14	0.08	0.13	1.23	1.37	1.0	2.0	2.00	6.00
PD522	4	2	2	7	COSL			0.15	0.15	0	0	0	0	96	100	91	100	64	74	31	37	15	18	0.08	0.12	1.37	1.50	0.5	1.0	2.00	6.00
PD522	4	3	7	12	SCL			0.28	0.28	0	0	0	0	95	100	91	100	78	88	38	44	20	22	0.14	0.19	1.27	1.40	0.5	1.0	0.60	2.00
PD522	5	1	0	7	SL			0.24	0.24	0	0	0	0	100	100	90	100	78	91	33	41	10	15	0.08	0.13	1.23	1.37	1.0	2.0	2.00	6.00
PD522	5	2	7	15	CL			0.32	0.32	0	0	0	0	100	100	91	100	86	98	63	72	35	38	0.17	0.21	1.27	1.40	0.5	1.0	0.20	0.60
PD533	1	1	0	2	COSL	SL		0.20	0.20	0	0	0	0	91	100	91	100	69	84	29	40	10	18	0.11	0.13	1.35	1.45	1.0	2.0	2.00	6.00
PD533	1	2	2	6	SL			0.24	0.24	0	0	0	0	91	100	91	100	71	84	35	44	12	18	0.11	0.13	1.38	1.48	1.0	2.0	2.00	6.00
PD533	1	3	6	12	SCL			0.28	0.28	0	0	0	0	100	100	100	100	86	94	45	53	22	30	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD533	2	1	0	2	GR-COSL	COSL	SL	0.15	0.15	0	0	0	0	68	91	66	90	45	67	22	35	8	14	0.08	0.11	1.25	1.35	1.0	2.0	6.00	20.00
PD533	2	2	2	8	SL	SCL		0.28	0.28	0	0	0	0	83	100	82	100	68	91	35	51	16	24	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD533	2	3	8	23	SCL			0.28	0.28	0	0	0	0	83	100	82	100	69	94	39	57	20	30	0.14	0.16	1.32	1.42	0.5	1.0	0.60	2.00
PD536	1	1	0	2	GR-COSL	COSL		0.10	0.15	0	0	0	0	68	94	66	94	39	60	20	33	11	16	0.09	0.11	1.25	1.35	1.0	2.0	2.00	6.00
PD536	1	2	2	4	COSL			0.17	0.17	0	0	0	0	75	96	74	96	41	62	22	37	10	19	0.09	0.11	1.25	1.35	1.0	2.0	2.00	6.00
PD536	1	3	4	8	L	SCL		0.37	0.37	0	0	0	0	80	96	48	96	41	89	29	66	21	28	0.16	0.18	1.25	1.35	0.5	1.0	0.60	2.00
PD536	1	4	8	11	SCL	CL	GR-SCL	0.28	0.28	0	0	0	0	62	96	60	96	48	87	27	53	22	32	0.14	0.16	1.27	1.37	0.5	1.0	0.60	2.00
PD536	2	1	0	1	SL			0.20	0.20	0	0	0	0	100	100	74	100	55	79	24	38	12	17	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD536	2	2	1	5	SCL			0.24	0.24	0	0	0	0	100	100	90	100	78	99	38	55	21	34	0.14	0.16	1.25	1.35	0.5	1.0	0.60	2.00
PD536	2	3	5	12	SCL			0.24	0.24	0	0	0	0	100	100	94	100	76	90	39	51	21	30	0.14	0.16	1.27	1.37	0.5	1.0	0.60	2.00
PD536	3	1	0	1	SL			0.15	0.20	0	0	0	0	82	100	82	100	58	77	25	36	10	16	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD536	3	2	1	4	SCL			0.24	0.24	0	0	0	0	100	100	96	100	81	91	40	47	20	26	0.14	0.16	1.20	1.30	1.0	2.0	0.60	2.00
PD536	3	3	4	9	SCL			0.24	0.24	0	0	0	0	100	100	98	100	77	86	39	47	22	29	0.14	0.16	1.28	1.38	0.5	1.0	0.60	2.00
PD543	1	1	0	2	L	GR-SL		0.20	0.28	0	0	0	0	83	91	65	81	47	68	27	43	12	24	0.11	0.13	1.20	1.30	1.0	2.0	2.00	6.00
PD543	1	2	2	8	CL	SCL	C	0.24	0.24	0	0	0	0	100	100	100	100	70	95	46	71	20	45	0.14	0.16	1.15	1.25	0.5	1.0	0.06	0.20
PD543	1	3	8	14	CL	C	SC	0.20	0.20	0	0	0	0	95	100	90	100	73	90	44	59	32	42	0.14	0.16	1.25	1.35	0.5	1.0	0.06	0.20
PD543	2	1	0	1	COSL	GR-SL		0.17	0.24	0	0	0	0	83	87	65	73	48	59	22	31	9	18	0.11	0.13	1.20	1.30	1.0	2.0	2.00	6.00
PD543	2	2	1	3	CL	SL		0.24	0.24	0	0	0	0	100	100	100	100	73	89	37	53	12	28	0.11	0.13	1.30	1.40	0.5	1.0	2.00	6.00
PD543	2	3	3	7	SCL	COSL		0.24	0.24	0	0	0	0	100	100	100	100	75	88	36	49	15	28	0.14	0.16	1.25	1.35	0.5	1.0	0.60	2.00
PD543	2	4	7	17	SCL			0.20	0.20	0	0	0	0	100	100	100	100	84	87	52	55	31	34	0.14	0.16	1.25	1.35	0.5	1.0	0.60	2.00
PD543	3	1	0	4	SL			0.24	0.24	0	0	0	0	88	95	75	90	56	73	28	40	11	17	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD543	3	2	4	13	CL			0.28	0.28	0	0	0	0	100	100	100	100	87	93	64	70	31	37	0.19	0.21	1.20	1.30	0.5	1.0	0.60	2.00
PD550	1	1	0	1	SL	GR-SL		0.20	0.20	0	0	0	0	75	100	74	100	58	84	27	43	10	16	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD550	1	2	1	3	SL			0.28	0.28	0	0	0	0	100	100	100	100	79	87	40	48	10	18	0.11	0.13	1.28	1.38	1.0	2.0	2.00	6.00
PD550	1	3	3	11	SCL			0.32	0.32	0	0	0	0	100	100	100	100	86	92	46	52	20	29	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD550	2	1	0	1	SL			0.20	0.20	0	0	0	0	82	100	82	100	65	84	28	39	10	15	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD550	2	2	1	5	SL			0.24	0.24	0	0	0	0	91	100	90	100	72	83	31	38	12	16	0.11	0.13	1.27	1.37	1.0	2.0	2.00	6.00
PD550	2	3	5	12	SCL	SL		0.28	0.28	0	0	0	0	100	100	100	100	83	93	42	52	18	28	0.14	0.16	1.30	1.40	0.5	1.0	0.60	2.00
PD550	3	1	0	2	SL	GR-SL		0.20	0.20	0	0	0	0	68	100	66	100	51	82	21	37	10	15	0.10	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD550	3	2	2	6	SL	SCL		0.24	0.24	0	0	0	0	84	100	83	100	66	88	33	48	16	24	0.11	0.13	1.37	1.47	0.5	1.0	2.00	6.00

PD550	3	3	6	14	SCL	SL		0.20	0.20	0	0	0	0	100	100	100	100	79	89	39	49	18	28	0.14	0.16	1.39	1.49	0.5	1.0	0.60	2.00
PD550	4	1	0	2	SL	GR-SL		0.15	0.24	0	0	0	0	75	89	74	88	57	74	24	34	10	16	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD550	4	2	2	4	SCL	CL		0.37	0.37	0	0	0	0	83	100	82	100	73	99	56	79	24	34	0.19	0.21	1.28	1.38	0.5	1.0	0.60	2.00
PD550	4	3	4	11	SCL	CL		0.37	0.37	0	0	0	0	100	100	100	100	88	98	69	79	24	34	0.19	0.21	1.30	1.40	0.5	1.0	0.60	2.00
PD562	1	1	0	2	SL	COSL	GR-COSL	0.20	0.24	0	0	0	0	68	100	67	100	51	84	22	40	8	15	0.10	0.13	1.29	1.39	1.0	2.0	2.00	6.00
PD562	1	2	2	3	COSL	SL		0.28	0.28	0	0	0	0	100	100	100	100	78	86	38	46	10	18	0.11	0.13	1.35	1.45	1.0	2.0	2.00	6.00
PD562	1	3	3	9	CL	SCL		0.37	0.37	0	0	0	0	100	100	100	100	85	95	44	54	20	30	0.14	0.16	1.32	1.42	0.5	1.0	0.60	2.00
PD562	1	4	9	23	CL	SCL		0.32	0.32	0	0	0	0	100	100	100	100	86	98	46	58	20	32	0.14	0.16	1.35	1.45	0.5	1.0	0.60	2.00
PD562	1	5	23	28	SCL	CL	COSL	0.20	0.24	0	0	0	0	78	100	77	100	49	78	25	47	16	30	0.08	0.11	1.50	1.60	0.0	0.5	2.00	6.00
PD562	2	1	0	1	SL	COSL		0.10	0.15	0	0	0	0	68	100	67	100	39	66	18	35	7	15	0.08	0.11	1.30	1.40	1.0	2.0	6.00	20.00
PD562	2	2	1	4	SCL	COSL	SL	0.20	0.20	0	0	0	0	83	100	82	100	49	66	25	38	12	26	0.09	0.11	1.33	1.43	0.5	1.0	2.00	6.00
PD562	2	3	4	13	CL	SCL		0.32	0.32	0	0	0	0	81	100	81	100	70	95	54	75	26	34	0.19	0.21	1.18	1.28	0.5	1.0	0.60	2.00
PD562	2	4	13	22	SCL	SL	L	0.24	0.24	0	0	0	0	100	100	100	100	78	90	41	53	18	30	0.14	0.16	1.27	1.37	0.5	1.0	0.60	2.00
PD562	2	5	22	31	SL			0.32	0.32	0	0	0	0	100	100	100	100	78	85	43	50	12	19	0.11	0.13	1.50	1.60	0.0	0.5	2.00	6.00
PD562	2	6	31	43	SL			0.24	0.24	0	0	0	0	100	100	100	100	74	81	35	42	12	19	0.11	0.13	1.50	1.60	0.0	0.5	2.00	6.00
PD562	2	7	43	50	SCL	SL		0.32	0.32	0	0	0	0	100	100	100	100	82	92	44	54	16	26	0.14	0.16	1.45	1.55	0.0	0.5	0.60	2.00
PD562	2	8	50	53	CL			0.37	0.37	0	0	0	0	100	100	100	100	89	97	67	75	27	35	0.19	0.21	1.35	1.45	0.0	0.5	0.60	2.00
PD565	1	1	0	3	SL	L		0.20	0.24	0	0	0	0	83	100	82	100	65	85	32	45	12	18	0.11	0.13	1.30	1.40	1.0	2.0	2.00	6.00
PD565	1	2	3	9	CL	SCL		0.43	0.43	0	0	0	0	94	100	94	100	85	96	67	77	24	30	0.19	0.21	1.29	1.39	0.5	1.0	0.60	2.00
PD565	2	1	0	2	SL			0.24	0.24	0	0	0	0	75	100	74	100	54	80	25	39	8	14	0.11	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD565	2	2	2	9	SCL	SL		0.32	0.32	0	0	0	0	100	100	100	100	84	92	44	52	16	24	0.14	0.16	1.28	1.38	0.5	1.0	0.60	2.00
PD565	3	1	0	1	SIL	SICL	L	0.32	0.37	0	0	0	0	80	100	80	100	72	100	50	74	20	31	0.16	0.18	1.10	1.20	1.0	2.0	0.60	2.00
PD565	3	2	1	2	CL	SICL	L	0.37	0.37	0	0	0	0	89	100	89	100	81	99	63	79	24	32	0.19	0.21	1.07	1.17	1.0	2.0	0.60	2.00
PD565	3	3	2	7	C	SICL		0.43	0.43	0	0	0	0	100	100	100	100	90	98	73	81	36	44	0.14	0.16	1.19	1.29	0.5	1.0	0.06	0.20
PD565	3	4	7	19	SIC	SICL		0.43	0.43	0	0	0	0	100	100	100	100	95	100	89	96	35	42	0.19	0.21	1.21	1.31	0.0	0.5	0.20	0.60
PD565	4	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD568	1	1	0	2	SL			0.37	0.37	0	0	0	0	93	100	87	100	60	78	26	38	10	18	0.11	0.13	1.23	1.36	1.0	2.0	2.00	6.00
PD568	1	2	2	6	SL			0.43	0.43	0	0	0	0	98	100	96	100	70	81	40	49	14	22	0.11	0.13	1.23	1.36	1.0	2.0	2.00	6.00
PD568	1	3	6	17	SCL	L		0.49	0.49	0	0	0	0	100	100	100	100	81	89	45	53	20	28	0.14	0.16	1.40	1.53	0.5	1.0	0.60	2.00
PD568	2	1	0	1	SL	GR-COSL		0.28	0.37	0	0	0	0	80	100	60	100	43	80	19	40	10	18	0.11	0.13	1.23	1.36	1.0	2.0	2.00	6.00
PD568	2	2	1	9	SCL	CL		0.49	0.49	0	0	0	0	97	100	95	100	77	91	43	55	20	30	0.14	0.16	1.40	1.53	0.5	1.0	0.60	2.00
PD568	3	1	0	1	FSL	L		0.20	0.28	0	0	0	0	87	100	73	100	62	89	42	61	14	18	0.14	0.16	1.14	1.21	1.0	2.0	0.60	2.00
PD568	3	2	1	4	SL	L		0.49	0.49	0	0	0	0	95	100	90	100	70	79	44	51	16	18	0.11	0.13	1.23	1.36	1.0	2.0	2.00	6.00
PD568	3	3	4	10	SCL	CL		0.49	0.49	0	0	0	0	96	100	91	100	77	92	44	56	24	32	0.14	0.16	1.40	1.53	0.5	1.0	0.60	2.00
PD569	1	1	0	1	SL	COSL		0.20	0.20	0	0	0	0	100	100	73	94	52	72	22	34	12	18	0.11	0.13	1.23	1.27	1.0	2.0	0.60	2.00
PD569	1	2	1	5	SCL	SL		0.32	0.32	0	0	0	0	100	100	94	94	76	83	38	45	14	21	0.14	0.16	1.32	1.39	1.0	2.0	0.60	2.00
PD569	1	3	5	12	SCL			0.28	0.28	0	0	0	0	100	100	100	100	87	100	46	59	22	35	0.14	0.16	1.30	1.37	0.5	1.0	0.60	2.00
PD569	2	1	0	2	COSL	SL		0.20	0.20	0	0	0	0	75	94	74	94	54	73	24	34	10	14	0.11	0.13	1.26	1.33	1.0	2.0	2.00	6.00
PD569	2	2	2	6	SL	SCL		0.20	0.20	0	0	0	0	91	96	90	96	69	81	32	41	14	22	0.11	0.13	1.26	1.33	1.0	2.0	2.00	6.00
PD569	2	3	6	17	SCL	CL		0.24	0.24	0	0	0	0	91	100	91	100	70	94	34	55	19	36	0.14	0.16	1.30	1.35	0.5	1.0	0.60	2.00
PD569	3	1	0	1	COSL	SL		0.15	0.20	0	0	0	0	91	91	60	90	43	71	19	34	10	16	0.09	0.13	1.26	1.34	1.0	2.0	2.00	6.00
PD569	3	2	1	3	COSL	SL		0.24	0.24	0	0	0	0	75	96	74	96	55	76	26	38	12	16	0.11	0.13	1.26	1.34	1.0	2.0	2.00	6.00
PD569	3	3	3	9	SL	SCL		0.24	0.24	0	0	0	0	51	94	48	94	34	82	14	42	12	28	0.10	0.16	1.30	1.38	0.5	1.0	0.60	2.00
PD569	4	1	0	1	COSL	LCOS		0.05	0.10	0	0	0	0	100	100	75	100	39	56	13	21	6	10	0.05	0.07	1.37	1.44	1.0	2.0	6.00	20.00
PD569	4	2	1	6	LCOS			0.15	0.15	0	0	0	0	100	100	83	100	45	61	18	28	6	12	0.05	0.07	1.41	1.49	0.0	0.5	6.00	20.00
PD569	4	3	6	19	COS			0.10	0.15	0	0	0	0	100	100	85	100	40	54	9	17	4	10	0.03	0.05	1.61	1.69	0.0	0.5	20.00	20.00
PD581	1	1	0	1	GR-C	C	L	0.17	0.28	0	0	0	17	63	81	58	78	44	73	32	57	24	42	0.11	0.13	1.00	1.10	1.0	2.0	0.06	0.20
PD581	1	2	1	2	C	GR-COSL		0.24	0.32	0	0	0	18	73	90	69	89	63	83	49	64	40	44	0.11	0.13	1.05	1.15	0.5	1.0	0.06	0.20

PD581	1	3	2	8	C			0.32	0.32	0	0	0	0	100	100	100	100	91	95	70	74	40	44	0.14	0.16	1.10	1.20	0.5	1.0	0.06	0.20
PD581	1	4	8	12	C	CL		0.32	0.32	0	0	0	0	100	100	100	100	88	94	67	73	38	44	0.14	0.16	1.25	1.35	0.0	0.5	0.06	0.20
PD581	2	1	0	1	C	CL		0.28	0.28	0	0	0	0	95	100	89	100	81	99	63	78	36	44	0.18	0.20	1.10	1.20	1.0	2.0	0.20	0.60
PD581	2	2	1	3	C			0.32	0.32	0	0	0	0	95	100	89	100	81	97	65	79	40	46	0.14	0.16	1.10	1.20	0.5	1.0	0.06	0.20
PD581	2	3	3	7	C			0.32	0.32	0	0	0	0	100	100	100	100	91	97	73	79	40	46	0.14	0.16	1.15	1.25	0.5	1.0	0.06	0.20
PD581	2	4	7	13	CN-C	C		0.20	0.32	0	0	0	0	100	100	100	100	93	97	75	79	40	44	0.11	0.13	1.20	1.30	0.5	1.0	0.06	0.20
PD581	3	1	0	1	C	CB-C		0.28	0.28	0	0	6	18	72	100	68	100	62	93	48	72	40	44	0.14	0.16	1.00	1.10	0.0	2.0	0.06	0.20
PD581	3	2	1	6	CL	C		0.28	0.28	0	0	0	17	87	100	85	100	75	97	56	74	36	44	0.18	0.20	1.20	1.30	0.5	1.0	0.20	0.60
PD581	3	3	6	14	C			0.32	0.32	0	0	0	0	91	100	90	100	82	97	63	76	40	46	0.14	0.16	1.15	1.25	0.5	1.0	0.06	0.20
PD581	4	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD584	1	1	0	1	SL	COSL		0.15	0.20	0	0	0	0	75	100	74	100	46	68	26	41	10	16	0.09	0.11	1.29	1.37	1.0	2.0	6.00	20.00
PD584	1	2	1	3	SL	COSL		0.24	0.24	0	0	0	0	100	100	90	100	58	65	35	40	14	15	0.09	0.11	1.27	1.33	1.0	2.0	2.00	6.00
PD584	1	3	3	8	SCL			0.28	0.28	0	0	0	0	100	100	91	100	70	93	37	57	18	34	0.14	0.16	1.30	1.37	0.5	1.0	0.60	2.00
PD584	1	4	8	24	SCL			0.28	0.28	0	0	0	0	100	100	100	100	77	90	38	51	16	29	0.14	0.16	1.30	1.37	0.5	1.0	0.60	2.00
PD584	2	1	0	2	SL	CB-SL		0.10	0.10	0	0	10	22	65	91	64	90	45	67	18	29	12	16	0.07	0.09	1.39	1.47	1.0	2.0	2.00	6.00
PD584	2	2	2	5	SCL	CL		0.24	0.24	0	0	0	0	95	100	90	100	75	99	37	57	20	36	0.14	0.16	1.27	1.34	0.5	1.0	0.60	2.00
PD584	2	3	5	9	SCL	CL		0.24	0.24	0	0	0	0	95	100	90	100	76	96	37	53	22	34	0.14	0.16	1.27	1.34	0.5	1.0	0.60	2.00
PD584	3	1	0	1	L			0.28	0.28	0	0	0	0	86	96	85	96	72	86	50	62	20	26	0.16	0.18	1.15	1.19	1.0	2.0	0.60	2.00
PD584	3	2	1	3	L			0.32	0.32	0	0	0	0	90	100	90	100	76	90	52	65	20	26	0.16	0.18	1.17	1.24	1.0	2.0	0.60	2.00
PD584	3	3	3	6	CL			0.24	0.24	0	0	0	0	100	100	100	100	87	93	64	70	32	38	0.18	0.20	1.27	1.33	0.5	1.0	0.20	0.60
PD584	3	4	6	11	SCL			0.24	0.24	0	0	0	0	100	100	100	100	83	91	47	55	24	32	0.14	0.16	1.30	1.36	0.5	1.0	0.60	2.00
PD584	4	1	0	2	LCOS	GR-SL		0.10	0.15	0	0	0	0	89	100	82	100	44	63	16	28	8	17	0.05	0.07	1.30	1.40	1.0	2.0	6.00	20.00
PD584	4	2	2	6	GR-SL	L		0.20	0.28	0	0	0	0	80	100	74	100	57	87	27	48	10	21	0.11	0.13	1.30	1.40	1.0	2.0	2.00	6.00
PD584	4	3	6	12	LCOS	SCL	L	0.15	0.17	0	0	0	0	93	100	92	100	49	70	18	35	6	22	0.05	0.07	1.50	1.60	0.0	0.5	6.00	20.00
PD584	5	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD587	1	1	0	3	L	SL	SCL	0.24	0.32	0	0	0	0	73	100	72	100	59	97	39	69	15	30	0.16	0.18	1.15	1.25	1.0	2.0	0.60	2.00
PD587	1	2	3	7	CL	SCL		0.32	0.37	0	0	0	0	75	100	74	100	67	99	51	77	27	35	0.19	0.21	1.25	1.35	0.5	1.0	0.60	2.00
PD587	1	3	7	13	CL	SCL		0.37	0.37	0	0	0	0	91	100	90	100	80	97	61	75	27	35	0.19	0.21	1.25	1.35	0.5	1.0	0.60	2.00
PD587	2	1	0	2	GR-SL	GR-COSL		0.15	0.24	0	0	0	0	61	75	60	74	44	60	18	28	7	15	0.09	0.13	1.25	1.35	1.0	2.0	2.00	6.00
PD587	2	2	2	5	GR-SL	COSL		0.15	0.24	0	0	0	0	75	83	74	82	55	65	25	32	10	16	0.11	0.13	1.28	1.38	1.0	2.0	2.00	6.00
PD587	2	3	5	13	SL	COSL		0.24	0.28	0	0	0	0	84	100	83	100	63	81	31	44	13	19	0.11	0.13	1.37	1.47	0.5	1.0	2.00	6.00
PD587	3	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD615	1	1	0	1	GR-COSL	COSL	SL	0.24	0.24	0	0	0	0	87	98	74	96	51	75	24	40	10	19	0.11	0.13	1.20	1.30	1.0	2.0	2.00	6.00
PD615	1	2	1	3	GR-SCL	CL	SCL	0.32	0.32	0	0	0	0	91	98	81	96	70	92	39	55	20	30	0.14	0.16	1.20	1.30	0.5	1.0	0.60	2.00
PD615	1	3	3	8	CL	SCL		0.32	0.32	0	0	0	0	88	98	75	96	56	88	41	68	20	36	0.18	0.20	1.25	1.35	0.5	1.0	0.20	0.60
PD615	1	4	8	16	CL	SCL		0.32	0.32	0	0	0	0	91	98	82	96	65	91	48	71	24	39	0.18	0.20	1.30	1.40	0.5	1.0	0.20	0.60
PD615	2	1	0	1	GR-LCOS	COSL	GR-COSL	0.15	0.15	0	0	0	0	91	100	60	73	34	48	20	30	8	16	0.09	0.11	1.20	1.30	1.0	2.0	2.00	6.00
PD615	2	2	1	3	COSL			0.24	0.24	0	0	0	0	88	95	75	90	45	61	27	39	10	18	0.11	0.13	1.25	1.35	0.5	1.0	2.00	6.00
PD615	2	3	3	7	SL	SCL	COSL	0.32	0.32	0	0	0	0	87	95	74	90	61	86	32	52	16	30	0.14	0.16	1.20	1.30	0.5	1.0	0.60	2.00
PD615	2	4	7	13	GR-COSL	CL	GR-SCL	0.17	0.17	0	0	0	0	81	87	60	74	50	69	27	40	16	30	0.11	0.13	1.30	1.40	0.5	1.0	0.60	2.00
PD615	3	1	0	1	LCOS	COSL		0.20	0.20	0	0	0	0	87	95	74	90	44	59	24	35	8	14	0.09	0.11	1.20	1.30	1.0	2.0	6.00	20.00
PD615	3	2	1	3	SL	SCL	COSL	0.24	0.24	0	0	0	0	91	100	82	100	49	70	28	44	10	20	0.09	0.11	1.25	1.35	0.5	1.0	2.00	6.00
PD615	3	3	3	6	SCL	COSL	SL	0.24	0.24	0	0	0	0	91	95	82	91	62	81	32	47	16	30	0.11	0.13	1.30	1.40	0.5	1.0	2.00	6.00
PD615	3	4	6	20	GR-SCL			0.24	0.24	0	0	0	0	83	87	66	74	57	72	30	43	20	32	0.14	0.16	1.25	1.35	0.5	1.0	0.60	2.00
PD615	4	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00

PD615	5	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD701	1	1	0	1	GR-LCOS			0.05	0.10	0	0	0	0	67	79	60	74	29	40	10	16	8	14	0.05	0.07	1.30	1.40	1.0	2.0	6.00	20.00
PD701	1	2	1	4	COSL			0.15	0.15	0	0	0	0	100	100	91	96	52	58	28	33	16	20	0.09	0.11	1.34	1.44	0.5	1.0	2.00	6.00
PD701	1	3	4	6	LCOS			0.10	0.10	0	0	0	0	100	100	91	100	42	53	12	21	10	18	0.05	0.07	1.45	1.55	0.5	1.0	6.00	20.00
PD701	1	4	6	20	GRV-SCL			0.24	0.24	0	0	0	0	100	100	91	96	73	83	35	43	22	28	0.07	0.11	1.35	1.45	0.5	1.0	0.60	2.00
PD701	2	1	0	3	LCOS			0.15	0.15	0	0	0	0	100	100	91	96	51	57	21	26	6	10	0.05	0.07	1.35	1.45	1.0	2.0	6.00	20.00
PD701	2	2	3	8	COSL			0.20	0.20	0	0	0	0	100	100	96	100	54	64	26	35	8	16	0.09	0.11	1.37	1.47	0.5	1.0	6.00	20.00
PD701	2	3	8	11	COSL			0.20	0.20	0	0	0	0	100	100	96	100	52	64	25	35	8	18	0.09	0.11	1.41	1.51	0.5	1.0	2.00	6.00
PD701	3	1	0	1	COSL			0.10	0.10	0	0	0	0	100	100	82	100	46	62	25	36	14	19	0.09	0.11	1.25	1.35	1.0	2.0	2.00	6.00
PD701	3	2	1	4	SCL			0.28	0.28	0	0	0	0	100	100	96	100	80	91	40	49	20	28	0.14	0.16	1.26	1.36	0.5	1.0	0.60	2.00
PD701	3	3	4	6	SCL			0.28	0.28	0	0	0	0	100	100	96	100	81	92	41	50	20	28	0.14	0.16	1.29	1.39	0.5	1.0	0.60	2.00
PD701	3	4	6	11	SCL			0.15	0.15	0	0	0	0	100	100	96	100	73	85	36	47	26	35	0.14	0.16	1.32	1.42	0.0	0.5	0.60	2.00
PD701	4	1	0	60	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00
PD702	1	1	0	1	SL	L	SCL	0.24	0.32	0	0	0	0	74	100	73	100	59	93	33	58	14	26	0.14	0.16	1.10	1.20	1.0	2.0	0.60	2.00
PD702	1	2	1	3	L	CL		0.37	0.37	0	0	0	0	100	100	100	100	88	100	65	79	22	36	0.16	0.18	1.20	1.30	0.5	1.0	0.60	2.00
PD702	1	3	3	7	SCL	CL		0.32	0.32	0	0	0	0	100	100	100	100	88	92	65	69	26	30	0.19	0.21	1.25	1.35	0.5	1.0	0.60	2.00
PD702	1	4	7	20	L	SCL	CL	0.32	0.32	0	0	0	0	100	100	100	100	84	92	59	67	22	30	0.16	0.18	1.30	1.40	0.5	1.0	0.60	2.00
PD702	2	1	0	3	L	SCL		0.28	0.28	0	0	0	0	87	100	73	100	64	91	47	68	23	26	0.16	0.18	1.10	1.20	1.0	2.0	0.60	2.00
PD702	2	2	3	13	L	CL		0.28	0.28	0	0	0	0	95	100	90	100	75	93	57	73	26	36	0.19	0.21	1.25	1.35	0.5	1.0	0.60	2.00
PD702	3	1	0	5	GR-L	SL	CNV-SCL	0.10	0.24	0	0	5	20	75	95	33	84	26	73	12	38	16	24	0.08	0.10	1.10	1.20	1.0	2.0	0.60	2.00
PD702	3	2	5	12	SCL	CL		0.24	0.28	0	0	0	5	87	100	86	100	73	93	39	54	22	30	0.14	0.16	1.20	1.30	0.5	1.0	0.60	2.00
PDBL	1	1	0	9	UWB			0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00

Soil properties to a depth of 9 inches are averaged.
The percent passing designated sieves in this table is used to calculate the KINEROS parameter for the rock fraction in the soil.

From the averaged layers and percentage composition of soils for each map unit, a texture is determined. From this texture, the other KINEROS parameters are estimated in AGWA, according to the kin-lut.dbf table (Table B-3).

Table B-3: AGWA Conversion from Soil Texture to KINEROS Input

TEXTURE	KS	G	POR	SMAX	CV	SAND	SILT	CLAY	DIST	KFF
C	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.340
CBV	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.050
CEM	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.280
CIND	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.020
CL	2.300	259.0	0.464	0.840	0.940	32.00	34.00	34.00	0.240	0.390
COS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.150
COSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.240
FB	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.050
FRAG	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.050
FS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.200
FSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.350
G	210.000	46.0	0.437	0.950	0.690	27.00	23.00	50.00	0.160	0.150
GYP	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.050
HM	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
ICE	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
IND	0.300	100.0	0.200	0.300	0.200	0.00	0.00	0.00	0.000	0.250
L	13.000	108.0	0.463	0.940	0.400	42.00	39.00	19.00	0.250	0.420
LCOS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.180
LFS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.250
LS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.230
LVFS	61.000	63.0	0.437	0.920	0.850	83.00	7.00	10.00	0.550	0.440
MUCK	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
PC	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.320
PEAT	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
S	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.180
SC	1.200	302.0	0.430	0.750	1.000	50.00	4.00	46.00	0.340	0.360
SCL	4.300	263.0	0.398	0.830	0.600	59.00	11.00	30.00	0.400	0.360
SI	3.000	260.0	0.450	0.920	0.550	8.00	81.00	11.00	0.130	0.430
SIC	0.900	375.0	0.479	0.880	0.920	9.00	45.00	46.00	0.150	0.310
SICL	1.500	345.0	0.471	0.920	0.480	12.00	54.00	34.00	0.180	0.400
SIL	6.800	203.0	0.501	0.970	0.500	23.00	61.00	16.00	0.230	0.490
SL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.320
SPM	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
SR	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.330
UWB	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
VAR	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.550
VFS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.460
VFSL	26.000	127.0	0.453	0.910	1.900	65.00	23.00	12.00	0.380	0.500
WB	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
MPT	0.600	407.0	0.475	0.810	0.500	27.00	23.00	50.00	0.160	0.020
COARSE	67.100	92.7	0.445	0.920	1.357	75.16	14.15	10.69	0.486	0.268
MEDIUM	9.056	205.7	0.463	0.917	0.738	36.57	42.98	20.45	0.272	0.416
FINE	0.824	382.8	0.470	0.818	0.610	27.02	25.41	47.57	0.181	0.345
D/SS	210.000	46.0	0.437	0.950	0.690	91.00	1.00	8.00	0.690	0.180
SALT	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.050
ROCK	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.020
GLACIER	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
WATER	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000
NO DATA	0.000	0.0	0.000	0.000	0.000	0.00	0.00	0.00	0.000	0.000

ATTACHMENT C: LAND COVER DATABASE TABLES

CLASS	NAME	A	B	C	D	COVER	INT	N	IMPERV
11	Open Water	100	100	100	100	0	0.00	0.000	0.00
12	Perennial Ice/Snow	98	98	98	98	0	0.00	0.000	0.00
21	Low Intensity Residential	77	85	90	92	15	0.10	0.150	0.40
22	High Intensity Residential	81	88	91	93	10	0.08	0.120	0.75
23	Commercial/Industrial/Transportation	89	92	94	95	2	0.05	0.010	0.80
31	Bare Rock/Sand/Clay	96	96	96	96	2	0.00	0.010	0.00
32	Quarries/Strip Mines/Gravel Pits	78	85	90	92	2	0.00	0.010	0.00
33	Transitional	72	82	87	90	20	0.00	0.010	0.00
41	Deciduous Forest	55	55	75	80	50	1.15	0.015	0.00
42	Evergreen Forest	55	55	70	77	50	1.15	0.015	0.00
43	Mixed Forest	55	55	75	80	50	1.15	0.015	0.00
51	Shrubland	63	77	85	88	25	3.00	0.055	0.00
61	Orchards/Vineyards/Other	77	77	84	88	70	2.80	0.040	0.00
71	Grasslands/Herbaceous	49	69	79	84	25	2.00	0.015	0.00
81	Pasture/Hay	68	79	86	89	70	2.80	0.040	0.00
82	Row Crops	72	81	88	91	50	0.76	0.040	0.00
83	Small Grains	65	76	84	88	90	4.00	0.040	0.00
84	Fallow	76	85	90	93	30	0.50	0.040	0.00
85	Urban/Recreational Grasses	68	79	86	89	90	2.50	0.040	0.01
91	Woody Wetlands	85	85	90	92	70	1.15	0.060	0.00
92	Emergent Herbaceous Wetlands	77	77	84	90	70	1.15	0.060	0.00

ATTACHMENT D: DISTURBANCE PERCENTAGES

	Estimated Existing Well-Field Disturbance (acres)	Potential Estimated Surface Disturbance (acres) by Alternatives (including Existing Dist.)				
Basin and Hydrologic Unit Code		**No Action 2011**	**Proposed Action 2011**	**Alternative C 2011**	**Proposed Action 2023**	**Alternative C 2023**
Green River-Tyler Draw 140401010403	21.7	66.7	66.7	66.7	66.8	66.7
Green River-The Mesa 140401010404	10.1	17.6	17.6	17.6	17.6	17.6
Sand Draw-Alkali Creek 140401010701	502.2	1021.2	929.3	946.9	1,579.00	1,779.30
North Alkali Draw 140401010705	116.5	267.4	215.1	250.1	348.1	392.2
New Fork River-Duck Creek 140401020102	92.4	233.5	131	131	273.4	207.1
Hay Gulch 140401020105	3.9	3.9	3.9	3.9	3.9	3.9
Lower Pine Creek 140401020203	3.7	3.7	3.7	3.7	3.7	3.7
New Fork River-Stewart Point 140401020301	361.9	553.2	569.5	569.5	1296.2	1240.5
East Fork River 140401020302	12	12	12	12	12	12
New Fork River-Alkali Creek 140401020303	2,353.60	4,584.00	6,239.40	6,583.70	8,542.70	8,394.00
Sand Springs Draw 140401020304	81.3	86.5	174.6	183.7	321.7	417.7
New Fork River-Blue Ridge 140401020305	228.8	365.1	479.8	446.6	762.3	734.1
Mack Reservoir 140401020306	850.3	1788.8	2,444.00	2,082.80	3,492.60	3,350.00
Lower Pole Creek 140401020403	0.9	0.9	0.9	0.9	0.9	0.9

South Muddy Creek 140401020602	0	0	0	0	0	0
Lower Muddy Creek-New Fork 140401020603	0	7	7	7	7	7
Big Sandy River-Waterhole Draw 140401040105	1.5	4.2	1.8	1.8	1.8	1.8
Big Sandy River-Bull Draw 140401040106	74.2	85.1	108.7	108.7	108.7	108.7
Mud Hole Draw 140401040107	344.4	443.1	499.4	499.4	499.4	593.8
Long Draw 140401040109	0	0	0	0	0	0
Total Modeled Disturbance	**5059.4**	**8824.2**	**10151.3**	**10155.3**	**15030.9**	**15024.4**

Total modeled disturbance is not exactly equal to total estimated potential disturbance, since estimates changed from the time modeling was conducted. However, modeling is considered conservative, and small increases in estimated potential disturbance would not change modeling results.

ATTACHMENT E: SALINITY ESTIMATION

Table E-1: Salinity per Map Unit

Map Unit ID (MUID)	Soil Series	Soil Series Percent Composition per Map Unit	Estimated Salinity for Soil Series (ERO 1988) (mS/cm)	Estimated Numeric Value for Salinity (µS/cm)	Average Salinity (µS/cm) for Map Unit
PD100	Horsley	40%	2-4	3000	4600
	Badland	33%			
	Boltus	27%	8-16	12000	
PD102	Langspring Variant	72%	<2	1000	1000
	Langspring	28%	<2	1000	
PD103	Terada	44%	<2	1000	1700
	Huguston	37%	2-4	3000	
	Fraddle	19%	<2	1000	
PD104	Chrisman	100%	<2	1000	1000
PD106	Monte	67%	<2	1000	1000
	Leckman	33%	<2	1000	
PD107	Leckman	100%	<2	1000	1000
PD108	Dines	45%	8-16	12000	7600
	Clowers	33%	4-8	6000	
	Quealman	22%	<2	1000	
PD110	Fraddle	72%	<2	1000	1000
	Tresano	28%	<2	1000	
PD111	Fraddle	50%	<2	1000	1000
	Space City	28%	<2	1000	
	Koonich	22%	<2	1000	
PD112	Koonich	22%	<2	1000	1000
PD113	Haterton	53%	2-4	3000	3000
	Garsid	47%	2-4	3000	
PD114	Ouard	35%	<2	1000	4300
	Ouard Variant	35%	<2	1000	
	Boltus	30%	8-16	12000	
PD116	Huguston	44%	2-4	3000	2660
	Horsley	39%	2-4	3000	
	Terada	17%	<2	1000	
PD117	Huguston	53%	2-4	3000	5800
	Rock Outcrop	23%			
	Boltus	24%	8-16	12000	
PD119	Garsid	53%	2-4	3000	2060
	Monte	47%	<2	1000	
PD120	Kandaly	50%	<2	1000	1400
	Terada	28%	<2	1000	
	Huguston	22%	2-4	3000	
PD121	Garsid	47%	2-4	3000	1940
	Terada	29%	<2	1000	
	Langspring Variant	24%	<2	1000	
PD122	Baston	44%	<2	1000	4410
	Boltus	31%	8-16	12000	
	Chrisman	25%	<2	1000	

PD123	Spool Variant	41%	<2	1000	1540
	Ouard Variant	41%	<2	1000	
	San Arcacio Variant	18%	<8	4000	
PD124	Fraddle	35%	<2	1000	1900
	Ouard	35%	<2	1000	
	San Arcacio Variant	30%	<8	4000	
PD125	San Arcacio	56%	<8	4000	2680
	Saguache	44%	<2	1000	
PD127	Vermillion Variant	39%	<2	1000	1000
	Seedskadee	39%	<2	1000	
	Fraddle	22%	<2	1000	
PD128	Fraddle	56%	<2	1000	1660
	Ouard	22%	<2	1000	
	San Arcacio Variant	22%	<8	4000	
PD129	Dunul Variant	47%	<2	1000	4100
	Garsid	30%	2-4	3000	
	Boltus	23%	8-16	12000	

APPENDIX K

Wildlife Technical Report

Wildlife Technical Report
Mule Deer Over-Winter Mortality in the Sublette Herd Unit

INTRODUCTION

Potential impacts to mule deer by natural gas development near Pinedale, Wyoming, were addressed by Bureau of Land Management (BLM) in the *Draft Environmental Impact Statement* (DEIS) *for the Pinedale Anticline Oil and Gas Exploration and Development Project Sublette County, Wyoming* (BLM, 1999). In the DEIS and accompanying Technical Report, BLM observed that human-related factors causing mule deer to expend energy during winter, in addition to the energy that would be expended without human-related factors, could lead to increased over-winter mortality. Migratory mule deer that normally winter near natural gas development are expected to avoid development, potentially forced to depend on inferior habitats for over-winter survival (BLM, 1999). Potential for similar impacts to wintering mule deer by natural gas development have been echoed by Sawyer et al. (2002) and Lutz et al. (2003).

The Pinedale Anticline Project Area (PAPA) is within winter range utilized by mule deer in the Sublette Herd Unit. Recognizing the importance of the PAPA to wintering mule deer and other big game, the Record of Decision (ROD) for the *Pinedale Anticline Oil and Gas Exploration and Development Project Sublette County, Wyoming* stated (page 19, BLM, 2000a):

> *To ensure protection of wintering big game, all surface-disturbing or human activity associated with construction, including roads, pipelines, well pads, drilling, completion, or workover operations, will be seasonally and location restricted pursuant to the Mitigation Guidelines and Standard Practices described in Appendix A* (of the EIS, BLM 2000b). *To protect important big game winter habitat, activities or surface use will not be allowed from November 15 through April 30 within certain areas encompassed by the authorization.*

In 2004, Questar Exploration and Development Company (Questar) proposed to modify its strategy for future development of its 14,800-acre leasehold in the PAPA. To shorten the period necessary to develop their leases and to provide for more economically-attractive drilling rig utilization, Questar proposed year-round drilling within their leases in the northern portion of the PAPA. BLM (2004) analyzed the environmental consequences of Questar's proposal (including various applicant-committed measures to avoid or minimize environmental harm) in an Environmental Assessment (Questar EA) and issued a Decision Record with a Finding of No Significant Impact (BLM, 2004).

In 2005, Anschutz Pinedale Corporation (Anschutz), Shell Exploration & Production Company (Shell), and Ultra Resources Inc. (Ultra), collectively referred to as ASU, submitted a proposal to BLM for a year-round demonstration project within the PAPA. In September 2005, BLM issued a Decision Record which approved drilling operations between November 15, 2005 and July 31, 2006 within big game crucial winter ranges. It also allowed completion operations beginning May 1, 2006. BLM (2005a) analyzed the environmental consequences of the ASU proposal (including various applicant-committed measures to avoid or minimize environmental harm) in an Environmental Assessment (ASU EA) and issued a Decision Record with a Finding of No Significant Impact in September 2005 (BLM, 2005). The Decision Record allowed up to two rigs drilling on each of three well pads between November 15, 2005 and July 31, 2006.

In 2005, BLM issued a Decision Record (BLM, 2005b) for an addendum to Questar's Year-Round Drilling Proposal that allowed for accelerated winter development on the Mesa, including well completions and the addition of a third drilling rig.

In addition to the Decision Records that were evaluated through the NEPA process, BLM evaluated multiple requests from operators for exceptions to lease stipulations to continue or conduct surface disturbing activities that would not otherwise be allowed from November 15 through April 30 within big game crucial winter ranges. An exception is a one-time exemption to a lease stipulation, determined on a case-by-case basis. From winters 2001-2002 through 2005-2006, 307 exceptions to development within big game crucial winter ranges (during winter while mule deer and pronghorn were present) were requested by PAPA Operators. BLM granted 249 of the requests, which may have been for only a few days within the period from November 15 to April 30, or longer. BLM partially granted 18 requests for exceptions and denied 38.

Wildlife technical reports were appended to the Questar EA (Appendix E in BLM, 2004) and the ASU EA (Appendix C in BLM, 2005) which examined mule deer over-winter mortality in the Sublette Herd Unit. Analyses of over-winter fawn mortality in both technical reports indicated that fawn mortality rate increased with increasing winter snowfall estimated for each month on crucial winter ranges used by the population. Over-winter fawn mortality has also been affected by drought conditions, specifically the total amount of precipitation during the two years prior to the onset of winter. As reported in the ASU EA (BLM 2005), fawn mortality increased with increasing total snowfall between November and March but decreased with more total precipitation in the two water years prior to that winter. Consequently, similar mortality rates may be observed during winters with very different amounts of snow, the effects of which are ameliorated or exacerbated by overall moist or dry conditions during the two previous years. The minimum temperature observed each November also influenced over-winter fawn mortality. Fewer fawns died in years with higher minimum temperatures at the onset of winter compared to mortality rates with lower minimum temperatures in November.

This Wildlife Technical Report provides an analysis of the variation in demographic parameters of mule deer in the Sublette Herd Unit before and during natural gas development in the PAPA with the addition of data collected for winter 2005-06.

METHODS

Over-winter Survival Rates. Wyoming Game and Fish Department (WGFD) biologists have been collecting data useful for estimating adult and fawn over-winter survival rates for mule deer in the Sublette Herd Unit (Doug McWhirter, Scott Smith, Dean Clause) since winter 1992-1993. The required data are 1) counts of fawns and adults alive during early winter, usually December, 2) counts of fawns and adults alive during spring, usually April, and 3) counts of fawn and adult carcasses made in late April or early May, after the spring survey of surviving animals. Three ratios, ***A, B,*** and ***C*** are constructed from these three counts (White et al., 1996):

A = fawns counted in December/adults counted in December (pre-winter)
B = fawns counted in April/adults counted in April (post-winter)
C = fawn carcasses counted in April-May/adult carcasses counted in April-May (post-winter).

Estimates of adult over-winter survival ($\hat{S}_a$) and fawn over-winter survival ($\hat{S}_f$) are computed from these three ratios (see White et al., 1996 for derivation of the estimates):

$$\hat{S}_a = \left(\frac{\boldsymbol{C - A}}{\boldsymbol{C - B}}\right)$$

and

$$\hat{S}_f = \left(\frac{\boldsymbol{C - A}}{\boldsymbol{C - B}}\right) \times \left(\frac{\boldsymbol{B}}{\boldsymbol{A}}\right)$$

Variances for the estimated survival rates were computed by the delta method (see Appendix in White et al., 1996) and 90% confidence intervals were estimated as ±1.64 SE ($\hat{S}$). Estimates of over-winter mortality rates ($\hat{W}$) are related to survival by $\hat{W} = 1 - \hat{S}$.

Climatological Data. Total monthly precipitation (inches of water), total monthly snowfall (inches of snow), average maximum and minimum temperatures (^{o}F) for each month were compiled for all National Weather Service (NWS) Cooperative Observer stations in western Wyoming, southeastern Idaho, and northeastern Utah (Western Regional Climate Center, Historical Climate Summaries, available at http://www.wrcc.dri.edu/climsum.html) from January 1970 through June 2005. These data were compiled by water year (also called a hydrologic year), October of one year through September of the next year, rather than by calendar year.

All monthly totals (precipitation, snowfall) and averages (temperature) reported by each NWS station were examined for missing data (number of days not reported in a given month). Data for months with >5 days of missing data were determined to be inadequate following NWS protocol for computing annual summary statistics and were designated the same as if no data were reported for that month. NWS provides latitude and longitude for each reporting station. Because not all of the winter ranges utilized by mule deer in the Sublette Herd Unit are proximate to NWS stations and many NWS stations report >5 days of missing data or no data at all for varying periods, climatological data were estimated for winter ranges by interpolation.

Latitude and longitude at the approximate center of the crucial winter range were averaged over all crucial winter ranges delineated for the Sublette Herd Unit. Euclidean distances (km) from the winter range average center point were computed to each NWS station, based on the reported coordinates for each station. A routine was developed to select the closest five stations (an arbitrary number) with adequate data to a winter range center point for each month in each water year, 1971 to 2005. The value of a particular climatological variable, $\boldsymbol{Y}$, for each month at the approximate centers of crucial winter range complexes, $\boldsymbol{x}$, was interpolated as the weighted average of the variable's value at the five closest stations ($\boldsymbol{x_i}$) (see page 153, Burrough, 1986):

$$\hat{\boldsymbol{Y}}(\boldsymbol{x}) = \sum_{i=1}^{5} \lambda_i \, \boldsymbol{Y}(\boldsymbol{x_i}) \quad \text{where} \quad \Sigma \lambda_i = 1$$

The weights, λ_i, are reciprocals of distance, d_i, between a NWS station and the approximate winter range center point divided by the sum of those values for all five NWS stations having adequate data:

$$\lambda_i = (1/d_i) \Big/ \sum_{i=1}^{5} (1/d_i)$$

Thus, climatological variables measured at NWS stations close to a crucial winter range complex have greater influence on that variable's estimate $\hat{\boldsymbol{Y}}(\boldsymbol{x})$ on the complex than more distant NWS stations.

RESULTS and DISCUSSION

Over-winter Mortality Rates – Sublette Herd Unit. Raw data collected by WGFD biologists on Sublette Herd Unit winter ranges each year are provided in Table 1. Included are the three ratios, ***A***, ***B***, and ***C***, that are used to estimate over-winter survival of fawn and adult mule deer. Estimates of fawn and adult survival rates are provided in Table 2.

Table 1
Data Collected by Wyoming Game and Fish Department for Mule Deer in the Sublette Herd Unit and Three Ratios Derived from the Data That Are Used to Estimate Over-winter Survival Rates for Fawns and Adults

Winter	Counts in December		Ratio A	Counts in April		Ratio B	Carcasses Counted		Ratio C
	Fawns	Adults		Fawns	Adults		Fawns	Adults	
1992-93	2090	4658	0.449	329	1544	0.213	105	45	2.333
1993-94	1587	4241	0.374	536	1483	0.361	13	6	2.167
1994-95	2698	5370	0.502	681	1629	0.418	21	13	1.615
1995-96	2358	5406	0.436	691	2506	0.276	35	25	1.400
1996-97	2181	3967	0.550	709	2081	0.341	182	49	3.714
1997-98	2694	4218	0.639	931	1796	0.518	65	56	1.161
1998-99	3115	5843	0.533	1120	2441	0.459	43	13	3.308
1999-00	3064	5248	0.584	1258	2349	0.536	16	10	1.600
2000-01	3227	5273	0.612	1185	2640	0.449	56	50	1.120
2001-02	3730	7139	0.522	760	2156	0.353	183	57	3.211
2002-03	2727	5429	0.502	724	2193	0.330	51	52	0.981
2003-04	3664	6040	0.607	760	2986	0.255	485	194	2.500
2004-05	3066	5556	0.552	1234	3042	0.406	45	15	3.000
2005-06	2925	5650	0.518	863	2852	0.303	145	42	3.452

Ratios ***A*** and ***B*** are related to fawn and adult survival rates by $\hat{S}_f / \hat{S}_a = \boldsymbol{B} / \boldsymbol{A}$ (see equation 9 in Paulik and Robson, 1969). Consequently, $\hat{S}_f < \hat{S}_a$ for any given winter. To be consistent with analyses presented in the DEIS and Technical Report (BLM, 1999), survival rates were converted to mortality rates ($\hat{W} = 1 - \hat{S}$) and so, $\hat{W}_f > \hat{W}_a$ for any given winter. Time series plots of fawn and adult mortality rates are provided in Figure 1.

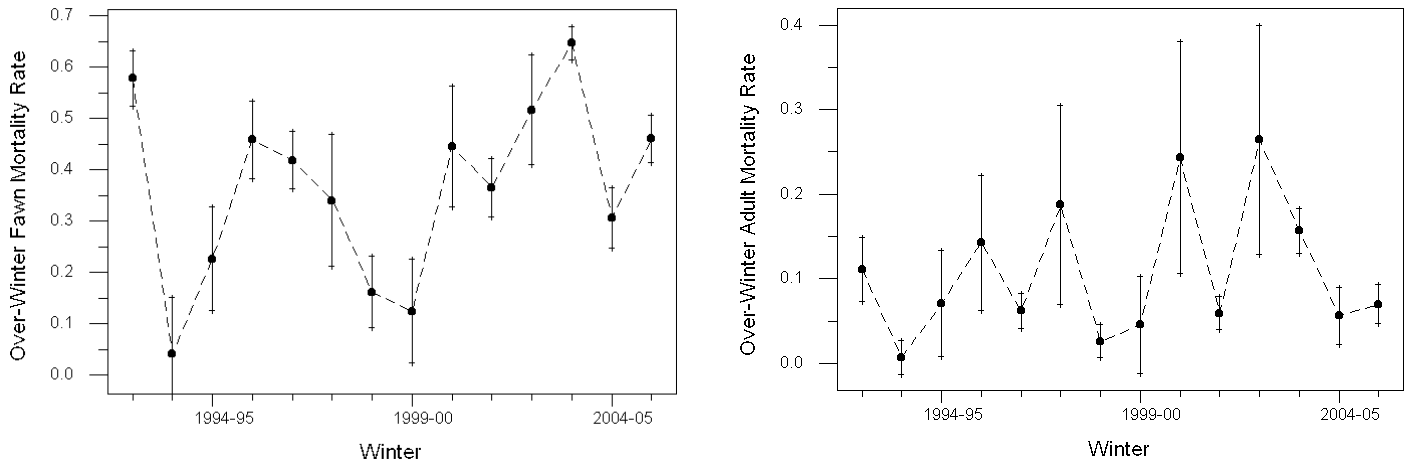
Variance estimates on survival rates (likewise on mortality rates) are large for many years with corresponding wide confidence intervals, in part due to small samples of fawn and adult carcasses. With some exceptions, fawn over-winter mortality rates on the Sublette Herd Unit winter range complex do not differ significantly (P > 0.10) from the previous year's mortality rate, as evident from overlapping 90% confidence intervals. In 1993-1994 fawn mortality was significantly less than in the previous year 1992-1993. The first year of this study was winter 1992-1993 and carcasses of mule deer that died in winters prior to that winter may have been included in the tallies. That issue is addressed below.

Table 2
Over-winter Survival Rate Estimates for Fawns ($\hat{S}_f$) and Adults ($\hat{S}_a$), Mortality Rate Estimates for Fawns ($\hat{W}_f$) and Adults ($\hat{W}_a$), Variances (Var), Standard Errors (SE), and 90% Confidence Intervals (90%CI) for Each Winter on the Sublette Herd Unit

Winter	Fawns					Adults				
	$\hat{S}_f$	$\hat{W}_f$	Var	SE	90%CI	$\hat{S}_a$	$\hat{W}_a$	Var	SE	90%CI
1992-93	0.42	0.58	0.0011	0.033	±0.05	0.89	0.11	0.0005	0.023	±0.04
1993-94	0.96	0.04	0.0045	0.067	±0.11	0.99	0.01	0.0002	0.012	±0.02
1994-95	0.77	0.23	0.0037	0.061	±0.10	0.93	0.07	0.0014	0.038	±0.06

Table 2 (concluded).

	Fawns					Adults				
Winter	$\hat{S}_f$	$\hat{W}_f$	**Var**	**SE**	**90%CI**	$\hat{S}_a$	$\hat{W}_a$	**Var**	**SE**	**90%CI**
1995-96	0.54	0.46	0.0021	0.046	±0.08	0.86	0.14	0.0023	0.048	±0.08
1996-97	0.58	0.42	0.0012	0.034	±0.06	0.94	0.06	0.0002	0.013	±0.02
1997-98	0.66	0.34	0.0061	0.078	±0.13	0.81	0.19	0.0051	0.071	±0.12
1998-99	0.84	0.16	0.0018	0.042	±0.07	0.97	0.03	0.0001	0.012	±0.02
1999-00	0.88	0.12	0.0037	0.061	±0.10	0.95	0.05	0.0012	0.035	±0.06
2000-01	0.56	0.44	0.0051	0.072	±0.12	0.76	0.24	0.0070	0.083	±0.14
2001-02	0.63	0.37	0.0012	0.034	±0.06	0.94	0.06	0.0001	0.012	±0.02
2002-03	0.48	0.52	0.0042	0.065	±0.11	0.74	0.26	0.0068	0.082	±0.14
2003-04	0.35	0.65	0.0004	0.020	±0.03	0.84	0.16	0.0003	0.016	±0.03
2004-05	0.69	0.31	0.0013	0.036	±0.06	0.94	0.06	0.0004	0.021	±0.03
2005-06	0.54	0.46	0.0008	0.028	±0.05	0.93	0.07	0.0002	0.014	±0.02



1a **1b**

Figure 1.
Mule Deer Mortality Rate Estimates (With 90% CI on the Estimates) for Fawn (1a) and Adult (1b) Mule Deer on the Sublette Herd Unit Winter Ranges.

Fawn mortality in 1995-1996 was significantly greater than in 1994-1995 (Figure 1a). Also, fawn mortality rates from winters 2000-2001 through 2005-2006 have been significantly higher than for the 2 years preceding 2000-2001. Fawn mortality in 2003-2004 was significantly greater than for any year prior to 2000-2001, except 1992-1993. In 2005 however, fawn mortality declined so that it was significantly less than in 2004. Likewise, the adult mortality rate in 2005 was significantly less than the mortality rate observed in 2004 (Figure 1b). Fawn mortality during winter 2005-2006 was significantly higher than mortality the previous year (Figure 1a) although adult mortality had increased only slightly compared to 2004-2005; the increase in adult mortality was not significant (Figure 1b).

Comparison of Mortality Rates on the Mesa and Pinedale Front Winter Range Complexes. Two mule deer winter range complexes – the Mesa and Pinedale Front – have served as treatment (the Mesa) and control (Pinedale Front) areas in Phase II of the Sublette Mule Deer Study (Sawyer et al., 2004). The study was designed to detect changes in mule deer habitat use, animal distribution, abundance, and population parameters due to natural gas development on the Mesa (treatment area). Data for computing over-winter mortality have been collected by WGFD biologists on both of the winter ranges and reported separately most consistently since winter 1994-1995. Raw data and the 3 ratios, ***A***, ***B***, and ***C***, are provided in Table 3.

Table 3
Data Collected by WGFD for Mule Deer on the Mesa and Pinedale Front Winter Range Complexes from 1994-95 through 2005-06 and 3 Ratios Derived from the Data Required to Estimate Over-winter Survival Rates for Fawns and Adults in Table 4.

Winter Range Complex	Winter	Counts in December		Ratio A	Counts in April		Ratio B	Carcasses Counted		Ratio C
		Fawns	Adults		Fawns	Adults		Fawns	Adults	
Mesa Winter Range Complex	1994-95	1136	2476	0.459	521	1312	0.397	18	12	1.500
	1995-96	889	2125	0.418	511	1962	0.260	35	25	1.400
	1996-97	1026	1873	0.548	501	1508	0.332	99	25	3.960
	1997-98	1042	1567	0.665	512	931	0.550	20	28	0.714
	1998-99	1473	2996	0.492	828	1982	0.418	21	3	7.000
	1999-00	1547	2550	0.607	764	1390	0.550	12	9	1.333
	2000-01	1458	2420	0.602	707	1685	0.420	41	32	1.281
	2001-02	1275	2546	0.501	460	1366	0.337	121	43	2.814
	2002-03	914	1864	0.490	470	1489	0.316	9	8	1.125
	2003-04	1201	2063	0.582	319	1215	0.263	273	130	2.100
	2004-05	1183	2162	0.547	547	1477	0.370	33	8	4.125
	2005-06	1112	2099	0.530	458	1288	0.356	47	10	4.700
Pinedale Front Winter Range Complex	1994-95	1562	2894	0.540	160	317	0.505	3	1	3.000
	1995-96	1469	3281	0.448	180	544	0.331	no data	no data	none
	1996-97	1155	2094	0.552	208	573	0.363	83	24	3.458
	1997-98	1652	2651	0.623	419	865	0.484	45	25	1.800
	1998-99	1642	2847	0.577	292	459	0.636	22	10	2.200
	1999-00	1517	2698	0.562	494	959	0.515	4	1	4.000
	2000-01	1769	2853	0.620	478	955	0.501	15	14	1.071
	2001-02	2455	4593	0.535	300	790	0.380	62	14	4.429
	2002-03	1813	3565	0.509	254	704	0.361	42	44	0.955
	2003-04	2463	3977	0.619	441	1771	0.249	212	64	3.313
	2004-05	1883	3394	0.555	687	1565	0.439	12	7	1.714
	2005-06	1813	3551	0.511	405	1564	0.259	98	32	3.063

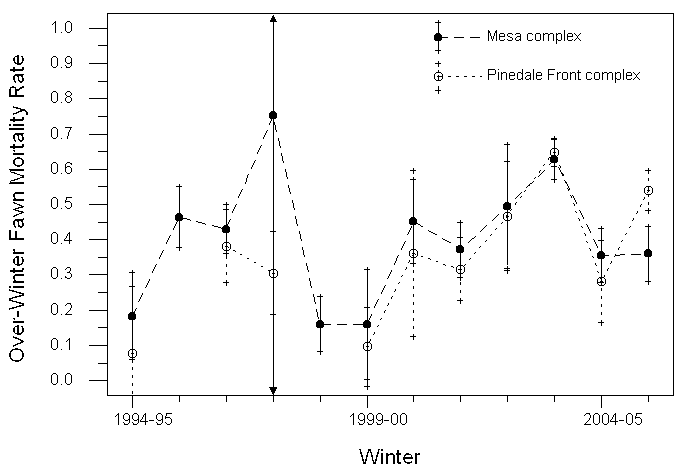
Sample sizes, particularly numbers of fawn and adult carcasses, are very small during several years when divided between the two winter range complexes (Table 3). Hence, variances for estimates of fawn and adult mortality rates are large and corresponding 90% confidence intervals on the estimates are wide (Table 4 and Figure 2). In most winters since 1994-1995, fawn mortality rates on the Mesa winter range complex have tended to be higher than rates on the Pinedale Front complex, when adequate data have been collected on the two areas. Because of the large variances, none of the mortality estimates for one area is significantly different from estimates on the other area in any given year. The one notable exception was observed this year, following the winter 2005-06, when fawn mortality on the Pinedale Front Complex was significantly higher (P<0.1) than on the Mesa Winter Range Complex (Figure 2a).

Table 4
Over-winter Survival Rate Estimates for Fawns ($\hat{S}_f$) and Adults ($\hat{S}_a$), Mortality Rate Estimates for Fawns ($\hat{W}_f$) and Adults ($\hat{W}_a$), Variances (Var), Standard Errors (SE), and 90% Confidence Intervals (90%CI) on the Mesa and Pinedale Front Winter Range Complexes

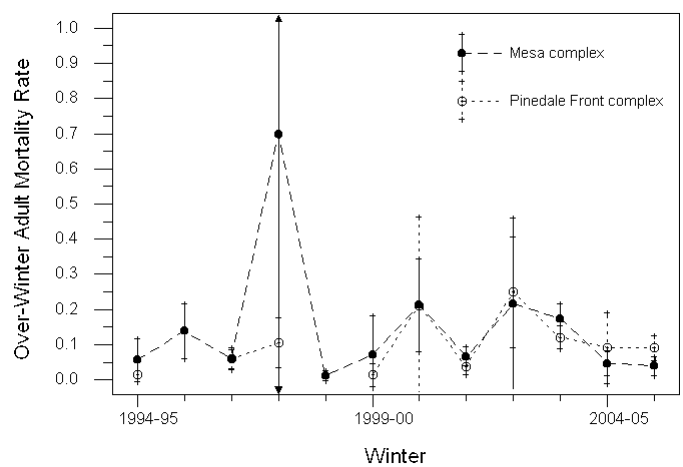
Winter Range Complex	Winter	Fawns					Adults				
		$\hat{S}_f$	$\hat{W}_f$	Var	SE	90%CI	$\hat{S}_a$	$\hat{W}_a$	Var	SE	90%CI
Mesa Winter Range Complex	1994-95	0.82	0.18	0.0057	0.075	±0.12	0.94	0.06	0.0013	0.037	±0.06
	1995-96	0.54	0.46	0.0028	0.053	±0.09	0.86	0.14	0.0023	0.048	±0.08
	1996-97	0.57	0.43	0.0018	0.042	±0.07	0.94	0.06	0.0003	0.016	±0.03
	1997-98	0.25	0.75	0.5667	0.753	±1.24	0.30	0.70	0.8224	0.907	±1.49
	1998-99	0.84	0.16	0.0022	0.047	±0.08	0.99	0.01	0.0001	0.008	±0.01

Table 4 (concluded)

Winter Range Complex	Winter	Fawns					Adults				
		$\hat{S}_f$	$\hat{W}_f$	Var	SE	90%CI	$\hat{S}_a$	$\hat{W}_a$	Var	SE	90%CI
Mesa Winter Range Complex	1999-00	0.84	0.16	0.0091	0.095	±0.16	0.93	0.07	0.0045	0.067	±0.11
	2000-01	0.55	0.45	0.0052	0.072	±0.12	0.79	0.21	0.0064	0.080	±0.13
	2001-02	0.63	0.37	0.0022	0.047	±0.08	0.93	0.07	0.0003	0.017	±0.03
	2002-03	0.50	0.50	0.0115	0.107	±0.18	0.78	0.22	0.0221	0.149	±0.24
	2003-04	0.37	0.63	0.0012	0.034	±0.06	0.83	0.17	0.0006	0.025	±0.04
	2004-05	0.64	0.36	0.0022	0.047	±0.08	0.95	0.05	0.0005	0.022	±0.04
	2005-06	0.64	0.36	0.0023	0.048	±0.08	0.96	0.04	0.0003	0.016	±0.03
Pinedale Front Winter Range Complex	1994-95	0.92	0.08	0.0131	0.115	±0.19	0.99	0.01	0.0008	0.028	±0.05
	1995-96	-	-	-	-	-	-	-	-	-	-
	1996-97	0.62	0.38	0.0040	0.063	±0.10	0.94	0.06	0.0004	0.019	±0.03
	1997-98	0.70	0.30	0.0051	0.071	±0.12	0.89	0.11	0.0019	0.044	±0.07
	1998-99	1.14	-0.14	0.0174	0.132	±0.22	1.04	-0.04	0.0015	0.039	±0.06
	1999-00	0.90	0.10	0.0047	0.068	±0.11	0.99	0.01	0.0004	0.020	±0.03
	2000-01	0.64	0.36	0.0205	0.143	±0.24	0.79	0.21	0.0239	0.155	±0.25
	2001-02	0.68	0.32	0.0030	0.055	±0.09	0.96	0.04	0.0002	0.014	±0.02
	2002-03	0.53	0.47	0.0088	0.094	±0.15	0.75	0.25	0.0092	0.096	±0.16
	2003-04	0.35	0.65	0.0006	0.024	±0.04	0.88	0.12	0.0004	0.020	±0.03
	2004-05	0.72	0.28	0.0050	0.071	±0.12	0.91	0.09	0.0037	0.061	±0.10
	2005-06	0.46	0.54	0.0011	0.034	±0.06	0.91	0.09	0.0004	0.021	±0.03



2a



2b

Figure 2
Comparisons of Mule Deer Mortality Rate Estimates (With 90% CI on the Estimates) for Fawn (2a) and Adult (2b) Mule Deer on the Mesa and Pinedale Front Winter Range Complexes

Climatological Trends. NWS stations used to interpolate monthly precipitation and snowfall at the approximate center of crucial winter ranges in the Sublette Herd Unit (latitude 42.68 ^{o}N, longitude -109.79 ^{o}W) were listed in Table 2.3-3 of Appendix E in the Questar EA (BLM, 2004). Data from the same NWS stations were used to estimate minimum and maximum monthly temperatures on mule deer crucial winter range. Estimates of total precipitation for each water year, total snowfall from November through March, maximum and minimum temperatures averaged for each water year are shown in Figure 3. In each plot, 30-year averages from water years 1971 through 2000 are also shown as estimated at the approximate center of the Sublette Herd Unit winter range complex.

During the 4-year period from 2000 through 2003, total precipitation on mule deer crucial winter range had been consistently below the 30-year average, whereas total precipitation in water years 2004 and 2005 were above average (Figure 3a). On the other hand, total snowfall between November and March has been at or below the 30-year average since water year 1987 (Figure 3b). Snowfall was at the 30-year average in water year 1996, and nearly so in 2004, and 2006.

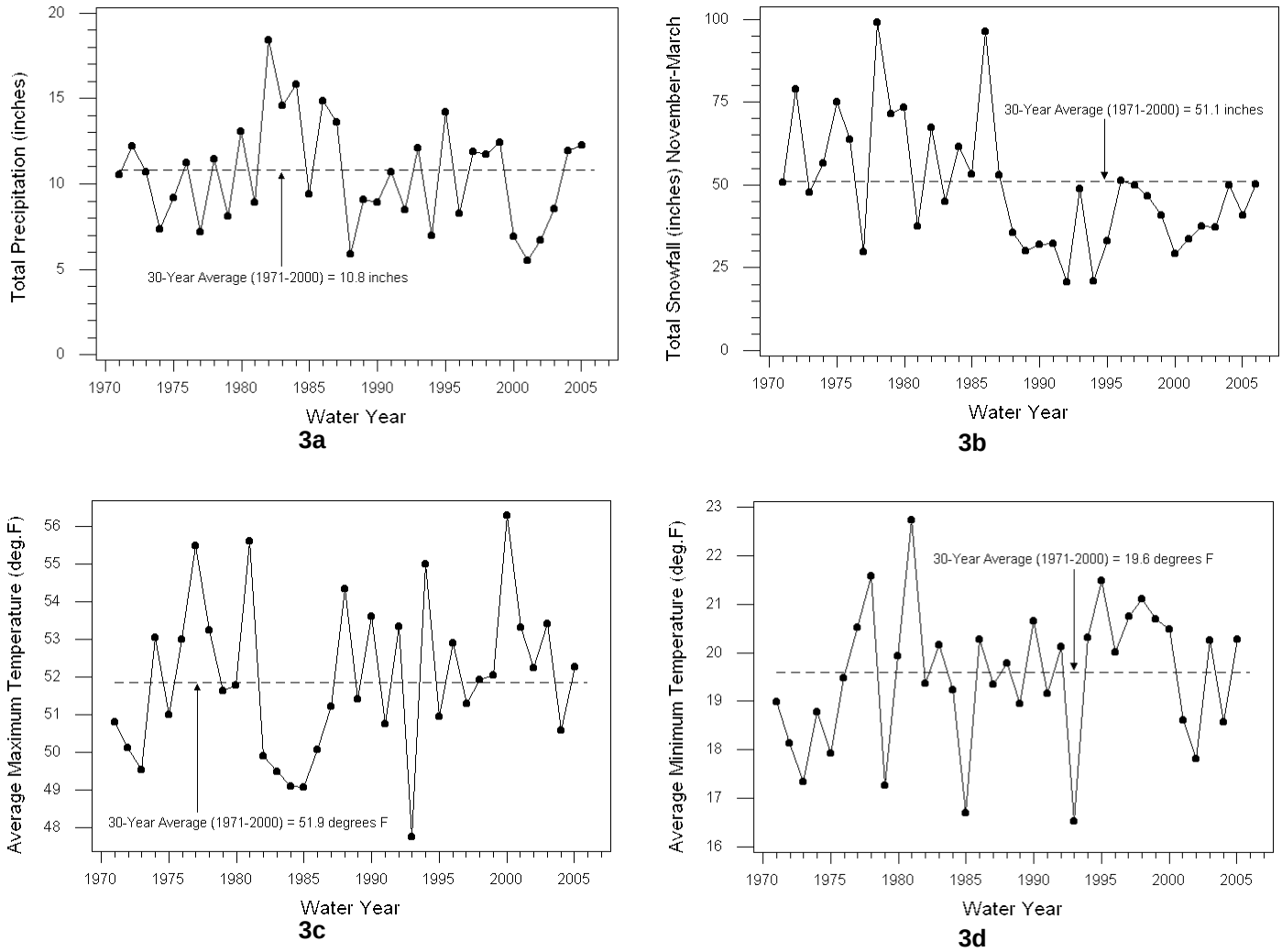


Figure 3
Total Water Year Precipitation (3a), Total Snowfall November Through March (3b), Average Maximum (3c) and Average Minimum (3d) Temperatures for Each Water Year Since 1971 With 30-Year Averages (From 1971 Through 2000) Interpolated on the Sublette Winter Range Complex

Relationships of Fawn Mortality to Climatological Conditions. Noted in the Questar EA, WGFD biologist Doug McWhirter expressed reservations about the validity of mule deer carcass counts made during the first year of data collection (1993). Specifically, carcasses of mule deer that died in winters prior to the first year of study may have been included in the tallies. Consequently, data from winter 1992-93 are not included in the following analyses.

In the Technical Report prepared for the Questar EA (BLM, 2004 Appendix E), over-winter fawn mortality rates in the Sublette Herd Unit from 1994 through 2000 were found to have a significant relationship (r^2 = 0.871, P = 0.002) to total snowfall, November through March.

Alternatively, fawn mortality rates from 2001 through 2004 were found to have a significant relationship (r^2 = 0.923, P = 0.039) to total snowfall, October through April. Total precipitation had been well below average on winter ranges since water year 2000 so that by 2003, there were four consecutive water years of below-average precipitation.

Total precipitation during water year 2004 was above the 30-year average (Figure 3a). As reported in the Technical Report appended to the ASU EA (BLM, 2005a), the total precipitation for two consecutive years immediately prior to any given winter had a significant effect on over-winter fawn mortality. When total snowfall, November through March, and total precipitation in the two previous water years are used in linear multiple regression, over-winter fawn mortality in the Sublette Herd Unit can be visualized on a continuous surface in three-dimensional space (Figure 5). The relationship, shown in Figure 5, was Y (Over-Winter Fawn Mortality Rate) = 0.320 + 0.013 X_1 (Total Snowfall November-March) – 0.025 X_2 (Total Precipitation 2 Previous Years) - with multiple r^2 = 0.796, P = 0.001.

Further analysis in the Technical Report appended to the ASU EA (BLM, 2005a) determined that the Average Minimum Temperature during November of any year also significantly affected fawn mortality rates, though not by itself but in combination with the variables Total Snowfall November-March and Total Precipitation 2 Previous Years. The resultant multiple regression equation with three independent variables was Y (Over-Winter Fawn Mortality Rate) = 0.233 + 0.015 X_1 (Total Snowfall November-March) – 0.020 X_2 (Total Precipitation 2 Previous Years) – 0.011 X_3 (November Average Minimum Temperature); multiple r^2 = 0.879, P = 0.001.

As discussed in the Technical Report (BLM, 2005a), fawn mortality increased with increasing snowfall November-March but decreased with more total precipitation in the two water years prior to a winter. Consequently, similar mortality rates may be observed during winters with very different amounts of snow, the effects of which are ameliorated or exacerbated by overall moist or dry conditions during the two previous years. The inverse influence of November Average Minimum Temperature on fawn mortality is possibly due to duration of early winter snow cover with low temperatures and/or crusting snow - melting during the day but freezing at night - that persists through much or all of the remaining winter.

However, over-winter fawn mortality rate in winter 2005-2006 was 0.46 (with 90% CI of ± 0.05). The total snowfall November-March was 42.10 inches and total precipitation for the two previous years was 24.18 inches (Table 5). With the values for those two independent variables, the regression equation shown in Figure 4 predicts that the over-winter fawn mortality rate in 2005-2006 to be 0.25 (with 90% confidence interval of ± 0.08), significantly lower than the observed mortality of 0.46 (± 0.05). As seen in Figure 4, the over-winter fawn mortality rate observed in 2005-2006 extends well above the plane of the regression model derived from previous years' observations.

Table 5
Over-Winter Fawn Mortality Rates and Values of Three Independent Variables Used in Multiple Regress Analysis

Winter	Over-Winter Fawn Mortality Rate	Independent Variables In Multiple Regression		
		Total Snowfall November through March (inches)	Total Precipitation During Previous Two Water Years (inches)	November Average Minimum Temperature (°F)
1993-94	0.04	20.83	20.61	3.5
1994-95	0.23	33.06	19.07	6.7
1995-96	0.46	51.42	21.19	16.4

Table 5 (concluded)

Winter	Over-Winter Fawn Mortality Rate	Independent Variables In Multiple Regression		
		Total Snowfall November through March (inches)	Total Precipitation During Previous Two Water Years (inches)	November Average Minimum Temperature (°F)
1996-97	0.42	49.93	22.52	15.4
1997-98	0.34	46.71	20.19	9.0
1998-99	0.16	40.89	23.66	13.7
1999-00	0.12	29.22	24.21	11.1
2000-01	0.44	33.68	19.40	0.5
2001-02	0.37	37.58	12.44	14.2
2002-03	0.52	36.14	12.19	7.8
2003-04	0.65	49.86	15.37	1.0
2004-05	0.31	40.93	20.60	12.5
2005-06	0.46	42.10	24.18	12.2

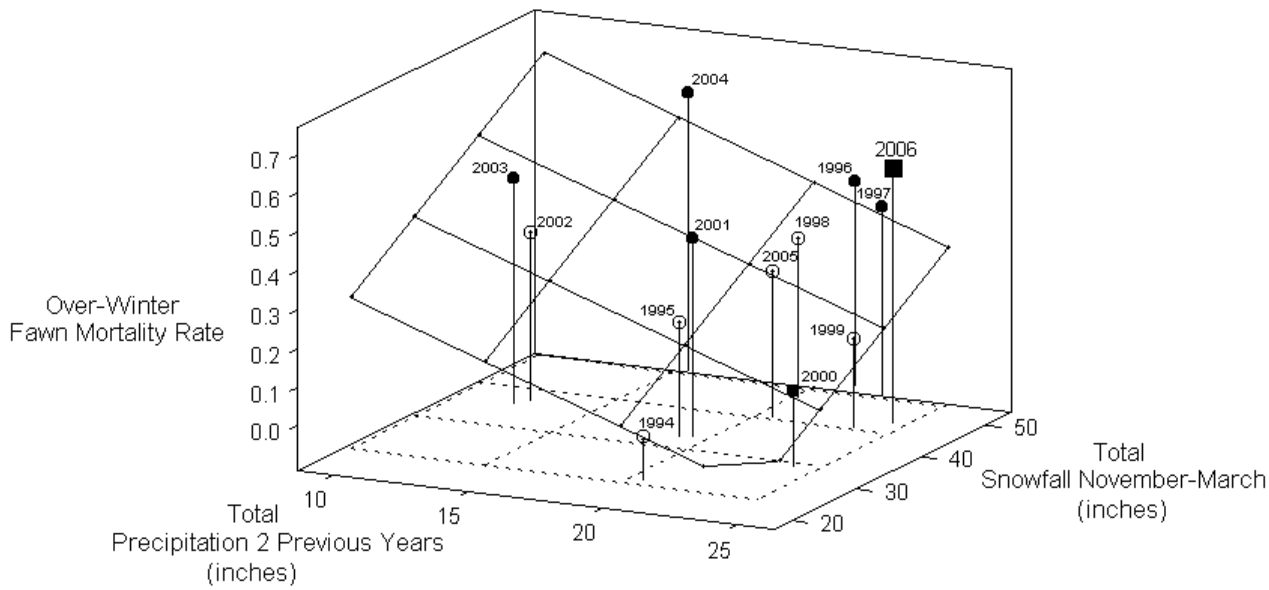


Figure 4
Modeled Surface of Data Relationships from 1993-94 through 2004-05 by the Equation Y (Over-Winter Fawn Mortality Rate) = 0.320 + 0.013 X_1 (Total Snowfall November-March) – 0.025 X_2 (Total Precipitation 2 Previous Years); multiple r^2 = 0.796, P = 0.001. Years with Fawn Mortality Values as Solid Circles are Above the Regression Surface, Years with Open Circles are Below the Surface. The Position of the Fawn Mortality Rate Observed in 2005-06, with Observed Values for Each Independent Variable, is Labeled and Marked with a Square above the Modeled Surface

Noted above, the three independent variables (Total Snowfall November-March, Total Precipitation 2 Previous Years, and November Average Minimum Temperature) account for nearly 88 percent of the variation in fawn mortality in the Sublette Herd Unit. With the values for each independent variable observed in 2005-06 (Table 5), the multiple regression equation derived from the previous years' observations predicts over-winter fawn mortality rate of 0.25 (with 90% CI of ±0.06). Again, the observed fawn mortality rate of 0.46 ± 0.05 is significantly higher (P<0.10) than predicted.

In the discussion above, the point was made that for the first time in this study, over-winter fawn mortality rates on the two winter range complexes had been significantly different (P< 0.1)

following winter 2005-2006; the fawn mortality rate on the Pinedale Front complex was significantly higher than the fawn mortality rate observed on the Mesa winter range complex. The mortality rate of fawns on the Mesa complex was estimated to be 0.36 (with 90% CI of ± 0.08, see Table 4). That value is within that predicted by the multiple regression equation above, for the values of total snowfall, total precipitation two previous years, and average minimum temperature in November (Over-Winter Fawn Mortality Rate = 0.233 + 0.015 (Total Snowfall November-March) – 0.020 (Total Precipitation 2 Previous Years) – 0.011 (November Average Minimum Temperature). On the other hand, the mortality rate of fawns on the Pinedale Front was estimated to be 0.54 (with 90% CI of ± 0.06, see Table 4), significantly higher than predicted by the equation.

The question motivated by the observation of different fawn mortality rates on the two winter range complexes in 2005-2006 is one of different climatological conditions on the two complexes in that winter. To explore that possibility, weighted averages of climatological conditions were interpolated from the nearest five NWS stations to the approximate center of Mesa Winter Range Complex (latitude 42.79 ^{o}N, longitude -110.03 ^{o}W) and the nearest five NWS stations to the approximate center of Pinedale Front Range Complex (latitude 42.54 ^{o}N, longitude -109.41 ^{o}W). The estimated values on the two winter range complexes are included in Table 6 along with the observed fawn mortality rate and mortality rate predicted by the climatological values on each winter range.

Paradoxically, estimated total snowfall on the Mesa winter range complex in 2005-2006 exceeded the total snowfall estimated on the Pinedale Front complex, 60.35 inches compared to 41.87 inches (Table 6). The estimate of total precipitation during the previous two water years was also higher on the Mesa than on the Pinedale Front while average minimum at the onset of winter, November 2005, was about the same. Using the climatological values estimated on each winter range complex in the multiple regression model developed for fawn mortality on the entire Sublette Herd Unit, winter conditions on the Mesa in 2005-2006 predicted a fawn mortality rate of 0.47, higher, though not significantly so, than the observed rate of 0.36. The fawn mortality rate predicted on the Pinedale Front was 0.26, significantly lower, given the estimated climatological values, than the observed rate of 0.54.

Table 6
Over-Winter Fawn Mortality Rates and Values of Three Climatological Variables Used Estimated on the Mesa and Pinedale Front Winter Range Complexes in Winter 2005-06

Winter Range Complex	Over-Winter Fawn Mortality Rate (with 90% CI) Observed in 2005-06 And Predicted [1]		2005-06 Climatological Values Estimated on Winter Range Complex		
			Total Snowfall November through March (inches)	Total Precipitation During Previous Two Water Years (inches)	November Average Minimum Temperature (^{o}F)
Mesa	Observed	0.36 ± 0.08	60.35	26.68	13.4
	Predicted	0.47 ± 0.12			
Pinedale Front	Observed	0.54 ± 0.06	41.87	23.17	13.2
	Predicted	0.26 ± 0.06			

[1] Predicted fawn mortality rate values and 90% CI from the multiple regression equation:
Over-Winter Fawn Mortality Rate = 0.233 + 0.015 (Total Snowfall November-March) – 0.020 (Total Precipitation 2 Previous Years) – 0.011 (November Average Minimum Temperature).

Clearly, the winter conditions estimated by interpolation on the Pinedale Front did not reflect conditions that likely occurred there. Indeed, anecdotal reports indicated more severe conditions throughout that winter range complex, particularly later in the winter, than suggested by the estimates from NWS stations (Smith, 2006 and Sawyer, 2006). Because there are no

NWS stations on the Pinedale Front winter range complex, the discrepancies between anecdotes and interpolations point to the limitations of utilizing NWS data for evaluating mule deer mortality on that portion of the Sublette Herd Unit.

CONCLUSION

Other investigators have demonstrated direct relationships between mule deer over-winter mortality and snowfall or snow on the ground (Roper and Lipscomb, 1973; Leckenby and Adams, 1986; Bartmann and Bowden, 1984). Energy expense by mule deer traveling through snow increases exponentially with increasing snow depth relative to the height of a deer or relative to animals' sinking depth in snow (Parker et al., 1984). Fawns will expend more energy than adult deer when moving through snow. Such differential energy cost of locomotion through snow contributes to higher mortality rates in fawns (Hobbs, 1989). Increased over-winter fawn mortality was an expected consequence of increased energy expense during winter if deer were escaping from vehicular traffic and other natural gas activities within crucial winter range (BLM, 1999).

From 1993-1994 through 2004-2005, there was a very strong relationship found between fawn mortality rates, total winter snowfall, precipitation in the two previous years, and minimum temperature at the onset of winter, in November. The relationship established that fawn mortality on the Sublette Herd Unit increased with increasing snowfall but decreased with more total precipitation in the two water years prior to that winter. Vegetation growth and nutritional content on Sublette Herd Unit crucial winter ranges has undoubtedly been enhanced or limited by precipitation regimes in a given growing season, as well as the previous growing season. Ultimately, availability of nutritional forage as a function of precipitation is most likely one key factor in fawn over-winter survival (McKinney, 2003). The influence of average minimum temperature in November on fawn mortality is possibly due to duration of early winter snow cover with low temperatures and/or crusting snow - melting during the day but freezing at night - that persists through much or all of the remaining winter.

The fawn mortality rate rates observed in 2005-2006 did not conform to the relationship established for previous winters. Fawn mortality compiled for the Mesa and the Pinedale Front winter range complexes was significantly higher than predicted by the climatological conditions estimated at the approximate geographic center of all crucial winter ranges within the Sublette Herd Unit. Fawn mortality on the Pinedale Front complex was significantly higher than on the Mesa complex and that observed very high mortality rate influenced the estimate for the entire herd unit. Apparently, the distribution of and climatological measurements available from NWS stations proximate to the Pinedale Front winter range complex were not sufficient to account for the extreme fawn mortality observed there.

One justifiable conclusion from the forgoing would be a recommendation for establishing climatological measuring stations throughout the crucial winter ranges utilized by mule deer so estimates by interpolating data from distant NWS stations would be unnecessary. Another more basic conclusion points to the importance of all crucial winter ranges utilized by a population. Unmeasured though presumably density-independent events on one winter range may have significant effects on the over-winter survival for the portion of the population that depends on it, reflected in lower over-winter survival for the entire mule deer population. With differential over-winter survival on the two winter range complexes utilized by mule deer in the Sublette Herd Unit, demonstrated above, the importance of all winter ranges to the population must be reiterated.

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APPENDIX L

Spatial Analysis of Future Surface Disturbance

Spatial Analysis of Future Surface Disturbance

The inventory of wellfield disturbance since 2005 and by the end of 2006 is the baseline for the accumulation of all future natural gas development in the PAPA, whether by the No Action Alternative, the Proposed Action Alternative, or Alternative C. In the future, each Operator in the PAPA has different plans for numbers and dimensions of new well pads and the numbers and dimensions of existing well pads that will be expanded. To approximate the spatial distribution of those future developments it was assumed that all disturbances would occur within each Operator's current leasehold. For the most part, current leases are sub-divided as quarter-sections which are approximately 160-acre parcels but there is considerable variation in that area across the PAPA. For some Operators, most of their leased lands are contiguous, for others the lease is patchy, forming a checkerboard pattern of leased quarter-sections across portions of the PAPA.

The Operators provided their respective plans for new and expanded well pads and locations by quarter-section in 2006. Specific locations within those quarter sections were not provided. Therefore, a model was developed to evaluate the accumulation of surface disturbance in each quarter-section in 2006 and into the future with development by the No Action Alternative, the Proposed Action Alternative, and Alternative C.

The following assumptions were applied in the model used to develop the distribution of surface disturbances in 2006 and future outcomes for each alternative.

- Each existing well pad could only be assigned to one quarter-section. Well pads that overlap two or more quarter-sections would be assigned to the one with most of the pads' area.
- All expansion acreage of an existing pad would occur within the quarter-section in which the expanded pad was assigned.
- Expansion acreage would be applied to the smallest existing pad if there was more than one existing pad in the quarter-section.
- Each new well pad and its specified (by the Operators) acreage would be placed entirely within a quarter-section. Any future expansion of the pad also would be entirely within that quarter-section.
- No pad could be expanded to exceed 30 acres.
- Whenever possible, new pads would not be placed in situations with No Surface Occupancy (Lander Trail 0.25-mile buffer, greater sage-grouse leks 0.25-mile buffer, and residence 0.25-mile buffer).
- Whenever possible, new pads would not be placed in quarter-sections with existing pads but no more than four new pads would be placed in any quarter-section (maximum allowed by PAPA ROD was 16 pads per section or 16 pads per square mile).

Proposed condensate and produced water pipelines were placed in quarter-sections where new pads would be constructed (Questar) or in quarter-sections with existing and new pads (Shell and Ultra). Central gathering facilities were distributed throughout an Operator's lease. New facilities with specific locations were placed in those quarter-sections and expansions of existing facilities were within the quarter-sections where those facilities were originally located. In the model, no quarter-section could be disturbed by more than 100 percent.

Areas of disturbance by new gas gathering pipelines and new local and/or resource roads to new pads were estimated from patterns of development through 2005. In general, the acres disturbed by roads and pipelines within a quarter-section increase linearly with the number of well pads in the quarter-section. However, as the number of pads within a quarter-section increases, the disturbance (acres) by roads and pipelines **per pad** decreases. Areas of new disturbance by roads and pipelines were added to existing disturbance by roads and pipelines on a **per pad** basis. For example, there would be one existing pad in a quarter-section with 2 acres disturbed by roads and 2.5 acres disturbed by pipelines. A second well pad would be placed in that quarter-section which would result in 2 acres + 2.65 new acres (from Table 1) = 4.65 acres of total road disturbance and 2.5 acres + 2.65 new acres (from Table 1) = 5.15 acres of total pipeline disturbance in the quarter-section. A well pad placed in a quarter-section with no existing pads would result in an additional 3.07 acres disturbed by roads and that same amount disturbed by pipelines, regardless of the size of the well pad.

Table 1
Relationship of Areas Disturbed by Roads and Gas Gathering Pipelines in Quarter-Sections with Varying Numbers of Well Pads

Well Pads per Quarter-Section	Total Area (acres) in Quarter-Section	Area (acres) per Well Pad
1	3.07	3.07
2	5.31	2.65
3	7.55	2.52
4	9.80	2.45

APPENDIX M

Air Quality Impact Tables
Project Alternative Modeling

Table M-1 Summary of Maximum Modeled Near-field NO_2 Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards and PSD Class II Increments[1]

Alternative	Averaging Time	Direct Modeled Impact[2,3]	PSD Class II Increment[2]	Background Concentration[2]	Total Concentration[2]	NAAQS/ WAAQS[2]	Percent of NAAQS/ WAAQS
No Action	Annual	39.9	25	8	47.9	100	49
Proposed Action	Annual	39.9	25	8	47.9	100	49

1 All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.
2 In µg/m^3.
3 Background concentrations are not added to modeled concentrations for comparison to the PSD increment.

Table M-2 Summary of Maximum Modeled Near-field CO Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	1-hour	329	1,979	2,308	40,000	6
	8-hour	232	931	1,163	10,000	12
Proposed Action	1-hour	329	1,979	2,308	40,000	6
	8-hour	232	931	1,163	10,000	12

1 In µg/m^3.

Table M-3 Summary of Maximum Modeled Near-field SO_2 Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	3-hour	13.5	132	145.5	1,300	11
	24-hour	3.2	43	46.2	365/260	13/18
	Annual	0.7	9	9.7	80/60	12/16
Proposed Action	3-hour	13.5	132	145.5	1,300	11
	24-hour	3.2	43	46.2	365/260	13/18
	Annual	0.7	9	9.7	80/60	12/16

1 In µg/m^3.

Table M-4 Summary of Maximum Modeled Near-field PM_{10} Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	24-hour	74.2	32	106.2	150	71
	Annual	1.7	9	10.7	50	21
Proposed Action	24-hour	74.2	32	106.2	150	71
	Annual	1.7	9	10.7	50	21

[1] In $\mu g/m^3$.

Table M-5 Summary of Maximum Modeled Near-field $PM_{2.5}$ Concentrations from Direct Project Sources Compared to Ambient Air Quality Standards

Alternative	Averaging Time	Direct Modeled Impact[1]	Background Concentration[1]	Total Concentration[1]	NAAQS/ WAAQS[1]	Percent of NAAQS/ WAAQS
No Action	24-hour	14.3	15	29.3	65 (35)[2]	45 (84)
	Annual	1.7	5	6.7	15	45
Proposed Action	24-hour	14.3	15	29.3	65 (35)[2]	45 (84)
	Annual	1.7	5	6.7	15	45

[1] In $\mu g/m^3$.
[2] Revised NAAQS effective December 18, 2006.

Table M-6 Summary of Maximum Modeled HAP Concentrations from Direct Project Sources

		Benzene			Toluene			Ethylbenzene		
Alternative	Averaging Period	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard
No Action	1-Hour	1,300	128	9.8	37,000	249	0.7	350,000	15	0.004
		30	0.2	0.8	400	0.6	0.1	1,000	0.03	0.003
Proposed Action	1-Hour	1,300	128	9.8	37,000	249	0.7	350,000	15	0.004
	Annual	30	0.5	1.5	400	1.2	0.3	1,000	0.1	0.01

Annual		Xylene			n-Hexane			Formaldehyde		
Alternative	Averaging Period	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard	Health-based Level[1,2]	Modeled Concen-tration[2]	Percent of Health-based Standard
No Action	1-Hour	22,000	190	0.9	390,000	82	0.02	94	79.3	84.4
		100	0.4	0.4	200	0.1	0.07	9.8	0.2	1.8
Proposed Action	1-Hour	22,000	190	0.9	390,000	82	0.02	94	79.3	84.4
	Annual	100	1.0	1.0	200	0.1	0.07	9.8	0.2	1.8

[1] Based on (EPA, 2006).
[2] Annual in $\mu g/m^3$.

Table M-7 Summary of Long-Term MLE and MEI Cancer Risk Analyses from Direct Project Sources[1]

			MLE			MEI		
Alternative	HAP Constituent	Modeled Concentration[2]	Unit Risk Factor[3]	Exposure Adjustment Factor	Cancer Risk	Unit Risk Factor[3]	Exposure Adjustment Factor	Cancer Risk
No Action	Benzene	0.24	7.8E-06	0.0949	1.8E-07	7.8E-06	0.86	1.6E-06
	Formaldehyde		1.3E-05	0.0949	2.2E-07	1.3E-05	0.86	2.0E-06
	Total Combined							
Proposed Action	Benzene	0.45	7.8E-06	0.0949	3.3E-07	7.8E-06	0.86	3.0E-06
	Formaldehyde	0.18	1.3E-05	0.0949	2.2E-07	1.3E-05	0.86	2.0E-06
	Total Combined			4.0E-07			3.6E-06	

1 Based on EPA (1993, 2006a). 0.18
2 In µg/m^3.
2 In 1/µg/m^3.

5.5E-07 5.0E-06

Table M.8 - Summary of Maximum Modeled NO_2 Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.35	8.35	0.02	8.02	0.01	8.01	0.03	8.03	0.001	8.00
Proposed Action	0.34	8.34	0.02	8.02	0.01	8.01	0.03	8.03	0.001	8.00
Alternative C	0.22	8.22	0.02	8.02	0.01	8.01	0.02	8.02	0.001	8.00
Alternative C - 80 % Drill Rig Mitigation	0.08	8.08	0.01	8.01	0.002	8.00	0.01	8.01	0.0002	8.00
Proposed Action - Maximum Field Production	0.12	8.12	0.01	8.01	0.003	8.00	0.01	8.01	0.0003	8.00

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.08	8.08	0.004	8.00	0.004	8.00	0.05	8.05	0.003	8.00
Proposed Action	0.07	8.07	0.004	8.00	0.004	8.00	0.05	8.05	0.002	8.00
Alternative C	0.04	8.04	0.003	8.00	0.002	8.00	0.03	8.03	0.001	8.00
Alternative C - 80 % Drill Rig Mitigation	0.02	8.02	0.001	8.00	0.001	8.00	0.01	8.01	0.001	8.00
Proposed Action - Maximum Field Production	0.03	8.03	0.002	8.00	0.002	8.00	0.02	8.02	0.001	8.00

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 100 $\mu g/m^3$ on an annual basis.

[2] Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.

Table M.9 - Summary of Maximum Modeled SO_2 Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources

	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
	Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.24	0.06	0.01	132.2	43.1	9.01	0.05	0.01	0.0008	132.0	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00	0.05	0.01	0.001	132.1	43.0	9.00	0.01	0.002	0.0001	132.0	43.0	9.00
Proposed Action	0.23	0.08	0.01	132.2	43.1	9.01	0.06	0.02	0.001	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00	0.05	0.01	0.001	132.1	43.0	9.00	0.01	0.003	0.0001	132.0	43.0	9.00
Alternative C	0.67	0.23	0.02	132.7	43.2	9.02	0.20	0.06	0.003	132.2	43.1	9.00	0.07	0.02	0.0009	132.1	43.0	9.00	0.16	0.04	0.002	132.2	43.0	9.00	0.03	0.01	0.0003	132.0	43.0	9.00
Alternative C - 80 % Drill Rig Mitigation	0.16	0.06	0.01	132.2	43.1	9.01	0.04	0.01	0.0007	132.0	43.0	9.00	0.02	0.004	0.0002	132.0	43.0	9.00	0.04	0.01	0.001	132.0	43.0	9.00	0.01	0.002	0.0001	132.0	43.0	9.00
Proposed Action - Maximum Field Production	0.01	0.00	0.0002	132.0	43.0	9.00	0.003	0.001	0.0000	132.0	43.0	9.00	0.001	0.0002	0.0000	132.0	43.0	9.00	0.002	0.001	0.0000	132.0	43.0	9.00	0.0005	0.0001	0.0000	132.0	43.0	9.00

	Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
	Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.05	0.02	0.002	132.1	43.0	9.00	0.01	0.004	0.0002	132.0	43.0	9.00	0.01	0.004	0.0002	132.0	43.0	9.00	0.07	0.02	0.001	132.1	43.0	9.00	0.01	0.003	0.0001	132.0	43.0	9.00
Proposed Action	0.06	0.01	0.002	132.1	43.0	9.00	0.02	0.003	0.0002	132.0	43.0	9.00	0.02	0.004	0.0002	132.0	43.0	9.00	0.06	0.02	0.002	132.1	43.0	9.00	0.02	0.003	0.0001	132.0	43.0	9.00
Alternative C	0.18	0.04	0.01	132.2	43.0	9.01	0.05	0.01	0.0006	132.0	43.0	9.00	0.05	0.01	0.0007	132.0	43.0	9.00	0.18	0.05	0.005	132.2	43.0	9.00	0.05	0.01	0.0003	132.0	43.0	9.00
Alternative C - 80 % Drill Rig Mitigation	0.04	0.01	0.002	132.0	43.0	9.00	0.01	0.002	0.0001	132.0	43.0	9.00	0.01	0.003	0.0002	132.0	43.0	9.00	0.04	0.01	0.001	132.0	43.0	9.00	0.01	0.002	0.0001	132.0	43.0	9.00
Proposed Action - Maximum Field Production	0.002	0.001	0.0001	132.0	43.0	9.00	0.00	0.0002	0.0000	132.0	43.0	9.00	0.001	0.0002	0.0000	132.0	43.0	9.00	0.003	0.001	0.0001	132.0	43.0	9.00	0.001	0.0001	0.0000	132.0	43.0	9.00

[1] Total concentration includes direct modeled impact and background concentration for comparison with NAAQS/WAAQS which are 1,300 $\mu g/m^3$ on a 3-hour basis, 365/260 $\mu g/m^3$ on a 24-hour basis and 80/60 $\mu g/m^3$ on an annual basis. Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.

Table M.10 - Summary of Maximum Modeled PM_{10} Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	2.54	0.13	34.5	9.13	0.75	0.03	32.8	9.03	0.31	0.01	32.3	9.01	0.60	0.02	32.6	9.02	0.16	0.005	32.2	9.00
Proposed Action	2.69	0.13	34.7	9.13	0.88	0.03	32.9	9.03	0.26	0.01	32.3	9.01	0.49	0.03	32.5	9.03	0.20	0.005	32.2	9.00
Alternative C	1.93	0.10	33.9	9.10	0.60	0.02	32.6	9.02	0.18	0.01	32.2	9.01	0.34	0.02	32.3	9.02	0.14	0.003	32.1	9.00
Alternative C - 80 % Drill Rig Mitigation	0.85	0.04	32.8	9.04	0.25	0.01	32.2	9.01	0.08	0.004	32.1	9.00	0.18	0.01	32.2	9.01	0.06	0.002	32.1	9.00
Proposed Action - Maximum Field Production	0.55	0.04	32.5	9.04	0.37	0.01	32.4	9.01	0.10	0.004	32.1	9.00	0.15	0.01	32.1	9.01	0.07	0.002	32.1	9.00

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.61	0.05	32.6	9.05	0.18	0.01	32.2	9.01	0.22	0.01	32.2	9.01	0.70	0.04	32.7	9.04	0.17	0.01	32.2	9.01
Proposed Action	0.70	0.05	32.7	9.05	0.20	0.01	32.2	9.01	0.26	0.01	32.3	9.01	0.81	0.04	32.8	9.04	0.17	0.01	32.2	9.01
Alternative C	0.48	0.04	32.5	9.04	0.14	0.01	32.1	9.01	0.18	0.01	32.2	9.01	0.56	0.03	32.6	9.03	0.12	0.004	32.1	9.00
Alternative C - 80 % Drill Rig Mitigation	0.18	0.02	32.2	9.02	0.06	0.002	32.1	9.00	0.07	0.002	32.1	9.00	0.22	0.01	32.2	9.01	0.05	0.002	32.1	9.00
Proposed Action - Maximum Field Production	0.25	0.02	32.2	9.02	0.08	0.003	32.1	9.00	0.10	0.003	32.1	9.00	0.30	0.01	32.3	9.01	0.06	0.002	32.1	9.00

[1] Total Concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS whaich are 150$\mu g/m^3$ on a 24-hour basis and 50 $\mu g/m^3$ on an annual basis.

Background PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.

Table M.11 - Summary of Maximum Modeled $PM_{2.5}$ Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.96	0.13	16.0	6.13	0.24	0.03	15.2	6.03	0.18	0.01	15.2	6.01	0.25	0.02	15.3	6.02	0.07	0.005	15.1	6.00
Proposed Action	1.08	0.13	16.1	6.13	0.27	0.03	15.3	6.03	0.16	0.01	15.2	6.01	0.22	0.03	15.2	6.03	0.08	0.005	15.1	6.00
Alternative C	0.77	0.10	15.8	6.10	0.19	0.02	15.2	6.02	0.11	0.01	15.1	6.01	0.16	0.02	15.2	6.02	0.05	0.003	15.1	6.00
Alternative C - 80 % Drill Rig Mitigation	0.32	0.04	15.3	6.04	0.07	0.01	15.1	6.01	0.05	0.004	15.1	6.00	0.07	0.01	15.1	6.01	0.02	0.002	15.0	6.00
Proposed Action - Maximum Field Production	0.32	0.04	15.3	6.04	0.10	0.01	15.1	6.01	0.05	0.004	15.0	6.00	0.08	0.01	15.1	6.01	0.02	0.002	15.0	6.00

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.31	0.05	15.3	6.05	0.11	0.01	15.1	6.01	0.10	0.01	15.1	6.01	0.31	0.04	15.3	6.04	0.09	0.01	15.1	6.01
Proposed Action	0.32	0.05	15.3	6.05	0.09	0.01	15.1	6.01	0.10	0.01	15.1	6.01	0.32	0.04	15.3	6.04	0.08	0.01	15.1	6.01
Alternative C	0.22	0.04	15.2	6.04	0.06	0.01	15.1	6.01	0.07	0.01	15.1	6.01	0.22	0.03	15.2	6.03	0.06	0.004	15.1	6.00
Alternative C - 80 % Drill Rig Mitigation	0.09	0.02	15.1	6.02	0.03	0.002	15.0	6.00	0.03	0.002	15.0	6.00	0.09	0.01	15.1	6.01	0.03	0.002	15.0	6.00
Proposed Action - Maximum Field Production	0.10	0.02	15.1	6.02	0.04	0.003	15.0	6.00	0.04	0.003	15.0	6.00	0.11	0.01	15.1	6.01	0.03	0.002	15.0	6.00

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 65 $\mu g/m^3$ (revised NAAQS of 35 $\mu g/m3$ effective on Dec 18, 2006) on a 24-hour basis and 15 $\mu g/m^3$ on an annual basis.

[2] $PM_{2.5}$ concentration values of 15 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

Background PM

Table M.12 - Summary of Maximum Modeled NO_2 Concentration Impacts ($\mu g/m^3$) from Direct Project Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.35	2.5	0.02	2.5	0.01	2.5	0.03	25.0	0.001	2.5
Proposed Action	0.34	2.5	0.02	2.5	0.01	2.5	0.03	25.0	0.001	2.5
Alternative C	0.22	2.5	0.02	2.5	0.01	2.5	0.02	25.0	0.001	2.5
Alternative C - 80 % Drill Rig Mitigation	0.08	2.5	0.01	2.5	0.002	2.5	0.01	25.0	0.0002	2.5
Proposed Action - Maximum Field Production	0.12	2.5	0.01	2.5	0.003	2.5	0.01	25.0	0.0003	2.5

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.08	25.0	0.004	2.5	0.004	2.5	0.05	25.0	0.003	2.5
Proposed Action	0.07	25.0	0.004	2.5	0.004	2.5	0.05	25.0	0.002	2.5
Alternative C	0.04	25.0	0.003	2.5	0.002	2.5	0.03	25.0	0.001	2.5
Alternative C - 80 % Drill Rig Mitigation	0.02	25.0	0.001	2.5	0.001	2.5	0.01	25.0	0.001	2.5
Proposed Action - Maximum Field Production	0.03	25.0	0.002	2.5	0.002	2.5	0.02	25.0	0.001	2.5

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis

Table M.13 - Summary of Maximum Modeled SO_2 Concentration Impacts ($\mu g/m^3$) from Direct Project Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
	Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.24	0.06	0.01	25.0	5.0	2.0	0.05	0.01	0.001	25.0	5.0	2.0	0.02	0.01	0.0003	25.0	5.0	2.0	0.05	0.01	0.001	512.0	91.0	20.0	0.01	0.002	0.0001	25.0	5.0	2.0
Proposed Action	0.23	0.08	0.01	25.0	5.0	2.0	0.06	0.02	0.001	25.0	5.0	2.0	0.02	0.01	0.0003	25.0	5.0	2.0	0.05	0.01	0.001	512.0	91.0	20.0	0.01	0.003	0.0001	25.0	5.0	2.0
Alternative C	0.67	0.23	0.02	25.0	5.0	2.0	0.20	0.06	0.003	25.0	5.0	2.0	0.07	0.02	0.0009	25.0	5.0	2.0	0.16	0.04	0.002	512.0	91.0	20.0	0.03	0.01	0.0003	25.0	5.0	2.0
Alternative C - 80 % Drill Rig Mitigation	0.16	0.06	0.01	25.0	5.0	2.0	0.04	0.01	0.001	25.0	5.0	2.0	0.02	0.004	0.0002	25.0	5.0	2.0	0.04	0.01	0.001	512.0	91.0	20.0	0.01	0.002	0.0001	25.0	5.0	2.0
Proposed Action - Maximum Field Production	0.01	0.002	0.0002	25.0	5.0	2.0	0.003	0.001	0.0000	25.0	5.0	2.0	0.001	0.0002	0.0000	25.0	5.0	2.0	0.002	0.001	0.0000	512.0	91.0	20.0	0.0005	0.0001	0.0000	25.0	5.0	2.0

	Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
	Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.05	0.02	0.002	512.0	91.0	20.0	0.01	0.004	0.0002	25.0	5.0	2.0	0.01	0.004	0.0002	25.0	5.0	2.0	0.07	0.02	0.001	512.0	91.0	20.0	0.01	0.003	0.0001	25.0	5.0	2.0
Proposed Action	0.06	0.01	0.002	512.0	91.0	20.0	0.02	0.003	0.0002	25.0	5.0	2.0	0.02	0.004	0.0002	25.0	5.0	2.0	0.06	0.02	0.002	512.0	91.0	20.0	0.02	0.003	0.0001	25.0	5.0	2.0
Alternative C	0.18	0.04	0.01	512.0	91.0	20.0	0.05	0.01	0.0006	25.0	5.0	2.0	0.05	0.01	0.0007	25.0	5.0	2.0	0.18	0.05	0.005	512.0	91.0	20.0	0.05	0.01	0.0003	25.0	5.0	2.0
Alternative C - 80 % Drill Rig Mitigation	0.04	0.01	0.002	512.0	91.0	20.0	0.01	0.002	0.0001	25.0	5.0	2.0	0.01	0.003	0.0002	25.0	5.0	2.0	0.04	0.01	0.001	512.0	91.0	20.0	0.01	0.002	0.0001	25.0	5.0	2.0
Proposed Action - Maximum Field Production	0.002	0.001	0.0001	512.0	91.0	20.0	0.00	0.0002	0.0000	25.0	5.0	2.0	0.001	0.0002	0.0000	25.0	5.0	2.0	0.003	0.001	0.0001	512.0	91.0	20.0	0.001	0.0001	0.0000	25.0	5.0	2.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis .

Table M.14 - Summary of Maximum Modeled PM_{10} Concentration Impacts ($\mu g/m^3$) from Direct Project Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	2.54	0.13	8.0	4.0	0.75	0.03	8.0	4.0	0.31	0.01	8.0	4.0	0.60	0.02	30.0	17.0	0.16	0.005	8.0	4.0
Proposed Action	2.69	0.13	8.0	4.0	0.88	0.03	8.0	4.0	0.26	0.01	8.0	4.0	0.49	0.03	30.0	17.0	0.20	0.005	8.0	4.0
Alternative C	1.93	0.10	8.0	4.0	0.60	0.02	8.0	4.0	0.18	0.01	8.0	4.0	0.34	0.02	30.0	17.0	0.14	0.003	8.0	4.0
Alternative C - 80 % Drill Rig Mitigation	0.85	0.04	8.0	4.0	0.25	0.01	8.0	4.0	0.08	0.004	8.0	4.0	0.18	0.01	30.0	17.0	0.06	0.002	8.0	4.0
Proposed Action - Maximum Field Production	0.55	0.04	8.0	4.0	0.37	0.01	8.0	4.0	0.10	0.004	8.0	4.0	0.15	0.01	30.0	17.0	0.07	0.002	8.0	4.0

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.61	0.05	30.0	17.0	0.18	0.01	8.0	4.0	0.22	0.01	8.0	4.0	0.70	0.04	30.0	17.0	0.17	0.01	8.0	4.0
Proposed Action	0.70	0.05	30.0	17.0	0.20	0.01	8.0	4.0	0.26	0.01	8.0	4.0	0.81	0.04	30.0	17.0	0.17	0.01	8.0	4.0
Alternative C	0.48	0.04	30.0	17.0	0.14	0.01	8.0	4.0	0.18	0.01	8.0	4.0	0.56	0.03	30.0	17.0	0.12	0.004	8.0	4.0
Alternative C - 80 % Drill Rig Mitigation	0.18	0.02	30.0	17.0	0.06	0.002	8.0	4.0	0.07	0.002	8.0	4.0	0.22	0.01	30.0	17.0	0.05	0.002	8.0	4.0
Proposed Action - Maximum Field Production	0.25	0.02	30.0	17.0	0.08	0.003	8.0	4.0	0.10	0.003	8.0	4.0	0.30	0.01	30.0	17.0	0.06	0.002	8.0	4.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis .

Table M.15 - Summary of Maximum Modeled In-field Pollutant Concentrations ($\mu g/m^3$) from Direct Project Sources

	NO_2				SO_2											
	Direct Modeled Impact[1]	PSD Class II Increment[2]	Total Concentration[3]	NAAQS/ WAAQS	Direct Modeled Impact[1]			PSD Class II Increment[2]			Total Concentration[3]			NAAQS/WAAQS		
Alternative	Annual	Annual	Annual	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	52.8	25.0	60.8	100	32.8	5.3	0.7	512.0	91.0	20.0	164.8	48.3	9.7	1,300	365/260	80/60
Proposed Action	60.5	25.0	68.5	100	32.6	5.4	0.7	512.0	91.0	20.0	164.6	48.4	9.7	1,300	365/260	80/60
Alternative C	37.0	25.0	45.0	100	112.6	18.2	2.3	512.0	91.0	20.0	244.6	61.2	11.3	1,300	365/260	80/60
Alternative C - 80 % Drill Rig Mitigation	10.3	25.0	18.3	100	22.6	3.8	0.5	512.0	91.0	20.0	154.6	46.8	9.5	1,300	365/260	80/60
Proposed Action - Maximum Field Production	8.3	25.0	16.3	100	0.5	0.1	0.0	512.0	91.0	20.0	132.5	43.1	9.0	1,300	365/260	80/60

	PM_{10}								$PM_{2.5}$					
	Direct Modeled Impact[1]		PSD Class II Increment[2]		Total Concentration[3]		NAAQS/ WAAQS		Direct Modeled Impact		Total Concentration[3]		NAAQS/ WAAQS	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	51.4	18.3	30.0	17.0	83.4	27.3	150	50	14.1	5.2	29.1	11.2	65 (35)[4]	15
Proposed Action	24.6	8.5	30.0	17.0	56.6	17.5	150	50	12.1	3.4	27.1	9.4	65 (35)[4]	15
Alternative C	29.9	10.8	30.0	17.0	61.9	19.8	150	50	9.9	3.5	24.9	9.5	65 (35)[4]	15
Alternative C - 80 % Drill Rig Mitigation	29.6	9.7	30.0	17.0	61.6	18.7	150	50	5.7	2.3	20.7	8.3	65 (35)[4]	15
Proposed Action - Maximum Field Production	17.5	4.9	30.0	17.0	49.5	13.9	150	50	4.0	1.2	19.0	7.2	65 (35)[4]	15

[1] Total concentration includes direct modeled impact and background concentration

[2] Background concentrations are not added to modeled concentrations for comparison to the PSD increment. All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis

[3] Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.
Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.
Back ground PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.
Back ground $PM_{2.5}$ concentration values of 15 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

[4] Revised NAAQS effective December 18, 2006.

Table M.16 - Summary of Maximum Modeled Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources Using FLAG Background Data - (MVISBK=6)

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
No Action	7.4	62.0	4.8	8.0	1.6	2.0	3.6	6.0	0.9	0.0
Proposed Action	8.5	67.0	5.6	10.0	1.7	3.0	4.1	8.0	0.7	0.0
Alternative C	6.3	40.0	4.0	5.0	1.2	1.0	2.9	2.0	0.5	0.0
Alternative C - 80 % Drill Rig Mitigation	2.6	10.0	1.5	1.0	0.4	0.0	1.2	1.0	0.2	0.0
Proposed Action - Maximum Field Production	3.3	16.0	2.1	3.0	0.8	0.0	1.8	1.0	0.3	0.0

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
No Action	2.8	12.0	1.1	1.0	1.1	2.0	3.7	9.0	0.8	0.0
Proposed Action	3.2	14.0	1.2	1.0	1.3	2.0	4.2	10.0	0.8	0.0
Alternative C	2.2	6.0	0.8	0.0	0.9	0.0	3.0	5.0	0.5	0.0
Alternative C - 80 % Drill Rig Mitigation	0.9	0.0	0.3	0.0	0.3	0.0	1.3	1.0	0.2	0.0
Proposed Action - Maximum Field Production	1.5	1.0	0.5	0.0	0.5	0.0	1.8	2.0	0.3	0.0

Note: Δdv = change in deciview.

Table M.17 - Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Community Locations from Direct Project Sources Using Boulder Background Data

	Boulder		Cora		Pinedale	
Alternative	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)
No Action	13.1	126	11.2	58	12.5	89
Proposed Action	15.3	138	12.5	62	12.3	91
Alternative C	12.2	107	9.5	47	9.4	70
Alternative C - 80 % Drill Rig Mitigation	6.6	45	4.0	12	4.4	25
Proposed Action - Maximum Field Production	6.8	54	3.3	12	5.2	23

[1] Δdv = change in deciview.

Table M.18 - Summary of Maximum Modeled Total Nitrogen (N) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.097	1.517	0.012	1.432	0.007	1.297	0.014	1.434	0.004	1.294
Proposed Action	0.089	1.509	0.012	1.432	0.006	1.296	0.013	1.433	0.004	1.294
Alternative C	0.056	1.476	0.007	1.427	0.004	1.294	0.008	1.428	0.003	1.293
Alternative C - 80 % Drill Rig Mitigation	0.021	1.441	0.003	1.423	0.001	1.291	0.003	1.423	0.001	1.291
Proposed Action - Maximum Field Production	0.031	1.451	0.004	1.424	0.002	1.292	0.004	1.424	0.002	1.292

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.036	1.456	0.005	1.295	0.005	1.295	0.022	1.442	0.004	1.294
Proposed Action	0.032	1.452	0.005	1.295	0.005	1.295	0.020	1.440	0.004	1.294
Alternative C	0.020	1.440	0.003	1.293	0.003	1.293	0.013	1.433	0.002	1.292
Alternative C - 80 % Drill Rig Mitigation	0.008	1.428	0.001	1.291	0.001	1.291	0.005	1.425	0.001	1.291
Proposed Action - Maximum Field Production	0.011	1.431	0.002	1.292	0.002	1.292	0.007	1.427	0.001	1.291

[1] gen deposition analysis level of concern for total impacts - 3.00 kg/ha-yr.

[2] Nitro position value of 1.42 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.

[3] Includes N de position value of 1.29 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.

Includes N de

Table M.19 - Summary of Maximum Modeled Total Sulfur (S) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Direct Project Sources[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.0030	0.743	0.0004	0.740	0.0002	0.680	0.0004	0.740	0.0001	0.680
Proposed Action	0.0032	0.743	0.0005	0.740	0.0002	0.680	0.0004	0.740	0.0001	0.680
Alternative C	0.0093	0.749	0.0015	0.741	0.0006	0.681	0.0013	0.741	0.0004	0.680
Alternative C - 80 % Drill Rig Mitigation	0.0022	0.742	0.0003	0.740	0.0001	0.680	0.0003	0.740	0.0001	0.680
Proposed Action - Maximum Field Production	0.0001	0.740	0.0000	0.740	0.0000	0.680	0.0000	0.740	0.0000	0.680

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.0014	0.741	0.0002	0.680	0.0002	0.680	0.0008	0.741	0.0001	0.680
Proposed Action	0.0014	0.741	0.0002	0.680	0.0002	0.680	0.0009	0.741	0.0001	0.680
Alternative C	0.0043	0.744	0.0005	0.680	0.0006	0.681	0.0026	0.743	0.0004	0.680
Alternative C - 80 % Drill Rig Mitigation	0.0010	0.741	0.0001	0.680	0.0001	0.680	0.0006	0.741	0.0001	0.680
Proposed Action - Maximum Field Production	0.0000	0.740	0.0000	0.680	0.0000	0.680	0.0000	0.740	0.0000	0.680

[1] position analysis level of concern for total impacts = 5.0 kg/ha-yr.
[2] Sulfur de position value of 0.74 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.
[3] Includes S de position value of 0.68 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.
Includes S de

Table M.20 - Summary of Maximum Modeled Change in ANC (μeq/L) at Acid Sensitive Lakes from Direct Project Sources

	Black Joe Lake		Deep Lake		Hobbs Lake		Lazy Boy Lake		Lower Saddlebag		Ross Lake		Upper Frozen	
	Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Popo Agie Wilderness Class II		Fitzpatrick Wilderness Class I		Bridger Wilderness Class I	
Alternative	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)
Level of Acceptable Change(μeq/L)	6.71	10%	5.97	10%	6.99	10%	1.00	--	5.52	10%	5.37	10%	1.00	--
Background	67.1	--	59.7	--	69.9	--	10.8	--	55.2	--	53.7	--	6.0	--
No Action	0.28	0.42%	0.31	0.52%	0.15	0.21%	0.09	--	0.30	0.55%	0.08	0.14%	0.34	--
Proposed Action	0.25	0.37%	0.28	0.46%	0.15	0.21%	0.08	--	0.26	0.48%	0.07	0.13%	0.30	--
Alternative C	0.18	0.27%	0.20	0.33%	0.10	0.15%	0.06	--	0.19	0.35%	0.05	0.10%	0.22	--
Alternative C - 80 % Drill Rig Mitigation	0.07	0.10%	0.07	0.12%	0.04	0.05%	0.02	--	0.07	0.13%	0.02	0.03%	0.08	--
Proposed Action - Maximum Field Production	0.08	0.12%	0.09	0.15%	0.05	0.07%	0.03	--	0.09	0.17%	0.03	0.05%	0.10	--

[1] USFS Level of Acceptable Change; 10% change in ANC for lakes with ANC background values greater than 25 μeq/L, 1 μeq/l for lakes with ANC values less than or equal to 25 μeq/L.

Table M-21 RFD Projects Included in Cumulative Analysis

Atlantic Rim	Lower Greys River - MA 32
Bitter Creek	Monell Oil Recovery
BTA Bravo	Moxa Arch
Burley	Moxa Arch Infill
Burlington Little Monument	Mulligan Draw
Cave Gulch	Pacific Rim
Cliff Creek - USFS Management Area (MA) 22	Piney Creeks - MA 26
Compressor Station, Pipeline- Williams	Pioneer Gas Plant
Cooper Reservoir (1998)	Powder River Basin
Cottonwood Creek - MA 25	Riley Ridge
Desolation Flats	Road Hollow Gas Plant
Fontenelle Natural Gas Infill Drilling	Scotty Lake
Ham's Fork Pipeline	Seminoe Road
Hay Reservoir Pilot	Sierra Madre
Hickey Mountain-Table Mountain	Soda Unit
Horse Creek - MA 24	South Baggs
Horse Trap	South Piney
Jack Morrow Hills	
	Stage Coach
Jonah Enterprise	Upper Hoback – MA 23
Jonah Infill	Vermillion Basin
LaBarge Creek - MA 12	Willow Creek - MA 49
Little Greys River - MA 31	Wind Dancer
Lower Bush Creek CBM (Kennedy Oil	Wind River (Bureau of Indian Affairs [BIA] lead agency)

Table M.22 - Summary of Maximum Modeled Cumulative NO_2 Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.40	8.40	0.03	8.03	0.12	8.12	0.04	8.04	0.002	8.00
Proposed Action	0.39	8.39	0.03	8.03	0.11	8.11	0.04	8.04	0.002	8.00
Alternative C	0.26	8.26	0.02	8.02	0.11	8.11	0.03	8.03	0.002	8.00
Alternative C - 80 % Drill Rig Mitigation	0.13	8.13	0.01	8.01	0.11	8.11	0.02	8.02	0.001	8.00
Proposed Action - Maximum Field Production	0.16	8.16	0.02	8.02	0.11	8.11	0.02	8.02	0.001	8.00

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[1]	Direct Modeled Impact	Total Concentration[2]
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.09	8.09	0.01	8.01	0.005	8.00	0.06	8.06	0.003	8.00
Proposed Action	0.09	8.09	0.01	8.01	0.005	8.00	0.06	8.06	0.003	8.00
Alternative C	0.06	8.06	0.004	8.00	0.003	8.00	0.04	8.04	0.002	8.00
Alternative C - 80 % Drill Rig Mitigation	0.03	8.03	0.002	8.00	0.002	8.00	0.02	8.02	0.001	8.00
Proposed Action - Maximum Field Production	0.04	8.04	0.003	8.00	0.003	8.00	0.03	8.03	0.001	8.00

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 100 $\mu g/m^3$ on an annual basis.

[2] Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.

Table M.23 - Summary of Maximum Modeled Cumulative SO_2 Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources

	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
	Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.25	0.08	0.01	132.3	43.1	9.01	0.07	0.02	0.001	132.1	43.0	9.00	0.03	0.01	0.001	132.0	43.0	9.00	0.07	0.02	0.001	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00
Proposed Action	0.30	0.09	0.01	132.3	43.1	9.01	0.09	0.03	0.001	132.1	43.0	9.00	0.03	0.01	0.001	132.0	43.0	9.00	0.07	0.02	0.001	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00
Alternative C	0.76	0.24	0.02	132.8	43.2	9.02	0.22	0.07	0.003	132.2	43.1	9.00	0.08	0.02	0.001	132.1	43.0	9.00	0.18	0.04	0.003	132.2	43.0	9.00	0.03	0.01	0.0005	132.0	43.0	9.00
Alternative C - 80 % Drill Rig Mitigation	0.24	0.07	0.01	132.2	43.1	9.01	0.07	0.02	0.001	132.1	43.0	9.00	0.03	0.01	0.0005	132.0	43.0	9.00	0.06	0.01	0.001	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00
Proposed Action - Maximum Field Production	0.10	0.03	0.002	132.1	43.0	9.00	0.03	0.01	0.001	132.0	43.0	9.00	0.01	0.004	0.0003	132.0	43.0	9.00	0.03	0.01	0.0004	132.0	43.0	9.00	0.02	0.01	0.0002	132.0	43.0	9.00

	Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
	Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]			Direct Modeled Impact			Total Concentration[1]		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.08	0.02	0.003	132.1	43.0	9.00	0.02	0.01	0.0004	132.0	43.0	9.00	0.02	0.01	0.0005	132.0	43.0	9.00	0.09	0.02	0.002	132.1	43.0	9.00	0.02	0.01	0.0002	132.0	43.0	9.00
Proposed Action	0.09	0.02	0.003	132.1	43.0	9.00	0.02	0.01	0.0004	132.0	43.0	9.00	0.03	0.01	0.0005	132.0	43.0	9.00	0.10	0.02	0.002	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00
Alternative C	0.19	0.05	0.008	132.2	43.1	9.01	0.06	0.01	0.0008	132.1	43.0	9.00	0.06	0.01	0.0010	132.1	43.0	9.00	0.19	0.06	0.006	132.2	43.1	9.01	0.06	0.01	0.0005	132.1	43.0	9.00
Alternative C - 80 % Drill Rig Mitigation	0.08	0.02	0.003	132.1	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00	0.02	0.01	0.0005	132.0	43.0	9.00	0.09	0.02	0.002	132.1	43.0	9.00	0.02	0.01	0.0002	132.0	43.0	9.00
Proposed Action - Maximum Field Production	0.06	0.01	0.001	132.1	43.0	9.00	0.01	0.01	0.0002	132.0	43.0	9.00	0.02	0.01	0.0003	132.0	43.0	9.00	0.06	0.01	0.001	132.1	43.0	9.00	0.01	0.003	0.0002	132.0	43.0	9.00

[1] Total concentration includes direct modeled impact and background concentration for comparison with NAAQS/WAAQS which are 1,300 $\mu g/m^3$ on a 3-hour basis, 365/260 $\mu g/m^3$ on a 24-hour basis and 80/60 $\mu g/m^3$ on an annual basis. Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.

Table M.24 - Summary of Maximum Modeled Cumulative PM_{10} Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	3.28	0.17	35.3	9.17	1.05	0.04	33.0	9.04	1.00	0.07	33.0	9.07	0.70	0.04	32.7	9.04	0.27	0.01	32.3	9.01
Proposed Action	2.98	0.18	35.0	9.18	1.11	0.04	33.1	9.04	1.00	0.07	33.0	9.07	0.57	0.04	32.6	9.04	0.31	0.01	32.3	9.01
Alternative C	2.22	0.14	34.2	9.14	0.89	0.04	32.9	9.04	0.97	0.06	33.0	9.06	0.48	0.03	32.5	9.03	0.25	0.01	32.2	9.01
Alternative C - 80 % Drill Rig Mitigation	1.13	0.09	33.1	9.09	0.69	0.02	32.7	9.02	0.87	0.06	32.9	9.06	0.45	0.02	32.5	9.02	0.17	0.01	32.2	9.01
Proposed Action - Maximum Field Production	0.97	0.08	33.0	9.08	0.73	0.02	32.7	9.02	0.89	0.06	32.9	9.06	0.46	0.02	32.5	9.02	0.19	0.01	32.2	9.01

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.89	0.08	32.9	9.08	0.56	0.04	32.6	9.04	0.38	0.02	32.4	9.02	1.14	0.08	33.1	9.08	0.27	0.01	32.3	9.01
Proposed Action	0.99	0.08	33.0	9.08	0.56	0.04	32.6	9.04	0.42	0.02	32.4	9.02	1.26	0.08	33.3	9.08	0.24	0.01	32.2	9.01
Alternative C	0.77	0.07	32.8	9.07	0.56	0.04	32.6	9.04	0.34	0.02	32.3	9.02	1.01	0.08	33.0	9.08	0.19	0.01	32.2	9.01
Alternative C - 80 % Drill Rig Mitigation	0.64	0.05	32.6	9.05	0.56	0.03	32.6	9.03	0.23	0.01	32.2	9.01	0.70	0.07	32.7	9.07	0.13	0.01	32.1	9.01
Proposed Action - Maximum Field Production	0.67	0.05	32.7	9.05	0.56	0.03	32.6	9.03	0.26	0.01	32.3	9.01	0.75	0.07	32.8	9.07	0.15	0.01	32.1	9.01

[1] Total Concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS whaich are 150$\mu g/m^3$ on a 24-hour basis and 50 $\mu g/m^3$ on an annual basis.

Background PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.

Table M.25 - Summary of Maximum Modeled Cumulative $PM_{2.5}$ Concentration Impacts ($\mu g/m^3$) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	1.08	0.17	19.1	6.17	0.33	0.04	18.3	6.04	0.41	0.07	18.4	6.07	0.32	0.04	18.3	6.04	0.10	0.01	18.1	6.01
Proposed Action	1.25	0.17	19.3	6.17	0.36	0.04	18.4	6.04	0.41	0.06	18.4	6.06	0.33	0.04	18.3	6.04	0.11	0.01	18.1	6.01
Alternative C	0.95	0.13	19.0	6.13	0.27	0.03	18.3	6.03	0.40	0.06	18.4	6.06	0.27	0.03	18.3	6.03	0.09	0.01	18.1	6.01
Alternative C - 80 % Drill Rig Mitigation	0.51	0.08	18.5	6.08	0.19	0.02	18.2	6.02	0.36	0.06	18.4	6.06	0.17	0.02	18.2	6.02	0.06	0.01	18.1	6.01
Proposed Action - Maximum Field Production	0.51	0.08	18.5	6.08	0.19	0.02	18.2	6.02	0.36	0.06	18.4	6.06	0.18	0.02	18.2	6.02	0.07	0.01	18.1	6.01

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[1]		Direct Modeled Impact		Total Concentration[2]	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.49	0.08	18.5	6.08	0.30	0.04	18.3	6.04	0.15	0.02	18.1	6.02	0.55	0.08	18.6	6.08	0.13	0.01	18.1	6.01
Proposed Action	0.52	0.08	18.5	6.08	0.30	0.04	18.3	6.04	0.16	0.02	18.2	6.02	0.58	0.08	18.6	6.08	0.13	0.01	18.1	6.01
Alternative C	0.45	0.07	18.4	6.07	0.30	0.04	18.3	6.04	0.13	0.02	18.1	6.02	0.50	0.08	18.5	6.08	0.10	0.01	18.1	6.01
Alternative C - 80 % Drill Rig Mitigation	0.34	0.05	18.3	6.05	0.28	0.03	18.3	6.03	0.09	0.01	18.1	6.01	0.44	0.07	18.4	6.07	0.07	0.01	18.1	6.01
Proposed Action - Maximum Field Production	0.37	0.05	18.4	6.05	0.29	0.03	18.3	6.03	0.10	0.01	18.1	6.01	0.45	0.07	18.4	6.07	0.07	0.01	18.1	6.01

[1] Total concentration includes direct modeled impact and background concentration for comparison to NAAQS/WAAQS which are 65 $\mu g/m^3$ (revised NAAQS of 35 $\mu g/m3$ effective on Dec 18, 2006) on a 24-hour basis and 15 $\mu g/m^3$ on an annual basis.

[2] Background $PM_{2.5}$ concentration values of 18 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

Table M.26 - Summary of Maximum Modeled Cumulative NO_2 Concentration Impacts ($\mu g/m^3$) from Direct Project and Regional Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absoroka Wilderness Class I	
	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.40	2.5	0.03	2.5	0.12	2.5	0.04	25.0	0.002	2.5
Proposed Action	0.39	2.5	0.03	2.5	0.11	2.5	0.04	25.0	0.002	2.5
Alternative C	0.26	2.5	0.02	2.5	0.11	2.5	0.03	25.0	0.002	2.5
Alternative C - 80 % Drill Rig Mitigation	0.13	2.5	0.01	2.5	0.11	2.5	0.02	25.0	0.001	2.5
Proposed Action - Maximum Field Production	0.16	2.5	0.02	2.5	0.11	2.5	0.02	25.0	0.001	2.5

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment	Direct Modeled Impact	PSD Increment
Alternative	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
No Action	0.09	25.0	0.005	2.5	0.005	2.5	0.06	25.0	0.003	2.5
Proposed Action	0.09	25.0	0.006	2.5	0.005	2.5	0.06	25.0	0.003	2.5
Alternative C	0.06	25.0	0.004	2.5	0.003	2.5	0.04	25.0	0.002	2.5
Alternative C - 80 % Drill Rig Mitigation	0.03	25.0	0.002	2.5	0.002	2.5	0.02	25.0	0.001	2.5
Proposed Action - Maximum Field Production	0.04	25.0	0.003	2.5	0.003	2.5	0.03	25.0	0.001	2.5

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis

Table M.27 - Summary of Maximum Modeled Cumulative SO_2 Concentrations ($\mu g/m^3$) from Direct Project and Regional Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I						Fitzpatrick Wilderness Class I						Grand Teton National Park Class I						Gros Ventre Wilderness Class II						North Absaroka Wilderness Class I					
	Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.25	0.08	0.01	25.0	5.0	2.0	0.07	0.02	0.001	25.0	5.0	2.0	0.03	0.01	0.001	25.0	5.0	2.0	0.07	0.02	0.001	512.0	91.0	20.0	0.02	0.01	0.0003	25.0	5.0	2.0
Proposed Action	0.30	0.09	0.01	25.0	5.0	2.0	0.09	0.03	0.001	25.0	5.0	2.0	0.03	0.01	0.001	25.0	5.0	2.0	0.07	0.02	0.001	512.0	91.0	20.0	0.02	0.01	0.0003	25.0	5.0	2.0
Alternative C	0.76	0.24	0.02	25.0	5.0	2.0	0.22	0.07	0.003	25.0	5.0	2.0	0.08	0.02	0.001	25.0	5.0	2.0	0.18	0.04	0.003	512.0	91.0	20.0	0.03	0.01	0.0005	25.0	5.0	2.0
Alternative C - 80 % Drill Rig Mitigation	0.24	0.07	0.01	25.0	5.0	2.0	0.07	0.02	0.001	25.0	5.0	2.0	0.03	0.01	0.0005	25.0	5.0	2.0	0.06	0.01	0.001	512.0	91.0	20.0	0.02	0.01	0.0003	25.0	5.0	2.0
Proposed Action - Maximum Field Production	0.10	0.03	0.002	25.0	5.0	2.0	0.03	0.01	0.001	25.0	5.0	2.0	0.01	0.004	0.0003	25.0	5.0	2.0	0.03	0.01	0.0004	512.0	91.0	20.0	0.02	0.01	0.0002	25.0	5.0	2.0

	Popo Agie Wilderness Class II						Teton Wilderness Class I						Washakie Wilderness Class I						Wind River Roadless Area Class II						Yellowstone National Park Class I					
	Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment			Direct Modeled Impact			PSD Increment		
Alternative	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	0.08	0.02	0.003	512.0	91.0	20.0	0.02	0.01	0.0004	25.0	5.0	2.0	0.02	0.01	0.0005	25.0	5.0	2.0	0.09	0.02	0.002	512.0	91.0	20.0	0.02	0.01	0.0002	25.0	5.0	2.0
Proposed Action	0.09	0.02	0.003	512.0	91.0	20.0	0.02	0.01	0.0004	25.0	5.0	2.0	0.03	0.01	0.0005	25.0	5.0	2.0	0.10	0.02	0.002	512.0	91.0	20.0	0.02	0.01	0.0003	25.0	5.0	2.0
Alternative C	0.19	0.05	0.008	512.0	91.0	20.0	0.06	0.01	0.0008	25.0	5.0	2.0	0.06	0.01	0.0010	25.0	5.0	2.0	0.19	0.06	0.006	512.0	91.0	20.0	0.06	0.01	0.0005	25.0	5.0	2.0
Alternative C - 80 % Drill Rig Mitigation	0.08	0.02	0.003	512.0	91.0	20.0	0.02	0.01	0.0003	25.0	5.0	2.0	0.02	0.01	0.0005	25.0	5.0	2.0	0.09	0.02	0.002	512.0	91.0	20.0	0.02	0.01	0.0002	25.0	5.0	2.0
Proposed Action - Maximum Field Production	0.06	0.01	0.001	512.0	91.0	20.0	0.01	0.01	0.0002	25.0	5.0	2.0	0.02	0.01	0.0003	25.0	5.0	2.0	0.06	0.01	0.001	512.0	91.0	20.0	0.01	0.00	0.0002	25.0	5.0	2.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis .

Table M.28 - Summary of Maximum Modeled Cumulative PM_{10} Concentration Impacts ($\mu g/m^3$) from Direct Project and Regional Sources Compared to PSD Increments[1]

	Bridger Wilderness Class I				Fitzpatrick Wilderness Class I				Grand Teton National Park Class I				Gros Ventre Wilderness Class II				North Absaroka Wilderness Class I			
	Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	3.28	0.17	8.0	4.0	1.05	0.04	8.0	4.0	1.00	0.07	8.0	4.0	0.70	0.04	30.0	17.0	0.27	0.01	8.0	4.0
Proposed Action	2.98	0.18	8.0	4.0	1.11	0.04	8.0	4.0	1.00	0.07	8.0	4.0	0.57	0.04	30.0	17.0	0.31	0.01	8.0	4.0
Alternative C	2.22	0.14	8.0	4.0	0.89	0.04	8.0	4.0	0.97	0.06	8.0	4.0	0.48	0.03	30.0	17.0	0.25	0.01	8.0	4.0
Alternative C - 80 % Drill Rig Mitigation	1.13	0.09	8.0	4.0	0.69	0.02	8.0	4.0	0.87	0.06	8.0	4.0	0.45	0.02	30.0	17.0	0.17	0.01	8.0	4.0
Proposed Action - Maximum Field Production	0.97	0.08	8.0	4.0	0.73	0.02	8.0	4.0	0.89	0.06	8.0	4.0	0.46	0.02	30.0	17.0	0.19	0.01	8.0	4.0

	Popo Agie Wilderness Class II				Teton Wilderness Class I				Washakie Wilderness Class I				Wind River Roadless Area Class II				Yellowstone National Park Class I			
	Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment		Direct Modeled Impact		PSD Increment	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	0.89	0.08	30.0	17.0	0.56	0.04	8.0	4.0	0.38	0.02	8.0	4.0	1.14	0.08	30.0	17.0	0.27	0.01	8.0	4.0
Proposed Action	0.99	0.08	30.0	17.0	0.56	0.04	8.0	4.0	0.42	0.02	8.0	4.0	1.26	0.08	30.0	17.0	0.24	0.01	8.0	4.0
Alternative C	0.77	0.07	30.0	17.0	0.56	0.04	8.0	4.0	0.34	0.02	8.0	4.0	1.01	0.08	30.0	17.0	0.19	0.01	8.0	4.0
Alternative C - 80 % Drill Rig Mitigation	0.64	0.05	30.0	17.0	0.56	0.03	8.0	4.0	0.23	0.01	8.0	4.0	0.70	0.07	30.0	17.0	0.13	0.01	8.0	4.0
Proposed Action - Maximum Field Production	0.67	0.05	30.0	17.0	0.56	0.03	8.0	4.0	0.26	0.01	8.0	4.0	0.75	0.07	30.0	17.0	0.15	0.01	8.0	4.0

[1] All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis .

Table M.29 - Summary of Maximum Modeled Cumulative In-field Pollutant Concentrations ($\mu g/m^3$) from Direct Project and Regional Sources

	NO_2				SO_2											
	Direct Modeled Impact[1]	PSD Class II Increment[2]	Total Concentration[3]	NAAQS/ WAAQS	Direct Modeled Impact[1]			PSD Class II Increment[2]			Total Concentration[3]			NAAQS/WAAQS		
Alternative	Annual	Annual	Annual	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual	3-hr	24-hr	Annual
No Action	53.1	25.0	61.1	100	32.8	5.3	0.8	512.0	91.0	20.0	164.8	48.3	9.8	1,300	365/260	80/60
Proposed Action	60.8	25.0	68.8	100	32.6	5.4	0.8	512.0	91.0	20.0	164.6	48.4	9.8	1,300	365/260	80/60
Alternative C	37.3	25.0	45.3	100	112.6	18.2	2.3	512.0	91.0	20.0	244.6	61.2	11.3	1,300	365/260	80/60
Alternative C - 80 % Drill Rig Mitigation	10.6	25.0	18.6	100	22.6	3.8	0.5	512.0	91.0	20.0	154.6	46.8	9.5	1,300	365/260	80/60
Proposed Action - Maximum Field Production	9.2	25.0	17.2	100	9.5	2.2	0.2	512.0	91.0	20.0	141.5	45.2	9.2	1,300	365/260	80/60

	PM_{10}								$PM_{2.5}$					
	Direct Modeled Impact[1]		PSD Class II Increment[2]		Total Concentration[3]		NAAQS/ WAAQS		Direct Modeled Impact		Total Concentration[3]		NAAQS/ WAAQS	
Alternative	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
No Action	51.5	18.8	30.0	17.0	83.5	27.8	150	50	14.5	5.5	32.5	11.5	65 (35)[4]	15
Proposed Action	25.1	9.1	30.0	17.0	57.1	18.1	150	50	12.2	3.6	30.2	9.6	65 (35)[4]	15
Alternative C	30.1	11.4	30.0	17.0	62.1	20.4	150	50	10.0	3.7	28.0	9.7	65 (35)[4]	15
Alternative C - 80 % Drill Rig Mitigation	29.6	10.2	30.0	17.0	61.6	19.2	150	50	6.2	2.6	24.2	8.6	65 (35)[4]	15
Proposed Action - Maximum Field Production	17.9	4.9	30.0	17.0	49.9	13.9	150	50	4.4	1.3	22.4	7.3	65 (35)[4]	15

1 t

2 Background concentrations are not added to modeled concentrations for comparison to the PSD incremen

3 All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis

Total concentration includes direct modeled impact and background concentration

Annual background NO_2 concentration value of 8 $\mu g/m^3$ from Boulder monitor.

Background SO_2 concentration values of 132 $\mu g/m^3$, 43 $\mu g/m^3$, and 9 $\mu g/m^3$, from Craven Creek used for 3-hour, 24-hour, and annual averaging periods, respectively.

Back ground PM_{10} concentration values of 32 $\mu g/m^3$ and 9 $\mu g/m^3$, from Boulder used for 24-hour and annual averaging periods, respectively.

Back ground $PM_{2.5}$ concentration values of 15 $\mu g/m^3$ and 6 $\mu g/m^3$, from Pinedale used for 24-hour and annual averaging periods, respectively.

4 Revised NAAQS effective December 18, 2006.

Table M.30 - Summary of Maximum Modeled Visibility Impacts at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources Using FLAG Background Data - (MVISBK=6)

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
No Action	8.6	75	6.0	13	2.2	4	4.6	12	1.0	1
Proposed Action	9.7	77	6.7	15	2.5	5	5.1	12	1.0	1
Alternative C	7.6	56	5.2	7	1.9	2	4.0	8	0.8	0
Alternative C - 80 % Drill Rig Mitigation	4.5	25	3.1	4	1.3	1	2.6	2	0.5	0
Proposed Action - Maximum Field Production	5.1	31	3.6	4	1.6	1	3.0	3	0.6	0

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)	Maximum Visibility Impact (Δdv)	Number of Days > 1.0 Δdv (days)
No Action	3.9	21	1.5	2	1.7	2	5.3	12	1.2	1
Proposed Action	4.1	25	1.6	2	1.8	3	5.7	19	1.2	1
Alternative C	3.4	14	1.2	1	1.4	2	4.7	10	1.0	1
Alternative C - 80 % Drill Rig Mitigation	2.5	6	0.7	0	0.9	0	3.3	6	0.7	0
Proposed Action - Maximum Field Production	2.8	9	0.9	0	1.1	1	3.7	8	0.8	0

Note: Δdv = change in deciview.

Table M.31 - Summary of Maximum Modeled Visibility Impacts at Wyoming Regional Community Locations from Direct Project and Regional Sources Using Boulder Background Data

	Boulder		Cora		Pinedale	
Alternative	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)	Maximum Visibility Impact (Δdv)[1]	Number of Days > 1.0 Δdv[1] (days)
No Action	13.7	141	11.5	65	12.8	94
Proposed Action	15.8	153	13.0	68	13.2	96
Alternative C	12.8	118	10.2	60	10.8	79
Alternative C - 80 % Drill Rig Mitigation	7.6	69	5.2	25	6.7	45
Proposed Action - Maximum Field Production	7.8	74	5.6	27	7.3	43

[1] Δdv = change in deciview.

Table M.32 - Summary of Maximum Modeled Total Nitrogen (N) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.108	1.528	0.015	1.435	0.031	1.321	0.020	1.440	0.006	1.296
Proposed Action	0.101	1.521	0.014	1.434	0.030	1.320	0.018	1.438	0.006	1.296
Alternative C	0.068	1.488	0.010	1.430	0.029	1.319	0.013	1.433	0.005	1.295
Alternative C - 80 % Drill Rig Mitigation	0.033	1.453	0.006	1.426	0.027	1.317	0.008	1.428	0.003	1.293
Proposed Action - Maximum Field Production	0.042	1.462	0.007	1.427	0.027	1.317	0.009	1.429	0.003	1.293

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.044	1.464	0.007	1.297	0.007	1.297	0.028	1.448	0.005	1.295
Proposed Action	0.039	1.459	0.006	1.296	0.007	1.297	0.026	1.446	0.005	1.295
Alternative C	0.028	1.448	0.005	1.295	0.005	1.295	0.019	1.439	0.004	1.294
Alternative C - 80 % Drill Rig Mitigation	0.016	1.436	0.003	1.293	0.003	1.293	0.011	1.431	0.003	1.293
Proposed Action - Maximum Field Production	0.019	1.439	0.004	1.294	0.004	1.294	0.013	1.433	0.003	1.293

[1] gen deposition analysis level of concern for total impacts - 3.00 kg/ha-yr.
[2] Nitro position value of 1.42 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.
[3] Includes N de position value of 1.29 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.
Includes N de

Table M.33 - Summary of Maximum Modeled Total Sulfur (S) Deposition Impacts (kg/ha-yr) at PSD Class I and Sensitive PSD Class II Areas from Direct Project and Regional Sources[1]

	Bridger Wilderness Class I		Fitzpatrick Wilderness Class I		Grand Teton National Park Class I		Gros Ventre Wilderness Class II		North Absaroka Wilderness Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.0037	0.744	0.0007	0.741	0.0004	0.680	0.0008	0.741	0.0003	0.680
Proposed Action	0.0039	0.744	0.0008	0.741	0.0004	0.680	0.0008	0.741	0.0003	0.680
Alternative C	0.0101	0.750	0.0017	0.742	0.0008	0.681	0.0016	0.742	0.0006	0.681
Alternative C - 80 % Drill Rig Mitigation	0.0030	0.743	0.0006	0.741	0.0004	0.680	0.0007	0.741	0.0003	0.680
Proposed Action - Maximum Field Production	0.0010	0.741	0.0003	0.740	0.0002	0.680	0.0004	0.740	0.0002	0.680

	Popo Agie Wilderness Class II		Teton Wilderness Class I		Washakie Wilderness Class I		Wind River Roadless Area Class II		Yellowstone National Park Class I	
Alternative	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[3]	Modeled Impact	Total Impact[2]	Modeled Impact	Total Impact[3]
No Action	0.0021	0.742	0.0004	0.680	0.0004	0.680	0.0013	0.741	0.0003	0.680
Proposed Action	0.0022	0.742	0.0004	0.680	0.0004	0.680	0.0013	0.741	0.0003	0.680
Alternative C	0.0050	0.745	0.0007	0.681	0.0008	0.681	0.0030	0.743	0.0005	0.681
Alternative C - 80 % Drill Rig Mitigation	0.0018	0.742	0.0003	0.680	0.0004	0.680	0.0011	0.741	0.0003	0.680
Proposed Action - Maximum Field Production	0.0008	0.741	0.0002	0.680	0.0003	0.680	0.0005	0.740	0.0002	0.680

[1] position analysis level of concern for total impacts = 5.0 kg/ha-yr.
[2] Sulfur de position value of 0.74 kg/ha-yr measured at the CASTNET/NADP site near Pinedale for the year 2004.
[3] Includes S de position value of 0.68 kg/ha-yr measured at the CASTNET/NADP site at Yellowstone National Park for the year 2005.
Includes S de

Table M.34 - Summary of Maximum Modeled Change in ANC (μeq/L) at Acid Sensitive Lakes from Direct Project and Regional Sources

	Black Joe Lake		Deep Lake		Hobbs Lake		Lazy Boy Lake		Lower Saddlebag		Ross Lake		Upper Frozen	
	Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Bridger Wilderness Class I		Popo Agie Wilderness Class II		Fitzpatrick Wilderness Class I		Bridger Wilderness Class I	
Alternative	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)	ANC Change (μeq/L)	ANC Change (%)
Level of Acceptable Change(μeq/L)	6.71	10%	5.97	10%	6.99	10%	1.00	--	5.52	10%	5.37	10%	1.00	--
Background	67.1	--	59.7	--	69.9	--	10.8	--	55.2	--	53.7	--	6.0	--
No Action	0.33	0.50%	0.37	0.62%	0.18	0.25%	0.11	--	0.37	0.67%	0.10	0.19%	0.40	--
Proposed Action	0.30	0.45%	0.33	0.56%	0.17	0.25%	0.11	--	0.33	0.60%	0.10	0.18%	0.37	--
Alternative C	0.23	0.35%	0.26	0.43%	0.13	0.19%	0.09	--	0.26	0.47%	0.08	0.14%	0.28	--
Alternative C - 80 % Drill Rig Mitigation	0.12	0.18%	0.13	0.22%	0.07	0.10%	0.05	--	0.14	0.25%	0.04	0.08%	0.14	--
Proposed Action - Maximum Field Production	0.14	0.20%	0.15	0.25%	0.08	0.11%	0.06	--	0.16	0.29%	0.05	0.09%	0.17	--

[1] USFS Level of Acceptable Change; 10% change in ANC for lakes with ANC background values greater than 25 μeq/L, 1 μeq/l for lakes with ANC values less than or equal to 25 μeq/L.

APPENDIX N

Models of Potential Impacts to Groundwater

Pinedale Anticline SEIS
Models of Potential Impacts to Groundwater

Prediction of Drawdown

Drawdown impacts in the Wasatch aquifer in the PAPA due to drilling water extractions were modeled for dense drilling patterns. There is little hydraulic information available for the Wasatch in the PAPA, and drilling locations, extraction rates, and such variables are not closely specified, but some bounds may be placed on the extent and amount of drawdown using a semi-analytical method. This consists of developing a probable drawdown cone for a single pumping well, summing a number of cones in a section, and sketching the drawdown about a cluster of contiguous sections with active drilling at one time.

The drawdown cone (half of it in section) in time is shown in Figure 1. The basis for this cone is the Theis equation for drawdown at time t and distance r due to pumping an extensive, approximately homogeneous aquifer with transmissivity T and storativity S. The Wasatch is believed to have T between 300 and 2,000 sq,ft/day; a value of 300 was used to be conservative (lower T causes more drawdown); S = 0.001 is typical for a confined aquifer. Pumping rate is taken to be the higher Operator estimates of usage, namely ten gallons per minute. The water levels decline logarithmically in time.

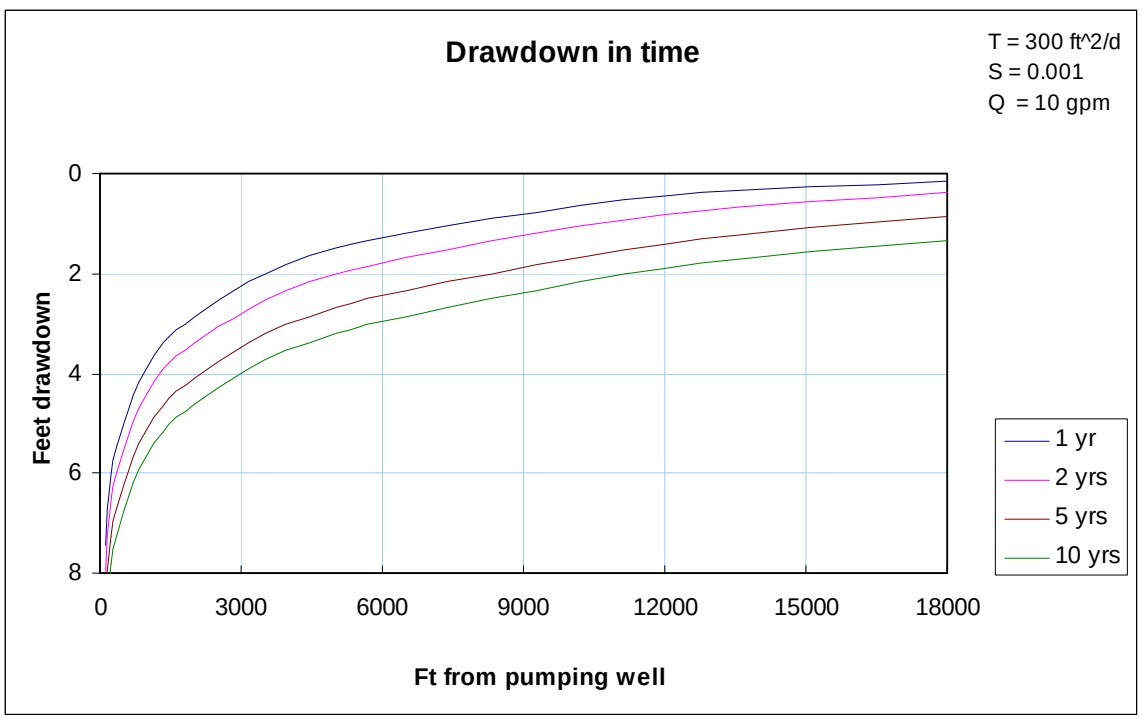


Figure 1
Analytical Model of Drawdown in the Wasatch due to Pumping a Single Well

At a radius of 2,000 ft (a little less than half a section width) the drawdown of the model well is about 1.5 ft after a year on the boundary of the section, and a little over 2 ft in 5 years. Adding the effects of more wells scattered in a section multiplies these values by the number of wells; for instance, five wells spread over a section would give an average of 6 ft drawdown after 1 year, and 8 ft in 10 years. Moving the pumping points with gas

drilling (that is, pumping water supply wells at each new pad a gas rig occupies) gives periods of respite in which water levels recover somewhat, but if the moves are short in time and distance the averaging approach is approximately valid for a cluster of active sections.

As an example, a cluster of actively drilling well pads at the southern boundary of Concentrated Development Area 1 in the Proposed Action Alternative for year 2008, the number of rigs active by section (~ square mile) is given as:

4	6	3	2
		1	1

If these rigs withdrew Wasatch groundwater from supply wells located on the well pads steadily and stayed within these sections for 5 years, the average drawdown at the section perimeters (in feet), due to just the pumping within each section, would be:

16	24	12	8
		4	4

Adding all the components of drawdown in each section due to pumping in that section plus all the effects of the other wells (drawdown components can be superposed, which are linear with respect to pumping rate) gives a matrix as below (the six sections with active pumping are outlined in the middle).

2	4	6	10	11	10	8	5	4	2
3	7	11	16	19	18	15	11	8	5
5	10	16	25	29	27	23	17	11	7
7	13	21	37	45	39	31	22	13	8
5	10	17	26	31	31	27	19	12	8
4	8	13	18	22	22	19	15	10	6
2	5	8	12	15	15	13	10	7	5
1	3	5	8	8	8	8	6	4	3

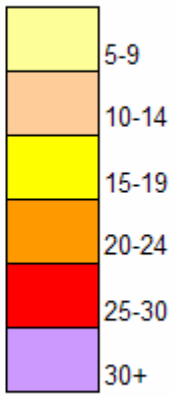


Figure 2
Drawdown in Wasatch Aquifer after 5 Years
Pumping with 17 Rigs in Eight Central Sections

It should be emphasized the transmissivity on which this drawdown is estimated is conservatively low, and actual drawdown may be. The Fort Union and Wasatch strata achieve a local maximum thickness in the PAPA area (Glover et al, 1996), which is said to be near 7,000 ft. No estimate of local sand percentages or transmissivities in the Wasatch are available, but a 1,000 ft thickness of sands in the upper part of the "7,000 ft" packet, with hydraulic conductivity 0.3 ft/day, would give the transmissivity assumed in these calculations. If the Wasatch sands were in fact thicker, coarser grained and more permeable, then transmissivity and storage would be higher and the aquifer would yield more water with less drawdown.

This model assumes zero recharge during the period of pumping. If 1 percent of assumed surface infiltration (that is, 0.001 ft/yr) passes through the alluvial cover and reaches the Wasatch, this would yield about 5 acre-ft/yr per section, or 10 bbl/day. This would shrink the drawdown surface in Figure 2 inward, so that the ten-foot contour would be 2 rather than 3 miles from the cluster.

Based on this analysis of potential drawdown impacts:

- up to 4 feet of drawdown may be observed within a distance of a mile of a single water supply well that has been steadily active for 5 years;
- Up to 30 feet drawdown may be observed within a mile of a dense cluster of active drilling well pads (here, 17 wells in six sections);
- Measurable drawdown (more than 2 feet) around a dense cluster of drilling activity and groundwater extraction extends approximately four miles from the perimeter of the cluster, after 5 years of pumping;
- The radius from a dense well cluster at which drawdown is measurable increases as long as pumping continues, but the rate of drawdown at any point declines logarithmically
- Recovery is expected to be rapid overall, although there will be variability where aquifer sandstones are poorly connected. Leakage from shale aquitards would hasten recovery. In the analytical model (without leakage), drawdown doubles from 1 to 5 years in active pumping; if pumping ceases at 5 years, recovery to initial conditions is similarly half complete 1 year later.

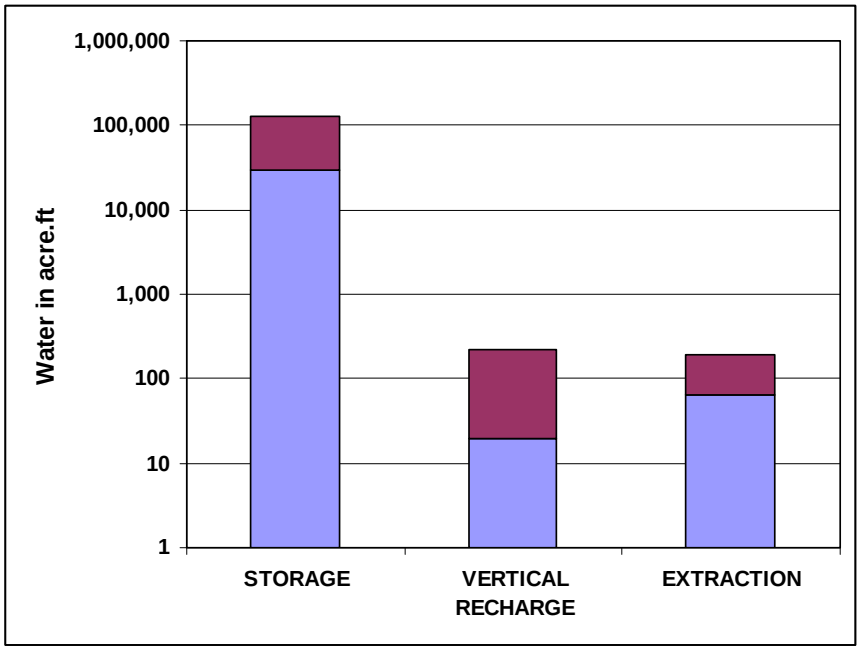
Groundwater Resource and Usage in Wasatch Aquifer

The potential for impacts on the groundwater resource should be judged against the overall resource quantity and recharge rates. The table below compares estimates of water usage by the Operators to the vertical recharge rate, and to the water stored in the Wasatch. The plot beneath the table compares the ranges of estimates on a log scale. Low and moderately high estimates are given in acre-feet (the volume of water covering 1 acre to 1 foot depth) in table and plot, and in oil field barrels (42 gallons) in the right column of the table with prefix M indicating thousands, MM millions and MMM trillions. Note that storage is a *volume*, and usage and recharge are annual *rates*.

Available stored water in the Wasatch is estimated from the surface area of the PAPA, a likely range of confined storativity coefficient, and the amount of available drawdown. Recharge to the Wasatch comes both vertically, as infiltration through the base of alluvium, and laterally from the Wind River and Wyoming ranges. Current extraction is based on Operator provided data, which suggested between 500,000 and 800,000 bbl/year pumped from the Wasatch in 2005-2006.

Likely Groundwater Storage, Vertical Recharge and Drilling Water Demand

Groundwater storage, low and high estimates PAPA area 200,000 acres x Storage 0.0005 x 300 ft drawdown 200,000 ac x Storage 0.001 x 500 ft drawdown	30 M ac.ft 100 M ac.ft	2 MMM bbl 8 MMM bbl
Current Extractions, high and low estimates Operator estimates	64 ac.ft/yr 129 ac.ft/yr	0.5 MM bbl/yr 1 MM bbl/yr



Impacts are local as well as regional. Focused pumping can locally deplete aquifers and discharge to alluvium-stream waters, even though average depletions across the PAPA are minimal. It is a function of the monitoring program to demonstrate such impacts are not significant, or to trigger mitigation. The plot above indicates that regional capacity should allow management of groundwater resource to prevent significant impacts (by for instance retiring or resting wells that may be over-depleting surface discharge, or switching to Fort Union wells in heavy use areas), or to mitigate impacts that do occur (e.g. pumping wells to augment surface water).

Reference

Glover, Naftz, and Martin. 1996. Geohydrology of Tertiary Rocks in Upper Colorado River Basin in Colorado, Utah, and Wyoming. USGS Water Resources Investigation Report 96-4105.

APPENDIX O

DRAFT
PAPA Water Monitoring Plan

DRAFT
PAPA Water Monitoring Plan

The management objectives for monitoring groundwater resources are to protect those resources from oil and gas operational impacts by determining if current mitigation measures are effective. Those objectives include:

- to protect and maintain existing livestock and domestic water wells and aquifers,
- to prevent excessive drawdown and inter-aquifer leakage of the Wasatch aquifer, and
- to protect and maintain groundwater discharge to streams.

A groundwater monitoring plan was developed by the PAPA Operators, BLM, WDEQ and others within the Pinedale Anticline Working Group (PAWG) as set forth as a condition of the PAPA ROD. It required an initial sampling of all stock and supply wells within 1 mile of the PAPA development and analysis for a mixed suite of inorganics and organics, and subsequent monitoring of water levels and reduced analyses. The number of wells being monitored grew rapidly to over 200 and it appears that the number will continue to escalate annually. WDEQ expressed concern to BLM in August 2005 that the groundwater monitoring program was flawed, particularly not discriminating monitored aquifers. Thus, the program is not satisfactory in some regards though it has grown tremendously. An overhaul is therefore proposed. The data already collected will be analyzed to form a baseline, but the monitoring is re-focused to efficiently achieve resource protection objectives. While the Wyoming State Engineer's Office records are not specific enough to identify individual aquifers, the Operators would make an attempt to correlate aquifers or at least show separation by listing the top and bottom of screened or perforated intervals relative to ground elevation and comparing zones used by industry versus those used for stock or domestic purposes.

The sampling protocol and analysis parameters currently used by the contractor (Sublette County Conservation District) as established by the PAWG Water Resources Task Group will be maintained unless altered by the PAWG process.

The Wasatch water supply wells used by the operators are completed in multiple Wasatch aquifers, and therefore, it is likely that monitoring a selected network of these wells will more reasonably represent the entire interval than attempting any selected aquifer monitor well or well nests. There is adequate water supply for domestic and livestock use above the Wasatch aquifers being used by the Operators. Therefore, it is important to monitor the intervals being used by the Operators to determine if any inter-aquifer leakage is occurring.

Objectives of groundwater monitoring are to establish baseline conditions and disclose any impacts to the resource. Components of the groundwater monitoring plan are:

- establish baseline conditions of water quality and quantity in alluvial and Wasatch aquifers;
- establish baseline conditions of water quality and quantity in PAPA groundwater discharge to surface water; and
- monitor any impacts to those baseline conditions.

Some potential impacts to groundwater resources are not of primary concern to the groundwater monitoring program, but are addressed by regulatory requirements and management practices. These include:

- Stormwater Pollution Prevention Plans (SWPPPs);
- Spill Prevention Countermeasure and Control Plans (SPCC Plans);
- Assurance of good annular seals in gas production wells through the Wasatch (WOGCC and BLM APDs)
- Assurance of good annular seals of water supply wells through shallow alluvium (WOGCC and BLM APDs).

This Groundwater Monitoring Plan does not address response plans that would be triggered by WDEQ regulation pertaining to a large spill, pit washout or other accident. Nor does it address evolution of monitoring to more closely follow any mitigation measures warranted by detection of deleterious impacts. Such events would initiate development of response and monitoring plans by the responsible parties and the jurisdictional agencies.

Groundwater monitoring would consist of measurement of well water levels to develop potentiometric data, and water parameters including pH and specific conductance (conductivity) as a surrogate for salinity. Any suspected impacts would be immediately reported to WDEQ as required in Chapter 4 Section 4 (a). The current sampling procedure would also require a re-sampling to determine the validity of the suspected impact. Some baseline data has been obtained which is adequate to characterize the major inorganic chemistry of PAPA groundwater.

Monitoring would be conducted on an annual basis by the Operators' contractor, and tabular and spatial results reported to PAWG, BLM and WDEQ before the subsequent monitoring season. This would allow agencies and the PAPA Operators to modify the monitoring schedule, if necessary, to answer any questions raised by the previous year's monitoring data. Monitoring data would be maintained by the PAPA Operators' contractor in a commonly available database. The Operators wouldl be responsible for having a database constructed that would aid in the analysis of the data and for determining trends. BLM and WDEQ have reviewed this proposed groundwater monitoring program.

Alluvial Aquifer Monitoring (Mesa)

An old outwash alluvium covers part of the Mesa. It is a high permeability aquifer of good water quality that may be tapped by stock wells. Drilling supply wells do not tap into this aquifer, and are sealed through the shallow interval to prevent losses from this aquifer. Monitoring of this aquifer may also aid in watching for any possible contamination from surface spills or other releases of hydrocarbons or hazardous substances. The specific prevention plans for surface releases are listed above.

Monitoring water levels and conductivity in a number of these stock wells is intended to give a regional background against which any apparent impacts may be judged. This aquifer may be susceptible to drops in water level in drought periods due to both lack of recharge and higher demand.

The PAPA Operators, in coordination with BLM and WDEQ, would identify ten to twenty stock wells, widely distributed across the PAPA, in which water levels may be readily measured, and which static water levels may be easily and properly recorded. Survey data (N,E and elevation coordinates to 1 foot precision) would be provided for each of these wells.

Essential elements 10 stock wells water levels and {T, pH, SC} properly measure static water levels

Wasatch Aquifer Monitoring

The objective of monitoring groundwater in the Wasatch is primarily to manage the resource and to minimize regional impacts such as aquifer leakage. This is the principal drilling water supply aquifer.

The water supply wells drilled and completed by Operators would themselves become the monitoring wells for the Wasatch used to meet the objectives of Wasatch groundwater monitoring. These wells would be constructed in a manner allowing easy access for monitoring and sampling purposes. Proper construction and minimum standards of these Wasatch wells is under the jurisdiction of the Wyoming State Engineers Office.

For protection purposes, the Operators would adhere to the requirements from PAPA Record of Decision stating that “The Operators, in consultation with the BLM and State Engineers Office, will locate the production zone (perforated interval), for any water supply well within 1,000 feet of an existing stock or domestic well, at least 200 feet below that of the domestic well.” In addition, “The Operators, in conjunction with BLM and the State Engineers Office, will cement behind casing and/or seal off upper aquifers (up to 500 feet) in water zones that supply water for domestic or livestock proposes to prevent potential drainage/drawdown of that water supply and contamination from other aquifers.” (Page A-25, PAPA ROD).

The Operators, in coordination with BLM and WDEQ, would select 60 Wasatch wells to monitor, distributed over the PAPA, to serve as monitoring wells. Collar coordinates to 1 foot precision and completion details would be provided for each of these selected wells. Supply wells are, by and large, open across the major water bearing sand lenses of the Wasatch, and represent average properties of the variable sands at their locations. Very few of the Wasatch drilling source wells are logged. It is not known if correlation of aquifers is possible due to the laterally discontinuous nature of the sands. Logging may be conducted in selected cases to determine if correlation is possible.

Water levels and field parameters would be measured in at least 45 of these wells annually, it being understood that it may be inconvenient to get water levels in some wells on some occasions. It is in the Operators’ interest to obtain as full a baseline as possible.

Some supply wells, designated as monitor wells, would be actively pumping in any monitoring event. Where water levels are to be measured in active wells the pumping should be shut down for at least 4 hours to allow levels to recover, and at least two readings should be taken 5 minutes apart to demonstrate that they are reasonably stable. Care must be taken to properly assess well conditions to assure true static conditions are achieved prior to measurement.

Essential elements 98 Wasatch wells on roster measure water levels and field parameters in at least 45 wells annually, may add wells as drilling proceeds into new areas properly record static water levels

If adverse impacts to the Wasatch are observed, an alternate source could be deeper Fort Union aquifers combined with reuse of produced water where appropriate. Operators using Fort Union water should establish baseline data prior to extensive development of that aquifer.

Valley Fill Aquifer Monitoring

Valley fill is modern alluvium in watercourses, distinct from the older alluvial fan (terrace gravels on the northern part of the Mesa) deposits. Valley fill in tributaries to the rivers off of the anticline carry groundwater discharge to surface water. Valley fill groundwater has shallow seasonal and Wasatch groundwater discharge components; the former is subject to meteorological variability; the latter is potentially susceptible to depletion from groundwater extraction (drilling water supply wells). Only about 600 feet of Wasatch Formation is exposed from the top of the Mesa to the Green River valley floor. The current PAPA ROD requires that operators "…will locate the production zone (perforated interval), for any water supply well within 1,000 feet of an existing stock or domestic well, at least 200 feet below that of the domestic well". Also the PAPA ROD states operators "…will cement behind the casing and/or seal off the upper aquifers (up to 500 feet) in water zones that supply water for domestic or livestock purposes to prevent potential drainage/drawdown of that water supply and contamination from other aquifers." (Page A-25 PAPA ROD). These two protection measures will be continued in the SEIS to prevent Wasatch aquifer depletion. The objective of monitoring valley fill groundwater is to distinguish these components in baseline and assure that Wasatch discharge to surface water is not impacted or un-naturally reduced. Mitigation of reduced flows would consist of utilization of alternative (deeper) aquifers or reuse of produced water where appropriate.

The PAPA Operators, in coordination with the BLM and WDEQ, would install seven wells in the larger river tributaries draining the PAPA. These would be screened across the saturated valley fill deposits, from bedrock to a few feet above the water table. One of these would be located in the flood plain of the New Fork River to compare the river hydrographs with the local drainages; this would be located in the vicinity of one of the local tributary wells. The others would be located in tributaries, sufficiently above the rivers that their water levels will not be affected by river stage. These valley fill aquifer monitoring wells will also detect any contamination from surface spills from the oil and gas operations that might occur in the PAPA area and aid in preventing the contamination from reaching the perennial streams.

It is necessary to acquire monthly data from valley fill wells for 1 year to establish hydrographs with some continuity, for confident distinction of seasonal variability and baseflow components.

Essential elements 7 valley fill wells, one in the New Fork alluvium measure water levels and field parameters monthly for one year to establish baseline measure water levels seasonally thereafter

Domestic Well Monitoring

The PAPA Operators would continue to monitor domestic wells within 1 mile of existing or new gas wells in the PAPA. Some wells may be monitored less frequently where several wells are in close proximity and appear to be in the same aquifer.

Essential elements 40 wells on current roster measure water levels and field parameters on wells depending on number of proximity wells in the say aquifer properly record static water levels

Reporting

The PAPA Operators would maintain a database with well information, baseline chemistry data, and water level data.

The PAPA Operators would submit annual monitoring reports to PWAG Water Resources Task Group, BLM and WDEQ for as long as drilling is active. Reports would be issued each fall. Reports would contain an introduction identifying the reported monitoring period, the distribution list, a list of monitored wells and a summary of any impacts to groundwater resources observed. It would contain a well location map, hydrographs for all wells monitored in the reporting period and tables of field parameter readings. Other maps would be developed as needed to display the monitored data in a clear, comparative and concise manner. The Water Resources Task Group would forward any recommendations for plan alterations or procedural modifications to the PAWG at the annual review.