# Final Environmental Assessment

## Southern Ute Indian Tribe

## North Carracas Natural Gas
## Plan of Development

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# ACRONYM/SELECTED DEFINITIONS LIST

| | |
|---|---|
| \|C\| | absolute contrast value |
| µeq/l | microequivalents per liter |
| µg/m³ | micrograms per cubic meter |
| ADT | average daily traffic |
| AMI | Area of Mutual Interest |
| ANC | acid neutralizing capacity |
| APD | Application for Permit to Drill |
| AQIA | air quality impact analysis |
| AQRV | air quality related values |
| bbl | barrel |
| bcf | billion cubic feet |
| BIA | Bureau of Indian Affairs |
| BLM | Bureau of Land Management |
| BMP | best management practices |
| ca | circa |
| $CAM_X$ | photochemical dispersion model |
| CBM | coalbed methane |
| CCC | Criterion Continuous Concentration |
| CDOT | Colorado Department of Transportation |
| CDOW | Colorado Division of Wildlife |
| CDPHE | Colorado Department of Public Health and Environment |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| CNF | Carson National Forest |
| CO | carbon monoxide |
| $CO_2e$ | carbon dioxide equivalent |
| COA | Condition of Approval |
| COGCC | Colorado Oil and Gas Conservation Commission |
| COPIF | Colorado Partners in Flight |
| CR | County Road |
| DAT | Deposition Analysis Threshold |
| dB | decibel |
| DNR | Department of Natural Resources |
| DO | dissolved oxygen |
| DOE | Department of Energy |
| dV | deciview |
| DWRM | Division of Wildlife Resource Management |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| Energen | Energen Resources Corporation |
| EPD | Environmental Programs Division |
| FCAQTF | Four Corners Air Quality Task Force |
| GHG | Greenhouse gas |
| GIS | geographic information systems |
| gpm | gallons per minute |
| ha | hectare |
| HAP | hazardous air pollutant |
| hp | horsepower |

| | |
|---|---|
| IPCC | Intergovernmental Panel on Climate Change |
| kg | kilogram |
| km | kilometer |
| MBTA | Migratory Bird Treaty Act |
| mcf/d | thousand cubic feet per day |
| MEI | maximum exposed individual |
| mg/l | milligrams per liter |
| MLE | most likely exposed individual |
| MOU | Memorandum of Understanding |
| MU | management unit |
| NAAQS | National Ambient Air Quality Standards |
| NDMA | Non-Development Minerals Agreement |
| NEPA | National Environmental Policy Act |
| NMPM | New Mexico Principal Meridian |
| $NO_2$ | nitrogen dioxide |
| $NO_X$ | nitrogen oxides |
| NRCS | Natural Resources Conservation Service |
| NRMP | Natural Resource Management Plan |
| NSPS | New Source Performance Standards |
| $O_3$ | Ozone |
| PEA | Programmatic Environmental Assessment |
| PILT | payment in lieu of taxes |
| PL | Public Law |
| PM | particulate matter |
| POD | Plan of Development |
| ppb | parts per billion |
| ppg | parts per gallon |
| ppm | parts per million |
| Red Cedar | Red Cedar Gathering Company |
| Red Willow | Red Willow Production Company |
| Reservation | Southern Ute Indian Reservation |
| ROD | Record of Decision |
| ROW | right-of-way |
| SECMG | Safety and Environmental Compliance Management Group |
| $SO_2$ | sulfur dioxide |
| SPCC | Spill Prevention, Control, and Countermeasure |
| SUIT | Southern Ute Indian Tribe |
| SWPPP | Stormwater Pollution Prevention Plans |
| tcf | trillion cubic feet |
| TCP | Traditional Cultural Property |
| TDS | total dissolved solids |
| tpy | tons per year |
| Tribal Trust lands | Lands held in trust by the United States for the benefit of the Tribe and specifically described in the NDMA |
| Tribe | Southern Ute Indian Tribe |
| USACE | United States Army Corps of Engineers |
| USBR | United States Bureau of Reclamation |
| USC | United States Code |
| USDA | United States Department of Agriculture |
| USDI | United States Department of the Interior |
| USDW | Underground Source of Drinking Water |

| | |
|---|---|
| USEPA | United States Environmental Protection Agency |
| USFS | United States Forest Service |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| VOC | volatile organic compound |
| ΔE | maximum color difference index |

# 1. INTRODUCTION

The Southern Ute Indian Tribe (SUIT or Tribe) proposes to develop natural gas resources in the North Carracas area of the Reservation in accordance with the North Carracas Plan of Development (POD). The POD contemplates the drilling of 48 Fruitland coalbed methane (CBM) wells located on 18 well pads utilizing horizontal and non-horizontal (vertical and s-shaped) drilling and completion techniques, one salt-water disposal well, associated roads and pipelines, and a compressor facility located on Tribal Trust and private (fee) lands in Archuleta County, Colorado. Refer to Map 1 in Appendix A, which shows the location and vicinity of the proposed POD.

The Tres Rios Field Office has prepared this programmatic environmental assessment (EA) for the SUIT proposal and various federal actions that would be required by the Bureau of Land Management (BLM) and the Bureau of Indian Affairs (BIA) to proceed with the SUIT proposal.

In 2007, pursuant to the Indian Mineral Development Act of 1982 (25 United States Code [USC] 2101 et seq.) and its implementing regulations (25 Code of Federal Regulations [CFR] Part 225), the SUIT (as lessor) and the SUIT doing business as Red Willow Production Company (Red Willow) (as lessee) entered into a Non-Development Minerals Agreement (NDMA) for the North Carracas Area. The NDMA was approved by an authorized representative for the Secretary of the Interior, became effective on November 1, 2007 (#750-08-2008), and was subsequently amended to correct a legal description (BIA approval issued October 1, 2010). The terms of the NDMA prohibit the drilling of wells on the surface of the described Tribal Trust lands within the boundaries of the NDMA, but authorize the subsurface extension of well laterals from neighboring private lands into Tribal subsurface mineral formations. The terms of the NDMA further expressly contemplate and authorize the pooling of private and Tribal mineral lands within the area of mutual interest (AMI), either on a spacing unit basis through communitization or on an AMI basis through unitization. The terms of the NDMA also contemplate the potential location of roads, pipelines, or other non-well facilities on the surface of Tribal Trust lands. However, because the associated wells would be located on neighboring private fee lands, most of the road, pipeline, and facility locations would also be located on private fee lands.

This EA is prepared in compliance with the National Environmental Policy Act of 1969 (NEPA), as amended (Public Law [PL] 91-90, 42 USC 4321 et seq.) and with all applicable guidelines, regulations and laws passed subsequent to NEPA, including Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500-1508); United States Department of the Interior (USDI) requirements (Department Manual 516, Environmental Quality [USDI 2004]); BLM guidelines in Handbook H-1790-1 (USDI/BLM 2008); and BIA guidelines in Indian Affairs Manual 59 IAM 3-H (USDI/BIA 2005).

In order to develop the NDMA, Applications for Permit to Drill (APDs) would be prepared as specified by BLM for the drilling program (25 CFR § 225.4; 43 CFR § 3162.3-1). In the case of fee/fee wells, APDs would be submitted to the COGCC. Each well pad would be subject to additional site-specific environmental and cultural analysis at the time of the APD submittal, as determined by the SUIT, BLM, and BIA. Rights-of-way (ROW) grants would be prepared as specified by the BIA and SUIT (25 CFR Part 162; 25 CFR Part 169). The pipeline and/or access roads would be subject to site-specific environmental and cultural analysis at the time of the grant submittal.

## 1.1 Background

The NDMA permits Red Willow to explore for and produce oil and gas minerals from lands where the oil and gas minerals are owned legally or beneficially by the Tribe. The terms of the North Carracas lease prohibit drilling wells on the described Tribal Trust lands within the boundaries of the lease; therefore, as to the NDMA, in almost all instances, wells associated with the proposed actions would be located on private lands accessing Federal minerals held in trust for the Tribe. In one instance, however, the surface of private lands where a well would be located (Section 22, Township 32 North, Range 4 West) has been acquired by the Tribe and placed into federal trust status since approval of the NDMA, subject to pre-existing private mineral development rights. A well is anticipated to be located on those acquired Tribal Trust surface lands and directionally and horizontally drilled into the neighboring, subsurface oil and gas resources underlying NDMA Tribal Trust lands. As a general matter, flow lines, gathering lines, and access roads would be constructed on private lands to the maximum extent practicable.

In order to minimize surface disturbance associated with potential natural gas resource development through cooperative use of horizontal drilling, in 2008, Red Willow and Energen Resources Corporation (Energen) entered into joint development and joint operating agreements to form the North Carracas AMI.

Two pilot projects and several scientific (test) and stratigraphic wells have undergone environmental review and are in various stages of current implementation for the AMI. The two pilot projects, and scientific and stratigraphic wells are shown on Map 2 in Appendix A. The purpose of these pilot projects has been to evaluate the potential of the resource, to identify the most efficient extraction techniques, and ultimately to guide a development plan that optimizes benefits for parties with interests in the natural gas resources, including the SUIT. The proposed North Carracas POD is the product of the information generated from these past pilot projects, stratigraphic tests, and scientific wells.

The East Pilot project consists of eight wells drilled on the Energen Ranch within the AMI. This pilot project was designed to evaluate production potential and extraction techniques in the eastern portion of the AMI. All eight of these wells have been drilled and are currently producing. Approximately 3 miles of gas and water gathering pipelines were constructed to connect the East Pilot project wells to Energen's Carracas Gathering System in New Mexico. In addition to the East Pilot project, Energen has also drilled a well that is currently producing on the east side of the AMI from New Mexico. This well was drilled to test the production potential of the southeastern portion of the AMI where potential geologic differences exist.

The West Pilot project consists of seven wells located on one well pad on the western edge of the North Caracas AMI. Five of these wells have been drilled and are currently producing. Results of pilot testing in the western portion of the AMI have confirmed that this area has comparatively low geological risk, as the coal package is thicker and more continuous than in the east. The Navajo Split to Carracas gathering system consists of approximately 4 miles of gas and water gathering pipelines constructed to connect the West Pilot project wells into a Red Cedar Gathering Company (Red Cedar) pipeline. The water line was constructed to connect to Energen's water disposal system in Tiffany, Colorado.

Information obtained from pilot testing and stratigraphic tests support full-scale development of the AMI as outlined in the POD. To facilitate this development, Red Willow and Energen are currently proposing

the Middle Pipeline project that would connect the Navajo Split to Carracas pipeline (West Pilot products line) with the East Pilot project that currently moves produced volumes to market outlets in New Mexico. This Middle Pipeline is currently undergoing site-specific analysis due to the Tribe's interest in moving the East Pilot minerals through Red Cedar's gathering systems rather than sending production from the East Pilot project through New Mexico gathering systems. The Middle Pipeline project is included as part of the North Carracas POD evaluated in this EA because it is integral to the Tribal purpose and need for the North Carracas development (refer to Section 1.2 below).

## 1.2 Purpose and Need for Action

The purpose of the proposed actions is to allow extraction, in an efficient and environmentally compatible manner, of the recoverable natural gas reserves known to exist in mineral estates held in trust by the United States for the economic benefit of the SUIT. Additionally, the purpose of the actions is to avoid long-term natural gas reserve drainage from wells located and completed on adjoining privately owned lands, which could potentially drain Tribal reserves and result in permanent loss of the Tribal resources and associated revenue. The actions would meet the goals and objectives of the SUIT as set forth in the Southern Ute Indian Tribe Natural Resource Management Plan (NRMP), Planning Period 2012 to 2032 (SUIT 2012a), as well as the Southern Ute North Carracas Energy Development: Guidance and Protocol to Reduce Wildlife Impacts (SUIT 2010a). The guiding goal from the NRMP is to identify and implement processes and procedures to provide integrated management of renewable and non-renewable resources in an environmentally, culturally, and socially responsible manner to benefit current and future generations of the Southern Ute Tribal Membership and support the Permanent Fund Mission statement and guiding principles. In addition, the proposed actions help meet the Southern Ute Department of Energy's (DOE) mission of ensuring that the members of the Tribe receive maximum benefit from the energy and mineral resources located on their Reservation while at the same time minimizing the impact of extraction of the resources on the natural and cultural environment.

The proposed actions fall within the BIA's and BLM's authority under the Indian Mineral Development Act of 1982 (25 USC 2101 et seq., 25 CFR § 225.4). The BIA administers lease activity, while the BLM is responsible for subsurface operation administration of such leases under the authority of the Federal Oil and Gas Royalty Management Act of 1982 (30 USC 1701, 43 CFR Part 3160). The existing NDMA is a binding legal contract that allows development of the Tribe's mineral estate.

The objectives of the proposed actions are to balance development of the minerals and the protection of other resources in a manner consistent with the lease rights granted to Red Willow under the NDMA. The proposed actions are designed to develop the resources in an economical manner while optimizing resource extraction, minimizing surface disturbance to the described Tribal Trust lands, minimizing impacts to cultural and biological resources, and consolidating disturbance in order to reduce surface impacts.

### 1.2.1 Decision to Be Made

The BLM, BIA, and SUIT will decide whether or not to allow development of the North Carracas AMI as outlined in this POD, and if so, under what terms and conditions. The POD contemplates the drilling of 48 Fruitland CBM wells located on 18 well pads utilizing horizontal and non-horizontal drilling and completion techniques, one salt-water disposal well, associated roads and pipelines, and a compressor

facility located on Tribal Trust and private (fee) lands in Archuleta County, Colorado. The decision would not approve any APDs or ROW grants.

Subsequent federal actions would be the approvals to be issued by the BLM and BIA in order to implement the POD. Specifically, those approvals would be:

1. The BLM issuing APDs for all wells in the affected area whose laterals would penetrate Tribal Trust minerals.
2. The United States Environmental Protection Agency (USEPA) approving the drilling and operation of the salt-water disposal well.
3. The BIA approving the communitization agreements that pool natural gas resources from Tribal Trust and fee mineral lands within designated spacing units.
4. The possible approval by the BIA for a unit agreement that pools natural gas resources and governs operations on a POD-wide basis.
5. The BIA issuing ROWs for roads or pipelines needed to implement the POD.
6. The BIA approving any surface lease agreements associated with any other POD facilities located on Tribal Trust land.

The jurisdiction and compliance with federal and Tribal rules and regulations depends on the ownership of surface and mineral rights. The *Exploration and Production Operator's Compliance Manual for Energy Development Projects on the Southern Ute Indian Reservation* outlines and discusses the jurisdiction of federal, state, and Tribal agencies in relation to surface and mineral ownership and is provided as Appendix B (SUIT 2010b). For the gas drilling contemplated in this EA, there are four combinations of surface and mineral ownership. These combinations and the applicable agency jurisdictions requirements for drilling authorization for each type of estate are listed in Table 1-1. Additional information is provided in Appendix B.

**Table 1-1. Surface and mineral ownership and the applicable agency jurisdictions**

| | Surface and Mineral Ownership | | | |
|---|---|---|---|---|
| | **Tribe surface and Tribe minerals** | **Tribe surface and Fee minerals** | **Fee surface and Tribe minerals** | **Fee surface and Fee minerals** |
| **Agency Jurisdiction** | BLM, BIA, SUIT DOE and DNR | BIA, SUIT DOE and DNR | BLM (BIA included under NEPA) | State (unless tribally operated/owned) |
| **Applicable Requirements for Drilling Authorization for Each Type of Estate** | Permission to Survey, Tribal Proposed Project Notification and On-site Process required | | BLM On-site Process required | |
| | NEPA required (federal action) | | | |
| | Section 106 Compliance (cultural) | | | |
| | Federal Application for Permit to Drill required | | | |
| | State Application for Permit to Drill | | | |

Source: SUIT 2010a.

Notes: BIA; Bureau of Indian Affairs; BLM = Bureau of Land Management; DOE = Department of Energy; DNR = Department of Natural Resources; NEPA = National Environmental Policy Act

Although surface disturbance of Tribal Trust lands under the POD is limited, specific road, pipeline, or facility installation on Tribal Trust lands would be subject to on-site review, location approval, and stipulations designed to eliminate or minimize adverse impacts to valued natural or archaeological resources.

## 1.3 Regulatory Authorities

The BIA and BLM have federal responsibility for environmental protection, public health and safety, and operation and production oversight related to mineral leasing and development on Indian lands. In addition to federal regulatory oversight, the proposed action is subject to regulatory oversight and approval by the Tribe as well as tribal conditions for approval. Two applicable federal laws provide direction to these agencies in that regard: the Indian Mineral Development Act of 1982 and the NEPA. Other legislation, notably laws to protect cultural resources and endangered species, also affect various aspects of energy resource development. This EA is prepared under the authority of the NEPA of 1969 and it's implementing regulations. A list of the major federal, tribal, and state, authorizing actions that are likely needed for the proposed actions is provided as Appendix C.

## 1.4 Relationship to Policies, Plans, and Programs

The Secretary of the Interior has assigned to BLM the responsibility for approving the drilling and overseeing the operation of wells associated with mineral agreements issued by Indian tribes under authority of the Indian Mineral Development Act. The Secretary of the Interior has assigned to the BIA the responsibility for approving mineral agreements issued by Indian tribes under the Indian Mineral Development Act and associated communitization or unitization agreements (25 CFR § 225.20). Further, the Secretary has assigned to the BIA the responsibility for approving surface lease agreements and granting ROWs involving Tribal Trust lands. The SUIT is integrally involved in the decision-making processes regarding any legal instruments encumbering Tribal lands, which may be issued only with SUIT consent in compliance with the Indian Reorganization Act of 1934 (25 USC 476).

The proposed actions would be consistent with the federal mandates contained in the Energy Policy and Conservation Act (42 USC 6217) and Executive Order 13212, which direct federal land managing agencies to quantify and expedite the production of the federal mineral estate for the development of reliable domestic sources of energy.

Access to oil and gas reserves attributable to Indian trust lands is regulated by well density or spacing regulations applicable to subsurface formations. The procedures for establishing well density applicable to Tribal minerals on the Reservation are governed by two companion agreements among the SUIT, the BLM, the BIA, and the Colorado Oil and Gas Conservation Commission (COGCC). In 1991, the SUIT entered into a written memorandum with the BIA and the BLM regarding these matters. Simultaneously, the BIA and BLM entered into a companion Memorandum of Understanding (MOU) with the COGCC. Refer to the Memorandum of Understanding between *the Colorado Bureau of Land Management and the Colorado Oil and Gas Conservation Commission* (Colorado BLM and COGCC, 1991) and *Memorandum of Understanding between Southern Ute Indian Tribe and Bureau of Land Management and Interagency Agreement between Bureau of Indian Affairs and Bureau of Land Management* (SUIT/BLM 1991 [August 22, 1991]). Under those MOUs, the COGCC conducts hearings and reviews matters affecting Indian lands and makes advisory decisions regarding those matters. The procedures described in the

MOUs prevent the COGCC from hearing matters related to Tribal lands without the prior concurrence of the Tribe and, following a decision by the COGCC, the BLM reserves the right to accept, modify, or reject the COGCC decision.

One of the principal planning documents guiding resource planning on the Reservation is the NRMP 2012-2032 (SUIT 2012a). The purpose of the NRMP is to provide a foundation for the management of surface natural resources on the Reservation. It is updated every 10 years to capture changes in management issues and activities—the most recent update was in 2012. The NRMP document serves as a guide and reference for land managers and Tribal members so they may understand resource management on the Reservation. The Tribe manages its energy resources in a manner that is consistent with Tribal standards and federal law and meets the goals of the NRMP (SUIT 2012a). The proposed actions would be in conformance with the terms and provisions of the NDMA that permits the lessee to explore for and produce oil and gas minerals from lands owned by the Tribe.

The Tribe has developed the Southern Ute North Carracas Energy Development: Guidance and Protocol to Reduce Wildlife Impacts (SUIT 2010a). The guidance document was a collaborative effort between the SUIT DNR and SUIT DOE. This guidance document was developed to define the wildlife protection measures employed by SUIT tribal entities engaging in energy development in the North Carracas area. Since the area comprises a large portion of the Reservation that the Tribe has historically treated as sensitive because of its cultural and ecological significance, wildlife protection measures generally exceed those in place elsewhere on the Reservation. Primary protection measures in the guidance document have been developed for:

- Development scheduling and implementation;
- Siting of oil and gas roads and facilities;
- General avoidance/mitigation measures; and
- Reclamation.

The proposed actions would be in conformance with the North Carracas Energy Development guidelines and protocols to reduce wildlife impacts.

## 1.5 Land Involved in the Analysis

The North Carracas AMI is an 18,123-acre parcel located in Archuleta County, Colorado within the exterior boundaries of the Reservation, as shown on Map 1 in Appendix A. The AMI consists of Tribal Trust, Indian-owned fee, United States Bureau of Reclamation (USBR), and non-Indian owned fee lands. The AMI and the proposed components of the POD are shown on Map 3 in Appendix A. Map 3 shows the surface ownership within the AMI. The legal description of the AMI involved in this analysis is listed below:

W/2 of Section 3; all of Sections 4, 9, 10, 11, 12, 13, 14, 15, 24; E/2 and E/2 of the W/2 of Section 23, Township 32 North, Range 5 West, New Mexico Principal Meridian (NMPM);

All of Sections 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24; and the S/2 of Section 8, Township 32 North, Range 4 West, NMPM; and

All of Sections 17, 18, 19, and 20, Township 32 North, Range 3 West, NMPM

## 1.6 Issues Identification and Public Involvement

The CEQ defines scoping as "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action alternative" (40 CFR § 1501.7). Among other things, the scoping process is used to invite public participation, to help identify public issues, and to obtain public comment at various stages of the environmental analysis process.

Scoping is the process by which the BLM solicits internal and external input on the issues, impacts, and potential alternatives that will be addressed in an Environmental Impact Statement (EIS) or EA as outlined in the BLM NEPA Handbook, it is optional for the BLM to conduct external scoping on actions analyzed by an EA (USDI/BLM 2008, Section 6.3.2).

Internal scoping for this document was conducted by the BLM and BIA Interdisciplinary Team early in the process. The members of the Interdisciplinary Team are listed in Chapter 7. A meeting to present the North Carracas POD was held on August 11, 2011 and included representatives from the BIA, BLM, Southern Ute Growth Fund Safety and Environmental Compliance Management Group (SECMG), SUIT DOE, SUIT DNR, SUIT Environmental Programs Division (EPD), and a Tribal Council member. The Interdisciplinary Team met on August 30, 2011 to further discuss the proposal and identify issues. During the August 30, 2011 meeting, a list of stakeholder agency groups was developed to ensure that all interested agencies were represented. The following agencies and entities were identified for internal agency scoping: USBR, Jicarilla Apache Nation, U.S. Department of Agriculture (USDA) Carson National Forest (CNF) Jicarilla Ranger District, Archuleta County, U.S. Army Corps of Engineers (USACE), U. S. Fish and Wildlife Service (USFWS) Denver and/or Grand Junction offices, USEPA Region 8, the newly merged state agencies consisting of Colorado State Parks and Division of Wildlife, New Mexico State Parks, La Plata County, BLM Farmington Field Office, and San Juan County, New Mexico. A letter to notify these stakeholders was sent in October 2011 to solicit comments and further identify issues related to the proposed POD. Issues identified during internal scoping included:

- Tribal outreach concerning the proposed actions
- Air quality impacts
- Potential water depletion impacts
- Drill cuttings and disposal
- Potential impacts to recreation resources along Navajo Lake Reservoir
- Surface and groundwater protection

### 1.6.1 Tribal Outreach

A tribal outreach meeting was held on March 27, 2013 in Ignacio, Colorado. Prior to the meeting, all Tribal members over 18 years of age were notified with an informational mailing and by a notification published in *The Southern Ute Drum* on March 8 and 22, 2013. *The Southern Ute Drum* is the SUIT's biweekly community newspaper. Representatives from the BLM, BIA, SUIT DOE, SUIT DNR, SUIT EPD and SUIT SECMG attended the meeting. Four members of the Tribal Council were also in attendance. Background on the North Carracas POD and information regarding the availability of the preliminary EA and associated public comment period was presented during the outreach meeting. A

question and answer session followed the presentation. Seven Tribal members, four Tribal Council members, and three Growth Fund employees that are Tribal members attended the meeting.

### 1.6.2 Public Comment

On May 30, 2013, a notice of availability for the public comment period on the preliminary EA was mailed to 59 stakeholders. The stakeholders included those listed above in Section 1.6 as well as 28 Native American Tribes and Pueblos, Mesa Verde National Park, the USFS Pagosa, San Juan, and Columbine Ranger Districts, San Juan Citizens Alliance, Rocky Mountain Wild, and Great Old Broads for Wilderness. A legal notice was published in the Durango Herald and the Southern Ute Drum on May 31, 2013. A notice was also published on June 6, 2013 in the Pagosa Sun, which is a weekly paper.

The preliminary EA was posted on the Southern Ute Growth Fund web site on June 1, 2013, for a 30-day public comment period. Twelve comment letters were received. A thorough review of the comments was conducted and each carefully considered and addressed. Final comment resolution included the Interdisciplinary Team to ensure that all comments were captured and that the response was appropriate. No substantive comments (requiring a new alternative or major change to the content of this EA) were received. The Interdisciplinary Team comment response is provided as Appendix D.

## 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

### 2.1 Alternative A—No Action

The BLM NEPA Handbook (USDI/BLM 2008) states that for EAs on externally initiated proposed actions, the no action alternative generally means that the proposed activity will not take place. This option is provided in 43 CFR § 3162.3-2 (h) (2). The no action alternative would deny the approval of the North Carracas POD. Current land and resource uses would continue to occur in the North Carracas area. The POD would not be implemented to develop the mineral resources within the North Carracas AMI. Development of fee mineral reserves in adjoining areas could drain tribal reserves over the long term, resulting in lost tribal revenue and the permanent loss of the Tribe's resources.

### 2.2 Alternative B—Proposed Action

The SUIT proposes to develop the oil and gas resource in the North Carracas AMI, an 18,123-acre parcel located within the exterior boundaries of the Reservation (Map 1 in Appendix A). Map 3 in Appendix A shows the level of existing disturbance within the AMI. The proposed POD would include 48 Fruitland CBM wells located on 18 well pads, one salt-water disposal well, associated roads and pipelines, and a compressor facility. To minimize surface disturbance, (1) two existing pads would be utilized, (2) multiple wells would be drilled from individual well pads, and (3) existing corridors would be used to the greatest extent practicable for flow lines and access roads. Horizontal and non-horizontal drilling and completion techniques would be used to optimize resource recovery. The drilling and initial development is proposed to occur over an estimated 4- to 5-year period. The timing of the development is influenced by the price of natural gas.

The stipulations of the North Carracas NDMA prohibit drilling wells on described Tribal Trust lands within the boundaries of the NDMA; therefore, wells associated with the POD would generally be located

on fee lands accessing federal minerals held in trust for the Tribe. In one instance, however, the surface of private lands where a well would be located (Section 22, Township 32 North, Range 4 West) have been acquired by the Tribe and placed into federal trust status since approval of the NDMA, subject to pre-existing private mineral development rights. A well is anticipated to be located on those acquired Tribal Trust surface lands and directionally and horizontally drilled into the neighboring, subsurface oil and gas resources underlying NDMA Tribal Trust lands. Flow lines and access roads would be constructed on fee lands to the maximum extent practicable. However, impacts to the described Tribal Trust lands would occur. Surface use of described Tribal Trust lands for flow lines, roads, and surface leases would be subject to the issuance of the Tribe's consent to the location of such surface facilities, as is permissible under the NDMA terms and conditions.

In the future, APDs would be prepared as specified by the BLM for the drilling program. There are also instances where the BIA would approve a surface lease, with Tribal consent, to allow for a pad on Tribal Trust outside of the NDMA boundaries but within the AMI. There are also instances where the Tribe would consent to a surface lease to allow for a pad on Tribal fee lands outside of the NDMA boundaries, but BIA would not have to approve that surface lease. Finally, there are instances where a state APD would be issued by the COGCC for fee/fee wells within the AMI. Each well pad would be subject to additional site-specific environmental and cultural analysis at the time of the APD submittal, as determined by the BLM and BIA, or the Tribe. ROW grants would be prepared as specified by the BIA and SUIT. The pipeline and/or access roads would also be subject to site-specific environmental and cultural analysis at the time of the grant submittal. All future federal actions would be subject to additional site-specific NEPA analysis.

The proposed action is shown on Map 3 in Appendix A. The location of the proposed action components, as shown on Map 3, were developed based on land status, access, spacing, and reservoir characteristics. The exact well pad locations are expected to be in the same general locations, but would be adjusted based on future site-specific environmental and cultural analyses. Map 4 in Appendix A shows the proposed action in relation to surface ownership.

Design features associated with the development are listed in Section 2.2.9. The SUIT general well pad, compressor station, pipeline, and access road stipulations are provided in Appendix E. Special stipulations, if warranted, would be issued if any conditions were identified during the site-specific analysis.

### 2.2.1 Well Pad Construction

Well pad size would vary based on whether the location would be co-located since the well heads would need to be offset, the number of new wells drilled from the pad, the size of the rig, and the type and amount of additional equipment (e.g., tanks, pipe racks, etc.) needed to drill and complete the wells. Well pad size would also vary based on whether an existing location is co-located, in which case setbacks from existing wellheads would be needed. Short-term disturbance would range from approximately 3 to 6.25 acres per pad. Following interim reclamation, long-term disturbance associated with the well pads would range from approximately 1 to 3.65 acres per pad. Two existing well pads would be utilized as co-locations, thereby overlapping existing disturbance.

Table 2-1 lists the general well pad location, number of wells per pad, and short- and long-term disturbance. Total short-term disturbance from new well pad construction and expansion of existing pads would be approximately 65.75 acres. Total long-term disturbance would be approximately 35.45 acres.

**Table 2-1. Well pad location, number of wells, and disturbance acreage for the proposed North Carracas Plan of Development**

| Quarter | Section | Township and Range | New or Existing Pad | Number of Wells | Short-Term Disturbance (acres) | Long-Term Disturbance (acres) |
|---|---|---|---|---|---|---|
| NE | 9 | 32 North, 5 West | Existing | 3 | 6.25 | 3.65 |
| NE | 14 | 32 North, 5 West | New | 6 | 5.75 | 3.40 |
| SE | 12 | 32 North, 5 West | New | 4 | 3.75 | 2.50 |
| NW | 18 | 32 North, 4 West | New | 4 | 3.75 | 2.50 |
| SW | 17 | 32 North, 4 West | New | 6 | 5.75 | 3.40 |
| NE | 22 | 32 North, 4 West | New | 1 | 3.00 | 1.00 |
| NW | 14 | 32 North, 4 West | New | 4 | 3.75 | 2.50 |
| NE | 14 | 32 North, 4 West | New | 3 | 3.00 | 2.00 |
| NW | 24 | 32 North, 4 West | Existing | 1 | 3.00 | 2.00 |
| SW | 12 | 32 North, 4 West | New | 4 | 3.75 | 2.50 |
| NW | 19 | 32 North, 3 West | New | 1 | 3.00 | 1.00 |
| SW | 18 | 32 North, 3 West | New | 2 | 3.00 | 1.50 |
| NE | 18 | 32 North, 3 West | New | 1 | 3.00 | 1.00 |
| SE | 18 | 32 North, 3 West | New | 2 | 3.00 | 1.50 |
| NW | 17 | 32 North, 3 West | New | 1 | 3.00 | 1.00 |
| SW | 17 | 32 North, 3 West | New | 2 | 3.00 | 1.50 |
| SW | 17 | 32 North, 3 West | New | 2 | 3.00 | 1.50 |
| SW | 17 | 32 North, 3 West | New | 1 | 3.00 | 1.00 |
| | | | **Totals** | **48** | **65.75** | **35.45** |

Activities associated with the proposed action would include well pad construction, drilling, stimulation, and completion of the proposed natural gas wells and the installation of any surface equipment necessary for natural gas production. Additional information is available in the SUIT general wellsite conditions of approval (COA) provided in Appendix E.

At each well pad, construction crews would remove vegetation from the proposed location and the pad would be leveled and contoured. Existing pads would be expanded. Vegetation and 6 inches of topsoil would be stripped and stockpiled on-site for use in reclamation. Stockpiles would be located and protected to minimize wind and water erosion and to maximize reclamation potential. When site-specific locations are identified during the on-site process, appropriate stormwater controls such as ditches, berms, waterbars, culverts, silt fence or water retention ponds would be developed on a case-by-case basis, to reduce stormwater run-on/run-off and retain sediment on or near the location. Cuts and fills would vary between the proposed pads based on specific location characteristics. Excavated materials (spoils) from

the cuts would be used on the fill portion of the location to level the pad. Clearing and leveling is needed to provide a level surface for rig and equipment access and for drilling. Those locations with greater topographical relief would require greater cuts and fills to create a level well pad. During construction and drilling, slope ratios on some locations may be as high as 2:1. Following interim reclamation, the well pads would be re-contoured to achieve a 3:1 slope ratio. During the process of identifying site-specific locations, steep slopes would be avoided where possible or appropriately mitigated. There would be no reserve pit, blow pit, or flare stack for any of the natural gas wells. A reserve pit may be necessary during the drilling of the salt-water disposal well due to the potential for water zone encountered during drilling.

Natural gas well drilling facility assembly would occur on the well pad after site clearing and leveling. Drilling equipment located on each drilling pad would include the drilling rig and associated equipment (e.g., blowout preventer, separator, etc.), pipe storage, one 400-barrel flow line tank, pumps, generators, a forklift, four to five housing trailers, three additional 400-barrel storage tanks, and mud pallets. Any open pits would be lined and fenced, screened, or netted. Secondary containment systems would be designed, constructed, and maintained for all chemicals or industrial fluids stored on site.

Multiple wells on individual pads would be spaced to emphasize safe operation and maintenance, optimize rig movement, and minimize surface disturbance. After drilling, the pad design would also allow for uninterrupted operation of an artificial lift pump, while a workover (if needed) is proceeding on an adjacent well. A workover is the process of performing major maintenance or remedial treatments on an oil or gas well.

### 2.2.2 Drilling and Completion

Closed-loop systems would be utilized for all gas wells. The drilling mud would be water-based and would consist of fresh water with bentonite, barite, clay stabilizers, friction reducers, and fluid loss control material. During horizontal drilling operations, brine water with fluid loss control material, and calcium chloride used as a weighting agent, would be used. Fluid density is expected to be 9.0 to 10.5 parts per gallon (ppg) and anticipated salinity will be 100,000 to 200,000 parts per million (ppm).

Closed-loop systems employ a suite of solids control equipment to minimize drilling fluid dilution. This type of system results in a location where a reserve pit is not required, used fluids are recycled, and solid wastes can be hauled and land farmed. The percentage of fluids that would be recycled or reused is 50 to 80 percent. After the majority of the water is removed from the cuttings with the shaker and centrifuge, the cuttings would be stored in a bermed and lined “drying bed,” or a steel roll-off bin, and allowed to dry further. Cuttings would be buried on-site or transported to an approved disposal facility, depending on site-specific conditions. If buried on-site, appropriate mitigation measures would be implemented to minimize the potential for environmental impacts and ensure compliance with relevant requirements such as COA associated with the APD. Total cuttings volume would range from an average minimum of 9.5 cubic yards (non-horizontal wellbore) to an average maximum of 100 cubic yards (horizontal wellbore). Cuttings transport bins would be 20-cubic yard containers, but would only transport 12-cubic yards at a time for weight reasons. There would be approximately 10 cutting haul loads per well to account for any residual liquid.

Water for drilling and completion would be obtained from the City of Ignacio or other viable commercial water sources. The approximate volume range of water needed to drill each of the two different well types is listed in Table 2-2.

**Table 2-2. Approximate volume range of water per well for drilling**

| Well Type | Volume of Water (bbl) |
|---|---|
| Horizontal | 1,000 – 1,750 |
| Non-horizontal | 225 – 400 |

Note: bbl = barrel

Thirty-nine wells would be horizontally drilled to an approximate range of 1,300 to 3,000 feet total vertical depth to reach the target coal zone. A 9 5/8-inch surface casing would be set to no less than 400 feet total vertical depth. The 8 3/4-inch intermediate wellbore would then be drilled with a curve being built and landed in the target coal at an inclination of approximately 88 degrees. The intermediate well bore would be drilled to between 2,850 and 3,000 feet total vertical depth (with a measured depth range between 3,850 and 4,500 feet) A 7-inch intermediate casing would then be run, set to depth, and cemented to the surface. A 6 1/4-inch production lateral would then be drilled to the total depth and a pre-perforated liner with no less than eight shots per foot would then be run to provide wellbore integrity over the life of the well. The horizontal lateral lengths would average 4,000 feet (average measured depth between 8,500 and 9,500 feet). The completion technique for the 39 horizontal wells is illustrated in Figure 2-1.

Nine non-horizontal wells would be drilled under the proposed POD. Total vertical depth would range between 1,300 and 3,000 feet to reach the target zone. Non-horizontal wells would be completed in an area with multiple coal stringers that do not facilitate drilling a horizontal well. The difference in geologic formation depth between Figure 2-1 and Figure 2-2 is due to the updip toward the north and east within the AMI. Figure 2-2 shows the completion techniques for a non-horizontal well.

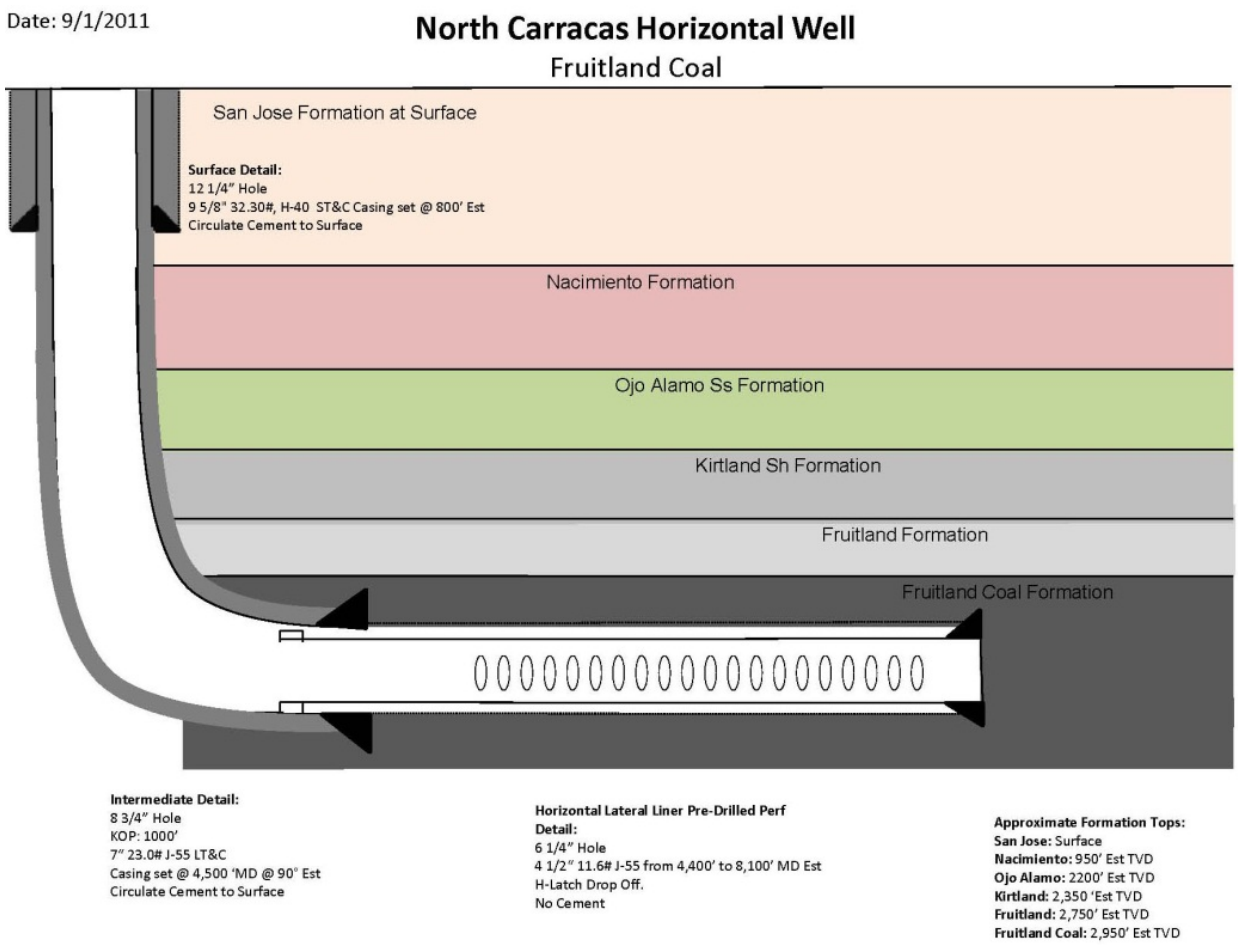


**Figure 2-1. North Carracas POD horizontal well drilling completion technique**

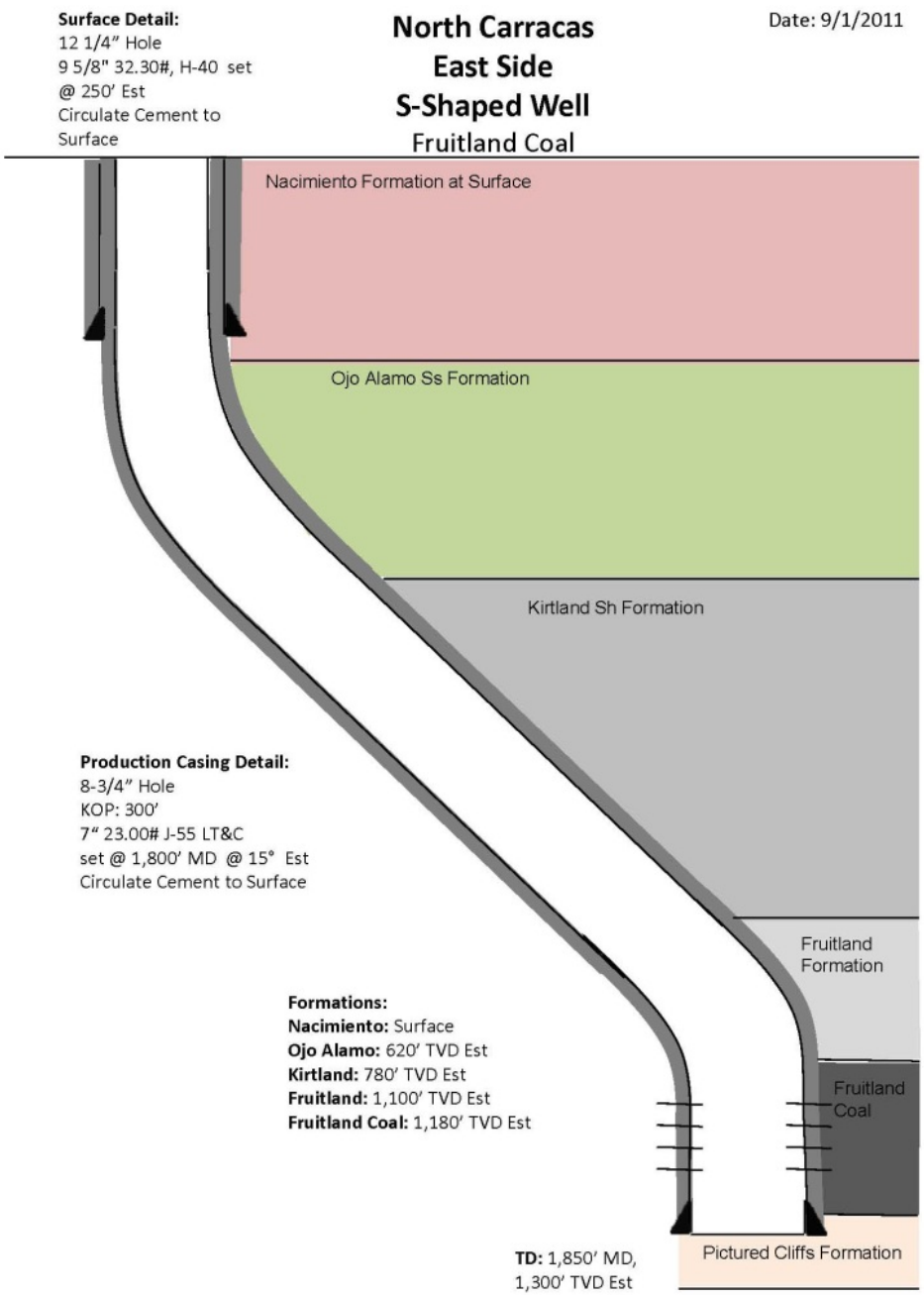


**Figure 2-2. North Carracas POD non-horizontal well drilling completion technique**

Wells are often treated during completion to improve resource recovery by increasing the rate and volume of hydrocarbons moving from the natural gas and/or oil reservoir into the wellbore. These processes are known as well-stimulation treatments and include hydraulic fracturing, acidizing, and other mechanical and chemical treatments, often used in combination.

Hydraulic fracturing (fracking) is a process used to maximize the extraction of underground resources by allowing oil or natural gas to move more freely from the rock pores to production wells that bring the oil or gas to the surface. Fluids, commonly made up of water and chemical additives, are pumped into a geologic formation at high pressure during hydraulic fracturing. When the pressure exceeds the rock strength, the fluids open or enlarge fractures. After the fractures are created, a propping agent is pumped into the fractures to keep them from closing when the pumping pressure is released. After fracturing is completed, approximately 60 to 80 percent of the injected fracturing fluid returns to the wellbore (USEPA 2004a).

Hydraulic fracturing is a 60-year-old process that is now being used more commonly as a result of advanced technology. Groundwater is protected during the fracturing process by a combination of the casing and cement that is installed when the well is drilled and by the depth of the rock between the fracture zone and any fresh-water bearing zones or aquifers (USDOE 2009). General casing specifications for horizontal and non-horizontal wells are provided in Figures 2-1 and 2-2. While there is limited vertical separation between the target zone and usable aquifers on the eastern portion of the AMI, the proposed casing and cement technique would provide redundant protection of all usable aquifers above the Fruitland Coal zone by cementing both the surface and intermediate casing strings from the base of pipe back to surface.

Hydraulic fracturing is not proposed for any horizontal wells for the North Carracas development. Completion of horizontal wells would entail standard industry practices such as acidizing, circulation, and swabbing of the well to free flow status.

It is anticipated that nine wells utilizing non-horizontal completion techniques would require hydraulic fracturing. If needed, Halliburton Delta 140 fracturing fluid (or similar fluid) would be used. The specific components of the fluid are determined at the time of completion. The Tribe would require the operator to disclose the hydraulic fracturing fluid chemical components to the Tribe, the BLM, and the BIA, and may authorize further public disclosure in a manner consistent with COGCC Order 1R-114, even though that COGCC order is not directly applicable on a jurisdictional basis.

Each non-horizontal well would require approximately 1,950 barrels of water for fracturing. If needed, approximately 2,380 barrels of water would be used to stimulate the salt-water disposal well. Water for hydraulic fracturing would be obtained under existing water rights or from commercial sources. Red Willow would comply with all governmental required well construction and testing practices in addition to conformance with industry best practices to minimize potential hydraulic fracturing risks.

Green completion technology would be used. Green completions take place during the flowback stage of the completion. The flowback involves removing the water necessary to stimulate the well. During this flowback, natural gas is produced with the water. What makes the well completion “green,” or environmentally friendly, is that the gas is separated from the water and placed in a pipeline instead of being released to the atmosphere.

Following drilling and completion, the well pads would be reclaimed as discussed in Section 2.2.8.

### 2.2.3 Pipelines

A pipeline gathering system would be constructed to transport both gas and produced water (in separate pipelines) from the proposed wells. Pipelines would be located adjacent to existing or proposed disturbance to the maximum extent practicable. All pipelines would typically be constructed within 40-foot wide ROWs. The Middle Pipeline project would consist of one subsurface, 20-inch outside diameter, welded steel line, and one subsurface 6-inch water line constructed of fiberspar or a comparable material. The Middle Pipeline project would be approximately 7.1 miles in length. An approximately 3.9 mile gathering system would also be constructed in the eastern portion of the study area. The system would consist of one subsurface 8- to 12-inch outside diameter welded steel pipeline and one subsurface 6-inch water line constructed of fiberspar or a comparable material (polyethylene). The pipeline is proposed to cross under the San Juan River and would be installed a minimum of 4 feet below the river bottom. The pipeline at the stream crossing would utilize a pipe-in-pipe design to minimize the potential for leaks. All pipeline crossings under waters of the United States would be installed a minimum of 4 feet below the channel bottom.

Shorter pipelines (well connects) from the proposed wells would connect to the Middle and East gathering lines. These pipelines would be 8- to 12-inch outside diameter welded steel lines. The exact length and location of these well-connect pipelines would be determined when the specific well locations are identified. Since the proposed well pads would be located near existing disturbance, each well-connect pipeline would likely be less than 1,200 feet in length. The total estimated disturbance associated with the pipeline gathering system would be approximately 71.5 acres.

During construction of pipelines, general stipulations and design features would be implemented to minimize impacts to environmental resources. All personnel, vehicles, and construction equipment would be confined to the ROW to minimize surface disturbance. Topsoil material would be stockpiled to the side of pipeline routes where cuts and fills or other surface disturbance occurs during construction. Any pipeline crossing ravines, canyons, or waterways would be laid at a depth necessary to prevent exposure in heavy runoff periods. Following installation, the pipeline ROWs would be reclaimed as discussed in Section 2.2.8. Refer to Appendix E for the SUIT general ROW stipulations.

### 2.2.4 Access

Archuleta County Road (CR) 500 (also known as Trujillo Road) bisects the North Carracas study area from west to east and is the primary access. Access to the North Carracas area would also be south from New Mexico, using Forest Service Road 218 and the North Carracas Road.

Under the proposed action, approximately 4.5 miles of access roads would be constructed. In general, proposed roads would be constructed on fee surface. Proposed well pad access roads would spur from CR 500 and be constructed within the same ROW as the proposed pipelines to the maximum extent practicable in order to minimize surface disturbance. Proposed roads would be located and designed to minimize impacts to environmental resources and to allow for successful interim and final reclamation. Roads would be constructed with proper drainage controls such as crowns, ditches and culverts, and with adequate surfacing for all-weather access. Roads would be constructed using applicable Gold Book

Standards (USDI/USDA 2006a). Refer to Appendix E for the SUIT general access road construction stipulations.

A bridge would be constructed over the San Juan River to access the proposed wells pads in the easternmost portion of the study area. Access to the bridge and wells would be acquired from a private land owner. The bridge design would be similar to the bridge constructed over the river to connect Carracas to CR 500. The bridge would be constructed with steel risers into competent bed rock within the river and with steel beams across to support. Surface would be an all-weather maintainable finish. Bridge design and construction would comply with USACE permitting requirements, and to the extent economically feasible or applicable, would conform to standards reflected in Colorado Department of Transportation (CDOT) regulations.

### 2.2.5 Production

Pumping units would be used for artificial lift at each well. Pumping units would have natural gas-powered engines. Dry gas is expected to be produced. The anticipated peak rate from individual horizontal wells in the eastern portion of the AMI is 1,129 thousand cubic feet per day (mcf/d). The anticipated peak rate from individual horizontal wells in the western portion of the AMI is 1,300 mcf/d. The anticipated peak rate from the non-horizontal wells is 361 mcf/d. The general life expectancy for the wells is approximately 30 years.

The North Carracas POD would include the drilling of a salt-water disposal well located adjacent to proposed disturbance in the NW 1/4 of Section 18, Township 32 North, Range 4 West. Produced water from the Fruitland Coal formation may have total dissolved solids (TDS) as high as 22,000 milligrams per liter (mg/l). The typical well in this area would initially produce approximately 3,000 bbls of produced water per month and would then steadily decrease over time. The injection volumes would therefore correlate with the number of wells producing at any given time.

Produced water would be transported via subsurface polyethylene pipe to the proposed salt-water disposal well facility. The water pipelines would be constructed concurrently with the gas pipelines and laid within the same trench, resulting in no additional surface disturbance. Water pipelines would be 6-inch outside diameter and constructed of fiberspar or comparable material. The produced water would be injected into the target formations—Bluff Sandstone and/or Entrada Sandstone. These formations are located at approximately 8,000 to 9,000 feet below ground surface in the project area. The salt-water disposal well would be completed using techniques protective of fresh-water bearing zones. The salt-water disposal well would not be a commercial disposal site.

### 2.2.6 Compressor Station

A compressor station would be constructed adjacent to an existing well pad in the NE ¼ of Section 9, Township 32 North, Range 5 West. This facility would disturb a total of approximately 4 acres. Approximately 8,200 horsepower (hp) is projected to compress gas produced from the proposed development. To achieve sufficient hp, six 1,380 hp engines with oxidation catalysts would be installed. No well head compression is anticipated.

## 2.2.7 Total Disturbance

Table 2-3 summarizes the estimated total disturbance associated with the North Carracas POD. The total estimated disturbance per land status is listed in Table 2-4.

**Table 2-3. Total estimated surface disturbance associated with the proposed North Carracas Plan of Development**

| | Short-Term Disturbance (acres) | Long-Term Disturbance (acres) |
|---|---|---|
| Well Pads | 65.75 | 35.45 |
| Salt-water Disposal Well | 1.50 | 1.50 |
| Pipelines/Roads | 71.52 | 35.76 |
| Compressor Station | 4.00 | 4.00 |
| **Totals** | **142.77** | **76.71** |

**Table 2-4. Total estimated disturbance associated with the proposed North Carracas Plan of Development per land status**

| | Short-Term Disturbance Tribal Trust (acres) | Short-Term Disturbance Private (acres) | Long-Term Disturbance Tribal Trust (acres) | Long-Term Disturbance Private (acres) |
|---|---|---|---|---|
| Well Pads | 3.00 | 62.75 | 1.00 | 34.45 |
| Salt-water Disposal Well | 0.00 | 1.50 | 0.00 | 1.50 |
| Pipelines/Roads | 5.24 | 66.28 | 2.62 | 33.14 |
| Compressor Station | 0.00 | 4.00 | 0.00 | 4.00 |
| **Totals**[1] | **8.24** | **134.53** | **3.62** | **73.09** |

[1] Acreage estimates may be marginally more or less than those described in Table 2-2 due to GIS polygon analysis.

## 2.2.8 Reclamation

The proposed well pads would be partially reclaimed (interim reclamation) following drilling and completion operations. A portion of the pad not required for production equipment and vehicular access would be re-contoured and reclaimed. Reclamation would typically consist of re-spreading topsoil, preparing the seedbed, seeding, mulching, and crimping with certified weed-free straw or native hay mulch. Depending on the number of wells per pad, approximately 1 to 2.6 acres for production facilities on each well pad would remain in use for production and vehicle access. These areas would not be reclaimed until final abandonment of the wells. Production equipment that would remain on site would include the wellheads, pumping unit, separators, and meter runs. Ancillary equipment could also be installed at the well pad site, such as a Christmas tree (i.e., valves, spools, and fittings on the well head), storage tank(s), and dehydrator.

The majority of proposed pipelines would parallel and overlap existing roads. Approximately 4.5 miles of pipeline ROW would parallel proposed new roads; therefore, approximately half of the proposed pipeline ROWs would be reclaimed following construction, with the other half remaining for access. On Tribal Trust lands, access roads would be reclaimed at final abandonment per BLM COAs and BIA/Tribal stipulations.

At final abandonment, the well locations, production facilities, and access roads would undergo final reclamation to restore the character and productivity of the land. During final reclamation, surface equipment would be removed from the well locations and compressor station. Disturbed areas would be re-contoured as close to the original landform as possible. Salvaged topsoil would be respread and the area reseeded. Appropriate erosion controls would be implemented. A reclamation plan would be included in the Surface Use Plan of Operations developed for each gas well. Roads and pipelines would be reclaimed as outlined in the project-specific stipulations. Additional reclamation measures may be required based on the conditions existing at the time of abandonment.

### 2.2.9 Design Features

Design features, also known as best management practices (BMP), are an integral part of the proposed action. The environmental effects are analyzed assuming that design features are in place and successful. For the proposed actions, standard and project-specific design features have been derived from the Programmatic Environmental Assessment for 80-Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation (USDI 2009) and the Southern Ute North Carracas Energy Development: Guidance and Protocol to Reduce Wildlife Impacts (SUIT 2010b).

The SUIT DNR, SUIT DOE, BLM, USEPA, and BIA may perform inspections of facilities within the exterior SUIT boundary to assess compliance with mitigation and may take additional, legally authorized enforcement actions to assure compliance. For any federal actions, all applicable (as designated by a BLM representative) Gold Book BMPs and site-specific mitigations will be utilized throughout the entire life of the proposed project wherever practically possible.

Design features for the proposed action include but are not limited to:

#### Air Quality

- Roads would be surfaced or dust inhibitors would be used (e.g., surfacing materials, non-saline dust suppressants, water, etc.), as appropriate, on roads and well locations constructed on soils susceptible to wind erosion, to reduce the amount of fugitive dust generated by traffic, or other activities.
- Speed limits would be enforced to the extent practicable on roads in and adjacent to the project area, to further reduce fugitive dust.
- All new and replacement internal combustion gas field engines must meet, at minimum, recently promulgated (January 18, 2008, 73 Federal Register 3568) New Source Performance Standards (NSPS) (40 CFR 60, Subpart JJJJ). Additionally, all new and replacement internal combustion gas field engines greater than or equal to 500 design-rate hp (or site de-rated hp values, as long as manufacturer de-ration values and emission factors are supplied and current demonstration compliant with appropriate emission rate requirement) must not emit more than 1 gram of

nitrogen oxides (NOx) per horsepower hour upon issuance of the Decision document, as opposed to being delayed under the NSPS.

- All prime mover diesel drilling rig engines (not work overs or recompletion rigs) will meet Tier 2 (or better) emission standards.
- Compressors would be ultra-lean-burn engines, each fitted with two oxidation catalysts to meet NSPS.
- Green completion technology will be used for all natural gas well completions.

### Water Quality

- Protect water quality within, and downstream of, the study area from soil erosion and sedimentation by BMPs that include erosion control devices and management procedures, retention of a vegetation buffer strip (minimum of 100 feet) between water bodies and disturbed areas, and spill prevention procedures.
- Whenever reasonably possible, bore under jurisdictional waters of the U.S., including drainages and wetlands to avoid and/or minimize surface impacts. Pipe would be installed a minimum of 4 feet below stream bottoms. Pipelines installed under streams will utilize a pipe-in-pipe design to minimize the potential for leaks.
- The operator will develop, implement, and strictly adhere to project-specific and comprehensive Spill Prevention, Control, and Countermeasure (SPCC) Plans, if required as a result of petroleum hydrocarbons in sufficient quantities (i.e., 1,320 gallons or more) being utilized and/or stored on a particular well or facility location.
- All spills shall be promptly reported to the SUIT DOE and BIA, in accordance to the SUIT Spill/Release Reporting Policy and reported to the BLM in accordance with BLM-Notice to Lessees NTL-3A.
- Containment structures sufficiently impervious to prevent a discharge to waters of the U.S., such as containment dikes, containment walls, drip pans, or equivalent protection actions will be constructed and maintained around qualifying fluid/chemical facilities or storage tanks.
- Monitor bradenhead pressures to identify wells that may have wellbore integrity problems and may be acting as vertical conduits for fluid migration, including but not limited to completion fluid, methane, or Fruitland Coal water.
- Monitor water quality, conduct bradenhead testing, and evaluate data accordingly.
- Cement all surface and production casing strings to the surface by circulation methods.
- If cement in the surface and/or production string is not circulated to the surface and a cement bond log or temperature log shows sufficient coverage and cement bond to isolate the appropriate zones, including the Fruitland Coal gas-bearing zone, and casing shoe tests positive, drilling will proceed. Otherwise, remediation will be performed.
- Within any areas of concern, the SUIT DOE and BLM may require water well monitoring as part of APD approval.
- In the event that any surface water body or usable groundwater aquifer is degraded by any of the proposed project activities, the problem shall be immediately reported and remediated or other corrective action taken as determined by the appropriate agency.

- The USEPA would perform mechanical integrity tests on the saltwater disposal well per the underground injection permit.
- Injection well operations will be monitored monthly for cumulative injection volumes and pressures in tubing and tubing/casing annulus.
- Self-contained, closed-loop systems will be utilized to drill the natural gas wells in this proposed POD.
- For the CBM wells, the operator will follow procedures in a manner consistent with COGCC Rule 608 for sampling water wells in the vicinity of the proposed natural gas wells.
- For the salt-water disposal well, the operator shall collect samples and conduct complete water analyses in a manner consistent with COGCC Rule 609.e(1) and (2) on all newly developed water wells less than 300 feet in depth within the project area if the landowner consents to sampling.
- Meet all applicable USEPA federal water quality standards.
- Avoid construction activities near or through streams (whether ephemeral or perennial) and implement USACE permit requirements.
- Require operators to map and delineate waters of the U.S., as defined at 33 CFR § 328.3, prior to the planning of any activity at or near such waters.
- Require operators to avoid impacting waters of the U.S. whenever practicable.
- Require operators to obtain 404 permits from the USACE, including the 401 certification from the USEPA for land within the boundary of the Reservation.
- Require operators to minimize unavoidable discharges of fill material to waters of the U.S.
- Require operators to mitigate waters of the U.S. that are adversely impacted by their activities.
- Require operators to obtain appropriate permits, including those associated with Section 404 of the Clean Water Act, when crossing surface waters or waters of the U.S., as defined at 33 CFR § 328.3.
- The Stormwater Recommendations for Oil and Gas Operations on Tribal Lands within the Southern Ute Indian Reservation will be implemented. The stormwater recommendations are provided in Appendix F.
- There will be no permanent structure constructed within the 100-year floodplain boundaries of streams unless it can be demonstrated on a case-by-case basis that there is no physically practical alternative. In cases where floodplain construction is approved, additional constraints and BMPs such as flood protection measures or construction timing restrictions may be applied
- Operators will implement the USEPA Reasonable and Prudent Practices for Stabilization BMPs to eliminate or minimize adverse impacts to the environmental health of the SUIT natural resources (USEPA 2004b).
- Implement BMPs to slow or reduce the flow of surface-water runoff across disturbed areas, including diversion of surface runoff around facilities.
- Appropriately sized culverts will be installed to convey surface flow under constructed access roads. Reduce erosion impacts from roads through measures described in the standard environmental protection criteria.

- Implement and maintain structural erosion and sediment controls such as interim or permanent water bars, detention ponds, straw bales, silt fences, earth dikes, and inlet and outlet protection.
- Implement non-structural control practices such as interim and permanent stabilization, permanent and temporary seeding and re-vegetation, geotextiles, mulch, tackifiers, and hydromulching (using approved weed free seed mix).
- Install culverts as erosion prevention measures in areas of high runoff.
- Protect water bodies and drainage pathways near drill sites or roads, which are the most susceptible to erosion by developing buffers or adding erosion control measures.
- Minimize erosion at sites located in steep terrain during the construction phase by utilizing stormwater BMP measures such as contouring, water bars, temporary ditches, and detention basins, along with minimizing the period of disturbance.
- Timely plug and abandon non-productive wells and associated flow lines and equipment.

### Vegetation

- Avoid areas containing sensitive vegetation types, such as wooded riparian vegetation or known sites with culturally important plants, to the fullest extent possible.
- All oil and gas operators will obtain a permit from the SUIT Forestry Division prior to the removal of wood materials greater than 4 inches in diameter from well pads or pipelines.
- Separate topsoil and set aside for reclamation purposes.
- Limit construction activities to dry conditions to reduce soil compaction and rutting, as appropriate.
- Reclaim and re-vegetate all disturbed areas of soil with approved, certified weed-free seed mixes, fertilizer, and/or mulch.
- Use spark arresters on chainsaws and mufflers on vehicles to prevent wildland fires.
- Burning brush, trash, or scrap materials, etc. is restricted by Reservation rules.
- Monitor invasive species populations.
- Use BMPs to minimize the introduction of invasive species.
- Require operators to control noxious weeds in disturbed areas.
- Apply herbicide only under the supervision of a licensed pesticide applicator, and ensure that application, storage, and disposal procedures meet federal and Tribal requirements.
- Avoid construction in wetlands to the fullest extent possible.
- Identify unavoidable direct and indirect impacts on wetland areas during individual project planning. Develop a wetland mitigation/monitoring plan and obtain necessary permits, prior to initiation of construction activities.
- When it is necessary to cross streams and riparian areas, design facilities to cross at right angles, rather than parallel, in order to minimize the area of impact on these resources. Use BMPs at any temporary stream crossings and rehabilitate wetlands as soon as possible.
- Minimize surface disturbance by accessing new wells via spur roads off existing roadways rather than through construction of new primary roads.
- Corridors for pipeline ROWs should be shared or consolidated to the extent practicable.

- Final reclamation must occur in a timely manner upon decommissioning and abandonment of facilities and in accordance with SUIT and/or BLM stipulations and COAs associated with APDs and ROW grants.

### Wildlife and Fisheries

- Minimize or avoid development in areas of critically important wildlife habitat, such as elk or deer winter concentration areas and wooded riparian vegetation.
- Where development in unique habitats cannot be avoided, mitigation (such as habitat enhancement and restoration) shall be considered. SUIT DNR or Division of Wildlife Resource Management (DWRM) will coordinate with the operator in the development of appropriate wildlife habitat mitigations and enhancements, and the operator will be responsible for construction of these improvements as a COA to proceed with the development activity.
- Conduct on-site inspections of potential development locations to ensure avoidance of wooded riparian areas to the greatest extent possible.
- Site major developments (e.g., well pads, heavily used roads, and processing facilities) away from migration corridors. Lightly used roads and pipelines may be placed in such areas. Tribal wildlife biologists shall be consulted directly on all major developments to develop specific mitigation to protect migration corridors.
- Locate facilities at the base of slopes where feasible to provide a background of topography and/or natural cover.
- Minimize the number of well monitoring trips by coordinating well visits to limit traffic or by installing automated monitoring systems.
- Re-vegetate disturbed areas as soon as possible. Monitor the success of re-vegetation efforts and reseed as needed to develop established stands of vegetation. As per requirements under the design features for vegetation resources, this re-vegetation shall be noted in the annual report.
- Maintain appropriate speed limits on access roads to minimize wildlife injuries or mortalities due to vehicle-wildlife collisions.
- Heater-treaters (separators) will be screened to prevent bird mortalities.
- All fences and cattle guards will be removed from well pads once vegetation has been established following completion of reclamation activities unless requested by landowners. Oil and gas operators will install pipe barriers or panels around wellheads, meters, valves, and other equipment to minimize impacts to wildlife and livestock.
- Bird netting will be suspended and maintained over all reserve pits, open tanks, and catchments if hydrocarbons or toxic chemicals are present in the fluids until reclamation is complete.
- Restrict new well locations and ROWs to at least ¼ mile from a raptor nest or winter roost.
- A migratory bird survey prior to construction during the migratory bird breeding season (March through August) will be conducted.
- SUIT DWRM biologists shall conduct yearly nesting surveys to document known nest sites and monitor nesting success. Annual winter roost surveys would also be conducted to identify and record additional winter roost sites. These data would be used to evaluate the effectiveness of mitigation measures for wooded riparian habitat and develop additional mitigation criteria as necessary.

- *Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors* (CDOW 2008) will be implemented, with the exception of bald eagle.
- To the extent practicable restrict timing of drilling activities in undisturbed areas to reduce disturbance impacts on deer and elk. Unless otherwise agreed by SUIT DNR/DWRM, no drilling activities will be allowed from December 1st through April 30th ("Closure Period") for any projects more than a 1/3-mile distance from Archuleta County Road 500 ("Buffer Area"). Routine maintenance, construction, and/or completion activities being conducted outside of the Buffer Area, during the Closure Period, may only occur between 8:30 am and 3:30 pm. Prior approval of SUIT DNR/DWRM is required for drilling activities outside of the Buffer Area prior to April 30th. The April 30th start date may be altered at the discretion of SUIT DNR/DWRM based on severity of snowpack conditions.
- Regardless of distance from Archuleta CR 500, construction, drilling, and completion activities should be scheduled to avoid particularly sensitive seasonal wildlife sites, specifically bald eagle winter roost sites, southwestern willow flycatcher nest sites, and raptor nest sites. SUIT DNR/DWRM should be consulted on sensitive sites, timing considerations, and buffer distances.
- As much as possible, drilling activities outside of the Buffer Area should be scheduled to avoid annual big game hunting seasons, when Tribal use of land is at its highest (i.e., generally from September through December). If the operator believes that drilling activities outside of the Buffer Area are necessary between September and December, consultation with SUIT DNR/DWRM should occur to address the issue on a site-specific basis.
- Avoid new surface disturbance and placement of new facilities in key wildlife habitats, especially within and adjacent to wetland-riparian zones. SUIT DNR/DWRM should be consulted in the planning stages in order to identify specific sensitive habitats that should be avoided.
- Locate roads as far from streams and bottoms of drainages as possible and outside of riparian habitat unless after consultation with SUIT DNR/DWRM it is determined that alternative alignments would be more environmentally disruptive. Consult with SUIT DNR/DWRM when stream/drainage crossings cannot be avoided.
- Establish company policies to protect wildlife and other natural resources while employees are on SUIT or SUIT partner lands (e.g., no poaching, no firearms, no dogs on location, no feeding of wildlife, no littering, bear proof trash containment, use restrooms or portable toilets only).
- Reduce noise by using current and effective sound dampening devices or techniques such as hospital grade mufflers, equipment housing, insulation, installation of sound barriers, earthen berms, and vegetative buffers. Specific sound dampening mitigation can be determined for new facilities at a site-specific level in consultation with SUIT DNR/DWRM.
- Install signage notifying the public that unauthorized vehicular travel on roads and facility ROWs is not permitted. If future activities indicate that signage is not sufficient to prevent unauthorized traffic, consider the use of locked gates.
- Any fencing required around facilities or along roads should use wildlife friendly designs to readily allow wildlife passage.
- Design and maintain access roads in light of the anticipated volume of traffic and the weight and speed of vehicles using these roads to minimize environmental damage, including the generation of fugitive dust and contribution of sediment to downstream areas.

- Avoid locating staging, refueling, and storage areas within 300 feet of any reservoir, lake, wetland, or natural perennial or seasonally flowing stream of river to the extent reasonable. If this cannot be avoided in a reasonable manner, consultation with SUIT DNR/DWRM should occur to address the issue on a site-specific basis.
- Promptly report all spills to the appropriate Federal/Tribal authorities.
- Close and immediately reclaim all roads that are redundant, or have been abandoned to the maximum extent possible to minimize disturbance and habitat fragmentation.
- The operator will notify the BLM authorized officer, nearest USFWS law enforcement office, and the SUIT DNR/DWRM within 24 hours, if the operator discovers a dead or injured federally protected species (i.e., migratory bird species, bald or golden eagle, or federally listed species) in or adjacent to a pit, trench, tank, exhaust stack or fence.
- The operator will construct and maintain pits, cellars, open-top tanks, and trenches that are not otherwise fenced, screened, or netted to exclude livestock, wildlife, and humans. At a minimum, the operator will construct and maintain escape ramps, ladders or other methods of wildlife escape in pits, cellars, open-top tanks, or at frequent intervals along trenches where entrapment hazards may exist.
- The operator will design, construct, and maintain all secondary containment systems to prevent wildlife and livestock exposure to harmful substances.

### Threatened and Endangered Species

- No disturbance will be allowed within 20 meters (65 feet) of federally listed plant occupied habitat, and any disturbance proposed within 200 meters (656 feet) of listed plants occupied habitat would be analyzed in a separate site-specific consultation.
- Conduct southwestern willow flycatcher (*Empidonax traillii extimus*) surveys within suitable habitat prior to any construction activities to determine presence or absence.
- If southwestern willow flycatchers are located during survey efforts, no surface-disturbing activities will be conducted from May 1 through August 15.
- Minimize construction activities in wooded riparian habitat, or any other potential southwestern willow flycatcher nesting habitat.
- No disturbance will be allowed within 200 meters (656 feet) of known or discovered occupied southwestern willow flycatcher breeding habitat.
- Pre-construction surveys for Gunnison (*Cynomys gunnisoni*) prairie dogs will be conducted on proposed locations. Direct impacts to prairie dog colonies will be avoided where possible, and in the light of other resource tradeoffs resulting from access road and or pad relocation.

***Bald Eagle Winter Roosting (November 15 to March 15)***

- For a construction project planned during the bald eagle winter roosting period and within ¼ mile of a riparian zone with a mature cottonwood component, a pre-construction survey shall be initiated within 10 days prior to the start of construction to verify the presence or absence of bald eagle roosting activity. The surveys must be conducted by qualified biologist(s) according to protocol as set forth by the USFWS. Generally, the survey should be performed during dawn and dusk periods on 2 or more days immediately prior to the construction start date. The survey should be documented and results sent to the Division Head of the SUIT DWRM.

- If one or no bald eagles are found to be roosting within ¼ mile of the study area during the pre-construction survey, work may proceed with no time of day restrictions.
- If two or more bald eagles are found to be roosting within ¼ mile of the proposed construction site study area during the pre-construction survey, the operator will be restricted to working between 10:00 a.m. and 2:00 p.m. on a daily basis.
- If bald eagles continue to occupy or enter the area within ¼ mile of the construction site between the 10:00 a.m. and 2:00 p.m. time window, work will stop until the bald eagles leave the area. Under no circumstances shall bald eagles be harassed in order to disperse them from the area.

***Bald Eagle Spring/Summer Nesting (March 16 to July 1)***

- For a construction project planned during the bald eagle nesting period and within ½ mile of suitable bald eagle nesting habitat (e.g., a riparian area with a mature cottonwood component), a pre-construction survey will be initiated within 10 days prior to the start of construction to verify the presence or absence of bald eagle nesting activity. The survey will be conducted by qualified biologist(s) according to protocol as set forth by the USFWS. Generally, the surveys should be performed during dawn and dusk periods on 2 or more days immediately prior to the construction start date. The survey will be documented and results sent to the Division Head of the SUIT DWRM.
- If no bald eagles are found to be nesting within ½ mile of the proposed construction site during the pre-construction survey, work may proceed with no restriction. If bald eagles are found to be nesting within ½ mile of the construction area, the construction must stop until all signs of nest use have stopped for the year.
- If an active bald eagle nest is known to exist within ½ mile of a proposed construction project, the construction project may not proceed until all signs of nest use have stopped for the year.

## Cultural Resources

- All oil and gas developments with a federal nexus must be implemented in compliance with Section 106 of the National Historic Preservation Act. Regulations implementing this Act require that: (1) cultural resources be thoroughly inventoried within areas that would be potentially affected by these projects; (2) the significance of any identified resources be evaluated; and (3) measures be taken to avoid or mitigate any identified adverse effects on significant resources. This requirement must be done in consultation with the State Historic Preservation Office, Federal Advisory Council on Historic Preservation, BIA, and other interested parties.
- Standard Tribal and BIA procedures require project developers to retain archaeological consultants to intensively survey project areas (accompanied by Tribal representatives), and prepare reports that document the survey results, assess projected impacts, and formulate recommendations about resource significance and measures to avoid or mitigate any identified adverse effects. These procedures must be completed in accordance with all applicable regulations. Standard procedures stipulate that all well site, access road, and pipeline development activities be confined within areas that have been inventoried for cultural resources.
- All work crews would be routinely informed of cultural resource protection laws and that they are subject to prosecution if they collect artifacts or disturb archaeological sites.
- It is anticipated that most projects probably can be modified to avoid direct impacts on archaeological and historical sites. If avoidance is impossible, the potential is high for

satisfactorily mitigating impacts through professional study to recover important data from archaeological and historical sites before they are affected by a proposed project.

- Environmental assessments of any subsequent authorized individual projects would consider impacts on archaeological sites and provide additional opportunities for the Tribe to assess and address protection of traditionally used native species and preservation of SUIT heritage.
- If COAs or other stipulations state that a cultural resources monitor must be present during construction activities and the operator does not comply with that stipulation, the project will be shut down until such monitoring is present. Additionally, lawfully authorized penalties may be imposed for non-compliance.

### Land Use and Ownership

- Situate project facilities, including roads, away from or at the edges of irrigated and non-irrigated agricultural land to the maximum extent practical to reduce direct and indirect effects on agricultural resources and operations.
- Minimize crossings or other direct effects on watershed restoration facilities; agricultural irrigation facilities including water canals, ditches, and pipelines; and other water conveyance systems to the maximum extent practical or provide for their protection to allow them to operate as designed.
- If facilities (e.g., fences, gates, cattle guards) are damaged or displaced by oil and gas activities, they would be repaired or replaced by the operator, to a condition as good as or better than original.
- Restrict project-related construction equipment and vehicle movement to specific, designated access roads to minimize disturbance to potentially sensitive areas.
- Continue to require responsibility for fence, gate, and cattle guard maintenance and for noxious weed control as COAs and stipulations for APDs and ROW grants.
- Develop reclamation plans for all areas that have been disturbed during production, and specify techniques for reclamation of well pads, pipeline ROW, and roads.
- Site facilities to avoid or minimize impacts on livestock or wildlife water. If such water is impacted, measures should be taken to replace the water source in respect to both quantity and quality.
- Site roads, pipelines, and well pads away from residences and out of view from residences as much as possible.
- Work with surface owner, when possible, to pick sites for roads, pipelines, and well pads.
- Choose sites that would provide topographic and vegetative screening for the location of well facilities.
- Use low-profile tanks and other production facilities to minimize visibility.
- Locate facilities away from prominent topographic features.
- If possible, avoid locations near populated areas, parks, scenic areas, hilltops, and natural or man-made structures. For linear facilities such as access roads, avoid crossing hillcrests.
- Where placement of a facility is necessary in a hilltop area, consider locations on the slopes or brow of a hill to minimize the silhouette.

- Paint facilities to match the surrounding vegetation/landscape.
- Design cut-and-fill slopes to achieve maximum compatibility with the surrounding natural topography.
- Align access roads to follow existing grades to minimize cuts and fills.
- Limit the clearing of trees and vegetation for the project facilities to the minimum area required. Clearing edges should be feathered and thinned, as appropriate.

### Public Health and Safety

Additional design features related to public health and safety are listed above under Air Quality and Water Quality.

- Motors or compressors will be located and/or oriented to reduce noise transmission.
- Unless otherwise authorized, the Tribe will require operators to meet noise standards no less stringent than those imposed by the COGCC on lands within its jurisdiction.
- Companies with oil and gas facilities on the Reservation will provide sanitary facilities at locations such that a person would not have to travel by vehicle any longer than 10 minutes from a given location to reach a sanitary facility.
- In the event that personnel are not able to reach a sanitary facility and must relieve themselves on-site, they are expected to have access to a shovel and bury any toilet paper and human waste sufficiently beneath the surface of the ground.
- Panel barriers will be erected around meter houses, pump heads or other surface facilities unless an allottee or private landowner requests fencing of the location. The type and location of barriers would be determined on a case-by-case basis during a site visit.
- Design exterior lighting of project facilities to minimize visual impacts while meeting applicable safety and security objectives.
- The operator will disclose the hydraulic fracturing fluid chemical components to the Tribe, the BLM, and the BIA, and may authorize further public disclosure in a manner consistent with COGCC Order 1R-114, even though that COGCC order is not directly applicable on a jurisdictional basis.

## 2.3 Alternatives Considered but Eliminated from Further Analysis

An alternative responding to an issue, but not substantially accomplishing the purpose and need, is not considered a reasonable alternative to the proposed action. Two alternatives were identified and subsequently eliminated from further analysis during the development of the North Carracas POD. These alternatives are discussed below and will not be evaluated further in this assessment. No other alternatives were identified for the proposed North Carracas POD that would result in fewer environmental impacts and still meet the purpose and need of the proposed action.

### 2.3.1 80-Acre Development Alternative

The North Carracas AMI is comprised of spacing units varying in size and number of wells authorized within each unit. Horizontal drilling and completion are contemplated within these units to minimize surface impacts and the number of wells required to effectively drain the reservoir. If the AMI were

developed using non-horizontal drilling and completion techniques at 80-acre spacing consistent with well density in other parts of the Ignacio-Blanco Field, approximately 128 wells would need to be drilled. This type of development would result in a substantial increase in surface disturbance from new well pads, roads, and pipelines. Since the terms of the AMI lease prohibit the drilling of wells from Tribal Trust lands, not all 128 wells could be drilled under this alternative. This scenario would result in unproduced reserves and a corresponding loss of revenue to the Tribe. Additionally, in some areas, adjoining fee lands could be developed resulting in drainage of Tribal resources and lost revenues. This alternative would result in substantially greater environmental impacts than the proposed action Alternative. This alternative does not meet the action's purpose and need as it would not optimize resource extraction, could result in drainage of Tribal non-renewable mineral resources and a loss of revenue to the Tribe, and would result in greater surface impacts; therefore, it is eliminated from detailed consideration.

### 2.3.2 Electrification Alternative

Providing electrical power to the North Carracas AMI for compressors and other production equipment was considered, but was not economically viable and would result in substantial environmental impacts. Currently, electrical power service to the area is provided by a 7,200 volt single-phase line. To provide minimally sufficient power to operate compressors and other production equipment, it would require upgrading the system to a 12,470-volt three-phase system. This would result in upgrading the entire La Plata Electric Association system from Durango to Arboles. Also, if electrically powered compressors are used, a power substation would need to be built near Arboles. Depending on the specific options, the estimated capital cost for this upgrade would be between $23 and $26 million. This would also require disturbance along an approximate 41-mile corridor that would result in greater impacts to topography, soils, vegetation, wildlife, and land use values. This alternative would not meet the purpose and need of the action, as it would result in greater environmental impacts from ground disturbance.

# 3. AFFECTED ENVIRONMENT

This section describes the environment that would be affected by implementation of the alternatives described in Chapter 2. Aspects of the affected environment described in this section focus on the relevant major resources or issues. Generally, for the purposes of this analysis, the study area is considered the North Carracas AMI, which encompasses approximately 18,123 acres. However, some analyses, such as Socioeconomics, identify a larger resource area to capture a sufficient area of interest. Elements of the human environment potentially affected by the alternatives are described in the following sections.

## 3.1 Air Quality

### 3.1.1 Climate and Wind Characteristics

The climate and prevailing wind characteristics for the project location are summarized in Table 3-1 and Figure 3-1. Table 3-1 includes average monthly maximum and minimum temperatures and average total precipitation for Ignacio, Colorado (Western Regional Climate Center. Ignacio 1N, Colorado (054250). Period of Record Monthly Climate Summary. Period of Record: 8/ 2/1948 to 7/31/1993).

**Table 3-1. Average monthly climate summary for Ignacio, Colorado**

| Measure | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Max. Temperature (F) | 38.8 | 44.6 | 52.1 | 62.2 | 71.9 | 82.9 | 87.5 | 84.7 | 77.5 | 66.1 | 51.4 | 41.8 | 63.4 |
| Average Min. Temperature (F) | 7.1 | 12.7 | 20.6 | 26.6 | 33.7 | 41.1 | 49.4 | 47.7 | 39.4 | 29.9 | 19.5 | 10.5 | 28.2 |
| Average Total Precipitation (in.) | 1.30 | 0.98 | 1.14 | 0.91 | 0.90 | 0.53 | 1.41 | 1.69 | 1.42 | 1.50 | 1.06 | 1.17 | 14.02[1] |

[1] Total annual precipitation summed from monthly average.

Note: F = Fahrenheit; in. = inches

The prevailing wind conditions are measured at Durango/La Plata County Airport NWS Station (WBAN 93005). Composite hourly wind rose from 2002 to 2007 is included in Figure 3-1 (SAT Initiative: Sunnyside Elementary School 2011).

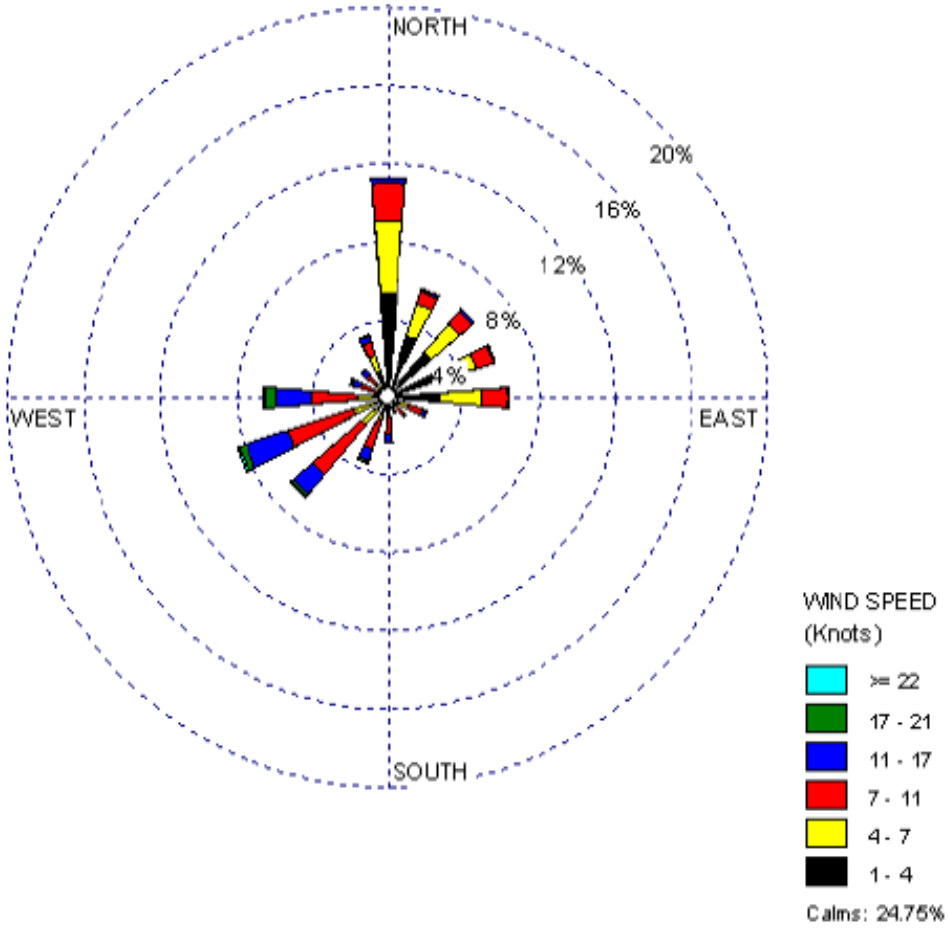


**Figure 3-1. Durango/La Plata County Airport composite hourly wind rose**

The details on the air quality impact analysis (AQIA) are included in Appendix G and summarized in Section 3.1 and 4.1. Please refer to AQIA report for details on background air quality, the approach, and modeling results used to estimate air quality for the proposed action.

Data collected at nearby air quality monitoring stations were used to establish background criteria pollutant air quality levels for the proposed study area. The SUIT collects high quality, representative air quality data from several monitoring stations within the study area. In general, the ambient air measurements show that existing air quality in the project area is good. Concentrations for the various air pollutants are in attainment with the National Ambient Air Quality Standards (NAAQS). Data collected at air quality monitoring stations near the North Carracas AMI were used to establish background criteria pollutant air quality levels used in the AQIA and are shown in Table 3-2.

**Table 3-2. Background ambient air concentrations for the study area**

| Pollutant | Averaging Time | Selected Value | Concentration | NAAQS[a] | Monitoring Station or Reference (years) |
|---|---|---|---|---|---|
| $NO_2$ | Annual | Annual mean | 5.34 ppb (10.04 µg/m$^3$) | 53 ppb | Ignacio S Ute (2009 to 2011) |
| $NO_2$ | 1-hour | 3-year average of 98th percentile daily maximum | 38 ppb (71.44 µg/m$^3$) | 100 ppb | Ignacio S Ute (2009 to 2011) |
| $SO_2$ | 3-hour | Highest 3-hour average over 3 years | 8 ppb (20.9 µg/m$^3$) | 500 ppb | Bloomfield AIRS ID 35-045-0009 (2009 to 2011) |
| $SO_2$ | 1-hour | 3-year average of 99th percentile daily maximum | 6 ppb (15.2 µg/m$^3$) | 75 ppb | Bloomfield AIRS ID 35-045-0009 (2009 to 2011) |
| CO | 8-hour | Max | 0.7 ppm (801.5 µg/m3) | 9 ppm | Ignacio S Ute (2009 to 2011) |
| CO | 1-hour | 2nd Max | 1.3 ppm (1,488.5 µg/m$^3$) | 35 ppm | Ignacio S Ute (2009 to 2011) |
| $O_3$ | 8-hour | 3-year average of annual 4$^{th}$ highest daily maximum | 0.068 ppm | 0.075 ppm | Ignacio S Ute (2009 to 2011) |
| $PM_{2.5}$ | Annual | Annual mean | 4.2 µg/m$^3$ | 12[b] ug/m$^3$ | Ignacio S Ute (2009 to 2011) |
| $PM_{10}$ | 24-hour | 4th highest value in 3 years | 20.8 µg/m$^3$ | 35 ug/m$^3$ | Farmington AIRS ID 35-045-0019 (2009 to 2011) |
| $PM_{2.5}$ | 24-hour | 3-year average of 98th percentile daily mean | 9 µg/m$^3$ | 150 ug/m$^3$ | Ignacio S Ute (2009 to 2011) |

Notes: ppb = parts per billion; ppm = parts per million; µg/m$^3$ = micrograms per cubic meter; PM = particulate matter; $SO_2$ = sulfur dioxide; $NO_2$ = nitrogen dioxide; CO = carbon monoxide; $O_3$ = ozone; NAAQS = National Ambient Air Quality Standards.

[a] Primary (health-based standards).

[b] As promulgated by USEPA on 14 December 2012.

Conservative estimates of background concentrations of all hazardous air pollutants (HAP) except n-hexane and formaldehyde were obtained from monitoring data collected over a 2-month period during 2009 at the Sunnyside Elementary School in Durango, CO as part of the USEPA school air toxics study.[1] These HAP measurements are the closest available to the proposed action but HAP levels at the school are likely higher than actual background HAP concentrations near the proposed action since the Sunnyside School is located in an area with significantly more human activity, including vehicle traffic. Thus, the Sunnyside HAP data are used here only as a conservative estimate of actual background HAP levels and are not intended to be representative of HAP baseline levels. N-hexane and formaldehyde data were not collected as part of the Sunnyside study. Background values for these two HAPs were therefore obtained from the Garfield County (CO) Air Toxics Study (CDPHE 2010). Garfield County is similar to La Plata and Archuleta counties in that it is a largely rural area with several small towns and a significant amount of natural gas production. Background HAP concentrations are provided in Table 4-4 with the impact estimates.

## 3.2 Geology and Mineral Resources

The study area is located in the valley of the San Juan River at its confluence with Navajo Reservoir. North of the valley is Sandoval Mesa and to the south is Carracas Mesa. The general area consists of moderately incised canyons within a relatively narrow (approximate ½-mile width) valley associated with the San Juan River. Tributaries in the project area include Sandoval Creek and Cat Creek from the north and Carracas Creek from the south. Elevations range from approximately 6,235 feet in the valley bottom to 7,380 feet on the mesa tops.

The geology across the San Juan Basin varies and information in this section is taken from literature regarding the basin, but geology within the AMI may vary slightly. A geochronologic chart of the San Juan Basin is shown as Figure 3-2. The oldest formation in the study area that would be affected by the proposed action is the Entrada Formation. As shown on Figure 3-2, the Entrada Sandstone unconformably overlies the Dolores Formation. The Entrada formation is composed of light-gray, cross-bedded sandstone and has a maximum thickness of about 250 feet. The overlying Morrison Formation is composed of two members, the Salt Wash Member and the overlying Brushy Basin Member. The Salt Wash member is comprised primarily of sandstone interbedded with claystone and mudstone while the Brushy Basin Member is mostly varicolored claystone and mudstone. Maximum thickness of the Late Jurassic Morrison Formation is about 800 feet (USDOE 2007).

[1] http://www.epa.gov/schoolair/SunnysideE.html

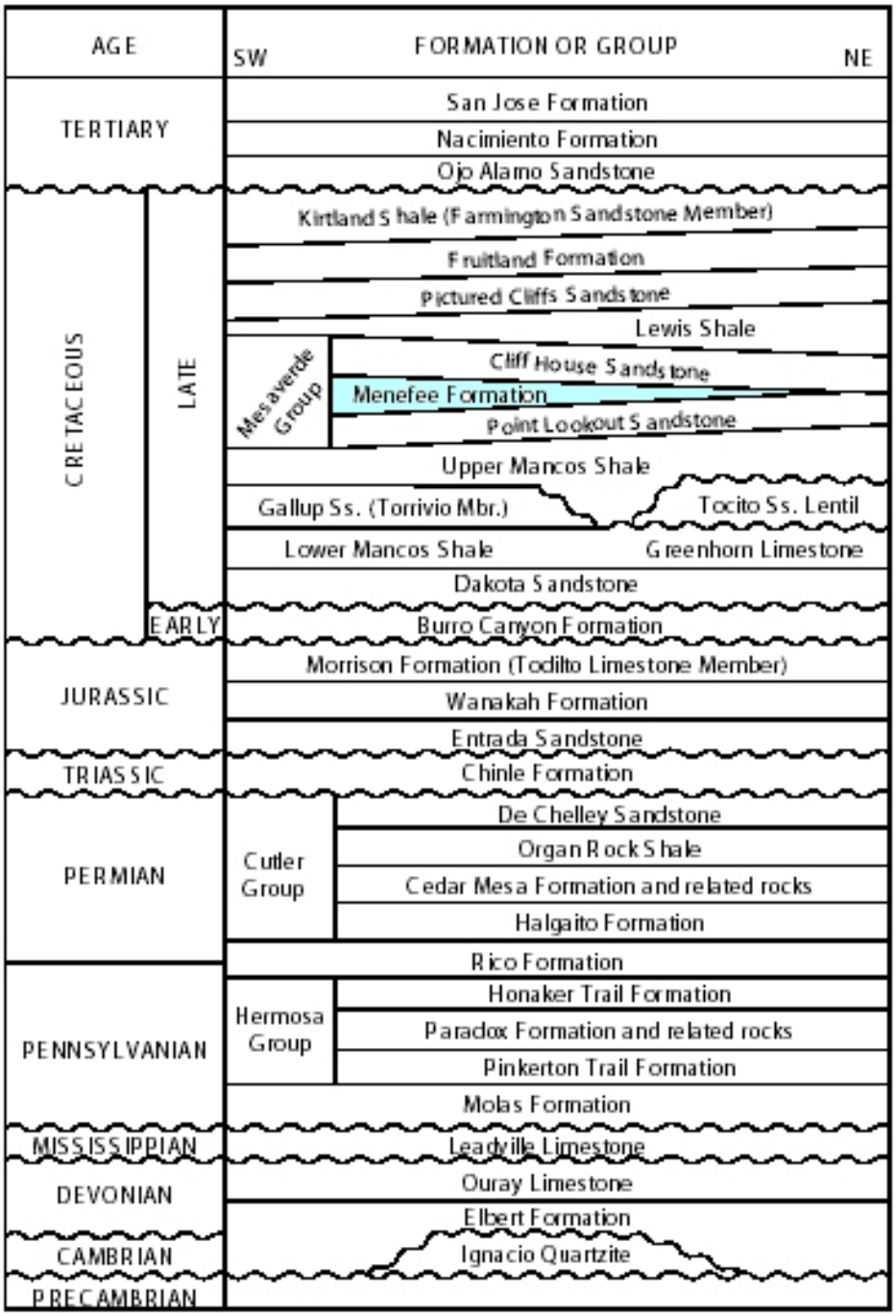


**Figure 3-2. Geologic time column of the San Juan Basin**

As shown in Figure 3-2, the Morrison Formation is overlain disconformably by the Early Cretaceous Burro Canyon Formation, which consists of about 100 feet of lenticular chert-pebble conglomerate interlayered with green and gray claystone (USDOE 2007). The Dakota Sandstone is about 300 feet thick and is composed of sandstone, light gray to yellowish-brown sandstone interbedded with siltstone and black carbonaceous shale. The Dakota Sandstone lies either disconformably over the Burro Canyon Formation or unconformably over the Morrison Formation (Brister and Hoffman 2002). The Dakota

Sandstone is only exposed in the San Juan River valley in the northeast corner of the Reservation, but it underlies the entire Reservation in the subsurface (USDOE 2007).

The Late Cretaceous Mancos Shale conformably overlies the Dakota Sandstone and intertongues with the overlying Point Lookout Sandstone. It underlies the entire Reservation and outcrops in the northeast corner. It is mostly dark gray marine shale and its maximum subsurface thickness on the Reservation is about 2,400 feet. The Dakota Sandstone is an unconventional gas play within the San Juan Basin and the study area. The reservoir quality is highly variable. Production is primarily at depths ranging from 6,500 to 7,500 feet.

The Late Cretaceous Mesaverde Group overlies the Mancos Shale. This group is a series of interbedded sandstones composed of the Point Lookout Sandstone, the Menefee Formation, and the Cliff House Sandstone (Figure 3-2). The Point Lookout Sandstone conformably overlies and is transitional with the Mancos Shale. The Point Lookout Sandstone is divided into a lower sandstone and shale member about 80 to 125 feet thick and an upper massive sandstone member about 200 to 250 feet thick. The sandstone and shale member is comprised of interbedded yellowish gray, fine-grained, cross-laminated sandstone and sandy dark-olive gray, fossiliferous shale. The upper massive sandstone member is composed of thick to massive beds of light gray to yellowish-gray, crossbedded, fine- to medium-grained sandstone. The Menefee Formation consists of a series of interbedded lenses of sandstone, siltstone, shale, and coal. Thin coalbeds occur throughout the formation, but most coalbeds greater than 1 foot thick are in the lowermost portion of the formation, and a few are immediately below the top. The Cliff House Sandstone consists of sandstone, siltstone, and shale, with sandstone becoming thicker toward the southwest. The Cliff House Sandstone interfingers laterally and vertically with the overlying marine Lewis Shale and with the underlying deposits of the upper member of the Menefee Formation. Principal gas reservoirs productive in the Mesaverde group are the Point Lookout and Cliff House marine sandstones.

The Lewis Shale is a marine shale consisting mostly of light-to dark-gray and black shale with interbeds of fine-grained sandstone, limestone, calcareous concretions, and bentonite. Relatively minor gas production is obtained from the Lewis Shale. The Pictured Cliffs is divided into an upper part that consists of one or more massive sandstone beds interbedded with some thin shale beds and a lower transitional zone comprised of thin intercalations of sandstone and shale. The contact with the overlying Fruitland Formation is conformable, with local inter-tonguing (USDOE 2007).

The mineral resources on the Reservation that would be affected by the POD include coal and CBM extracted from the Fruitland Formation. The Late Cretaceous Fruitland Formation is a sequence of inter-bedded and locally carbonaceous sandstones, siltstones, shales, coal, and thin limestone beds in the lower part of the formation. On the east side of the Reservation, the formation outcrops continuously from Archuleta Mesa to the Piedra River (Pratt and Henkes 1976). The formation ranges from about 300 to 500 feet thick on the west side of the Reservation, but thins eastward to about 300 feet in its outcrop area on the east side. Within the study area, the thickness of net coal ranges from 35 to 18, rapidly thinning and bifurcating to the east. The Fruitland Formation contains up to 50 trillion cubic feet (tcf) of CBM in place—half of which may be producible reserves. Production from the Fruitland Formation is controlled by net thickness of coals and is highly dependent on locating natural fractures in the formation.

The Late Cretaceous Kirtland Shale is divided into a lower shale member, a middle sandstone unit called the Farmington Sandstone Member, and an upper shale member. The lower shale member consists of

olive- to medium-gray sandy shale that commonly contains lenses of non-resistant olive-gray, fine-grained sandstone. The lower member also contains thin lenses of carbonaceous shale and abundant amounts of silicified wood at various horizons. The Farmington Member is a sequence of resistant sandstones and beds of shale. The upper shale member consists of shale and interbedded lenses of non-resistant, friable sandstone. The contact between the Kirtland Shale and the Animas Formation is transitional and arbitrary (USDOE 2007).

Surface geology within the study area is shown on Map 5 in Appendix A. Surface geologic material within the project area includes outcrop areas of San Jose and Animas Formation materials, with alluvial material present within drainage areas. The Tertiary-age San Jose Formation consists of siltstones, sandstone, and shales. The Animas Formation crops out in a band of variable width forming an east-west arc across the Reservation. The Tertiary-age Animas Formation consists of sandstone, shale, and conglomerate material.

## 3.3 Soils

General soil types within the project area consist of loams and clay loams with variable silt, sand, and gravel content. Soils are derived from shale and sandstone material exposed on hills and mesas above/up gradient of the study area. Soil characteristics relevant to the proposed POD activities are erosion potential and prime farmland designation. Erosion potential is determined based on soil chemistry, soil texture, parent material, and vegetation cover. Based on these characteristics, soils are rated for erodibility potential by the U.S. Department of Agriculture (USDA/NRCS 2010). The study area has been rated by the Natural Resources Conservation Service (NRCS) and the results are shown in Map 6 in Appendix A.

Prime farmland as designated by the NRCS has a combination of soil properties, growing season, and moisture supply that has potential to produce sustained yields of crops in an economic manner (USDA/NRCS 2010). The study area has been included in a national survey that identifies prime farmland. As the presence of water supply is a key factor in prime farmland, this may be a limiting factor in the study area. Areas identified as prime farmland by the NRCS are shown in Map 6 in Appendix A. There are a total of 2,034 acres of prime farmland within the study area.

## 3.4 Water – Surface and Groundwater

The water resources in the study area include Navajo Reservoir, the San Juan River, and the lower portion of the Piedra River where it empties into the reservoir, the tributary ephemerals to these water bodies, and groundwater aquifers. Domestic wells are drilled into shallow groundwater aquifers for drinking water, particularly in the study area where alluvial deposits are available. Map 7 in Appendix A identifies known domestic water well locations, surface waters, existing gas wells, San Juan Basin non-tributary areas, and National Hydrography Dataset “bluelines” in relation to the proposed development. Existing gas wells are identified in Map 2.

### 3.4.1 Surface Water

The majority of the study area is located within the Upper San Juan River watershed sub-basin, with a small portion located in the Piedra sub-basin. The Piedra and San Juan arms of Navajo Reservoir lie within the study area, as does the San Juan River that feeds the reservoir. The USBR operates the Navajo Dam and Reservoir to carry out the San Juan River Basin Recovery Implementation Program’s Flow

Recommendations for the San Juan River, while also continuing to protect all authorized purposes of the Colorado River Storage Project, including the Navajo Unit, and to protect Indian Trust assets (USDI/USBR 2006). Currently, there are no threatened or impaired surface waters in the study area (CDPHE 2010). Flow is measured on the Piedra River and San Juan River instantaneously by the U.S. Geologic Survey (USGS). The locations of the USGS gages are shown in Map 7. The drainage area to the USGS San Juan River gage near Carracas, Colorado (09346400) is 1,250 square miles and the annual runoff is approximately 434,800 acre-feet (for water years 1971-2011; USGS 2012a). The drainage area to the USGS Piedra River gage near Arboles, Colorado (09349800) is 653 square miles and the annual runoff is approximately 287,400 acre-feet (for water years 1963-2011; USGS 2012b). The monthly average streamflows for these rivers, over the period of record (UGSG 2011a, b), is presented in Figure 3-3.

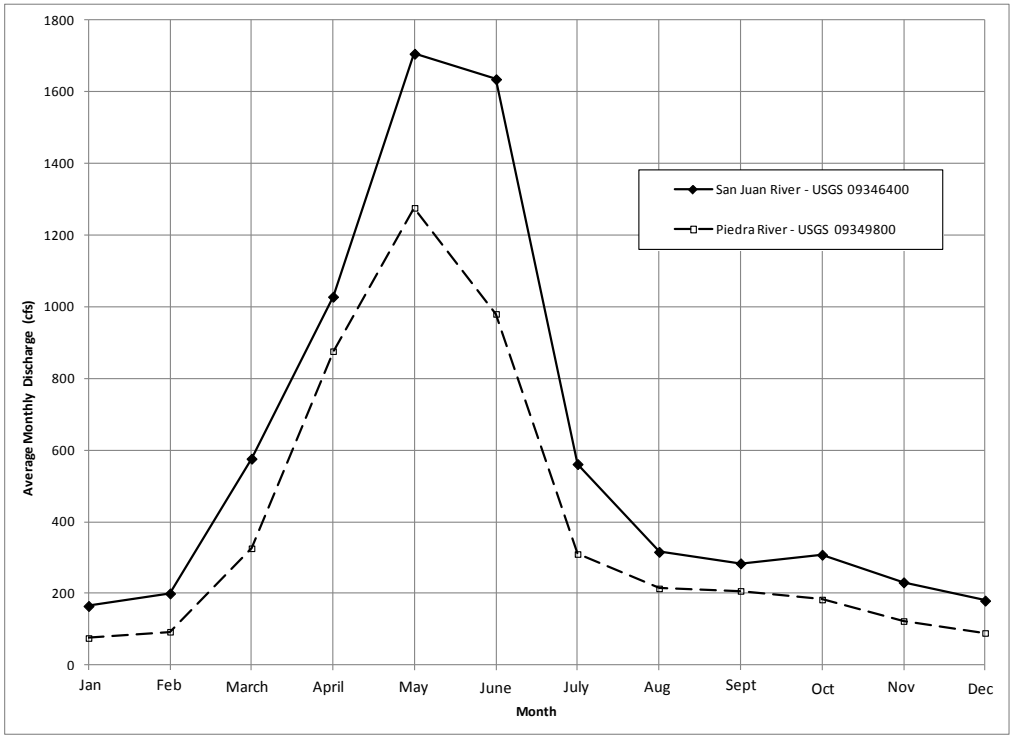


**Figure 3-3. Average monthly flow for the period of record for San Juan River (1971-2011) and Piedra River (1963-2011)**

The Tribe collects surface water quality data biannually on the Piedra River near Carracas (Piedra 2) and on the San Juan River near Arboles (San Juan 2). These data include measurements of total and dissolved metals, nutrients, and macro invertebrates as well as field parameters of dissolved oxygen, conductivity, pH, temperature, and turbidity. The data are input into the USEPA water quality database (STORET). A summary of select water quality parameters, from sampling events performed between March 2006 and January 2013 is presented in Tables 3-3 and 3-4. Respective USEPA aquatic life criteria are also provided in the tables, as the Tribe draft surface water quality standards for surface waters on the Reservation have yet to be approved by the USEPA (Valdez personal communication 2011).

**Table 3-3. Surface water quality data in San Juan River at SUIT monitoring location San Juan 2**

| Analyte | Units | USEPA CCC[a] | Average[b] | Min | Max | % ND |
|---|---|---|---|---|---|---|
| Aluminum – D | mg/l | 0.087 | 0.037 | ND | 0.1 | 57 |
| Aluminum – T | mg/l | - | 3.70 | 0.45 | 13 | 0 |
| Ammonia-nitrogen | mg/l | 2.15 | 0.10 | ND | 0.16 | 50 |
| Arsenic – D | mg/l | 0.150 | 0.0010 | 0.0005 | 0.0012 | 0 |
| Arsenic – T | mg/l | - | 0.0019 | 0.0011 | 0.003 | 0 |
| Cadmium – D | mg/l | 0.00025 | ND | ND | ND | 100 |
| Cadmium – T | mg/l | - | ND | ND | ND | 100 |
| Chloride – D | mg/l | 230 | 5 | 2 | 11 | 0 |
| Chromium – D | mg/l | - | 0.000 | ND | 0.0001 | 86 |
| Chromium – T | mg/l | - | 0.0034 | ND | 0.013 | 14 |
| Chromium(III) – D | mg/l | 0.074 | 0.0061 | 0.0061 | 0.0061 | 0 |
| Chromium(III) – T | mg/l | - | 0.0026 | ND | 0.013 | 33 |
| Chromium(VI) | mg/l | 0.011 | 0.0035 | ND | 0.018 | 71 |
| Copper – D | mg/l | 0.0132 | 0.0039 | ND | 0.01 | 88 |
| Copper – T | mg/l | - | 0.0040 | ND | 0.01 | 86 |
| Dissolved oxygen (DO) | mg/l | 6.5 | 10.65 | 7.53 | 15.29 | 0 |
| Hardness, carbonate | mg/l | - | 114 | 91 | 140 | 0 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | - | 0.14 | 0.13 | 0.14 | 0 |
| Iron – D | mg/l | 1.0 | 0.054 | 0.02 | 0.14 | 0 |
| Iron – T | mg/l | - | 3.77 | 0.54 | 11 | 0 |
| Lead – D/T | mg/l | 0.0025 | ND | ND | ND | 100 |
| Manganese – D | mg/l | - | 0.005 | 0.0019 | 0.0101 | 0 |
| Manganese – T | mg/l | - | 0.075 | 0.0172 | 0.176 | 0 |
| Mercury – D/T | mg/l | 0.00077 | ND | ND | ND | 100 |
| Nickel – D | mg/l | 0.052 | 0.006 | ND | 0.01 | 86 |
| Nickel – T | mg/l | - | ND | ND | ND | 100 |
| pH | None | 6.5-9.0 | 8.08 | 7.43 | 8.56 | 0 |
| Phosphorus – D | mg/l | - | 0.03 | 0.01 | 0.04 | 0 |
| Phosphorus – T | mg/l | - | 0.13 | 0.04 | 0.33 | 0 |
| Selenium – D | mg/l | 0.005 | 0.0003 | ND | 0.0008 | 25 |
| Selenium – T | mg/l | - | 0.0004 | 0.0001 | 0.001 | 0 |
| Silver – D | mg/l | 0.0032 | ND | ND | ND | 100 |
| Silver – T | mg/l | - | ND | ND | ND | 100 |
| Sulfate – D | mg/l | - | 75 | 20 | 140 | 0 |
| Sulfide | mg/l | 0.002 | 0.08 | ND | 0.06 | 71 |
| Temperature, water | deg C | 13.0/23.9 | 8.67 | -0.01 | 23.51 | 0 |
| Total dissolved solids (field) | mg/l | - | 224 | 140 | 305 | 0 |
| Total suspended solids | mg/l | - | 12 | 12 | 13 | 0 |
| Zinc – D | mg/l | 0.12 | ND | ND | ND | 100 |

| Analyte | Units | USEPA CCC[a] | Average[b] | Min | Max | % ND |
|---|---|---|---|---|---|---|
| Zinc – T | mg/l | - | 0.01 | ND | 0.04 | 57 |

[a] CCC=Criterion Continuous Concentration; Source: USEPA National Recommended Water Quality Criteria (Aquatic Life) – http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

[b] Average concentrations calculated using one-half of the value of the Method Detection Limit (MDL) where analyte not detected. MDLs obtained from http://www.caslab.com/EPA-Methods; http://seal-analytical.com/Portals/0/AQ2%20current%20method%20list/aq2-methods-list-EPA%20rev%2032.pdf; or (in few cases) the lowest value of sampled data.

ND = Non-detect; D = dissolved; T = Total; DO = dissolved oxygen; deg C = degrees centigrade; mg/l = milligrams per liter

**Table 3-4. Surface water quality data in Piedra River at SUIT monitoring location Piedra 2**

| Analyte | Units | USEPA CCC[a] | Average[b] | Min | Max | % ND |
|---|---|---|---|---|---|---|
| Aluminum – D | mg/l | 0.087 | 0.03 | ND | 0.04 | 71 |
| Aluminum – T | mg/l | - | 2.01 | 0.2 | 6.8 | 0 |
| Ammonia-nitrogen | mg/l | 1.72 | 0.05 | ND | 0.05 | 50 |
| Arsenic – D | mg/l | 0.150 | 0.0018 | 0.0007 | 0.0036 | 0 |
| Arsenic – T | mg/l | - | 0.0019 | 0.0012 | 0.0026 | 0 |
| Cadmium – D | mg/l | 0.00025 | ND | ND | ND | 100 |
| Cadmium – T | mg/l | - | ND | ND | ND | 100 |
| Chloride – D | mg/l | 230 | 4 | 1 | 6 | 0 |
| Chromium – D | mg/l | - | ND | ND | ND | 100 |
| Chromium – T | mg/l | - | 0.0011 | ND | 0.0031 | 43 |
| Chromium(III) – D | mg/l | 0.074 | 0.0022 | 0.0022 | 0.0022 | 0 |
| Chromium(III) – T | mg/l | - | 0.0006 | ND | 0.0031 | 83 |
| Chromium(VI) – D | mg/l | 0.011 | 0.003 | ND | 0.008 | 57 |
| Copper – D | mg/l | 0.016 | 0.004 | ND | 0.01 | 88 |
| Copper – T | mg/l | - | 1.11 | ND | 7.73 | 71 |
| Dissolved oxygen (DO) | mg/l | 6.5 | 16.46 | 7.55 | 86.2 | 0 |
| Hardness, carbonate | mg/l | - | 147 | 113 | 173 | 0 |
| Inorganic nitrogen (nitrate and nitrite) | mg/l | - | 0.030 | ND | 0.06 | 50 |
| Iron – D | mg/l | 1 | 0.043 | ND | 0.11 | 25 |
| Iron – T | mg/l | - | 2.35 | 0.32 | 7.89 | 0 |
| Lead – D/T | mg/l | 0.0025 | ND | ND | ND | 100 |
| Manganese – D | mg/l | - | 0.0071 | 0.0012 | 0.0136 | 0 |
| Manganese – T | mg/l | - | 0.0588 | 0.0147 | 0.1839 | 0 |
| Mercury – D/T | mg/l | 0.00077 | ND | ND | ND | 100 |
| Nickel – D | mg/l | 0.052 | ND | ND | ND | 100 |
| Nickel – T | mg/l | - | ND | ND | ND | 100 |
| pH | None | 6.5-9.0 | 8.23 | 7.62 | 8.88 | 0 |
| Phosphorus – D | mg/l | - | 0.01 | ND | 0.02 | 29 |
| Phosphorus – T | mg/l | - | 0.08 | 0.02 | 0.27 | 0 |
| Selenium – D | mg/l | 0.005 | 0.0003 | ND | 0.0012 | 25 |
| Selenium – T | mg/l | - | 0.0004 | ND | 0.0012 | 14 |

| Analyte | Units | USEPA CCC[a] | Average[b] | Min | Max | % ND |
|---|---|---|---|---|---|---|
| Silver – D | mg/l | 0.0032 | ND | ND | ND | 100 |
| Silver – T | mg/l | - | ND | ND | ND | 100 |
| Sulfate – D | mg/l | - | 80 | 10 | 120 | 0 |
| Sulfide – T | mg/l | 0.002 | 0.084 | ND | 0.07 | 71 |
| Temperature, water | deg C | 13.0/23.9 | 10.62 | -0.01 | 21.25 | 0 |
| Total dissolved solids (field) | mg/l | - | 220 | 110 | 310 | 0 |
| Total suspended solids | mg/l | - | 11 | 11 | 11 | 0 |
| Zinc – D | mg/l | 0.12 | ND | ND | ND | 100 |
| Zinc – T | mg/l | - | 0.01 | ND | 0.02 | 43 |

[a] CCC=Criterion Continuous Concentration; Source: USEPA National Recommended Water Quality Criteria (Aquatic Life) – http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm

[b] Average concentrations calculated using one-half of the value of the Method Detection Limit (MDL) where analyte not detected. MDLs obtained from http://www.caslab.com/EPA-Methods; http://seal-analytical.com/Portals/0/AQ2%20current%20method%20list/aq2-methods-list-EPA%20rev%2032.pdf; or (in few cases) the lowest value of sampled data.

ND = Non-detect; D = dissolved; T = Total; DO = dissolved oxygen; deg C = degrees centigrade; mg/l = milligrams per liter

## 3.4.2 Groundwater

### 3.4.2.1 Quaternary Aquifer

A hydrogeologic cross section of the San Juan Basin is shown in Figure 3-4. The uppermost aquifer system within the project area is Quaternary alluvium and terrace deposits (refer to Map 5 in Appendix A). These unconsolidated sediments are comprised of gravel, sand, silt, and clay. The alluvial aquifer is unconfined (Topper et al. 2003) and is recharged by infiltration from surface water sources (i.e., San Juan River, Piedra River, and Navajo Reservoir) and secondarily via seepage from rain and snowmelt. The alluvium thickness ranges from 40 to 100 feet (Topper et al. 2003) but may be as thick as 200 feet. Well completion reports indicate alluvial completions to depths as great as 400 feet (CDSS 2013). Terrace deposits are present throughout the site, providing a record of the former floodplain. These deposits are topographically higher (stratigraphically lower) and are present adjacent to streams; compositionally they contain cobbles, pebbles, and gravel (Condon 1990). The typical thickness for terrace deposits is 60 feet (Topper et al. 2003).

Alluvial wells produce 0 to 26 gallons per minute (gpm), but some wells may produce up to 50 gpm depending on thickness and location (Topper et al. 2003). Eighty-five percent of the alluvial wells produce less than 18 gpm and are used for domestic and livestock (Topper et al. 2003).

The TDS concentrations for alluvial wells have been documented and summarized by several sources. Reported TDS concentrations for these shallow wells are typically less than 1,000 milligrams per liter (mg/L) and can be less 500 mg/L in areas of extensive irrigation (Topper et al. 2003).

Existing data for shallow water wells in the study area show a range from 10 to 220 feet in depth. TDS concentrations measured in 18 shallow wells within the study area range from 205 to 1,210 mg/L (Red Willow personal communication 2013).

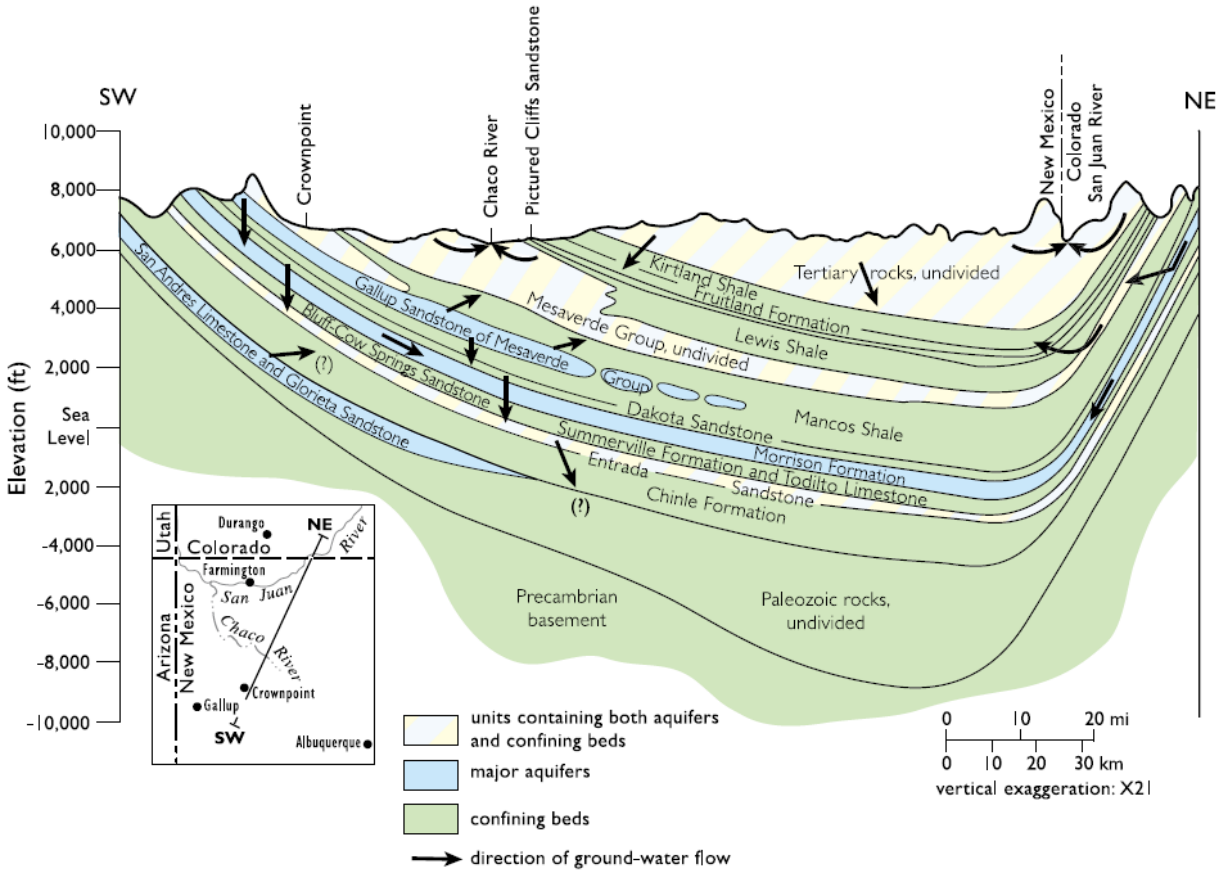


**Figure 3-4. Hydrogeologic cross section of the San Juan Basin**

### 3.4.2.2 Tertiary Aquifer System

The Tertiary aquifer system within the project area is the Animas Aquifer (Figure 3-4). The Animas Aquifer is divided into an Unnamed Member and the McDermott Member, which is generally confined (Topper et al. 2003). Tertiary sandstone units include the Animas, San Jose, Nacimiento, and Ojo Alamo Formations (Condon 1990), which tend to intertongue depending on location (Stone et al. 1983). The Animas and San Jose Formations are exposed in the project area at the surface, with recharge areas located at higher elevations where these formations outcrop.

Typical lithologies include shale, breccia, conglomerate, and tuffaceous sandstone, which together comprise the Animas Aquifer (Topper et al. 2003). Formation thickness ranges, listed by Condon (1990), include: San Jose Formation 1,100 to 2,500 feet; Nacimiento 350 to 1,100 feet, and the Animas Formation 1,300 to 2,600 feet. The total depth of the Animas Aquifer, undivided and including the Upper Cretaceous McDermott Member is 2,700 feet (Topper et al. 2003).

Well yields for the Animas Aquifer range from 1 to 10 gpm (Topper et al. 2003; Brogden et al. 1979).

TDS concentrations within the Animas Aquifer range from 114 to 916 mg/L (Topper et al. 2003). In general, TDS concentration within bedrock formations increases from the recharge areas to the center of the basin (USDI 2002).

#### 3.4.2.3 Cretaceous Aquifer System

The Animas Aquifer is separated from Cretaceous water-bearing formations by the Kirtland Shale (Figure 3-4). The Kirtland Shale is an interbedded sandstone, shale, and siltstone, which contains water producing intervals where fractured (Brogden et al. 1979) and within the Farmington Sandstone Member of the Kirtland Shale (Topper et al. 2003). The Farmington Sandstone is reported as 350 feet thick and separated by beds of shale, which range from 185 to 455 thick for the upper member and 195 to 325 feet for the lower member (Condon 1990). Maximum thickness for the Kirtland Shale is 1,500 feet (Topper et al. 2003).

The Fruitland Formation is the target coalbed seam for the proposed activities. The Fruitland Formation is below the Kirtland Shale and above the Pictured Cliffs Sandstone. In the northern part of the basin, the Pictured Cliffs intertongues with Fruitland, and it is within these intertongues that thick accumulations of coal were deposited (Ambrose and Ayers 2007). Toward the center of the San Juan Basin, the Pictured Cliffs Sandstone lies beneath the Fruitland Formation.

The Fruitland Formation is interbedded with sandstone, shale, and coal and is approximately 500 feet thick (Topper et al. 2003). Similar to other formations within the San Juan Basin, the recharge areas are along outcrops within the higher elevation margins of the basin. The estimated recharge to the Fruitland Formation is 200 acre-feet per year (SSPA 2006). The aquifer is likely unconfined in these recharge areas and confined in a basinward direction (SSPA 2006).

Water well yields in the Fruitland Formation range from 1 to 12 gpm (Topper et al. 2003). TDS concentrations range from 310 to 29,000 mg/L (Topper et al. 2003). The high TDS values may be associated with the marine origin of this formation as well as the diagenetic processes related to coal production (SSPA 2006).

Three tongues of the Pictured Cliffs Sandstone within the Fruitland Formation have been identified in the northern San Juan Basin and vary in thickness up to 100 feet (Ambrose and Ayers 2007). Elsewhere within the basin, the majority of the Pictured Cliffs lies beneath the Fruitland Formation. The intertonguing has led some researchers to consider the Fruitland Formation and the upper Pictured Cliffs Sandstone as a single hydrologic unit (SSPA 2006).

The Lewis Shale lies beneath the Pictured Cliffs Sandstone forming a confining layer and separating the Pictured Cliffs from the Mesaverde Aquifer (Topper et al. 2003). The Lewis Shale is approximately 1,800 feet thick (Topper et al. 2003).

A salt-water disposal well for produced water is proposed under the action. The produced water would be injected into the target formations—Bluff Sandstone and/or Entrada Sandstone. The Bluff/Entrada Formation is commonly used as a Class II injection formation (USEPA 2004a) and the USEPA has issued permits for injection into these formations in the northern San Juan Basin (Tom Aalto, personal communication March 20, 2013). The depth of these injected formations is targeted between 8,000 and 9,000 feet.

#### 3.4.2.4 Existing Well Inventory

There are two different classes of wells: those that are exempt from water rights administration and are not administered under the priority system, and those that are decreed, or non-exempt, and are governed

by the priority system. The decreed well has an official document issued by the court that defines the priority, amount, use, and location of the water right, while exempt wells are not subject to administration under the priority system. Approximately 135 water wells are located within 1 mile of the project area (CDSS 2013). Twelve of these are decreed wells and 123 are exempt wells. Map 7 provides the locations of these wells and is keyed to the use (i.e., decreed, exempt, domestic, or commercial). The majority of the wells are located near the western boundary of the project near the main body of the Navajo Reservoir. Approximately 72 percent of the exempt wells are for domestic use and are completed in the shallow alluvial or unconsolidated terrace deposits. The other major use categories of exempt wells are industrial wells at 12 percent and commercial wells at 7 percent, while irrigation, municipal, stock, and other use wells make up the remaining approximately 8 percent.

The domestic and commercial wells completed in the alluvial and terrace deposits averaged approximately 150 feet deep (CDSS 2013). The CDSS database did not include well completion information for the industrial wells. The irrigation, municipal, and other use wells averaged approximately 70 feet deep (CDSS 2013). Six of the exempt wells were deep wells completed in the Fruitland Formation. Only one of these wells had completion information, which indicated a completion depth of 2,950 feet. The 14 decreed wells have decreed rates ranging from a minimum of 4.9 to a maximum of 900 gpm. The well completion information available for the decreed wells indicated they were completed in the alluvial or terrace deposits and had minimum and maximum depths of 26 and 353 feet, respectively, and averaged approximately 140 feet.

## 3.5 Vegetation

Vegetation communities within the study area were derived from the Provisional Data Set for the Southwest Regional Gap Analysis Project (Utah State University 2004). According to the data set, 15 major vegetation communities occur within the study area (Utah State University 2004; USGS 2005a). Refer to Map 8 in Appendix A for the distribution of these community types within the study area. These communities and associated acreages within the study area are listed in Table 3-5. It is important to note that the Gap Analysis Program data were based on satellite imagery and that land cover maps are not considered a precise representation of the landscape, as they are coarse-grained and have not been field-verified. However, for the purposes of broad-scale management activities, the data set provides useful information for land managers and decision makers.

**Table 3-5. Vegetation communities and associated acreages within the study area**

| Description | Acres in Study Area | Percent of Study Area[1] |
|---|---|---|
| Colorado Plateau Piñon-Juniper Woodland | 10,595.6 | 58.5 |
| Rocky Mountain Ponderosa Pine Woodland | 1,569.1 | 8.7 |
| Rocky Mountain Lower Montane Riparian Woodland and Shrubland | 1,566.3 | 8.6 |
| Rocky Mountain Gambel Oak-Mixed Montane Shrubland | 1,425.3 | 7.7 |
| Inter-Mountain Basins Big Sagebrush Shrubland | 1,240.1 | 6.8 |
| Inter-Mountain Basins Semi-Desert Shrub Steppe | 294.0 | 1.6 |
| Southern Rocky Mountain Montane-Subalpine Grassland | 146.2 | 0.8 |
| Rocky Mountain Lower Montane-Foothill Shrubland | 49.6 | 0.3 |
| Inter-Mountain Basins Semi-Desert Grassland | 24.9 | 0.1 |
| Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland | 19.1 | 0.1 |
| Colorado Plateau Mixed Bedrock Canyon and Tableland | 12.2 | 0.07 |
| Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland | 8.1 | 0.04 |
| Inter-Mountain Basins Greasewood Flat | 3.9 | 0.02 |
| Southern Rocky Mountain Piñon-Juniper Woodland | 1.8 | 0.01 |
| North American Arid West Emergent Marsh | 1.6 | 0.01 |
| Open Water | 1,165.4 | 6.4 |
| **Total** | **18,123** | |

[1] Acreage estimates may be marginally more or less than 100 percent based on GIS polygon analysis

Colorado Plateau Piñon-Juniper Woodland comprises the majority of vegetation within the study area. The community is dominated by piñon pine (*Pinus edulis*) and two juniper species—Utah juniper (*Juniperus osteosperma*) and Rocky Mountain juniper (*Juniperus scopulorum*). These species may co-dominate, but often Rocky Mountain juniper dominates at higher elevations. Common associated understory species include antelope bitterbrush (*Purshia tridentata*), big sagebrush (*Artemisia tridentata*), blue grama (*Bouteloua gracilis*), and James' galleta grass (*Pleuraphis jamesii*). Piñon-juniper woodlands occur across approximately 10,596 acres, or 58.5 percent of the study area.

Rocky Mountain Ponderosa Pine Woodlands are dominated by ponderosa pine (*Pinus ponderosa*). The typically shrubby understory is often comprised of Gambel oak (*Quercus gambelii),* snowberry (*Symphoricarpos* spp.), and serviceberry (*Amelanchier* spp.). Ponderosa pine woodlands occur across approximately 1,569 acres, or 8.7 percent of the study area.

The overstory layer of the Rocky Mountain Lower Montane Riparian Woodland/Shrubland in the study area is dominated by narrowleaf cottonwood (*Populus angustifolia).* Rocky Mountain juniper occurs scattered throughout the riparian areas. Common understory shrubs include thinleaf alder (*Alnus incana*), skunkbush sumac (*Rhus trilobata*), willow (*Salix* spp.), silver buffaloberry (*Shepherdia argentea*), and

snowberry. The herbaceous understory is typically composed of native and introduced grasses and forbs. Riparian woodlands/shrublands occur across about 1,566 acres, or 8.6 percent of the study area.

Rocky Mountain Gambel Oak Mixed Shrublands are dominated by Gambel oak, with common co-dominant species of serviceberry, snowberry, big sagebrush, and chokecherry (*Prunus virginiana).* The herbaceous understory is typically composed of mixed herbaceous species and grasses. Gambel oak mixed shrublands occur across about 1,425 acres, or 7.7 percent of the study area.

Inter-Mountain Basins Big Sagebrush Shrublands are dominated by big sagebrush, commonly found intermixed with scattered juniper individuals (*Juniperus* spp.). Other shrub species commonly found with big sagebrush include rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus),* and antelope bitterbrush. Herbaceous species typically do not contribute a high percentage of vegetative cover within this community. Sagebrush shrubland occurs across 1,240 acres, or 6.8 percent of the study area.

Inter-Mountain Basins Semi-Desert Shrub Steppe typically occurs at lower elevations on alluvial fans and flats. The community supports Indian ricegrass (*Achnatherum hymenoides*), blue grama, galleta, saltgrass (*Distichlis spicata*), and needle and thread (*Herspoerostipa comata*). The woody layer is usually a mixture of shrubs and dwarf-shrubs including big sagebrush, rubber rabbitbrush, broom snakeweed (*Gutierrezia sarothrae*), and winterfat (*Krascheninnikovia lanata*). Approximately 294 acres, or 1.6 percent of the study area contains this vegetation community.

The Southern Rocky Mountain Montane-Subalpine Grassland occurs on dry slopes and consists of a mosaic of grass species commonly including oatgrass (*Danthonia* spp.), fescue (*Festuca* spp.), muhly (*Muhlenbergia* spp.), often with blue grama. Montane grasslands occur across approximately 146.2 acres, or less than 1 percent of the study area.

The Rocky Mountain Lower Montane-Foothill Shrubland vegetation is typically associated with exposed sites or rocky, dry conditions. It is dominated by serviceberry, antelope bitterbrush, mountain mahogany (*Cercocarpus montanus*), currant (*Ribes* spp.), or soapweed yucca (*Yucca glauca*). This vegetation community may have inclusions of scattered trees or patches of grassland. Common grass species include muhly, needle and thread (*Hesperostipa* spp.), and blue grama. These shrublands occur across about 50 acres, or less than 1 percent of the study area.

Dry plains and mesas throughout the intermountain west are vegetated with Inter-Mountain Basins Semi-Desert Grassland. These grasslands may occur in lowland and upland areas and are typically xeric (dry). The dominant perennial bunch grasses and shrubs in this community are all very drought-resistant. Dominant species include Indian ricegrass, threeawn (*Aristida* spp.), grama, needle and thread, James' galleta, big sagebrush, broom snakeweed and blackbrush (*Coleogyne* spp.). Approximately 25 acres or less than 1 percent of this vegetation community occurs within the study area.

Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland comprises less than 1 percent of the study area at approximately 19 acres. This is a mixed conifer forest containing ponderosa, white fir (*Abies concolor*), Douglas fir (*Pseudotsuga menziesii*), and blue spruce (*Picea pungens*).

Colorado Plateau Mixed Bedrock Canyon and Tableland community type is comprised of barren and sparsely vegetated landscapes, usually with less than 10 percent vegetation cover, on steep cliff faces,

narrow canyons, and open tablelands of sedimentary rocks such as sandstone, shale, and limestone. The vegetation is characterized by very open tree canopy and a minimal understory. Dominant species include piñon pine, juniper, and ponderosa pine. Approximately 8 acres, or less than 1 percent of this community type occurs within the study area.

According to the data set, the study area also contains small amounts of Inter-Mountain Basins Greasewood Flat, Southern Rocky Mountain Piñon-Juniper Woodland, and North American Arid West Emergent Marsh. Each of these community types accounts for less than 5 acres, or 1 percent of total vegetation within the study area.

Open water associated mainly with Navajo Reservoir accounts for approximately 6.4 percent of the study area.

### 3.5.1 Wetlands

A search of the USFWS's National Wetland Inventory map database indicated that wetland delineations are currently being processed for Archuleta County, Colorado (USDI/USFWS 2011). Scanned vector graphics are available for reference on the USFWS wetlands mapping website; however, no final National Wetland Inventory maps are currently available for the study area. The scanned graphics show riverine wetland complexes in the study area along the San Juan River corridor.

### 3.5.2 Invasive, Non-native Species

The Federal Noxious Weed Act of 1974, as amended (7 USC 2801−2814), defines a noxious weed as "any living stage, such as seeds and reproductive parts, of any parasitic or other plant of a kind, which is of foreign origin, is new to or not widely prevalent in the United States, and can directly or indirectly injure crops, other useful plants, livestock, or poultry or other interests of agriculture, including irrigation, or navigation, or the fish or wildlife resources of the United States or the public health."

Noxious weeds are likely present throughout the study area. The most heavily impacted areas are probably along roadsides and areas associated with disturbance from existing roads, oil and gas development, agriculture, and grazing. According to the SUIT NRMP update, the management units covering the study area have significant noxious weed infestations (SUIT 2012a).

Archuleta County does not have a mandate for weed control or enforcement (Ratliff 2011). The Tribe has taken responsibility for all noxious weed management on tribal lands. Currently, the SUIT utilizes the State of Colorado, Department of Agriculture's noxious weed lists (Colorado Department of Agriculture 2011) as a guide to determine what qualifies as a noxious weed and to what level of control is desirable. The Colorado Noxious Weed List is divided into three sub-lists—List A, List B, and List C. The management guidelines for populations of all species on List A are for eradication. List B species entail implementation of a cooperative state and local government-developed management plan designed to stop the continued spread of these species. List C weed species are species for which additional education, research, and biological control resources is provided to jurisdictions that choose to manage these species.

Colorado Noxious Weed List Class A and B species known to occur within the study area include musk thistle (*Carduus nutans),* Canada thistle (*Cirsium arvense),* Russian olive *(Elaeagnus angustifolia),* and tamarisk or saltcedar (*Tamarix* spp.) (Freeman et al. 2006). Other List A and B species known to occur

elsewhere on the Reservation with the potential to occur in the study area include hoary cress (*Cardaria draba*), leafy spurge (*Euphorbia esula*), oxeye daisy (*Chrysanthemum leucanthemum*), Russian knapweed (*Acroptilon repens*), spotted knapweed (*Centaurea maculosa*), and yellow toadflax (*Linaria vulgaris*) (USDI 2009).

## 3.6 Wildlife and Fisheries

### 3.6.1 Game Species

Game species are defined as those that are actively managed for harvest on the Reservation by the SUIT DWRM. Hunting activities on the Reservation are regulated and enforced under authority of the Tribe through its Wildlife Conservation Code, Title 13. Hunting permits are generally restricted to Tribal members; however, the 2013 Cow Elk Hunt is open to Native Americans from other Tribes. Game species legal for harvest on the Reservation include a variety of big and small game mammals, as well as upland game birds and waterfowl. Big game species include elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), mountain lion (*Felis concolor*), and Merriam's wild turkey (*Meleagris gallopavo merriami*). Black bear (*Ursus americanus*) is also considered a big game species in the State of Colorado; however, no black bear hunting occurs on the Reservation. Actual harvest of game species by SUIT members is low because of the relatively small hunter population—less than 250 hunters for deer and elk (USDI 2009). Additional information on hunting is provided in Section 3.12: Recreation.

#### 3.6.1.1 Big Game

Both elk and deer are found throughout the Reservation and within the study area. The SUIT does not prescribe specific population objectives for its deer and elk herds. The SUIT DWRM is tasked with monitoring the herds to determine population trends and herd health. Dramatic swings in trends will elicit management action. For example, in 2003, when it was determined that elk population trends were rising dramatically and Tribal hunter harvest was not sufficient to influence those numbers, an additional harvest through non-member hunting was recommended (A. Johnson, personal communication 2011a).

Currently, age ratios continue to suggest good reproduction and sufficient survival, indicating that deer and elk herds across most of the Reservation are healthy and stable (A. Johnson, personal communication 2011a). Map 9 in Appendix A shows the extent of big game winter range and calving/fawning habitat within the study area.

The SUIT DWRM has identified two main challenges in effectively managing big game herds along the San Juan River corridor within the study area. The first is habitat degradation due to wild horses on Tribal lands. Wild horse herds roam throughout the Carracas Mesa and Rosa Mesa area in New Mexico and Colorado. The Forest Services has historically managed the wild horse herds in New Mexico, but they are currently managed by the BLM Farmington Field Office, and are in the planning process of evaluating herd management options (I. Gold, personal communication 2011). The SUIT DWRM has established habitat exclosures along the San Juan River corridor to quantify the impact wild horses are having on big game winter range habitats. The results from these exclosure studies will not be available for several years.

The second challenge to managing big game and habitat in the study area is new energy development. The SUIT DWRM has been in the process of studying big game winter and migration movements since

2004. Global Positioning System radio collars have been deployed on mule deer within the study area. The collars collect specific data on winter range habitat use, migration routes into and out of the winter ranges, and timing of migration. Some of these data were the basis for developing mitigation measures for winter development within the study area (A. Johnson, personal communication 2011a). Data collected by the SUIT on radio-collared mule deer since 2004 indicate that only about 10 percent of the population is resident (A. Johnson, personal communication 2011c). Map 10 in Appendix A shows the modeled seasonal migratory movements in the study area based on radio collar data. The data are based on 8 mule deer and 28 seasonal migratory movements (15 spring migrations and 13 fall migrations). The data were collected between 2007 and 2008 as part of a larger study area. It is important to note that these data are represented as a very small set and not the limits of mule deer winter range in the area. However, the model does show that mule deer in the area tend to migrate along the San Juan River corridor and in areas with milder terrain. As shown in Map 11 in Appendix A, mule deer winter use in the area has also been modeled. The map illustrates winter range modeled using eight deer that were collared in 2007 and 2009, representing a minimum of two winter's worth of data that were collected at 5-hour intervals (A. Johnson, personal communication 2011c). Even though these models provide information on mule deer migration routes and use in the area, they are based on small sample sizes; therefore, it would be expected that mule deer, and likely elk, utilize much of the study area during the winter months. Further data collection and study may provide more robust information on heavy use areas and travel corridors within the study area.

Mountain lions occur throughout the Reservation in almost every habitat type. However, they are most often found in foothills and canyons associated with piñon-juniper woodlands, montane forests, and shrublands (USDI 2009). The SUIT DWRM does not track population numbers currently, but mountain lion populations are considered healthy and stable across the Reservation (A. Johnson, personal communication 2011d).

Wild turkeys occur throughout the Reservation. While Merriam's turkeys breed primarily in ponderosa pine and pine-oak habitats, breeding turkeys have also been documented in piñon-juniper habitats throughout the Reservation. During winter, turkeys may occur in ponderosa pine or migrate to lower elevation piñon-juniper woodlands (Hoffman et al. 1993). Currently, there are no population estimates for wild turkeys on the Reservation; however, SUIT DWRM staff considers wild turkey populations to be healthy and stable across the Reservation (A. Johnson, personal communication 2011d).

Though black bears occur on the Reservation, there is no black bear hunt on the Reservation due to SUIT cultural beliefs. Black bears may occur in almost any habitat type that provides adequate food resources and cover. However, they are most often found in montane shrublands and forests and subalpine forests where oak or berry-producing shrubs occur (Fitzgerald et al. 1994). Currently, there are no data available on black bear population trends or size for the Reservation; however, black bear populations appear to be stable and healthy across the Reservation (A. Johnson, personal communication 2011d).

#### 3.6.1.2 Small Game

Small game species may be harvested year round on the Reservation by hunting or trapping with no bag limits. Small game species available for harvest include:

- Bobcat (*Lynx rufus*)
- Coyote (*Canis latrans*)

- Gray fox (*Urocyon cinereoargenteus*)
- Red fox (*Vulpes vulpes*)
- Prairie dog (*Cynomys* spp.)
- Beaver (*Castor canadensis*)
- Black-tailed jackrabbit (*Lepus californicus*)
- Weasel (*Mustela* spp.)
- Ringtail (*Bassariscus astutus*)
- Muskrat (*Ondatra zibethicus*)
- Tree squirrel (*Microsciurus*, *Sciurus*, and *Tamiasciurus* spp.)
- Raccoon (*Procyon lotor*)

Many of these species are considered generalists, occurring in more than one or several habitat types; however, prairie dogs and jackrabbits are generally restricted to semi-desert grasslands and open shrublands. Beavers require aquatic habitats and may only be found in riparian woodlands and wetland habitats within the study area.

#### 3.6.1.3 Upland Game Birds and Waterfowl

Upland game birds with hunting seasons on the Reservation include dusky grouse (*Dendragapus obscurus obscurus*), Gambel's quail (*Callipepla gambelii*), and mourning dove (*Zenaida macroura*).

Waterfowl most likely to occur within the study area include (USDI 2009):

- Canada goose (*Branta canadensis*)
- Bufflehead (*Bucephala albeola*)
- Mallard (*Anas platyrhynchos*)
- Northern pintail (*Anas acuta*)
- Gadwall (*Anas strepera*)
- American wigeon (*Anas americana*)
- Northern shoveler (*Anas clypeata*)
- Blue-winged teal (*Anus discors*)
- Cinnamon teal (*Anus cyanoptera*)
- Green-winged teal (*Anas crecca*)
- Redhead (*Aythya americana*)
- Ring-necked duck (*Aytha collaris*)
- Lesser scaup (*Aythya affinis*)
- Common goldeneye (*Bucephala clangula*)
- Common merganser (*Mergus merganser*)
- Ruddy duck (*Oxyura jamaicensis)*

### 3.6.2 Non-Game Species

Non-game species are defined as those species not actively managed for harvest and include a wide variety of mammals, birds, reptiles, and amphibians.

Nearly 60 percent of vegetation within the study area is comprised of piñon-juniper woodland. Ponderosa pine woodland, lower montane woodland, and Gambel oak mixed montane woodland each cover roughly 8 to 10 percent of the study area. Together these vegetation communities comprise over 75 percent of the study area. Based on these habitat types, some mammals likely to occur in the study area are considered habitat generalists and may be found in numerous vegetative communities, such as dwarf shrew (*Sorex nanus*), Townsend's big-eared bat (*Plecotus townsendii*), least chipmunk (*Eutamius minimus*), Botta's pocket gopher (*Thomomys bottae*), and deer mouse (*Peromyscus maniculatus*). Other species that could utilize study area woodlands include piñon mouse (*Peromyscus truei*)—restricted to piñon-juniper woodlands; Abert's squirrel (*Sciurus aberti*)—only found in ponderosa pine forest; and southern red-backed vole (*Clethrionomys gapperi*) and montane vole (*Microtis montanus*)—only found in montane forest habitats.

Reptiles that may commonly be found in the area are prairie rattlesnake (*Crotalus viridis*), collared lizard (*Crotaphytus collaris*), western whiptail (*Cnemidophorus tigris*), and bull snake (*Pituophis melanoeucus*).

Probably the most common amphibians in the study area are tiger salamander (*Ambystoma tigrinum*), which may occur in wetland or riparian habitats throughout almost all the vegetative communities in the study area. Also found are the Woodhouse's toad (*Bufo woodhousei*) and western chorus frog (*Pseudacris triseriata*), both of which are widespread and common throughout their range.

### 3.6.3 Fisheries

The study area includes portions of the upper San Juan River and Navajo Reservoir that provide habitat for a variety of fish species. In the summer of 2011, the SUIT DWRM conducted electrofishing surveys on the San Juan River near Pagosa Junction, upstream of the study area. Native fish species documented during the surveys include:

- Bluehead sucker (*Catostomus discobolus*)
- Flannelmouth sucker (*Catostomus latipinnis*)
- Roundtail chub (*Gila robusta*)
- Speckled dace (*Rhinichthys osculus*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Brown trout (*Salmo trutta*)
- Mottled sculpin (*Cottus bairdi*)
- White sucker (*Catostomus commersoni*)
- Common carp (*Cyprinus carpio*)
- Channel catfish (*Ictalurus punctatus*)
- Smallmouth bass (*Micropterus dolomieui*).

Two hybrid species were also documented—a flannelmouth sucker/white sucker cross and a bluehead sucker/white sucker cross (B. Zimmerman, personal communication 2011). The SUIT DWRM does not stock the San Juan River for sport fishing, but has been stocking roundtail chub for several years to aid in the species recovery (B. Zimmerman, personal communication 2011). Fishing on the Tribal lands is regulated and enforced under authority of the SUIT through its Wildlife Conservation Code, Title 13. Fishing permits are free to SUIT members and are available for purchase to non-members.

### 3.6.4 Migratory Birds

In general, all native, non-game bird species, regardless of migratory status, are protected under the Migratory Bird Treaty Act (MBTA). Under the Act (16 USC 703-712) and Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds," federal agencies are required to consider impacts to migratory birds from management activities. In keeping with this mandate, several avian conservation plans were consulted to identify species at greater conservation risk based on moderate to severe threats to the species or their habitats and on unknown or declining local population trends. These plans include the USFWS Birds of Conservation Concern 2008 report (USDI/USFWS 2008) and the Colorado Partners in Flight Colorado Bird Conservation Plan (COPIF 2000).

The piñon-juniper woodland in and surrounding the study area provides foraging and roosting habitat for large raptors including golden eagle (*Aquila chrysaetos*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), and red-tailed hawk (*Buteo jamaicensis*). A variety of bird species may nest in the proposed project area such as house finch (*Carpodacus mexicanus*), chipping sparrow (*Spizella passerina*), blue-gray gnatcatcher (*Polioptila caerulea*), western scrub jay (*Aphelocoma californica*), mountain chickadee (*Parus gambeli*), and bushtit (*Psaltriparus minimus*).

The sagebrush shrublands and montane grassland habitats in and surrounding the study area provide foraging habitat for large raptors including golden eagle, prairie falcon, and red-tailed hawk. A variety of bird species also may be found such as western kingbird (*Tyrannus verticalis*), ash-throated flycatcher (*Myiarchus cinerascens*), horned lark (*Eremophila alpestris*), and rock wren (*Salpinctes obsoletus*).

Riparian woodlands/shrublands are utilized by more avian species than any other habitat in Colorado (COPIF 2000). Lower montane riparian areas also provide important nesting and foraging habitat for a wide variety of bird species including American kestrel (*Falco sparverius*), great horned owl (*Bubo virginianus*), yellow warbler (*Dendroica petechia*), and Bullock's oriole (*Icterus bullockii*).

A variety of bird species may nest in ponderosa pine woodlands such as wild turkey, Williamson's sapsucker (*Sphyrapicus thyroideus*), pygmy nuthatch (*Sitta pygmaea*), western bluebird (*Sialia mexicana*), and chipping sparrow.

Birds with potential to occur in the study area typically nest, in either shrubs or trees during the period from mid-April through mid-July. Habitats within the study area also may be utilized as foraging habitat by birds during the non-breeding season such as mourning dove, mountain bluebird (*Sialia currucoides*), and dark-eyed junco (*Juncus hyemalis*).

Important Bird Areas are identified by the National Audubon Society and are recognized as globally important habitats for the conservation of bird populations. There are no Important Bird Areas within the study area.

#### 3.6.4.1 Bald and Golden Eagle Act

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles are protected under the MBTA and the Bald and Golden Eagle Protection Act (16 USC 668). The Bald and Golden Eagle Protection Act provides for the protection of the bald eagle (the national emblem) and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession, and commerce of such birds.

There are no documented bald eagle nests within the study area and the closest nest is over 5 miles away from the west end of the study area boundary. Bald eagles do, however, commonly overwinter all along the San Juan River throughout the entire study area. It is also common for a dozen eagles to be counted along Navajo Reservoir to a few miles up the San Juan during SUIT DWRM aerial big game counts. There are no recorded golden eagle territories within 5 miles of the study area (A. Johnson, personal communication 2011b).

## 3.7 Threatened and Endangered Species

Under section 7 of the Endangered Species Act of 1973, as amended, (16 USC 1531 et seq.), federal agencies are required to consult with the USFWS on any proposed action that may affect federally listed threatened or endangered species or species proposed for listing. According to the USFWS, there are 10 threatened, endangered, or candidate species with potential to occur in Archuleta County and on the SUIT Reservation (SUIT 2012a). These species are listed in Table 3-6 with their protection status, a description of their habitats, and their potential to occur in the study area.

**Table 3-6. Flora/fauna listed by USFWS as threatened, endangered, or candidate with potential to occur in Archuleta County and the Southern Ute Indian Reservation**

| Species | Status[1] | Habitat Description | Potential to Occur in the Study Area |
|---|---|---|---|
| **Mammals** | | | |
| Canada Lynx (*Lynx canadensis*) | T | Large tracts of high elevation (>8,000 feet) mixed coniferous forest. | Study area does not include high elevation (>8,000 feet) mixed coniferous forest. |
| New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*) | C | Mesic meadows and/or contained permanent streams with dense, diverse vegetation. | Study area contains a permanent waterway and wetland vegetation. |
| North American Wolverine (*Gulo gulo luscus*) | C | In Colorado, wolverines are present at high elevations or alpine habitat where snow persists late into the spring season. | No alpine or sub-alpine habitat is present in the study area. |
| **Birds** | | | |
| Mexican Spotted Owl (*Strix occidentalis lucida*) | T | Mature to old growth mixed conifer stands on steep, north-facing slopes with snags, downed wood, and canopy closure. | No mature or old growth mixed conifer stands on cool aspect slopes. Piñon-juniper woodlands not suitable for foraging, given the absence of potential nesting habitat. |
| Southwestern Willow Flycatcher (*Empidonax traillii extimus*) | E | Dense, shrubby riparian vegetation, usually in close proximity to surface water or saturated soil. | Study area contains suitable habitat in patches along the San Juan River. |

| Species | Status[1] | Habitat Description | Potential to Occur in the Study Area |
|---|---|---|---|
| Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) | C | Gallery cottonwood forest with dense understory vegetation. Minimum habitat patch size is 2 hectares. | Study area contains narrow, open-canopy cottonwood stands. |
| **Fishes** | | | |
| Colorado Pikeminnow (*Ptychocheilus lucius*) | E | Large rivers with a strong current, deep pools, eddies, quiet backwaters, and relatively warm water temperatures. | The San Juan River within the study area does not provide the deep pools, quiet backwaters, and warm water temperatures preferred by the species. Not known to occur in Navajo Reservoir. |
| Razorback Sucker (*Xyrauchen texanus*) | E | Rivers with strong, steady currents over sandy bottoms. | The San Juan River within the study area does not provide the deep pools, quiet backwaters, and warm water temperatures preferred by the species. Not known to occur in Navajo Reservoir. |
| **Plants** | | | |
| Pagosa Skyrocket (*Ipomopsis polyantha*) | E | Occurs on rocky, clay soils of Mancos Shale, barren shrublands and roadsides, and montane grasslands under pine around 7,000 feet. | No Mancos Shale derived soils occur within the study area. |
| Knowlton's cactus *(Pediocactus knowltonii)* | E | Alluvial deposits that form rolling, gravelly hills in piñon-juniper and sagebrush communities (6,200-6,400 feet). A type locality of the Los Piños River area. | No suitable habitat occurs in the project or action area. No rolling, gravelly river terraces occur in the project or action area. |

[1] E= Endangered; T = Threatened; C = Candidate. Source: SUIT 2012b

Based on the habitat types within the study area, there is suitable habitat for three federally listed species—(1) New Mexico meadow jumping mouse, (2) southwestern willow flycatcher, and (3) yellow-billed cuckoo (S. Whiteman, personal communication 2011). None of these species has been recorded as occurring in the study area. Suitable habitat for New Mexico meadow jumping mouse would be limited to mesic areas along the San Juan River corridor, which bisects the study area from east to west. No suitable nesting habitat for southwestern willow flycatcher occurs within the study area, as willow patches or other dense multi-storied vegetation is limited in size and generally has a high edge to patch ratio. However, there is suitable migratory stopover habitat in the area. Scattered, linear strips of cottonwoods along the San Juan River corridor provide potential habitat for yellow-billed cuckoo.

## 3.8 Archaeological, Cultural, and Historical Values

Cultural resources are protected and managed under a variety laws and regulations by federal agencies. The primary laws under which cultural resource compliance studies are reviewed include Section 106 of the National Historic Preservation Act of 1966 (PL 89-665; 80 Stat. 915; 16 USC 470 et seq.), as amended (implemented under regulations of the Advisory Council on Historic Preservation, 36 CFR Part 800); the Archaeological Resources Protection Act of 1979 (PL 96-95; 93 Stat. 721; 16 USC 470aa et seq.), as amended (PL 100-555; PL 100-588); the American Indian Religious Freedom Act of 1978 (PL 95-431; 92 Stat. 469; 42 USC 1996); and the Native American Graves Protection and Repatriation Act of 1990 (PL 101-601; 104 Stat. 3048; 25 USC 3001; 43 CFR Part 10).

Cultural resources protected under these regulations are typically considered and evaluated under the review process set forth in Section 106 of the National Historic Preservation Act. In addition, the conservation of historic and cultural resources is established through federal policy as a component of the NEPA (Section 101[b][4]) process for federally authorized permits, funding, and projects (40 CFR § 1 1502.16[g]). Cultural properties considered significant and eligible for listing on the National Register must possess integrity of location, design, setting, materials, workmanship, feeling, and association and must meet one or more of the following criteria:

- Criterion A – Association with events that have made a significant contribution to the broad patterns of our history.
- Criterion B – Association with lives of persons significant in our past.
- Criterion C – Embodiment of distinctive characteristics of a type, period, or method of construction, or representation of the work of a master, or possession of high artistic values, or representation of a significant distinguishable entity whose components may lack individual distinction.
- Criterion D – Have yielded, or may be likely to yield, information important in prehistory or history.

Most prehistoric archaeological sites are evaluated for their data potential under Criterion D, unless standing architecture or linear features are present.

An archaeological site is defined as the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure (whether standing, ruined, or vanished) where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure (USDI/NPS 1995). Isolated finds are generally limited quantities of artifacts, usually less than ten items, or a non-datable feature in the absence of associated artifacts. It is assumed that following detailed field recording, no further significant information potential can be derived from an isolated find. Isolated finds do not require further evaluation and, by definition, are not eligible or potentially eligible to the National Register of Historic Places. Isolated finds do not require avoidance or other mitigation measures, as their limited information potential has been adequately characterized and preserved in archival form by field recordation.

### 3.8.1 Cultural Resources

The proposed action occurs within a culturally rich and diverse region, known as the Upper San Juan Basin. Cultural traditions with potential to occur in the proposed action area include mobile Paleo-Indian hunting groups of the Late Pleistocene (circa [ca.] 10,000 BC to 5500 BC), mobile Archaic hunting and gathering societies (ca. 5500 BC to AD 400), increasingly sedentary Ancestral Pueblo societies that focused on agriculture supplemented by hunting and gathering (ca. AD 400 to 1050), nomadic hunting and gathering to equestrian protohistoric to early historic Ute and Jicarilla Apache groups (ca. AD 1400-1800), nomadic pastoral Navajo protohistoric to historic groups (ca. AD 1400 to 1860), Spanish colonialists (AD 1540 to 1821), Mexican colonialists (AD 1821 to 1848), and historic to modern Hispanic Americans and European Americans (AD 1848 to present).

More detailed summaries of regional prehistory and history can be found in *Colorado Prehistory: A Context for the Southern Colorado River Basin* (Lipe and Pitblado 1999); *Prehistory of the Southwest* (Cordell 1984); and *Colorado Plateau Country Historic Context* (Husband 1984). A more detailed review

of cultural resources specific to the SUIT Reservation, excluding the eastern side of the Reservation, can be found in Appendix K of the 2002 *Oil and Gas Development on the Southern Ute Indian Reservation FEIS* (USDI 2002).

### 3.8.2 Cultural Resources within the Study Area

As part of the cultural resource analysis, a Class I records search was conducted for the entire study area on COMPASS, Colorado's on-line cultural resource database. The COMPASS database does not distinguish individual Ancestral Pueblo periods, but groups them into Basketmaker II to III and Pueblo I to III periods. The North Carracas area has not been subject to systematic pedestrian surveys and probably less than 5 percent of the archaeological sites have been documented. The majority of the sites were recorded between the late 1950s and 1960s for salvage operations preceding the construction of Navajo Reservoir and after 1979 for project specific cultural resource compliance studies. A total of 151 archaeological sites and 30 isolated finds have been previously recorded within the study area as listed in Table 3-7. Of the 151 sites, 189 temporally and culturally distinct components have been identified. Many more components are likely present at these sites, but are not visible from the surface and would require intensive archaeological excavations to identify them. In addition, Map 12 in Appendix A suggests that, even though less than 5 percent of the area has been intensively inventoried for cultural resources, a moderate to high site density can be expected in most of the study area; therefore, it is likely that site density reaches over 30 sites per square mile for most of the area.

**Table 3-7. Cultural affiliation of previously recorded site components and isolated finds within the North Carracas AMI**

| Cultural Affiliation | Identified Site Components | | Isolated Finds | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| Paleo-Indian | 0 | 0.0 | 0 | 0.0 |
| Oshara Archaic | 0 | 0.0 | 1 | 3.3 |
| Upper San Juan Ancestral Pueblo, Basketmaker II to III periods | 4 | 2.1 | 1 | 3.3 |
| Upper San Juan Ancestral Pueblo, Pueblo I to III periods | 127 | 67.2 | 3 | 10.0 |
| Protohistoric to Early Historic Navajo | 32 | 16.9 | 0 | 0.0 |
| Unspecified Prehistoric Native American (Aboriginal) | 8 | 4.2 | 16 | 53.3 |
| Historic Ute | 1 | 0.5 | 0 | 0.0 |
| Historic Hispanic | 2 | 1.1 | 0 | 0.0 |
| Historic European American | 7 | 3.7 | 0 | 0.0 |
| Unknown Historic | 8 | 4.2 | 9 | 30.0 |
| **Totals** | **189** | **99.9** | **30** | **99.9** |

The records search results suggest that Paleo-Indian and Archaic period occupations are largely non-existent or minimal in the area. No diagnostic Paleo-Indian remains have been found in the study area and only one isolated find, a projectile point, is attributed to the Archaic period. Ancestral Pueblo occupation of the North Carracas region begins slowly during the Basketmaker II to III periods. Only four Basketmaker II or III period components have been identified within the project area, or 2.1 percent of all identified components. However, a very intensive Pueblo I to Pueblo II period occupation is indicated based on available records from ca. AD 700 to 1050. Most of the sites exhibit architectural remains and indicate permanent settlement of the area. A total of 127 of the 189 components identified in the study

area (67.2 percent) date within the Pueblo I to III periods, all of which probably date specifically to the Pueblo I to early Pueblo II periods. Ancestral Pueblo occupation of the study area terminated prior to the Pueblo III period and known Pueblo components within the area consistently date to the Pueblo I and early Pueblo II periods. A cultural hiatus occurs from ca. AD 1050 to 1400 and the region appears uninhabited. By protohistoric times (ca. 1400 to 1500), an intensive Navajo occupation of the area is evident and continuing to at least ca. AD 1780, when the Navajo were driven southward from conflicts with the Capote and Mouache Ute and their allies. Thirty-two of the 189 known components within the study area, or 16.9 percent of the total, date to the Navajo Dinétah and Gobernador phases. Given the amiable relationships between the Weeminuche Ute band and the Navajo, many of these sites may be attributable to the Weeminuche. Historic European American, Ute, and Hispanic American components account for 9.5 percent of identified components within the study area. Most of these components date to the late 1800s to early 1900s, mostly associated with homesteading and the construction of the San Juan Extension of the Denver and Rio Grande Railroad, built between 1880 and 1881.

Of particular interest in the study area are the intensive Ancestral Pueblo, Pueblo I to early Pueblo II period occupations, the San Juan Extension of the Denver and Rio Grande Railroad, and the Santa Fe Trail (also referred to as the Old Spanish Trail). Eighty of the 127 Ancestral Pueblo components dating between the Pueblo I to II periods have architectural remains visible on the site surface. These architectural elements typically include pitstructures (pithouses or kivas), jacal and masonry roomblocks, non-contiguous jacal and/or masonry rooms, and field houses. In addition, nine of these components are known to contain prehistoric burials. Subsurface and intact burials are probably present at the majority of the Ancestral Pueblo architectural sites and, as such, are highly sensitive cultural resources.

Archuleta CR 500, the only thoroughfare in the San Juan River Valley above Navajo Reservoir, was constructed over much of the San Juan Extension of the Denver and Rio Grande Railroad bed (1880 to 1969) and it is no longer visible in these areas. Farming and ranching in the valley bottom has likewise destroyed much of the railroad bed, and the railroad grade can only be observed in small segments throughout its former course. Many of these segments, in turn, have been compromised and used as access roads by landowners and portions may have also been lost during major flooding events.

While the Santa Fe Trail is known to have passed down the San Juan River Valley and through the study area, to date, no physical remains of the trail, or associated sites, have been identified in the area. In fact, no portions of the Santa Fe Trail have been identified anywhere within Archuleta County. Given the steep side slope terrain of the San Juan River Valley above Navajo Reservoir, the trail must have passed primarily in the valley bottom along river terraces and possibly lower mountain slopes where the river valley becomes restricted. Much of the river valley has been modified and converted to farms and ranches and any traces of the trail have probably long since been destroyed on arable lands. Natural re-vegetation over undisturbed portions of the trail has likely contributed to its lack of visibility as well.

### 3.8.3 American Indian Religious Freedom Act Concerns

The American Indian Religious Freedom Act, Executive Order 13007, and the Native American Graves Protection and Repatriation Act are the primary laws protecting Native American religious freedom and beliefs, in addition to archaeological protection laws and regulations for resources of measurable antiquity.

As the Capote and Mouache bands were removed from their historic ranges and confined to the SUIT Reservation, the Tribe does not have ties of antiquity to specific areas within the SUIT. Historic land use by Tribal members has included hunting and gathering of native resources within the study area. Most of these activities were and are for food, although some gathering of medicinal plants continues. Currently, there are no practicing shamans on the Reservation. A comprehensive study of medicinal plant gathering areas has not been conducted on the Reservation, although plants of known importance to the tribe include bear root (*Ligusticum porteri*), cattail (*Typha* spp.) narrowleaf cottonwood, mint (*Lamiaceae*), piñon pine, juniper, Ute Lady's tresses (*Spiranthes diluvialis*), wild onion (*Allium* spp.), willow (*Salix* spp.), and yarrow (*Achillea lanulosa*) (USDI 2009).

Dr. Stacy Oberly (Culture Department Director for the SUIT) and Neil Cloud (SUIT elder and Traditional Cultural Specialist) were consulted regarding the presence of traditional cultural properties (TCP) within the North Carracas area. They stated that there are no medicinal plant gathering areas or other potential TCPs within the study area (S. Oberly, personal communication 2011).

The study area is within the northern extent of the Dinétah, or Navajo homeland. It is within this region that the Navajo coalesced into a culture distinct from other Athapaskan groups. A review of several sources addressing known Navajo sacred places and place names, including Navajo Indians III: Navajo Sacred Places (Van Valkenburgh 1974), Navajo Sacred Places (Kelley and Francis 1994), and Diné Bikéyah (Van Valkenburgh 1941) did not reveal any Navajo known TCPs within or immediately adjacent to the study area.

Other tribes, such as the Ute Mountain Ute (Weeminuche), Jicarilla Apache, Navajo, Taos Pueblo, Zuni, Hopi, and other Puebloan societies have affinity to archaeological sites within the study area. In addition, Hispanic American and European American groups have historical ties to the study area as well.

## 3.9 Socioeconomics

Impacts to the human environment are measured in terms of economic and social impacts to the affected area. Economic impacts are generally expressed as changes to population, employment, income, and government revenue. Social impacts are expressed as changes to community infrastructure, such as access to social services and quality health care services.

The affected area is comprised of Archuleta County and La Plata County, Colorado.

Table 3-8 shows the population estimates for these counties, as well as the State of Colorado for comparison. This affected area is selected because it is where the majority of the employees that would work on this proposed action would reside and it includes the communities where the revenues generated by natural gas production would be spent. In addition, the SUIT is considered because Tribal tax and royalty revenues flow to the entire Southern Ute membership through dividends and social services.

**Table 3-8. Population estimates for affected area**

| County/Year | 1990 | 2000 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|
| Archuleta, CO | 5,340 | 10,036 | 12,744 | 17,800 | 24,110 |
| La Plata, CO | 32,284 | 44,580 | 52,530 | 66,720 | 80,770 |
| Total Affected Area | 37,624 | 54,616 | 65,274 | 84,520 | 104,880 |
| Colorado | 3,294,394 | 4,301,261 | 5,029,196 | 6,171,730 | 7,193,036 |
| SUIT Membership | | | 1,375 | | |

Sources: State of Colorado 2010; USDI/BIA Southern Ute Agency 2010

The natural gas that would be produced by the North Carracas POD is located entirely in Archuleta County, Colorado; therefore, impacts to government revenues would be to Archuleta County and the SUIT. The ad valorem tax that would be paid to Archuleta County is estimated to be 2.62 percent of production value, to the extent the production is owned by a non-Tribal company. Archuleta County revenues associated with production owned by the SUIT would be determined in accordance with the Intergovernmental Agreement Regarding Taxation by and between the Tribe and Archuleta County dated May 16, 2011. Under the Agreement, the Tribe's property interests are exempt from County taxation. The Tribe's non-trust real property interests, however, are subject to a payment in lieu of taxes (PILT), which amounts to approximately one-third of what the taxes would be but for the Tribe's ownership. The SUIT government receives royalty and severance tax revenues from tribal minerals. Local spending by Energen and Red Willow on equipment and labor would occur throughout the affected area, as well as San Juan and Rio Arriba Counties in New Mexico. The potential economic impacts to these New Mexico counties are considered in the cumulative impact analysis.

### 3.9.1 Employment and Income

Overall, Archuleta County had higher unemployment and income in 2011 than La Plata County and the State of Colorado, as shown in Table 3-9.

**Table 3-9. Labor force, unemployment rate, and median household income**

| County | Civilian Labor Force (2011) | Annual Unemployment Rate (2011) | Median Household Income (2007-2011) |
|---|---|---|---|
| Archuleta, CO | 6,100 | 9.1% | $60,170 |
| La Plata, CO | 30,600 | 6.1% | $56,910 |
| Colorado | 2,702,000 | 7.9% | $57,685 |

Source: USCB 2011

The potential economic impacts of the alternatives are estimated using the IMPLAN model (MIG 2011). IMPLAN uses an input/output model of the local economy to estimate how different sectors of the local economy are interconnected, as well as to estimate imports and exports of goods and services. The multipliers generated by an input/output model of the combined economy in Archuleta and La Plata Counties with 2009 base data were used to estimate indirect impacts of changes in output and employment in a particular industry.

### 3.9.2 Government Revenue

The potential impacts to government revenue from the alternatives include severance tax, royalties, and PILT related to natural gas production. The economic impact analysis focuses on changes to government revenues to the SUIT and Archuleta County. Other potential government revenue impacts include sales and other property taxes. However, it is not possible to accurately estimate these tax revenues with the details available in the POD. The Tribal royalty share of revenues from natural gas production is 25 percent. The Tribal severance tax is 6.5 percent of annual production value.

## 3.10 Environmental Justice

President Clinton's Executive Order 12898 on February 11, 1994 requires that "each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." The CEQ guidance on incorporating environmental justice into NEPA analysis notes that "In order to determine whether a proposed action is likely to have disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, or Indian tribes, agencies should identify a geographic scale for which they will obtain demographic information on the potential impact area. Minority populations should be identified where…the minority population percentage of the affected area is meaningfully greater than the minority population in the general population or other appropriate unit of geographic analysis." The same guidance is given for measuring low-income populations. Usually, this is measured by comparing the individual poverty rate for the affected area to a comparison area.

To determine whether a risk or rate of hazards exposure by a vulnerable population such as minority or low-income population is significant according to NEPA, CEQ guidance requires that the risk or rate "…much appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards;" therefore, the Environmental Justice impact analysis compares the risk and rate of adverse impacts associated with the proposed action for the affected area to a comparison group to determine whether there are significant Environmental Justice impacts.

The affected population associated with the proposed POD includes people residing in Archuleta and La Plata Counties—including the SUIT Reservation. These counties and their minority population and poverty rate are included in Table 3-10

**Table 3-10. Potential affected populations for environmental justice impacts**

| County/State | Population (2010) | Percent Minority Population (2009) | Individual Poverty Rate (2007-2011) |
|---|---|---|---|
| Archuleta, CO | 12,084 | 3.7% | 7.7% |
| La Plata, CO | 51,334 | 7.0% | 10.6% |
| Colorado | 5,029,196 | 10.2% | 12.5% |

Source: USCB 2011

To better evaluate the potential vulnerable populations within these counties, particularly those on the Reservation, census tract data for poverty rate and percentage of minority population were analyzed (Maps 13 and 14 in Appendix A). As shown on Map 13, the percentage of Native American minority populations is higher on the Reservation than the remainder of the county and the state; therefore, disproportionate impacts to the residents of census tracts (including the Reservation) need to be specifically considered. In addition, the cumulative impact analysis will consider disproportionate cumulative impacts and potential "special" exposures to these vulnerable populations due to cultural or traditional use of resources such as ceremonial food or medicine gathering.

While the individual poverty rate for Archuleta and La Plata counties is not higher than Colorado, the census tracts where the POD is planned, as shown on Map 14, have higher individual poverty rates than the respective county. Therefore, it would be useful to evaluate potential disproportionate impacts to these communities.

## 3.11 Land Use and Ownership

Approximately two-thirds of Archuleta County is owned and managed by federal, state, and Tribal governments and 94 percent is undeveloped and vacant (Archuleta County 2001). SUIT and private lands near the study area are primarily forested with piñon and juniper, with smaller amounts of grasslands. The study area is bordered on the north, east, and west by SUIT lands with scattered private inholdings and on the south by the CNF Jicarilla Ranger District. The San Juan River flows through the southern part of the study area and enters Navajo Reservoir, which lies in the area's southwestern corner. The Piedra arm of Navajo Reservoir occurs in the western portion of the study area. The Colorado portion of the reservoir lies entirely within the boundaries of the SUIT. Navajo Reservoir is operated and administered by the USBR, with lands and recreational facilities bordering the reservoir in Colorado managed by Colorado Parks and Wildlife as Navajo State Park. In New Mexico, lands bordering the reservoir are managed by the New Mexico State Parks Division (USDI/USBR 2008).

The SUIT NRMP divided the Reservation into seven management units (MUs) based on watershed boundaries (SUIT 2012a). The study area covers parts of three of the units—the Piedra MU (Unit 5), the Upper San Juan MU (Unit 6), and the Lower San Juan MU (Unit 7) (see Map 15 in Appendix A). The NRMP contains maps, descriptions, and management goals for each of these units (SUIT 2012a). In the study area, the Piedra MU includes woodlands that border the eastern shore of the Piedra arm of Navajo Lake. The Upper San Juan MU covers most of the study area and is composed primarily of woodlands and timberlands, with smaller amounts of grasslands and agricultural lands bordering both sides of the San Juan River just east of Navajo Lake. The Lower San Juan MU covers the eastern portion of the study area and is comprised primarily of timberlands and woodlands, with smaller amounts of grasslands and riparian areas bordering the San Juan River.

The community of Carracas is located in the southern portion of the study area. It is one of the last remaining towns that sprang from the timber industry, which reached its peak in Archuleta County in the early 1900s (Motter 2008). Several private residences and ranches occur within the study area along the San Juan River corridor and are accessed by CR 500. Cultivated crops on private lands along the river are mainly limited to grass or alfalfa for livestock feed or pastureland.

The SUIT DNR manages the Sandoval and Vega grazing units that overlap the study area. Approximately 4,555 acres of the 24,285-acre Sandoval grazing unit and 2,964 acres of the 22,397-acre Vega grazing unit overlap the study area (see Map 16 in Appendix A). These areas are actively grazed by cattle owned by Tribal members at levels that fluctuate year to year in proportion to available forage.

## 3.12 Recreation

The majority of land that could be affected by the proposed action is privately owned land surrounded by SUIT lands. On private lands, the landowner controls the access and recreational opportunities. On SUIT lands, a number of recreational opportunities are available to both SUIT members and non-Tribal members.

Most outdoor recreation on SUIT lands including camping, hiking, biking, horseback riding, and off-road vehicle use is limited to enrolled Southern Ute Tribal members and their immediate family and guests. The SUIT DNR Lands Division establishes use restrictions including permissions and requirements for crossing Tribal lands (SUIT 2011).

Hunting activities on the Reservation are regulated by the Tribe through the Southern Ute Wildlife Conservation Code, Title 13. On SUIT lands, hunting opportunities for SUIT members include seasonal and year-round hunting for a number of game species including elk, mule deer, mountain lion, Merriam's wild turkey, upland and migratory game birds, waterfowl and small game species. Game species are described in Section 3.6 of this EA. Fishing on all waters within the SUIT Reservation is available to SUIT members who possess a Southern Ute Fishing Permit (SUIT 2011). Other dispersed recreational activities by Tribal members include gathering firewood, piñon nuts, and ceremonial materials (USDI 2002)

Hunting and fishing opportunities are available to non-Tribal members on a limited basis. When Tribal hunter harvest is not sufficient to effectively manage big-game populations, the SUIT DNR may open a hunt to non-SUIT members that are registered members of other federally recognized tribes. Non-members may obtain a Tribal fishing permit to fish on designated Tribal waters and may put-in or take-out small portable watercraft that can be carried by hand on Tribal lands. Recreational boaters are permitted to float through Tribal portions of the rivers that traverse the SUIT Reservation, including the San Juan River above the Navajo Reservoir. However, take out and put in on Tribal lands, access to streambeds or banks, and commercial guiding is not permitted (SUIT 2011).

There are a number of recreational opportunities on lands adjacent to the study area. Navajo Lake is formed by the Navajo Dam located at the confluence of the San Juan and Los Piños rivers and captures water from the Los Piños, San Juan, Piedra, Navajo and Blanco rivers. The lake and its 150 to 180 miles of shoreline offer year-round water and land based recreational opportunities including fishing, hunting, boating, swimming, scuba diving, sailing, hiking, camping, and wildlife viewing (NMSPD undated). The CNF borders the study area to the south. Recreational activities include hunting, camping, hiking, and wildlife viewing (USDA/USFS 2011).

## 3.13 Transportation and Traffic

As shown on Map 17 in Appendix A, access to the study area is from Colorado Highway 151 to Archuleta CR 500 on the west side of the project area and from Forest Service Route 218 (Forest Service Road 218/Carracas Mesa Road) on the south side of the project area.

CR 500 is a connector route from Arboles, Colorado/Navajo Reservoir on the west to Pagosa Springs on the east. CR 500 is also designated as a Rural Access/Local Access road by Archuleta County in the List of Primary System Roads (Archuleta County 2011). Design capacity for local access roads or rural access roads is not specified by Archuleta County. Low volume roads have design average daily traffic (ADT) volume that does not exceed 400 vehicles per day (Archuleta County 2005).

ADT counts for CR 500 were provided by Archuleta County (Y. Davis, personal communication 2011). For CR 500, at the location 0.45 mile south of the intersection with Highway 151, the ADT was 315 vehicles per day in 2000 and 307 vehicles per day in 2005.

## 3.14 Noise

Noise from oil and gas development is generated from site construction, drilling, production, transportation, site reclamation activities, and the associated equipment such as heavy machinery, vehicles, generators, and compressors. Noise is also generated by standard operating procedures, such as well venting or gas flaring. Most of these noises are loud, but vary in duration and timing. Compressors may run continuously and emit a more constant and long-term, low-pitched humming or rumble (USDI/USBR 2008).

Several noise measurement scales are used to describe noise in a particular location. A decibel (dB) is a unit of measurement that indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in dBs are calculated on a logarithmic basis. An increase of 10 dB represents a ten-fold increase in acoustic energy, while a 20 dB increase is 100 times more acoustic energy and a 30 dB increase is 1,000 times more acoustic energy, etc. There is a relationship between the subjective noisiness or loudness of a sound and its decibel level. Each 10 dB increase in sound level is perceived as approximately a doubling of loudness over a wide range of intensities.

Sound levels dissipate with increased distance from the source. Generally, sound levels from a noise source will decrease by about 6 dB for every doubling of distance away from the noise source over land and about 5 dB over water. For a linear noise source, such as highway traffic, sound levels decrease by about 3 dB for every doubling of distance away from the roadway. Sound levels may be increased or decreased due to weather, topographic, structural, and vegetative factors between the source and the receiver. Dense vegetation and intervening structural or topographic features can reduce sound levels (USDI/USBR 2008).

## 3.15 Public Health and Safety

The proposed project area consists of a mix of undeveloped land, rural residential, and agricultural land uses. Public health and safety concerns are related to vehicle travel on area roads and public and worker safety around natural gas wells, pipelines, or other production facilities. Worker safety concerns include

working near loud equipment, heavy equipment and moving parts, and near flammable and/or explosive material.

Other health and safety concerns identified are:

- Contamination of drinking water aquifers—possible aquifer contamination via downhole cross-flow between different water-bearing formations or hydrocarbon-bearing-producing formations within a single wellbore. Hydraulic fracturing has been labeled as a potential source of impacts to drinking water wells. The USEPA is currently studying the issue at the national level. The BLM has specific regulations regarding protection of groundwater and surface water quality during well drilling and the hydraulic fracturing process.
- Another source of potential contamination of drinking water aquifers is migration from the saltwater disposal well that could arise from:
    - A faulty injection well casing
    - An annulus located between the casing and well bore
    - The injection zone breaking through the confining strata
    - Vertical migration through improperly abandoned and/or improperly completed wells
    - Lateral migration from the injection zone into a protected portion of that stratum
    - Direct injection of fluids into or above drinking water aquifers.
- Risk of accidental spills and illegal dumping—coalbed methane development activities include transportation and handling of non-hazardous and hazardous materials. The handling and disposal of these materials is regulated and monitored by the USEPA, BIA, BLM, and SUIT EPD and DNR. Non-compliance with regulations specifies penalties and cleanup requirements.
- Contamination of surface waters, near-surface drinking water aquifers, and soil resources caused by surface degradation due to accidental spills and leaks of chemicals and waste products, or inadequate stormwater protection measures.
- Well fires or explosions—there is a potential for well fires or explosions during drilling or production. There are specific regulations and industry BMPs that are in place during drilling and production activities to reduce the potential for well fires and explosions including setback distances, control of ignition sources, and storage of flammable material away from ignition sources.

No risk has been identified for hydrogen sulfide gas from natural gas production within the study area. Underground coal fires do occur in the Fruitland Formation within the exterior boundaries of the Reservation near the Fruitland outcrop. The Fruitland outcrop is located well outside the study area; therefore, the risk of underground coal fires is not considered a public health and safety concern in this assessment.

# 4. ENVIRONMENTAL CONSEQUENCES

Environmental resources can be affected in many ways during implementation of the proposed action. The effect, or impact, is defined as any change or alteration in the pre-existing condition of the environment produced by the proposed action, either directly or indirectly. This chapter analyzes the environmental consequences of the no action and proposed action alternatives.

Impacts can be either long term (permanent, residual) or short term (incidental, temporary). Short-term impacts affect the environment for only a limited time and the environment usually reverts rapidly to the pre-construction condition. Short-term impacts are often disruptive and obvious. Long-term impacts are substantial and permanent alterations to the pre-project environment. The BLM defines long-term impacts as those impacts whose results endure more than 5 years. Impacts may be irreversible or residual and affected resources irretrievable.

## 4.1 Methodology and Assumptions for the Analysis

### 4.1.1 No Action Alternative

Under the no action alternative, the proposed development would not occur, but some oil and gas development would likely take place on private lands within the study area. Instead of a coordinated approach among the Tribe, Red Willow, and private oil and gas lessees through use of horizontal wells and minimal surface disturbance, it is possible that the no action alternative would result in some level of more traditional development of the private mineral lands through use of non-horizontal (vertical) wells—at least on those lands with high resource recovery potential and reasonable access to gathering and gas transportation facilities. Because of the difficulty in predicting the level of that activity, no impacts from oil and gas production to resources in the study area have been assigned to the no action alternative. The no action alternative would result in the continuation of the current land and resource uses in the project area. The POD would not be implemented to develop the mineral resources within the North Carracas AMI. Development of fee mineral reserves in adjoining areas could drain Tribal reserves over the long term, resulting in lost Tribal revenue. This alternative is presented as a baseline; therefore, it will not be evaluated further in Chapter 4.

### 4.1.2 Proposed Action

Although the SUIT has identified parcels on private lands available for drilling and in locations that would allow for effective mineral extraction using horizontal and non-horizontal drilling, the exact surface locations of the well pads, salt water disposal well, and compressor site have not been determined at this time, as that would require extensive on-the-ground surveying and analysis. Likewise, the exact locations of proposed access roads and pipelines have not yet been determined. When these locations are identified, and at the time of APD or ROW grant submittal, additional site-specific environmental and cultural surveys would be conducted as directed by the BLM and/or the BIA. Additional mitigation measures could be implemented at that time to minimize or avoid impacts to resources. It is assumed that final on-the-ground placement as determined by the APD and ROW grant process would not be significantly different from what is identified in this assessment and effects would essentially be the same as those presented here.

The information about the existing condition of the environment from Chapter 3 was used as a baseline by which to measure and identify potential impacts from the project. The analysis considered and incorporated design features (mitigation measures), where appropriate, before arriving at the impacts described here. Impacts in this section are analyzed programmatically by quantitatively estimating impacts without regard to site-specific information that is currently unknown. When necessary, impacts are analyzed qualitatively. This analysis was developed using the best available science. The primary data sources used for the analysis were existing geographic information system (GIS) data and information from the SUIT DNR.

## 4.2 Air Quality

The ambient impact analysis for this EA was determined through consultations with the BLM, the USFS, and USEPA. The resulting air quality analysis protocol was designed to measure air quality impacts with respect to:

- The NAAQS for criteria air pollutants—nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), carbon monoxide (CO), and particulate matter ($PM_{10}$/$PM_{2.5}$)
- HAPs—as measured by acute and chronic dose-response values for benzene, toluene, ethylbenzene, xylenes (BTEX), n-hexane, and formaldehyde.
- Air quality related values (AQRV)—including visibility, acid deposition, and acid neutralizing capacity of sensitive lakes in nearby Class I Areas

The AQIA modeling protocol implemented for this EA analysis, emissions inventory, and associated results are included in the AQIA Technical Support Document in Appendix G. In accordance with the protocol, ambient air quality impacts for near-source criteria air pollutants and HAPs were determined for an area within 2.5 kilometers (km) (1.6 miles) of the North Carracas AMI. Model results were reviewed to confirm that the maximum predicted concentrations all fall within the 2.5 km zone. AQRV impacts were measured for impacts to nearby Class I areas—Weminuche Wilderness Area and Mesa Verde National Park. Ozone impacts were evaluated based on results from a previous regional photochemical modeling study conducted in support of the Programmatic Environmental Assessment (PEA) for the Southern Ute 80-Acre Infill project (USDI 2009).

According to the protocol, impacts to air quality are assessed by estimating annual and daily emissions levels for development and production activities for the proposed action and compiling them into a maximum year and maximum day emissions estimate. These emission estimates were used in computer simulation models (AERMOD and VISCREEN) to estimate changes to ambient air concentrations in the study area. Criteria pollutant impacts for the proposed action were assessed by comparing modeled design values (when added to background concentrations from Table 3-2) to the levels of each of the appropriate NAAQS. The modeled design values for the annual NAAQS were based on a model run using the maximum year emissions scenario and the values for the hourly NAAQS were based on a model run using the maximum day emissions scenario. Changes to AQRVs were estimated from conservatively modeled concentration impacts at the Class I areas under the maximum day and maximum annual average emission scenarios.

## 4.2.1 Direct and Indirect Impacts

### 4.2.1.1 Emissions

Emissions estimates for the proposed action are based on emissions rates for equipment and vehicle travel for all activities in the development and production phases of the project. Emissions associated with the development phase of the proposed action would include (1) fugitive dust from construction of the well pads, pipelines, and roadways, (2) fugitive dust from haul road traffic, drill rig and supply traffic, and well completion traffic, (3) tailpipe emissions from haul trucks and off-road construction equipment, (4) drill rig engine emissions, and (5) well completion emissions including hydraulic fracturing pumps. Construction/road dust and tailpipe emissions are expected to occur throughout the study area, predominantly at the well pad locations and on the roadways and pipelines connecting them. Emissions associated with the production phase of the proposed action would include emissions from the pumpjack engines, separators, and water tank heaters located at each of the 48 new wellheads, the generator engine for the salt-water disposal well, and a group of six compressor engines proposed to be installed at the compressor station.

Maximum annual average emissions were estimated by combining the emissions estimates for the construction of eight well pads (the maximum number to be constructed in 1 year), with 19 wells drilled and completed (the maximum drilling activity that could occur in 1 year), 8 wells hydraulically fractured, and the full operational phase emissions expected to occur in a single year. Although maximum activity for the development and operational phases are not planned to occur in the same year, these two scenarios were combined to develop a worst case annual emission inventory. This "maximum activity year" was used in the computer model simulations to conservatively analyze impacts. Total emissions for this maximum activity year are presented in Table 4-1.

**Table 4-1. Estimated total construction, drilling, and completion emissions in tons per year for a projected maximum activity year**

| Source | Emissions (tons per year) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
| **Development Phase** | | | | | | |
| Well pad and pipeline construction emissions | 0.28 | 0.40 | 6.88 | 2.61 | 0.02 | 0.05 |
| Rig-up, drilling, and rig-down emissions | 12.21 | 43.33 | 17.78 | 2.80 | 0.05 | 3.60 |
| Completion and testing | 2.33 | 5.27 | 35.05 | 3.80 | 0.13 | 0.42 |
| Total Development Phase | 14.82 | 49.00 | 59.71 | 9.20 | 0.20 | 4.07 |
| **Operational Phase** | | | | | | |
| Compressor station | 12.57 | 36.96 | 0.02 | 0.02 | 0.14 | 17.74 |
| Salt-water disposal well | 0.55 | 3.77 | 0.09 | 0.09 | 0.01 | 0.03 |
| Pumpjacks | 4.94 | 21.59 | 0.28 | 0.28 | 0.00 | 0.08 |
| Separators and water tank heaters | 0.76 | 1.78 | 0.14 | 0.14 | 0.01 | 0.10 |
| Total Operational Phase | 18.82 | 64.10 | 0.54 | 0.54 | 0.17 | 17.96 |
| **Total Project – Maximum Year** | **33.64** | **113.11** | **60.25** | **9.74** | **0.37** | **22.03** |

Notes: CO = carbon monoxide, $NO_x$ = nitrogen oxides, $PM_{10}$ = particulate matter, $SO_2$ = sulfur dioxide, VOC = volatile organic compound. Totals may not exactly equal the sum of individual values due to rounding.

For dispersion modeling purposes, a "maximum day" emissions scenario was also developed, which identifies the time period during project development when the combined emissions from all sources (construction, drilling, completion, and partial production) are expected to be at a maximum. For this scenario, two drill rigs were assumed to be operating, one well pad was undergoing construction, two wells were undergoing fracturing, and 42 wells were in production. Table 4-2 shows criteria pollutant emissions for the maximum day emissions scenario.

**Table 4-2. Maximum day emissions scenario for criteria pollutants**

| Source | Emissions (pounds/day) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_x$ | $PM_{10}$ | $PM_{2.5}$ | $SO_2$ | VOC |
| Total development phase | 171.9 | 516.7 | 697.8 | 120.7 | 5.6 | 43.0 |
| Total operational phase | 90.2 | 307.3 | 2.6 | 2.6 | 0.8 | 86.1 |
| Total project – Maximum Day | 262.2 | 824.0 | 700.4 | 123.2 | 6.4 | 129.2 |

Notes: CO = carbon monoxide, $NO_x$ = nitrogen oxides, $PM_{10}$ = particulate matter, $SO_2$ = sulfur dioxide, VOC = volatile organic compound. Totals may not exactly equal the sum of individual values due to rounding.

#### 4.2.1.2 Air Quality Impacts

The air dispersion model, AERMOD, was implemented to evaluate NAAQS impacts. For the proposed action analysis, 5 years of meteorological data and the "maximum day" emissions scenario were used to evaluate impacts relative to the short-term (1, 3, 8 and 24-hour) NAAQS and the "maximum year" emissions scenario was used to evaluate impacts relative to the annual NAAQS. The resulting modeled design values were then added to the background concentrations from Table 3-2 and the sum compared to the level of the applicable NAAQS. Results are summarized in Table 4-3.

**Table 4-3. National Ambient Air Quality Standards impacts**

| Pollutant | Averaging Time | Modeled Design Value ($\mu g/m^3$) | Background Conc. ($\mu g/m^3$) | Total | NAAQS ($\mu g/m^3$) | NAAQS Exceeded? |
|---|---|---|---|---|---|---|
| $NO_2$ | Annual | 46.8 | 10.0 | 56.8 | 100 | No |
| | 1-hour | --[a] | var[a] | 149.8 | 188 | No |
| $SO_2$ | 3-hour | 10.2 | 20.9 | 31.1 | 1300 | No |
| | 1-hour | 9.5 | 18.3 | 27.8 | 196 | No |
| CO | 8-hour | 91.3 | 801.5 | 892.8 | 10,000 | No |
| | 1-hour | 164.3 | 1488.5 | 1652.8 | 40,000 | No |
| $PM_{2.5}$ | Annual | 0.9 | 4.2 | 5.1 | 12[b] | No |
| | 24-hour | 13.2 | 9 | 22.2 | 35 | No |
| $PM_{10}$ | 24-hour | 101.0 | 20.8 | 121.8 | 150 | No |

Notes: CO = carbon monoxide; $NO_x$ = nitrogen oxides; $PM_{10}$/ $PM_{2.5}$ = particulate matter; $SO_2$ = sulfur dioxide; NAAQS = National Ambient Air Quality Standards; $\mu g/m^3$ = micrograms per cubic meter

[a] Seasonal average diurnal profiles used for modeling background contribution to predicted total (modeled impact plus background) 1-hour $NO_2$ design value as per Fox (2011).

[b] As promulgated by USEPA on 14 December 2012.

No exceedances are predicted for any of the NAAQS as a result of the proposed action. The maximum (project impact plus background) 1-hour $NO_2$ concentration of 149.8 micrograms per cubic meter ($\mu g/m^3$)

is 79.7 percent of the 188 µg/m³ NAAQS. The maximum cumulative 24-hour $PM_{10}$ impact is 81 percent of the $PM_{10}$ NAAQS. Maximum cumulative impacts for all other pollutants are much smaller percentages of their respective NAAQS.

#### 4.2.1.3 HAPs Impact Analysis

An analysis of potential health risks from direct emissions of HAPs from the proposed action were evaluated by comparing maximum modeled 1-hour HAP concentrations (corresponding to the "maximum day" emissions scenario) and annual average HAP concentrations (corresponding to the "maximum year" emissions scenario) to the acute and chronic dose-response screening values recommended by the USEPA. Refer to Table 4.2 in Appendix G for the acute and chronic dose-response values and unit risk factors used for screening.

Results of the HAPs impact analysis are summarized in Table 4-4. Predicted incremental HAP impacts from the proposed action are all less than the corresponding dose-response screening values. Cumulative HAP impacts (equal to the incremental impact plus background concentration) are also all less than the screening values.

**Table 4-4. Hazardous air pollutant analysis results: non-cancer**

| | Avg. Time | Maximum Modeled Conc. (µg/m³) | Background Conc. (µg/m³) | Total Conc. (µg/m³) | Dose-Response Screening Value Exceeded? |
|---|---|---|---|---|---|
| Benzene | 1-hour | 0.98871 | 0.45 | 1.43871 | No |
| | Annual | 0.02286 | 0.45 | 0.47286 | No |
| Ethylbenzene | 1-hour | 0.1534 | 0.08 | 0.23345 | No |
| | Annual | 0.0021 | 0.08 | 0.08215 | No |
| n-Hexane | 1-hour | 1.46539 | 7.32[a] | 8.78539 | No |
| | Annual | 0.04978 | 7.32[a] | 7.36978 | No |
| Toluene | 1-hour | 0.72817 | 0.51 | 1.23817 | No |
| | Annual | 0.02063 | 0.51 | 0.53063 | No |
| Xylenes | 1-hour | 0.51991 | 0.25 | 0.76991 | No |
| | Annual | 0.00957 | 0.25 | 0.25957 | No |
| Formaldehyde | 1-hour | 41.62998 | 2.12 | 43.74998 | No |
| | Annual | 1.45341 | 2.12 | 3.57341 | No |

Note: µg/m³ = micrograms per cubic meter

Potential incremental cancer risks to the most likely exposed (MLE) individual and maximum exposed individual (MEI) due to benzene and formaldehyde emissions from the proposed action were calculated using the same methods and assumptions used to estimate formaldehyde exposure risks in the *Programmatic Environmental Assessment for the 80-Acre Infill Oil and Gas Development Project* (USDI 2009). Resulting incremental risks are provided in Table 4-5. Maximum incremental cancer risks from exposure to benzene emissions are less than one in a million; risks from formaldehyde exposures are between 1 and 10 in a million. The sum of the benzene and formaldehyde exposure risks is 5.45 per million for the MLE individuals and 1.79 per million for the MEIs. These values are within the 1 to 100 in a million ($10^{-6}$ to $10^{-4}$) range of generally acceptable risks based on the Superfund National Oil and

Hazardous Substances Pollution Contingency Plan (USEPA 1990). It should be noted that the additive effects of exposures to multiple chemicals are not fully understood and may or may not be accurately represented by a simple sum of risks from each individual chemical.

**Table 4-5. Maximum predicted incremental cancer risks associated with project emissions of benzene and formaldehyde**

| | Exposure Scenario | Exposure Factor | Unit Risk Factor | Max. Concentration (µg/m³) | Risk |
|---|---|---|---|---|---|
| Benzene | MEI | 0.286 | 7.8 x 10-6 | 0.02286 | 5.10 x 10-8 |
| | MLE | 0.0939 | 7.8 x 10-6 | 0.02286 | 1.67 x 10-8 |
| Formaldehyde | MEI | 0.286 | 1.3 x 10-5 | 1.45341 | 5.40 x 10-6 |
| | MLE | 0.0939 | 1.3 x 10-5 | 1.45341 | 1.77 x 10-6 |

Note: µg/m³ = micrograms per cubic meter

#### 4.2.1.4 Ozone Impact Analysis

Given the technical difficulties and uncertainties involved in estimating the impact on ambient ozone levels of a relatively small project such as the proposed action, a separate modeling analysis for ozone was not conducted. During the past 10 years, five different NEPA analyses have considered the impacts of emissions from oil and gas development within the Reservation on ozone levels in the Four Corners region. These studies include:

- 2002 SUIT EIS (USDI 2002).
- Northern San Juan Basin Coalbed Methane Environmental Impact Statement – Technical Support Document (USDI/USDA 2006b).
- Air Quality Modeling Study for the Four Corners Region. Additional Ozone Source Apportionment and Ozone Sensitivity Modeling Analyses. January 22, 2010 (FCAQTF 2010).
- 80-Acre Infill Oil and Gas Development PEA (USDI 2009).
- Gothic Shale Supplemental EIS (USDI/USDA 2011).

Two of these studies (80-Acre Infill Oil and Gas Development PEA and the Four Corners Air Quality Task Force [FCAQTF]) conducted detailed photochemical modeling to estimate air quality, visibility, and acid deposition impacts resulting from expected future development in the Four Corners region. Modeling performed for the 80-Acre Infill PEA was based on the FCAQTF study and focused specifically on the impacts of the proposed 80-Acre Infill project. Three emission scenarios were modeled:

1. A 2005 base case scenario.
2. A 2018 “no action” scenario including emission changes from existing sources and emissions from reasonably foreseeable sources (not including the proposed action) occurring or expected to occur between 2005 and 2018.
3. A 2018 “full infill” scenario, which is the same as the 2018 “no action” scenario but with emissions from the 80-Acre Infill project included.

Model results from these scenarios were used to calculate project incremental impacts (2018 "full infill" scenario impacts minus 2018 "no action" impacts) and cumulative incremental impacts (2018 "full infill" impacts minus 2005 base case impacts). Because the 770 well proposed 80-Acre Infill project analyzed in the PEA is much larger than the 48 well proposed action, project incremental impacts presented in the PEA can be reasonably assumed to be greater than the mid- and far-field project impacts (i.e., impacts outside of the 2.5 km near-field zone) from the much smaller proposed action. Results of the cumulative impacts analysis from the PEA and their implications for cumulative impacts of the proposed action are described in Chapter 5 below.

Modeled ozone design values were calculated in the PEA at each ozone-monitoring site within the Four Corners region using USEPA guideline procedures (USEPA 2007). Results showed that:

- Ozone design values are predicted to be below the level of the NAAQS at all locations under all three scenarios.
- Ozone design values are predicted to be lower under both 2018 scenarios as compared to the 2005 base case at all monitoring sites except at Bloomfield, New Mexico where the design value is predicted to remain unchanged.
- Ozone design values are predicted to remain unchanged under the 2018 full infill scenario as compared to the 2018 no action scenario at all monitoring sites except for an increase of 1 ppb (from 63 ppb to 64 ppb) at Bondad and an increase of 1 ppb (from 71 ppb to 72 ppb) at Mesa Verde.

It is reasonable to assume that the incremental project impact of the proposed action on ozone design values will be less than those predicted for the much larger 80-Acre Infill project. Thus, no exceedances of the ozone NAAQS are expected to result due to the proposed action.

### 4.2.2 Air Quality Related Values Impacts Analysis

Impacts from the proposed action on AQRVs in nearby Class I areas were analyzed according to methodologies recommended by the BLM, procedures presented in the Federal Land Managers' *Air Quality Related Values Work Group (FLAG) Phase I Report—Revised (2010)*, and other associated documents. The AQRV analysis methods and results for visibility impacts, sulfur and nitrogen deposition, and acid neutralizing capacity (ANC) are summarized below and detailed in the AQIA Technical Report (Appendix G).

#### 4.2.2.1 Visibility Analysis

A level-1 screening analysis was conducted using VISCREEN to provide a conservative upper-bound estimate of plume visual impacts in Weminuche Wilderness Area. The VISCREEN results for the proposed action scenario showed a maximum color difference index (ΔE) of 0.329 and a maximum absolute contrast value |C| of 0.006 inside the Class I area and a maximum ΔE of 1.28 and a maximum |C| of 0.015 outside the Class I area. All of these values are less than the screening values of a color difference index (ΔE) of 2.0 and a contrast [C] of 0.05 recommended by the Federal Land Managers' Interagency Guidance (Flag 2010); therefore, the proposed action would not have significant impacts to visibility in this Class I area.

A plume visual impact analysis for Mesa Verde is not appropriate in this case as Mesa Verde is located more than 50 km from the proposed action (see Figure 4.1 in Appendix G). In any case, impacts in Mesa Verde would be lower than those in Weminuche due to the greater distance of Mesa Verde (85 km) from the proposed action as compared to Weminuche (43 km).

Results of the detailed photochemical modeling analysis of Class I area regional haze impacts associated with the SUIT 80-Acre Infill Project were presented in the 80-Acre Infill Project PEA (USDI 2009). These results provide an upper bound estimate on the incremental regional haze impact of the proposed action as the 80-Acre Infill project is a much larger development (770 wells as compared to 48 wells in the proposed action), which is located in the same general vicinity of the proposed action and extends closer to the Weminuche and Mesa Verde Class I areas (see Figure 5-1 below). Results presented in the PEA show that maximum day project incremental visibility reductions due to emissions from the proposed 80-acre Infill Project were predicted to be 0.1 dV (deciview) at Weminuche and 0.3 dV at Mesa Verde. The significant impact threshold recommended by FLAG (2010) is 0.5 dV.

#### 4.2.2.2 Deposition Analysis

Sulfur and nitrogen depositions were estimated using the maximum modeled annual average $SO_2$ and $NO_2$ impacts within the Weminuche Class I area and along a 50-km (31 mile) arc of receptors in the direction of Mesa Verde under the "maximum year" emissions scenario. Modeled $NO_2$ impacts were conservatively evaluated assuming all $NO_x$ is emitted as $NO_2$. Results of this analysis are presented in Table 4-6.

**Table 4-6. Deposition analysis results**

| | Nitrogen | Sulfur |
|---|---|---|
| **Weminuche** | | |
| Maximum Annual Average Concentration (µg/m$^3$) | 0.00521 | 0.00002 |
| Deposition Flux (kg/ha/yr) | 0.050 | 0.00003 |
| **Mesa Verde**[a] | | |
| Maximum Annual Average Concentration (µg/m$^3$) | 0.00714 | 0.00002 |
| Deposition Flux (kg/ha/yr) | 0.069 | 0.00003 |
| Deposition Analysis Threshold (DAT) (kg/ha/yr) | 0.005 | 0.005 |

Note: kg = kilograms; ha = hectare; yr = year; µg/m$^3$ = micrograms per cubic meter

[a] As estimated along an arc of receptors located 50 km from the proposed action in the direction of Mesa Verde; these receptors are at least 35 km closer to the proposed action sources than is Mesa Verde.

Predicted sulfur deposition from the proposed action is less than the Deposition Analysis Threshold for the western U.S. (0.005 kg/ha/year), as specified in Federal Land Managers' Interagency Guidance for Nitrogen and Sulfur Deposition Analyses (USDI/NPS 2011). While the predicted nitrogen deposition exceeds the Deposition Analysis Threshold (DAT), an exceedance does not necessarily mean that acid deposition impacts from the project would be significant (*ibid*). However, additional information may be required to make a project-specific assessment of whether the projected increase in deposition would likely result in an adverse impact on resources.

Results of a detailed photochemical modeling analysis of acid deposition impacts associated with the adjacent and larger 80-Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation

(USDI 2009) were reviewed to provide an additional assessment of potential acid deposition impacts of the proposed action. Project incremental impacts were estimated in the 80-Acre Infill PEA at sensitive lakes in the Weminuche Class I area. Because the 80-Acre Infill Project is much larger than the proposed action and portions of the infill development lie closer to the Weminuche and Mesa Verde class I areas, project incremental deposition from the proposed action sources is likely to be less than estimates presented in the PEA.

Deposition estimates from the PEA are lower than those listed for the proposed action in Table 4-6. The lower rates are a result of the more refined modeling technique, which accounts for photochemistry used in the PEA. The maximum project incremental annual total nitrogen deposition was estimated in the PEA to be 0.00843 kg/ha/yr, which is closer to the DAT (0.005 kg/ha/yr) than the proposed action's AERMOD estimate of 0.050 kg/ha/yr shown in Table 4-6. This suggests the incremental nitrogen deposition impact from the proposed action is close to but possibly still greater than the DAT. A discussion of the cumulative sulfur and nitrogen deposition impacts associated with the proposed action is presented in Chapter 5.

Nitrogen and sulfur deposition impacts were estimated based on the maximum annual emissions scenario, which includes 49 tpy $NO_X$ from development phase sources (construction, drilling, completion) and 64 tpy $NO_X$ from operational phase sources (including 37 tpy from compressors, 22 tpy from pump jacks, and 5 tpy from other sources). Thus, approximately 43 percent of the nitrogen deposition is estimated to result from development phase sources. After the 5-year development phase is complete, nitrogen deposition is therefore estimated to be reduced to a level of 0.028 kg/ha/yr at Weminuche and 0.039 kg/ha/yr at Mesa Verde. These values also exceed the DAT. As shown below however, the more refined acid deposition analysis of the much larger 80-Acre Infill project conducted for the PEA suggests that the actual nitrogen deposition impacts from the proposed action are likely to be much closer to if not less than the DAT. In addition, as noted in Chapter 5, the cumulative impacts analysis in the PEA showed that acid deposition in the Weminuche Class I area is expected to decrease by 2018 relative to the 2005 baseline due to reductions in regional power plant emissions. Simply adding the estimated nitrogen and sulfur deposition from the proposed action to the cumulative deposition increments modeled for the Weminuche Class I area in the PEA, still results in net estimated decreases in acid deposition. This indicates that cumulative incremental acid deposition impacts for the proposed action would be below applicable thresholds.

#### 4.2.2.3 ANC Analysis

The ANC analysis was designed to show how additions of sulfate and/or nitrate deposition from the proposed action may cause a change in the ANC of sensitive lakes in the surrounding Class I areas from a monitored baseline. There were no sensitive lakes identified for analysis in Mesa Verde National Park. Predicted changes in ANC resulting from the proposed action are estimated to be smaller than the applicable threshold limits established by the United State Forest Service (USFS) at each lake as shown in Table 4-7. By way of comparison, it is useful to note that results of a detailed photochemical modeling analysis of changes in ANC at the lakes listed in Table 4-7 expected to result from the adjacent and larger 80-Acre Infill Project (USDI 2009) also found that that proposed development would not cause any project incremental ANC impacts exceeding the applicable threshold limits.

**Table 4-7. Acid neutralizing capacity analysis for Weminuche Wilderness lakes**

| Lake | Watershed Area (ha) | A (µeq/l) Lowest 10% | Precipitation (meters) | Predicted ANC Reduction (µeq/l) | Predicted ANC Reduction (%) | Limit of Acceptable Change |
|---|---|---|---|---|---|---|
| Big Eldorado | 115.26 | 20.39 | 1.143 | 0.467 | N/A | 1 µeq/l |
| Lower Sunlight | 97.89 | 85.04 | 1.143 | 0.467 | 0.55 | 10% |
| Upper Grizzly | 30.62 | 29.88 | 1.143 | 0.467 | 1.56 | 10% |
| Upper Sunlight | 79.58 | 28.00 | 1.143 | 0.467 | 1.67 | 10% |

Note: µeq/l = microequivalents per liter

### 4.2.3 Greenhouse Gases

The assessment of greenhouse gas emissions (GHG) and climate change is in its formative phase; therefore, it is not possible to know with confidence the net impact to climate. However, the Intergovernmental Panel on Climate Change (IPCC 2007) recently concluded that warming of the climate system is unequivocal and most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic (man-made) greenhouse gas concentrations. The lack of scientific tools designed to predict climate change on regional or local scales limits the ability to quantify potential future impacts.

GHG emissions were estimated for the completed project during full production and are presented in Table 4-8. The emissions levels were converted to carbon dioxide equivalent ($CO_2e$) according to BLM specifications. Total annual emissions would be about 49,400 $CO_2e$ tons per year (tpy).

**Table 4-8. Annual greenhouse gas estimated emissions for proposed action at full production in metric tons per year (metric tpy)**

| Equipment | $CO_2e$ per equipment type (metric tpy) | Proposed Action Equipment Inventory (No. of Units) | Proposed Action $CO_2e$ emissions (metric tpy) |
|---|---|---|---|
| Separators | 21.03 | 48 | 1009 |
| Heaters | 9.98 | 68 | 679 |
| Wellhead | 6.37 | 48 | 306 |
| Meter piping | 8.92 | 48 | 428 |
| Pumpjack Engine | 239.88 | 48 | 11514 |
| Salt-water Disposal Generator | 244.87 | 1 | 245 |
| Compressor Station Emissions | 35,040.68 | 1 | 35,041 |
| Low Bleed Pneumatic Devices | 4.46 | 48 | 214 |
| **Project Total GHG emissions** | | | **49,436** |

## 4.3 Geology and Minerals Resources

The Tribe's oil and mineral resources in the North Carracas AMI were irrevocably committed to Red Willow in Lease Agreement #750-08-2008, according to the terms of the NDMA. Through Red Willow's and Energen's establishment of the North Carracas AMI and related joint development and joint operating

agreements, the NDMA minerals and Energen's private leasehold interest within the AMI are proposed to be developed in accordance with the POD.

### 4.3.1 Direct and Indirect Impacts

There would be irretrievable impacts to mineral resources. The natural gas production from the proposed action is estimated to average 5 billion cubic feet (bcf) annually, assuming 30 years of production for the wells included in the POD.

The surface construction of wells and infrastructure would not affect subsurface geology. The well bores that would penetrate Quaternary and Tertiary geologic units are drilled under strict guidelines. Drilling fluids and materials are not expected to extend beyond a small circulation zone (a few feet in diameter); therefore, geologic formations other than the Fruitland Formation would not be impacted by drilling or completion. Impacts to the Fruitland Formation would include removal of natural gas resources and de-watering. These impacts would not affect the strength of the geologic unit due to the structure of the coalbeds and inherent geology.

Modifications to topography would be minimized, based on the drilling of multiple wells from single-well pads and the use of two existing well pads and other existing infrastructure; to reduce construction costs, cuts and fills would be minimized. Impacts to topography would be long term, as the original (or similar) land contours would not be re-established until final abandonment. Impacts to topography would include slight modifications to allow for level work areas. Road construction activities may also require areas of cut and fill to provide an even slope and adequate turning areas for drill rigs and semi-trucks. Impacts to topography would be minimized through the implementation of design features outlined in Section 2.2.9.

## 4.4 Soils

### 4.4.1 Direct and Indirect Impacts

Based on the overlap of the proposed action with existing prime farmland mapped areas, approximately 61 acres of prime farmland could be impacted. These impacts would affect 2.9 percent of prime farmland in the study area. Impacts would be minimized with the implementation of design features listed in Section 2.2.9. Approximately 26 acres of prime farmland could be impacted in the short term from pipeline construction. These areas would be reclaimed within 12 months of disturbance. Approximately 35 acres of prime farmland could be impacted by well pads. These impacts would be long term (greater than 5 years), but would not be irretrievable. It is assumed that after final project reclamation, prime farmland characteristics would be restored.

No areas of highly erodible soils would be impacted by the proposed action.

Impacts to project area soils would include compaction, mixing, and displacement due to wind and water erosion. Approximately 142.8 acres of soils would be affected for the short term. This total amount of disturbance would occur over the span of approximately 5 years. Following interim reclamation and stabilization, approximately 76.7 acres would be subject to long-term impacts.

No importing of soil is anticipated to occur during development of the proposed actions. Level well pads would be constructed balancing cuts and fills. Gravel would be imported from off site to stabilize driving

surfaces and well operation areas. Design features and BMPs would include prompt stabilization and reclamation of disturbed areas, control of runoff, and minimization of off-road travel in reclaimed areas. Interim reclamation would occur in phases following well pad and pipeline construction activities. Interim reclamation would be completed inside tie downs (anchors) on well pads and outside of driving areas (roads) on pipeline ROWs. In general, areas of short-term disturbance would have reclamation completed within 12 months. Approximately 76.7 acres of disturbance would be long term. These areas would include the access, parking, and work areas on well pads, compressor station, salt-water disposal well, and proposed access road driving surfaces. Impacts to these soils would be the same as described above, but reclamation would not occur until all project activities are completed and all infrastructure has been removed. Appropriate reclamation and BMPs would be implemented at final abandonment.

## 4.5 Water – Surface and Groundwater

### 4.5.1 Direct and Indirect Impacts

Potential impacts to surface water and groundwater resources from the proposed action include:

- Chemical contamination of surface water and shallow groundwater from accidental spills of chemicals, produced water, or flowback fluids.
- Chemical contamination of groundwater associated with development of the wells to be drilled as part of the proposed activities.
- Depletion of surface water or groundwater from proposed activities.
- Increased erosion and sedimentation of surface water due to disturbance from roads, well pads, pipelines, and other facility construction.

#### 4.5.1.1 Chemical Contamination of Surface Water and Alluvial Aquifers

Potential impacts to surface water and shallow groundwater resources could occur from stormwater runoff and the accidental spill of chemicals, produced water, or flowback fluids. The potential for these impacts would be long term for the life of the proposed actions. Impacts from chemical contamination have the potential to be short term or long term during drilling and/or operation, depending on the severity of the spill/leak. While accidental spills/leaks are inevitable in a project of this scope, corrective actions would be promptly taken to mitigate against site degradation. Impacts to surface and groundwater quality from stormwater runoff and accidental spills would be minimized by following the design features listed in Section 2.2.9, by complying with site-specific Stormwater Pollution Prevention Plans (SWPPP), the SPCC Plan (if required), project-specific Drilling Plan, and through on-site monitoring.

Specific features proposed to minimize surface and groundwater contamination include, but are not limited to, the following:

- A closed-loop system would be used for all gas wells to contain drill cuttings and fluids, which would eliminate the need for an aboveground reserve pit and minimize the potential for water quality impacts.
- Produced water and flowback fluids (the portion of injected hydraulic fracturing fluids that are returned to the surface during the fracturing process) would be temporarily stored on site in aboveground storage tanks during drilling and completion. Storage tanks would have secondary

containment structures and concrete pads or drip containment systems for loading/unloading, pursuant to requirements in the SPCC Plan.

- All spills would be promptly reported to the SUIT DOE and BIA, in accordance to the SUIT Spill/Release Reporting Policy and reported to the BLM in accordance with BLM-Notice to Lessees NTL-3A.
- Effective stormwater management BMPs to contain stormwater runoff from project facilities.
- Appropriate containment of chemicals stored on site during operation, pursuant to requirements.
- Containment structures sufficiently impervious to prevent a discharge to waters of the U.S., such as containment dikes, containment walls, drip pans, or equivalent protection actions would be constructed and maintained around qualifying fluid/chemical facilities or storage tanks.

The *Stormwater Recommendations for Oil and Gas Operations on Tribal Lands within the Southern Ute Indian Reservation* would be implemented. When site-specific locations have been identified, prior to the initiation of project activities, the operator would develop and implement detailed, comprehensive, and project-specific SWPPPs and SPCC Plans. Following well completion, water lines would be installed to transport produced water from the well to the saltwater disposal well. Installation of these water lines would reduce the potential for spills/leaks during loading and offloading or on-site tank storage.

#### 4.5.1.2 Chemical Contamination of Groundwater

Potential impacts to groundwater resources could occur from the proposed well bores, hydraulic fracturing, or salt-water injection. The proposed POD would involve hydraulic fracturing during completion of nine non-horizontal wells. These processes are regulated by various entities including the BLM and COGCC to prevent groundwater contamination. The risk of contamination of useable groundwater resources (including possible Underground Source of Drinking Water [USDW] as defined by 40 CFR 191.22 as having TDS concentrations less than 10,000 mg/L) by means of contaminant movement through the intervening geologic formations or along well bores would be minimized given the depth of the Fruitland Formation target zone (typically greater than 2,800 feet), the continuous confining layer of Kirtland Shale overlying the formation, best practices associated with completion techniques (as outlined in Section 2.2.8), and strict regulatory oversight. Specific BMPs proposed to minimize contamination of groundwater during the hydraulic fracturing process include, but are not limited to:

- Cement all surface and production casing strings to the surface via circulation methods.
- A closed-loop system would be used for all natural gas wells to contain drill cuttings and fluids, which would eliminate the need for an aboveground reserve pit and minimize the potential for water quality impacts.
- Timely plug and abandon non-productive wells and associated flow lines and equipment.
- In the event that any surface water body or usable groundwater aquifer is degraded by any of the proposed action, the problem would be immediately reported and remediated or other corrective action taken as determined by the appropriate agency.
- Monitoring of groundwater in the project area, follow procedures consistent with COGCC regulations for sampling water wells near oil and gas wells.
- Bradenhead pressures would be monitored to identify wells that may be acting as vertical conduits for fluid migration, including but not limited to completion fluid, methane, or Fruitland Coal water.

- The USEPA would perform mechanical integrity tests on the salt-water disposal well per the underground injection permit.

A thorough review of existing and abandoned well bores in the area would be conducted prior to well stimulation to minimize the potential for hydraulic fracturing fluids or produced water to migrate into shallow aquifers through vertical movement along damaged or poorly constructed well bore holes. Geologic information would be considered during the design of hydraulic fracturing treatments to (1) minimize the potential for fracturing to extend into zones of geologic weakness, such as fractures and faults that are conduits to other shallow zones (USGS 1996) and (2) minimize impacts to potential USDW. There are no verified instances of hydraulic fracturing adversely affecting groundwater in the San Juan Basin to date. Since 2000, the COGCC has required operators to collect pre- and post-development groundwater quality samples from more than 1,900 water wells in the basin (Neslin 2011). Programs have also been implemented to monitor existing well bore integrity (bradenhead testing program) and to identify and mitigate poorly abandoned wells.

COGCC rules in place to protect groundwater and drinking water quality include the safeguards listed in Table 4-9.

**Table 4-9. Colorado Oil and Gas Conservation Commission rules to protect groundwater and drinking water quality**

| Rule | Safeguard |
|---|---|
| 205 | Requires operators to inventory chemicals kept at drilling sites, including hydraulic fracturing fluids. This information must be provided to agency officials promptly upon request and to certain health care professionals who sign a confidentiality agreement. |
| 205A | Requires public disclosure of hydraulic fracturing chemicals using the FracFocus.org website. Applicable on or after February 1, 2012. |
| 317 | Requires wells to be cased with steel pipe and the casing to be surrounded by cement to create a hydraulic seal and ensure that gas and fluids do not leak into shallower aquifers. Requires operators to run cement bond logs on all production casing to confirm that the cement has properly isolated the hydrocarbon bearing zones. |
| 317B | Imposes mandatory setbacks and enhanced environmental protections on oil and gas development occurring near sources of public drinking water. |
| 341 | Requires operators to monitor well pressures during hydraulic fracturing and promptly report significant increases. |
| 608 | Requires operators to pressure test CBM wells and to sample nearby water wells before, during, and after operations to ensure that they are not contaminated by gas or other pollutants. |
| 609 | Requires operators to obtain baseline samples and monitor domestic water wells up to 4.5 miles from a dedicated injection well. |
| 903, 904, and 906 | Imposes requirements for pit permitting, lining, monitoring, and secondary containment to ensure that fluids in pits do not contaminate soil, groundwater, or surface water. |

Source: COGCC 2013

As reflected in the COGCC's regulations defining scope, the COGCC rules have limited direct effect on Indian trust lands or activities undertaken by the Tribe, including Red Willow, within the boundaries of the Reservation (COGCC Rule 201). Nonetheless, the Tribe's policies and practices as incorporated in stipulations imposed in BLM approval of APDs, generally mimic the substantive requirements found in the COGCC rules and regulations.

The BLM also has environmental oversight and safeguards in place to protect groundwater resources during hydraulic fracturing. Prior to approving an APD, a BLM geologist identifies all potential subsurface formations that will be penetrated by the wellbore. This includes all groundwater aquifers and any zones that would present potential safety or health risks that may need special protection measures during drilling, or that may require specific protective well construction measures.

Once the geologic analysis is completed, the BLM reviews the company's proposed casing and cementing programs to ensure the well construction design is adequate to protect the surface and subsurface environment, including the potential risks identified by the geologist and all known or anticipated zones with potential risks.

During drilling, the BLM is on location during the setting of critical casing and cementing intervals. Before hydraulic fracturing takes place, all surface casings and some deeper, intermediate zones are required to be cemented from the bottom of the cased hole to the surface. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run on certain strings of casing to ensure the cement has bonded to the casing and the formation. If the fracturing of the well is considered to be a "non-routine" fracture for the area, the BLM will always be on-site during those operations, as well as when abnormal conditions develop during the drilling or completion of a well.

Producing water from the Fruitland Formation and disposing of it in deeper, poor quality aquifers would not impact usable groundwater resources in shallow aquifers as long as protections are in place that are designed to prevent contamination. The poor water quality of most of the Fruitland Formation prevents this produced water from being a viable water resource (i.e., TDS >10,000 mg/L). CBM produced water from the proposed wells would be disposed by injection into Class II Underground Injection Control well or into a salt-water disposal well. The formations in which the produced water from the proposed action is to be re-injected (Bluff Sandstone or Entrada Sandstone) are not viable, usable, USDW groundwater supply sources in this area. A search of well data from the Dwights IHS database (K. Siesser personal communication 2013), indicated that 43 Class II injection wells (some active, some inactive) have been permitted in the Ignacio-Blanco field (Colorado portion of the San Juan Basin). Of the 43 wells, 26 were injected into the Bluff or Entrada Formations.

All appropriate regulations would be followed in the application and construction process of the injection well and injection well operations would be monitored monthly for cumulative injection volumes and pressures in tubing and tubing/casing annulus.

#### 4.5.1.3 Depletions

Under the proposed action, 21,150 bbls of fresh water would be consumed for the drilling and completion of the nine non-horizontal wells. An additional 3,175 bbls could be consumed to drill the salt-water disposal well. Approximately 68,250 bbls of fresh water would be needed to drill the 39 horizontal wells. A total of approximately 92,575 bbls of fresh water would be needed to implement the proposed POD.

The fresh water needed to drill and complete the wells would be acquired from a legal supply of water from private or commercial sources. Specifics regarding the acquisition of a legal supply of water to implement the proposed action are unknown. Because water is purchased from decreed commercial sources, depletions do not injure water rights holders in the basin.

During the production of CBM gas, water is typically removed from the producing formation and is referred to as produced water. The Fruitland Formation is recharged at the outcrop, which is located outside the study area.

The proposed action would have no measurable surface water depletions, as the entire study area is located within non-tributary areas (SSPA 2006). Non-tributary water is defined as groundwater located outside the boundaries of any designated groundwater basins, the withdrawal of which will not, within 100 years of continuous withdrawal, deplete the flow of a natural stream, including a natural stream at an annual rate greater than one-tenth of 1 percent of the annual rate of withdrawal (Colorado Revised Statute Sections 37-82-101(2) and 37-82 102(1)(b)). Under Colorado regulations promulgated for the propose of issuing water well permits based upon the best and most recent available science, the well in the proposed study area would be non-tributary to surface waters 2 CCR 402-17.7(d).

#### 4.5.1.4 Surface Water Quality

Along with the construction of roads and well pads, the proposed action would involve the construction of a bridge over the San Juan River, two pipelines (one gas and one produced water, constructed in the same trench) crossing under the San Juan River, and approximately 20 potential crossings of National Hydrography Dataset "bluelines" that may be considered jurisdictional waters of the U.S. These components of the proposed action could affect surface water quality from increased erosion and sedimentation. The potential for impacts to streams and wetlands from erosion and sedimentation from roads, pipelines, and project facilities would be minimized though the application of numerous BMPs, including, but not limited to:

- Implement BMPs to slow or reduce the flow of surface-water runoff across disturbed areas, including diversion of surface runoff around facilities.
- Implement and maintain structural erosion and sediment controls such as interim or permanent water bars, detention ponds, straw bales, silt fences, earth dikes, and inlet and outlet protection.
- Implement non-structural control practices such as interim and permanent stabilization, permanent and temporary seeding and re-vegetation, and geotextiles.
- Installation of appropriately sized culverts to convey surface flow under constructed roads.
- Retention of a vegetation buffer strip (minimum of 100 feet) between water bodies and disturbed areas.
- Avoidance of waters of the U.S. whenever practicable.
- Avoidance of construction activities near or through streams and implement USACE permit requirements and conditions.

Once site-specific locations are identified, prior to the initiation of project activities, the applicant would develop and implement detailed, comprehensive, and project-specific SWPPPs.

The impacts to the San Juan River resulting from bridge construction and reclamation activities would be short term. No measurable impacts to the San Juan River water quality or impacts to channel morphology from operation of the bridge are anticipated given the engineered design. The proposed bridge would be designed in general conformance to American Association of State Highway and Transportation Officials "Standards Specifications for Highway Bridges." As proposed, structural piles would be supported by

competent bedrock in the river. Clean Water Act permitting will be required and CDOT regulations followed. Conditions of these reviews and permitting requirements would mitigate impacts to the San Juan River. Additionally, with the implementation of design features, construction of the proposed bridge is not expected to result in detectable changes to water quality in Navajo Reservoir.

Direct impacts to the San Juan River from the proposed pipeline crossing would be short term considering the applicant is proposing to bore under the river and mitigation measures would serve to protect water quality during construction. When the specific site location has been identified, if it is determined boring is not possible, measures would be implemented to protect water quality during pipeline construction. If boring is not possible, then the stream would be trenched to install the pipeline. Site-specific BMPs would be implemented to protect water quality and could include baffles to divert water from where trenching is occurring, bank stabilization, etc. The USACE regulates the discharge of dredged or fill material into jurisdictional waters of the U.S. and has permitting authority over these actions.

Impacts to ephemeral waters of the U.S. would be short term from construction of pipelines, roads, or well pads. Clean Water Act permitting would be required if impacts to waters of the U.S., including ephemeral drainages, cannot be avoided. Furthermore, a Clean Water Act Section 401 Certification would be required if a 404 permit is needed. Impacts to waters of the U.S. may require mitigation, as specified during the permitting process that would occur when site-specific analysis is conducted.

No long-term impacts to water quality from physical erosion processes are anticipated in the San Juan River, Piedra River, or Navajo Reservoir; only potential short-term impacts from storm events washing sediment into the rivers or reservoir.

## 4.6 Vegetation

### 4.6.1 Direct and Indirect Impacts

Approximately 143 acres of vegetation would be affected, which is less than 1 percent of the total vegetation within the study area. Approximately 66 acres of vegetation would be impacted for the short term following interim reclamation. There would be long-term impacts to approximately 77 acres during operation and maintenance. Impacts to vegetation resources would be minimized by following the design features outlined in Section 2.2.9.

Direct and indirect impacts would be related to the removal and modification of vegetation. Indirect impacts would include a change in species composition, density, and age diversity within impacted areas compared to surrounding vegetation communities. Woodland areas could take several decades to return to current conditions.

The proposed action would impact over 1 acre of six community types out of the 15 vegetation community types in the study area. Table 4-10 lists the vegetation types, the amount of disturbance, and the percent total of that community affected within the study area.

**Table 4-10. Vegetation community types and acreages impacted by the proposed action**

| Community Type | Well Pad Area Disturbance (Acres) | Pipeline/Road Disturbance (Acres) | Total (Acres)[1] | Percent Community Type Affected in the Study Area |
|---|---|---|---|---|
| Colorado Plateau Piñon -Juniper Woodland | 40.8 | 47.5 | 88.3 | 0.8 |
| Inter-Mountain Basins Big Sagebrush Shrubland | 18.6 | 12.3 | 30.9 | 2.5 |
| Inter-Mountain Basins Semi-Desert Grassland | 0 | 0.7 | 0.7 | 2.7 |
| Inter-Mountain Basins Semi-Desert Shrub Steppe | 0 | 0.02 | 0.02 | >0.01 |
| Rocky Mountain Gambel Oak-Mixed Montane Shrubland | 0.7 | 2.9 | 3.6 | 0.3 |
| Rocky Mountain Lower Montane-Foothill Shrubland | 2.6 | 0.7 | 3.3 | 6.6 |
| Rocky Mountain Lower Montane Riparian Woodland and Shrubland | 2.5 | 5.8 | 8.3 | 9.2 |
| Rocky Mountain Ponderosa Pine Woodland | 1.4 | 0.1 | 1.5 | 0.1 |
| Southern Rocky Mountain Montane-Subalpine Grassland | 4.6 | 1.1 | 5.7 | 3.9 |
| **Total:** | **71.3** | **71.1** | **142.6** | |

[1]Acreage estimates may be marginally more or less than those described in Table 2-3 due to GIS polygon analysis.

During construction, contractor vehicles would be required to operate only within areas identified as work areas and on existing roadways. Implementation of proper soil salvage, storage, and reclamation would retain adequate infiltration and permeability rates that would allow for maintenance of soil moisture, which is necessary for plant growth and vigor, and minimize surface runoff. Interim reclamation would be initiated immediately following completion activities, and final reclamation would occur only after wells are properly capped and abandoned and all associated equipment is removed. Reclamation would include re-contouring disturbed areas to match original slopes as closely as practicable while providing a level or convex free-draining surface. Stockpiled topsoil would be replaced prior to reseeding with an approved diverse, weed-free seed mix consisting of grasses, forbs, and/or shrubs. All reclaimed areas would be mulched and crimped using certified weed-free straw or hay to reduce the erosion hazard and help maintain soil moisture, and invasive and noxious species control and monitoring would be required.

#### 4.6.1.1 Wetlands

Since site-specific locations under the proposed action have not been identified, potential impacts to wetlands are not quantifiable. Based on review of National Wetland Inventory database, there are riverine wetland complexes along the San Juan River corridor in the study area. Potential impacts to wetlands would be determined during the site-specific analysis at the time of APD or ROW grant submittal. It is expected that impacts to wetlands would be avoided or minimized during the siting of project components. The implementation of design features as listed in Section 2.2.9 and other mitigation

measures would also serve to minimize any potential impacts. USACE regulates the discharge of dredged or fill material into jurisdictional wetlands and has permitting authority over these actions.

#### 4.6.1.2 Invasive, Non-Native Species

The proposed action would have long-term impacts from the potential spread and/or introduction of invasive, non-native species on lands disturbed by construction, drilling, operation, and maintenance activities. Total disturbance of vegetation providing opportunity for the introduction and/or spread of invasive, non-native species is expected to occur on approximately 143 acres, or less than 1 percent of the study area.

Surface disturbance creates the potential for the establishment and spread of noxious weeds. Non-native species may also out-compete native species, resulting in changes in vegetation composition that may indirectly result in altered wildlife use or a loss in livestock forage. Vehicles entering the area have the potential to distribute and spread invasive, non-native plant species picked up from other areas. Proper seeding and monitoring of the disturbed areas would reduce the potential for invasive species to establish. Reclamation measures would be undertaken to minimize impacts from invasive, non-native species. Implementation of appropriate control/eradication measures prior to construction and monitoring for invasive, non-native species during operations would occur in accordance with the design features described in Section 2.2.9.

## 4.7 Wildlife and Fisheries

### 4.7.1 Direct and Indirect Impacts

Under the proposed action, direct and indirect impacts on wildlife would be short term (lasting roughly 5 years during construction and the drilling). Long-term impacts of the proposed action would remain, but would decrease in intensity as some areas disturbed during the first 5 years recover their value as habitat for wildlife. The proposed action would result in the long-term loss of approximately 76.7 acres of wildlife habitat that would be converted to an industrial use.

The intensity of impacts is supported by the following reasons: less than 1 percent of the study area would be impacted; wildlife populations are currently considered stable and healthy within the study area; the use of existing infrastructure and drilling multiple wells from single well pads would minimize surface disturbance; and the effectiveness of design features listed in Section 2.2.9.

Impacts to wildlife would result from habitat loss, human-wildlife encounters, and injury or mortality. The study area is largely undeveloped, but is bisected from east to west by CR 500 and has several arterial traffic routes leading north and south.

Two parameters are considered when evaluating habitat loss—direct habitat loss and effective habitat loss. Direct habitat loss occurs through the removal of vegetation that reduces the extent or quality of habitat in terms of food and cover. Vegetation removal strips the affected area of its value to wildlife; therefore, direct habitat loss can be quantified by comparing the area of habitat lost to the amount retained. The removal of approximately 143 acres of vegetation, including trees, would result in a direct loss of foraging, breeding, and denning habitat. Disturbed habitats not required for production would be reclaimed and reseeded, reducing the amount of long-term habitat loss. Reclamation would result in a

change in vegetative composition and density over approximately 74 acres. Reclaimed areas would generally be modified from their original condition—particularly woodland areas. A change in vegetation composition and density would occur in most areas and could result in a change in wildlife use; for example, removal of trees would create open areas and decrease cover habitat. Ground disturbance would also increase the potential for invasive, non-native species that could become established and affect vegetation composition and diversity.

The amount of habitat available to wildlife is called effective habitat. The effectiveness of habitat is lost when a species abandons or avoids an area. Because avoided areas meet no survival needs, the areas are no longer considered effective habitat. Loss of effective habitat area can exceed direct habitat loss. Quantifying the amount of effective habitat loss is difficult, as it depends on multiple variables including species, life cycles, and habitat type among others. Effective habitat loss can occur from habitat fragmentation, disturbance, and interference with movement. The impacts of habitat fragmentation are related to the loss of large contiguous habitat areas and the relative increase in habitat "edge" in smaller areas. Construction of roads and other development, as well as human and vehicular traffic on existing roads, can cause habitat fragmentation. Such disturbance can cause animals to shift their activity or alter their behavior.

Disturbance is a primary factor in effective habitat loss, as it can alter the ways wildlife use or move through an area and could push individual animals from preferred habitat into less suitable habitat. Such displacement would likely be localized around the source of the disturbance (i.e., equipment noise, human presence, etc.). Noise and human presence associated with the well pad construction and drilling, and the compressor station, would also cause impacts to wildlife. Most wildlife typically flee or escape noise disturbances, which can be displayed as either mild annoyance or panic behavior (Fletcher and Busnel 1978). Impacts to wildlife from noise are compounded by multiple variables such as the magnitude and duration of the noise generated, proximity of the noise source to an individual, individual behaviors/responses, time of year, time of day, and influence of other environmental stressors such as heat or snow depth.

Human activities would increase in the study area, which would increase the potential for human-wildlife encounters and conflicts. Possible conflicts could include human encounters with large predators, such as black bears and mountain lions, which could result in injury or death to individuals. There could also be an increase in illegal harvest by humans (i.e., poaching) resulting from new roads within the study area.

Direct impacts from vehicle traffic on roads could include incidental mortality to wildlife. Animal vehicle collisions are variable depending on time of day, speed and volume of traffic, local topography, structural features of the road, and the size and behavior of the individual impacted (Dodd et al. 2004). More mobile species, such as game birds, are less likely to be affected by vehicle traffic. The greatest potential for vehicle/wildlife collisions would occur on CR 500, which has a higher speed limit than unpaved existing and proposed access roads. Injury and mortality to wildlife could also result from exposure to chemical or hazardous substances, working heavy equipment, or moving machinery.

#### 4.7.1.1 Big Game

Impacts to big game would be long term given the amount of habitat that would be impacted in relation to adjacent suitable habitat. These impacts are minimized by utilizing existing disturbance, drilling multiple wells from single well pads, and restricting construction and drilling to December 1 through April 30

more than one-third mile from CR 500. In addition, routine maintenance, construction, and/or completion activities being conducted outside the buffer area during the closure period may only occur between 8:30 a.m. and 3:30 p.m. Most of the new development proposed by the action would be located within 1/3 mile of CR 500, which would minimize impacts to big game. Refer to Map 9 in Appendix A for the location of CR 500 and the buffer area. Because big game populations are currently considered stable and healthy within the study area, impacts from the proposed action are not expected to cause a loss of population viability for big game in the study area. By following the design features outlined in Section 2.2.9, impacts to big game would be minimized.

Big game species are typically very mobile with large home ranges; therefore, these species would be expected to use most of the study area depending on the time of year. Mule deer and elk have been shown to avoid natural gas wells, roads, and areas immediately surrounding them. This avoidance results in a loss of effective habitat. Hebblewhite summarized that the average zone of influence reported in eight different studies extended about 1,000 meters (3,281 feet) from roads and natural gas/oil wells. However, responses varied within seasons and between species (2011). The nature and extent of this avoidance is dependent upon the type of vegetation, particularly the amount of cover present, the volume of traffic, and whether the vehicles stop or continue moving. While no specific data are reported, Hoffman et al. (1993) suggest that Merriam's wild turkeys may abandon their habitats if road density is too high. There is some evidence that unpaved roads represent less of a barrier to black bear movement than do paved roads (Parsons 2006) and that black bears show no avoidance or attraction to low-traffic roads or hiking trails in the absence of hunting (Hightower 2003). Some studies indicate that early succession plants associated with roads may attract bears (Beringer et al. 1990; Coady 2001; Parsons 2006;). In Arizona and California, studies have shown that mountain lions are less likely to avoid unimproved dirt roads than improved dirt or paved roads (Van Dyke et al. 1986; Dickson et al. 2005).

Of particular concern is habitat loss for mule deer and elk in winter concentration areas, calving/fawning grounds, and migration corridors. Habitat fragmentation may result in deer and elk being unable to access habitats specific to their winter and summer life cycles and could decrease production or fitness of individuals. As shown on Maps 10 and 11 in Appendix A, some well pad locations and a portion of new road could be located within deer migration routes and at least one well pad could be located within a core winter use area. Portions of the proposed action would also be located within big game calving and fawning habitat. It is important to note that the migration routes and winter use areas depicted on the maps are based on a small sample size and may not be entirely representative of migration routes or use areas. However, for the purposes of this analysis, these data provide a general guideline. The construction of these roads, pipelines, well pads, and well drilling would occur outside the wintering season, as they are located outside the one-third mile buffer along CR 500. Because of this seasonal restriction, impacts to migrating or wintering mule deer and elk from increased traffic, noise, and human disturbance would be minimized.

#### 4.7.1.2 Small Game, Upland Game Birds, and Waterfowl

Impacts to small game species, upland game birds, and waterfowl would be long term and would affect less than 1 percent of the study area. Most small game species have relatively small home ranges and can readily move to adjacent suitable habitats. The proposed action may impact individuals. However, no adverse population level impacts would be expected, given the small amount of habitat affected and the use of design features listed in Section 2.2.9 that would minimize impacts to small game.

In general, small game including birds are very mobile species that would readily disperse from an area due to noise or human activity. These species would be expected to return to the area once the disturbance has subsided. Likewise, due to their mobility, roads would not be expected to act as barriers to movement though they could result in some avoidance.

There is the potential for small game species to encounter toxic substances or become entrapped in equipment (e.g., separators). A number of design features would minimize the potential for these impacts including netting open pits, screening open equipment, and proper chemical storage and handling.

#### 4.7.1.3 Non-Game

Impacts to non-game species would affect less than 1 percent of the study area. Impacts from the proposed action may impact individuals. However, no adverse population level impacts would be expected, given the small amount of habitat affected and the use of design features (listed in Section 2.2.9) that would minimize impacts to small game.

Roads could act as movement barriers to some smaller species disrupting natal dispersal, migration patterns, and gene flow among populations. These impacts would be limited to less mobile species or those with very small home ranges. However, some wildlife species have a high tolerance for human and vehicle presence and could occupy habitats adjacent to roads and well pads. Loss of wetland and riparian habitats would have the greatest impact on amphibians. However, impacts to riparian and wetland habitats would be minimized by the design features outlined in Section 2.2.9. Amphibians also utilize upland habitats for migration and overwintering; therefore, upland habitat loss and fragmentation in the study area could also impact local amphibian populations.

Injuries or deaths of non-game wildlife could result from vehicle collisions during all phases of the POD. Some animals could be injured or killed due to vehicle collisions. During construction activities, small, burrowing mammals, reptiles, or amphibians could also be injured or killed during blading and leveling of well pads, the compressor site, or access road/pipeline ROWs. There is the potential for non-game species to encounter toxic substances or become entrapped in equipment (e.g., separators). A number of design features would minimize the potential for these impacts including netting open pits, screening open equipment, and proper chemical storage and handling.

#### 4.7.1.4 Migratory Birds (including Bald and Golden Eagle)

Activities that result in the loss of habitat for one bird species may improve conditions for another. Habitat provides a source of food, security and escape cover, and nesting habitat for migratory bird species. Potential impacts to migratory birds can include disturbance from increased human presence, increased noise levels, temporary and permanent removal of nesting or foraging habitat and the resulting habitat fragmentation, increased edge creation, or destroying individual nests or eggs during habitat removal if the surface disturbance occurs during the migratory bird breeding season (generally March through August).

The proposed action would be expected to result in increased habitat fragmentation from the creation of the new well pads, roads, and pipelines. Direct impacts would include the removal of some piñon, juniper, ponderosa, and possibly cottonwood trees during construction activities, resulting in a long-term loss of potential nesting, foraging, and perching habitat for breeding birds. Less than 1 percent of the study area would be affected. Short-term impacts would include avoidance of the area during construction and

displacement of individuals to adjacent habitats, while long-term impacts would include a conversion of approximately 76.7 acres of potential nesting and foraging habitat to an industrial use. These impacts would be minimized by following the design features outlined in Section 2.2.9.

Indirect impacts could include nest abandonment during construction in adjacent areas (Fort 2002, Ralph et al. 1993), degradation of habitat from invasive species introduction or habitat fragmentation, increased mortalities associated with increased use of area roads, and decreased mammal prey base for raptors due to loss of habitat.

Direct and indirect impacts to migratory birds would be greater should construction and drilling occur during the breeding season. Any winter drilling that would occur under the proposed action would have no affect to breeding or nesting migratory birds. There could be positive long-term impacts to species such as Brewer's sparrow (*Spizella breweri*) and short-eared owl (*Asio flammeus*) from the conversion of woodlands to grasslands following interim and final reclamation.

USFWS Birds of Conservation Concern species are listed by Bird Conservation Regions. The study area occurs within Conservation Region 16—Southern Rockies/Colorado Plateau. Colorado Partners in Flight has identified priority species of birds for the State of Colorado by habitat type. The study area lies within the Colorado Plateau physiographic region as identified by the Colorado Partners in Flight. Species included on both lists with potential to occur in the habitats of the study area that could potentially be impacted include Brewer's sparrow, Lewis's woodpecker, peregrine falcon, gray vireo, piñon jay, and juniper titmouse. High priority migratory bird species and a brief assessment of the effects of the proposed action on their habitat are provided in Table 4-11.

**Table 4-11. Migratory bird species of concern occurring within the study area and potential impacts**

| Species | Habitat Type | Potential Impacts |
|---|---|---|
| Bald eagle *(Haliaeetus leucocephalus)* | Riparian | Removal of roost/nest trees, such as cottonwood, may be detrimental. |
| Band-tailed pigeon *(Patagioenas fasciata)* | Ponderosa pine, piñon-juniper | Removal of piñon-juniper and ponderosa pine would result in a loss of nesting habitat. |
| Brewer's sparrow *(Spizella breweri)* | Sagebrush, lower montane-foothill shrublands | Conversion of woodlands to sagebrush may result in positive impacts. |
| Broad-tailed hummingbird *(Selasphorus platycercus)* | Riparian, piñon-juniper, ponderosa pine | Removal of riparian, piñon-juniper, ponderosa pine would result in loss of breeding habitat. |
| Cordilleran flycatcher *(Empidonax occidentalis)* | Riparian | Minimal removal of riparian habitat anticipated. |
| Golden eagle *(Aquila chrysaetos)* | Grasslands, sagebrush | May be positively affected due to conversion to grassland/shrubland; may produce more prey over the long term. |
| Gray vireo *(Vireo vicinior)* | Nests in pinon-juniper | Reduction of piñon-juniper may be detrimental. |
| Green-tailed towhee *(Pipilo chlorurus)* | Gambel oak, lower montane-foothill shrublands, sagebrush | Minor amount of suitable habitat to be affected. |
| Juniper titmouse *(Baeolophus ridgwayi)* | Piñon-juniper | Secondary cavity nester; some loss of nesting habitat. |
| Lazuli bunting *(Passerina amoena)* | Gambel oak, lower montane-foothill shrublands, riparian | Minor amount of suitable habitat to be affected. |
| Lewis's woodpecker *(Melanerpes lewis)* | Ponderosa pine, riparian, piñon-juniper | Removal of piñon-juniper, riparian, ponderosa pine would result in loss of breeding habitat. |
| MacGillivray's warbler *(Oporornis tolmiei)* | Riparian, Gambel oak, lower montane-foothill shrublands | Minor amount of suitable habitat to be affected. |
| Olive-sided flycatcher *(Contopus cooperi)* | Ponderosa pine | Minor amount of suitable habitat to be affected. |
| Peregrine falcon *(Falco peregrinus anatum)* | Riparian | Minimal removal of riparian habitat anticipated. |
| Piñon jay *(Gymnorhinus cyanocephalus)* | Piñon-juniper | Colony nester in piñon; loss of piñon may negatively impact. |
| Prairie falcon *(Falco mexicanus)* | Grasslands, sagebrush | May be positively affected due to conversion to grassland/shrubland; may produce more prey over the long term. |
| Short-eared owl *(Asio flammeus)* | Grasslands, lower montane-foothill shrublands, sagebrush | May be positively affected due to conversion to grassland/shrubland; may produce more prey over the long term. |
| Virginia's warbler (*Vermivora virginiae*) | Ponderosa pine, piñon-juniper, Gambel oak, lower montane-foothill shrublands | Removal of piñon-juniper, Gambel oak, ponderosa pine would result in loss of breeding/foraging habitat. |

#### 4.7.1.5 Fisheries

Impacts to fisheries would be limited to potential water quality changes from increased sedimentation and accidental spills of petroleum products or other chemicals. Impacts from increased sedimentation would be of short duration because reclamation efforts would stabilize soils. The potential for accidental spills resulting in changes to water quality would be long term. Soils exposed during construction of well pads, roads and pipelines, the compressor station, and bridge would be subject to wind and water erosion. This erosion could lead to increased sedimentation in ephemeral waterways, the San Juan River, and Navajo Reservoir. Impacts to fisheries could include the alteration of habitats from erosion and sedimentation. Fish could be impacted directly from sedimentation of gravel spawning beds, and indirectly by depletion of food sources (e.g., invertebrates) that inhabit the interstitial spaces of streambeds. The actual amount of sediment from surface disturbance that reaches stream channels would be a result of numerous factors including:

- The location of roads
- Number of road/stream crossings
- Slope steepness and length
- Amount of exposed soil
- Type of vegetation in the area
- Frequency and intensity of rainfall
- Soil type
- The implementation and effectiveness of design features and other BMPs.

Accidental spills of petroleum products or other chemicals could also have the potential to negatively impact water quality and fisheries. Water contamination could result in the reduction of fish food resources or direct mortality.

There would be no measurable impacts to water quantity as the proposed action would be located in the non-tributary area and water used during drilling and completion would be purchased from private or commercial sources.

## 4.8 Threatened and Endangered Species

### 4.8.1 Direct and Indirect Impacts

Of the 10 species listed by the USFWS as threatened, endangered, or candidates potentially occurring in the study area, three have the potential to occur in the study area—New Mexico meadow jumping mouse, southwestern willow flycatcher, and yellow-billed cuckoo. The proposed action may affect, is not likely to adversely affect these three species. The project Biological Assessment is provided as Appendix H. Impacts to these species are anticipated to be short term and of low intensity, given the amount of potential habitat in the study area that could be affected and the effectiveness of design features outlined in Section 2.2.9. These design features include pre-development siting criteria to avoid effects to potential habitats, such as riparian corridors and wetlands. Site-specific analysis would be conducted once final siting of project components is completed and would identify any potential impacts to threatened and endangered species.

## 4.9 Archaeological, Cultural, and Historical Values

Current SUIT regulations do not allow for data recovery at prehistoric archaeological sites and all prehistoric sites, regardless of their official National Register of Historic Places eligibility status, must be avoided by development activities. In addition, while systematic pedestrian survey data is largely lacking in the study area, future cultural resource inventories should be aware that the study area may have potential for listing as a National Register District given the intensive Ancestral Pueblo occupation.

A total of 151 archaeological sites and 30 isolated finds have been previously recorded within the small portions of the study area that have been surveyed. Of the 151 sites, 189 temporally and culturally distinct components have been identified.

### 4.9.1 Direct and Indirect Impacts

Direct effects to cultural resources typically involve impacts to the physical integrity of buried cultural deposits and features, but could also include impacts such as noise or visual impairments that are not in character with the cultural property—particularly if the cultural property was recommended National Register of Historic Places-eligible under Criteria A through C, in the absence of, or in addition to, Criterion D. Indirect effects could include changing the erosional gradient or drainage patterns around a cultural resource and increased human presence in the area, which could lead to unauthorized artifact collecting or other site disturbances.

All proposed infrastructure associated with the proposed action would be subject to project-specific Class III cultural resource inventories during formal on-site analysis. Cultural resource management recommendations for the proposed action would be designed to fully avoid the sites, or if this is not possible, to reroute the project components into existing disturbance corridors if feasible.

All significant and potentially significant cultural resources would be avoided by the proposed action in consultation with SUIT and BIA Southwest Regional Office cultural resource managers. In addition, per SUIT guidelines, all prehistoric sites considered non-eligible to the National Register of Historic Places would also be avoided. The Colorado State Historic Preservation Office, in consultation with the BIA Southwest Regional Office, would also review the cultural resource inventory reports and ensure that avoidance of all significant and potentially significant cultural resources occurs. The two agencies would consult on implementing acceptable mitigation measures where avoidance is not possible.

For well pads, the compressor station, and the salt-water disposal facility, the areas would be adjusted to avoid the archaeological sites, preferably by over 50 feet. If a site could not be avoided by more than 50 feet, the site would be temporarily fenced and a qualified cultural resource manager would be present during all earth-disturbing construction activities. This practice ensures that the site boundary would not be encroached upon by work crews and equipment and it would also optimize detection of subsurface discoveries, if present.

For proposed roads and pipelines, which would generally follow existing road disturbance corridors, when an archaeological resource occurs on either side of a roadway within the proposed action area, the pipeline would be rerouted into existing disturbance to ensure undisturbed portions of the site are not further impacted by construction activities. All archaeological sites, whether prehistoric or historic, within 50 feet of proposed construction activities would be temporarily fenced with a qualified archaeologist

monitoring all earth-disturbing construction activities within 50 feet of the site boundaries to ensure compliance and detection of subsurface discoveries. Descansos (roadside memorials), if present, would be avoided and construction crews made aware of their presence to ensure no incidental impacts. If avoidance is not possible, an attempt to contact the family maintaining the descanso would be made. In the event that a family could not be reached, the descanso would be removed and secured safely in storage. Following reclamation, the stored descanso would then be placed back in its original location and in its pre-construction state.

In addition to the above measures, all employees, contractors, and sub-contractors of the project would be informed by the project proponent that cultural sites are to be avoided by all personnel, personal vehicles, and company equipment. They would further be informed that it is illegal to collect, damage, or destroy cultural resources, and that such activities are punishable by criminal and/or administrative penalties under the Archaeological Resources Protection Act, in addition to SUIT laws and regulations.

In the event that a discovery of a potentially significant cultural resource is detected during construction, the project proponent would immediately stop all construction activities within 100 feet of the discovery and immediately notify the archaeological monitor, if present, or the SUIT Lands Division. The SUIT would then evaluate or cause the site to be evaluated. Should a discovery be evaluated as a significant cultural resource, it would be protected in place until mitigating measures can be developed and implemented following consultations between the SUIT, BIA Southwest Regional Office, and Colorado State Historic Preservation Office.

Design features that serve to minimize impacts to soil, water, and vegetation resources would likely minimize long-term effects to cultural resources by stabilizing the ground surface and preventing excessive erosion. Design features of the proposed action are outlined in Section 2.2.9.

#### 4.9.1.1 American Indian Religious Freedom Act Concerns

The proposed action is not known to physically threaten the integrity of any SUIT TCPs, prevent access to sacred sites, prevent the possession of sacred objects, or interfere or otherwise hinder the performance of traditional ceremonies and rituals pursuant to American Indian Religious Freedom Act or Executive Order 13007. When site-specific locations for the POD are identified, tribes with interests in the area would be consulted in regard to the American Indian Religious Freedom Act, Executive Order 13007, and the Native American Graves Protection and Repatriation Act.

## 4.10 Socioeconomics

The potential economic impacts of the alternatives are estimated using the IMPLAN model (MIG 2011). IMPLAN uses an input/output model of the local economy to estimate how different sectors of the local economy are interconnected, as well as to estimate imports and exports of goods and services. The multipliers generated by an input/output model of the combined economy in Archuleta and La Plata Counties with 2009 base data were used to estimate indirect impacts of changes in output and employment in a particular industry.

### 4.10.1 Direct and Indirect Impacts

The proposed action would result in direct and indirect impacts to socioeconomics in the affected area. These impacts would be long term and persist for the life of the proposed wells. The natural gas production from the proposed action is estimated to average 5 bcf annually assuming 30 years of production for the wells included in the POD. Using an average natural gas price of $3.60 per thousand cubic feet, the estimated annual average production value would about $20 million. This production value would generate a total of about $6 million per year to the SUIT through royalties and severance taxes. In addition, Red Willow—a tribal enterprise—would retain a portion of the working interest revenue generated from the POD. A portion of the profits recovered by Red Willow would be distributed by the SUIT to fund pensions for elder members of the Tribe and as dividend distributions to other tribal members.

To estimate the revenues to Archuleta County related to production value of the POD, the terms of the MOU between SUIT and the County are considered: (1) SUIT production of trust minerals is exempt from local property tax and (2) SUIT's share of fee minerals is exempt from local ad valorem tax but is subject to PILT, which amounts to approximately 1/3 of what the taxes would be if the owner of the production were a non-tribal company. Based on these terms and the volume and price assumptions above, the PILT would increase by about $150,000 annually as compared to present levels with the addition of production from the POD. Total revenues to Archuleta County in 2010 amounted to about $23.5 million so the increase in the PILT from SUIT would amount to less than a 1 percent increase in annual revenue to the county (Archuleta County 2010). Since these tax revenues fund government programs and services that can benefit the local communities, they would represent a direct and indirect socioeconomic benefit.

Using the IMPLAN model, the estimated direct employment associated with $20 million in natural gas production is 40 jobs, which can be interpreted as approximately 40 new or retained jobs in Archuleta and La Plata Counties associated with the POD; therefore, the proposed action would have a measurable direct benefit to employment and indirect benefit to income in the affected area.

## 4.11 Environmental Justice

Federal agencies must consider the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations, or environmental justice impacts of a proposed action.

### 4.11.1 Direct and Indirect Impacts

There would be no measurable or disproportionate impacts to minority or low-income populations associated with activities included with the POD for the proposed action. There would be no activities of the proposed action that would disproportionately harm minority or low-income populations in the affected area. There would be measurable benefit to members of the SUIT associated with the proposed action related to royalty and severance tax revenues from the natural gas production and potential for additional employment opportunities for Tribal members because of Native hiring preferences. In addition, increased revenue to Archuleta County through PILT could increase county services for non-tribal members. Refer to the Socioeconomic Impact analysis in Section 4.10 for further details.

## 4.12 Land Use and Ownership

The proposed action would take place on private and SUIT lands in Archuleta County, Colorado. Land in the study area is primarily undeveloped piñon-juniper woodlands with lesser amounts of grasslands and a small amount of agricultural land. Surrounding land is similar—undeveloped with woodlands predominating. The CNF lies south of the study area in New Mexico. The Piedra and San Juan arms of the USBR-managed Navajo Reservoir enter the southwestern corner of the study area. The reservoir is surrounded by Navajo Lake State Park—managed by Colorado Parks and Wildlife and New Mexico State Parks Division.

### 4.12.1 Direct and Indirect Impacts

Most land use in the study area would remain unchanged. Lease stipulations prohibit drilling on Tribal lands within the NDMA boundaries, so directional drilling from adjacent private and Tribal Trust lands outside the lease would be employed to access the underlying oil and gas estate. Access roads and pipelines are expected to be located partially on SUIT Tribal lands. Site-specific analysis would be conducted once locations of well pads, flow and gathering lines, and access road sites are finalized.

Both private and SUIT lands where wells, flow lines, and roads would be built would change from undeveloped to industrial use for the long term. This change in land use is minimized by the co-locating of proposed wells and the compressor station with two existing well pads, drilling multiple wells (up to six) from single pads, and using existing corridors for pipelines and access roads where possible. It is estimated that the proposed access roads and pipelines would impact 5.2 acres of undeveloped Tribal lands. On private lands, about 137.5 acres would be impacted by the construction of a compressor station, well pads, a saltwater disposal well, pipelines, and roads resulting in a change in land use from undeveloped, primarily wooded lands, to industrial use for the long term.

The North Carracas AMI overlaps two grazing units—the Sandoval and the Vega. Current siting of proposed well pads would place three new well pads, and associated pipelines and access roads in the Vega grazing unit, resulting in changing approximately 2.7 acres to industrial use. In the Sandoval unit, approximately 1.5 acres would be disturbed and changed to an industrial use. Additionally, surface disturbance in this relatively undisturbed area would increase the chance of introduction of non-native, invasive weeds, reducing the quality of forage re-established after reclamation. Adherence to design features for the proposed action, described in Section 2.2.9, would reduce the possibility of introduction of noxious weeds.

## 4.13 Recreation

### 4.13.1 Direct and Indirect Impacts

Recreational opportunities in the study area would remain largely unchanged by the proposed POD. Most of the affected lands are privately owned, thus the landowner controls access to recreational opportunities. The proposed action is expected to impact about 5.2 acres of SUIT land in a generally undeveloped area of the Reservation. On SUIT and private land, habitat for game and viewable wildlife species would be removed. Additionally, noise from construction and operations of facilities, human presence, increased truck traffic, and visual changes could affect the presence of game and viewable wildlife species near the proposed facilities. There could also be effects to the quality of the recreation experience for users of the

study area and on adjacent USBR and state- and Forest Service-managed lands. Implementation of design features for vegetation, wildlife, noise, and visual impacts described in Section 2.2.9 would minimize impacts to recreation.

## 4.14 Transportation and Traffic

### 4.14.1 Direct and Indirect Impacts

The proposed action would cause an increase in traffic on county roads within the study area. Impacts to traffic would result in an estimated 5 percent increase in ADT on CR 500 and this increase would not exceed the road design capacity. These impacts would be short term as the greatest increase in traffic levels would occur during the construction, drilling, and completion processes. During operations and maintenance, there would be approximately 1 additional ADT above the current level of traffic.

Based on 315 ADT counts on CR 500, and the estimated maximum increase of approximately 13 vehicle trips per day, traffic levels could increase up to approximately 5 percent within the study area over the short term. A summary of the anticipated vehicle trips per activity for 5 years of project activities is provided in Table 4-12. The last column in the table is a summary of trips per day for the 5 years of project activities.

**Table 4-12. Estimated increase in traffic trips for the North Carracas Plan of Development**

| | Year | | | | |
|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **2016** | **2017** |
| Number of wells | 9 | 10 | 10 | 12 | 8 |
| Pipeline/Pad/Road Construction Trips | 504 | 560 | 560 | 672 | 448 |
| Drilling Trips | 1,863 | 2,070 | 2,070 | 2,484 | 1,656 |
| Completion and Testing Trips | 1,026 | 1,140 | 1,140 | 1,368 | 912 |
| Sub-Total Trips | 3,402 | 3,780 | 3,780 | 4,536 | 3,024 |
| Operations/Maintenance Trips | 365 | 365 | 365 | 365 | 365 |
| Grand Total Trips | 3,767 | 4,145 | 4,145 | 4,901 | 3,389 |
| **Average Trips Per Day** | **10** | **11** | **11** | **13** | **9** |

Based on the ADT levels measured by Archuleta County and the increase in traffic anticipated for the proposed project (estimated maximum of approximately 13 vehicles per day), the proposed project activities would not cause an increase in ADTs for CR 500 over the road design capacity of 400 vehicles per day; therefore, the level of service associated with CR 500 would not be changed by the proposed action. The estimated highest number of trips per day (13) is proposed to occur in 2016. The proposed action is not expected to increase traffic levels to a degree that would require turn lanes at the intersection of State Highway 151 and CR 500.

Under the proposed action, approximately 4.5 miles of access roads would be constructed. These new roads would spur off CR 500. These roads would not be open to the general public.

All transportation activities to and from the project site would be completed in compliance with CDOT regulations and specifications. Compliance with CDOT regulations would minimize traffic accidents and impacts to other transportation activities within the project area. Design features outlined in Section 2.2.9 would also minimize the impacts of increased traffic in the study area.

## 4.15 Noise

### 4.15.1 Direct and Indirect Impacts

The proposed compressor station would result in long-term impacts to noise levels in the area. Short-term impacts to noise levels would occur during construction and well drilling and completion activities and would be localized around the source.

The nearest noise sensitive receptor to the proposed compressor station is Navajo Lake State Park. All USBR lands are managed as a boundary-focused Noise Sensitive Area. The canyon rim overlooking the lake is approximately 1,600 feet southwest of the proposed compressor station site. The boundary of the park is located approximately 1,000 feet from the proposed compressor station. The compressor station would be enclosed in a building, which would reduce sound levels between 20 dBA and 30 dBA. Mufflers or other sound reducing equipment could also be implemented to reduce sound levels to meet noise level standards established by the COGCC.

During construction, well drilling, and completion activities, there would be increased short-term noise levels localized around the activity. Table 4-13 lists approximate sound levels for various activities that would occur during this phase of the proposed development.

**Table 4-13. Approximate maximum A-weighted sound levels at 50 feet**

| Activity | Range in dBA | Timing Pattern |
|---|---|---|
| Site construction and rehabilitation (earth moving equipment) | 93-108 | ▪ Intermittent and fluctuating sound levels during actual operations<br>▪ Typically day operations only |
| Oil/gas drilling/workover | 100-130 | ▪ Intermittent and fluctuating sound levels during operations.<br>▪ 24-hour/day operation<br>▪ 1 week to several months duration |
| Oil/gas fracturing operation | 100-145 | ▪ Intermittent and fluctuating sound levels during operations<br>▪ Venting/flaring of gas is loud and continuous, but lasts only 1 to 2 days<br>▪ 24-hour/day operation<br>▪ 1-2 weeks duration |
| Oil/gas production | 62-87 | ▪ Long term, generally continuous sound levels, though sometimes intermittent—24-hours/day, 7 days/week, year-round operations |
| Natural gas compressors | 65-90 | ▪ Long term, continuous sound levels |

Source: USDI/USBR 2008

## 4.16 Public Health and Safety

### 4.16.1 Direct and Indirect Impacts

Worker health and safety would be the primary public health and safety concern associated with the proposed project. Other concerns would be public health and safety risks from increased traffic, contamination of drinking water supplies, and risks from accidental spills or dumping.

The proposed North Carracas POD activities would be completed in a manner consistent with all applicable Occupational Safety and Health Administration regulations and appropriate industry standards to minimize risk of accidents. Impacts to the public would be minimized by controlling access to all work and operation areas. All roadway speed limits would be observed by project vehicles to reduce potential for traffic accidents. Additionally, hauling of materials or equipment would follow CDOT regulations.

Potential for contamination of drinking water aquifers would be minimal due to the confining geologic layers above and below the Fruitland Formation and with the implementation of the following design features.

- The development and implementation of site-specific SPCC plans (if required) and SWPPP plans.
- Containment structures such as dikes, containment walls, drip pans, or equivalent protection actions would be constructed and maintained around qualifying fluid/chemical facilities or storage tanks.
- Monitor bradenhead pressures to identify wells that may have wellbore integrity problems and may be acting as vertical conduits for fluid migration, including but not limited to completion fluid, methane, or Fruitland Coal water.
- Monitor water quality, conduct bradenhead testing, and evaluate data accordingly.
- Cement all surface and production casing strings to the surface by circulation methods.
- Within any areas of concern, the SUIT DOE and BLM may require water well monitoring as part of APD approval.
- The USEPA would perform mechanical integrity tests on the saltwater disposal well per the underground injection permit.
- Injection well operations would be monitored monthly for cumulative injection volumes and pressures in tubing and tubing/casing annulus.
- Self-contained, closed-loop systems would be utilized to drill the natural gas wells in this proposed POD.
- For the CBM wells, the operator will follow procedures in a manner consistent with COGCC Rule 608 for sampling water wells near the proposed natural gas wells.
- For the salt-water disposal well, the operator shall collect samples and conduct complete water analyses in a manner consistent with COGCC Rule 609.e(1) and (2) on all newly developed water wells less than 300 feet in depth within the project area if the landowner consents to sampling.

Refer to Section 4.5.1 for a more detailed discussion on impacts to groundwater quality.

There is a low potential for significant accidental spills and dumping within the study area due to the proposed action. Based on the experience in other areas of the San Juan Basin, the potential for these types of spills to impact the public are negligible. Operators are required to inventory chemicals kept at drilling sites—including hydraulic fracturing fluids. This information must be provided to agency officials promptly upon request and to certain health care professionals who sign a confidentiality agreement. All spills would be promptly reported to the SUIT DOE and BIA, in accordance to the SUIT Spill/Release Reporting Policy and reported to the BLM in accordance with BLM-Notice to Lessees NTL-3A. All spills exceeding 1 bbl or any spill originating or extending beyond an approved ROW, would need to be reported both verbally and in writing. A remediation plan would need to be developed for any spills that:

- May enter live water or impact surface waters or waters of the U.S.
- Spills/releases of 1 barrel or more of produced water
- Spills/releases of 25 gallons or more of refined crude oil products
- Any spill, venting, or fire in a sensitive area
- Any well blow-out that cannot be contained immediately by on-site equipment, facilities, or man-power
- Any fire that consumes any toxic chemical
- Any fire not contained in a pit or barrel or with the potential to escape

Sanitary facilities would be provided at each project location so that project workers are not required to travel more than 10 minutes by vehicle to reach a facility. In addition, specific requirements for the location and burial of human waste are specified in the project design features listed in Section 2.2.9.

There is also the low potential for well fire or explosions to occur. The potential risks are minimized by completing all project activities in compliance with federal and Tribal regulations and industry standards.

# 5. CUMULATIVE IMPACTS

The cumulative impacts analysis is important to understanding how multiple actions in a particular time and space (e.g., geographic boundaries) impact the environment. The CEQ regulations define cumulative effects as "…the impact on the environment, which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions" (40 CFR § 1508.7). Whereas the individual impact of one project in a particular area or region may not be considered significant, the result of numerous projects in the same area or region may cumulatively result in significant impacts. Cumulative impact analysis is subject to interpretation in analyzing the magnitude of impacts to a particular area or region.

## 5.1 Cumulative Impacts Assessment Methodology

In considering the potential cumulative impacts of the proposed action, the temporal and geographic scope of the analyses varies by resource as defined in Chapter 4. The approach to cumulative impacts analysis utilized here is in accordance with the BLM Manual Handbook 1790-1 (USDI/BLM 2008). Information is quantified to the extent practicable; however, the cumulative impacts analyses in this EA are primarily qualitative.

The following terminology is used in the cumulative impacts analysis to qualify the impacts of implementing the proposed action (USDI/BLM 2008). These terms are:

- Short term—up to 5 years
- Long term—the life of the project and beyond
- Additive—the effects of the action add together to make up cumulative effects
- Countervailing—the effects of some actions balance or mitigate the effects of other actions
- Synergistic—the effects of the actions together are greater than the sum of their individual effects

## 5.2 Reasonably Foreseeable Development

This analysis of cumulative impacts considers past, present, and reasonably foreseeable federal and non-federal activities that are expected to overlap temporally or geographically with the proposed action. Federal, state, and local government; SUIT; and private activities are considered in the analysis. Activities relevant to this analysis of cumulative impacts were identified from reviews of information available from government agencies including NEPA documents, land use and natural resource management plans, and private organizations. The proposed action would be one of a number of projects that have taken place or may reasonably be expected to take place in the region that are summarized in Table 5-1.

The proposed action would be located within Archuleta County, Colorado within the exterior boundaries of the Reservation. Approximately two-thirds of Archuleta County is owned and managed by federal, state, and Tribal governments. The remainder is privately owned or owned by local governmental and quasi-governmental entities (Archuleta County 2001). Most of the county's recent growth has occurred in the Pagosa Springs hub, which also supports about 63 percent of the total county population.

The study area lies in the northeastern portion of the San Juan Basin and is largely undeveloped. Approximately 95 percent of Archuleta County remains undeveloped and it is estimated about 85 percent of land will remain undeveloped or vacant in the next 20 years (Archuleta County 2001).

**Table 5-1. Past, present, and reasonably foreseeable development in the cumulative study area**

| Project | Status | Description |
|---|---|---|
| **Oil and Gas Related Projects** | | |
| Oil and Gas Development | Past, present | Over 30,000 natural gas and oil wells have been drilled in the San Juan Basin in New Mexico and Colorado. There are approximately five existing natural gas well pads within the study area. |
| Oil and Gas Development | Ongoing | The Final Environmental Impact Statement Record of Decision (ROD) for the lands managed by the BLM Farmington Field Office indicates development of 9,942 new oil and gas wells from 2003 and 2023 in the New Mexico portion of the San Juan Basin, allowing for about 16,100 acres of long-term disturbance. To date, approximately 722 wells have been drilled since implementation of the ROD. Of these wells, 1,452 have been co-located. |
| Oil and Gas Development | Ongoing | The San Juan Public Lands Center issued the ROD for drilling of up to 127 new CBM wells and 93 new miles of roads and pipelines in a 125,000-acre analysis area north of the Reservation in La Plata and Archuleta Counties. Additionally, approximately 100 well pads and 30 miles of road construction were authorized on private lands, outside of Federal jurisdiction. The COGCC estimates that in La Plata and Montezuma County, there would be a drilling of 40 to 140 oil and gas wells annually. These would be concentrated on private lands in La Plata County. |
| Oil and Gas Development | Ongoing | Based on a 2002 decision and subsequent 2009 decision, the BLM authorized approximately 433 conventional and CBM wells at 160-acre spacing and an additional 770 CBM wells (co-located) at 80-acre spacing within the boundaries of the Reservation. |
| Oil and Gas Development | Ongoing | The United States Forest Service issued a ROD to authorize the leasing of up to 5,000 acres on the CNF Jicarilla Ranger District, with projected development of approximately 27 wells and 6 miles of new roads in Rio Arriba County, New Mexico. |
| Oil and Gas Development | Ongoing | Gathering pipelines on lands managed by various agencies. The need for and location of these lines would vary based on production levels and carrying capacity. |
| Oil and Gas Development | Proposed | The Gothic Shale Gas Play is a 646,403-acre shale gas formation discovered primarily within Dolores and Montezuma Counties, and to a lesser extent in San Miguel and La Plata counties in Colorado. There is the potential for up to 1,769 new Gothic shale wells to be drilled within the gas play. |

| Project | Status | Description |
|---|---|---|
| **Power Plants and Transmission Lines** | | |
| Four Corners Generating Station | Existing/Change in Operations in 2014 | Sale of Southern California Edison's share of the power plant. Closure of units 1, 2, and 3 and installation of air pollution control on Units 4 and 5 for regional haze. Extent and timing are uncertain, and require approvals. Post-2016 Lease for Four Corners Generating Station with the Navajo Nation has been extended until 2041, but needs approval. |
| San Juan Generating Station | Existing/Change in Operations in 2014 | Best Available Retrofit Technology requirements for regional haze may require expensive retrofit on all four units. Could result in closure of some units to avoid costly retrofit. |
| Electric Transmission System Expansion | Proposed | Projects including Navajo Transmission Project and San Juan Basin Interconnect Project are proposed to expand the capacity of electric transmission across New Mexico to move renewable power, shift gas-fired compressors to electricity, and meet increased electric demand in the San Juan Basin. |
| Electric Power Expansion | Proposed or under consideration | Coal-fired generation for other coal-based development on Navajo or Ute reservations, renewable generation such as solar and pumped storage hydro. |
| **Coal Mining Projects** | | |
| San Juan Coal Company La Plata Mine | Past, present | From 1986 through 2002, the La Plata mine also supplied coal to the San Juan Generating Station. The mine ceased operation in 2002 and reclamation continued through 2005. Approximately 2,000 acres disturbed as of 2010. |
| Navajo Mine Areas I through III | Ongoing | Supplies coal to Four Corners Generating Station. Mining activities in Areas I and II have concluded. Reclamation is ongoing in Area II. Area III is actively mined in two pits with contemporaneous reclamation. |
| San Juan Coal Company San Juan Mine | Ongoing | An underground mine that is the exclusive supplier of coal to the San Juan Generating Station. Surface mining at San Juan reached a depth in the early 2000s that represented an economic limit, but underground mining is feasible and the coal supply contract with the generating station extends through 2017. Approximately 5,400 acres disturbed as of 2010. |
| **Land Management** | | |
| Eul and Carracas Rim Restoration project | Proposed | The CNF Jicarilla Ranger District is proposing to reintroduce frequent, low-intensity broadcast prescribed fire to improve conditions conducive to big game on the western side of the northern most portion of the District on Carracas Mesa. |
| SUIT Forest Management Activities | Ongoing | Both within and adjacent to the study area on SUIT lands, the use of mechanical and prescribed fire fuels reduction management treatments (including hydro-mowing/mastication, hand thinning and piling, burning slash piles, and broadcast burning) would continue. Other ongoing activities include fire suppression activities such as management of fire, timber harvesting, and forest development activities such as commercial forest stand improvement. |

| Project | Status | Description |
|---|---|---|
| Livestock Grazing | Ongoing | Both within and adjacent to the study area on SUIT and private lands. |
| **Other Development** | | |
| Urban Development | Ongoing | Population of Archuleta County<br>**Year** **Population**<br>1990 5,340<br>2010 12,744<br>2030 24,110<br><br>Population of the Surrounding Four County Area<br>(Archuleta, La Plata, Rio Arriba, San Juan)<br>**Year** **Population**<br>1990 163,798<br>2010 242,500<br>2030 307,400 |
| Animas-La Plata Project | Ongoing | Development includes Ridges Basin Dam and Reservoir, Durango Pumping Plant, and Ridges Basin Inlet conduit, with an average annual depletion of 57,100 acre-feet, and will include the construction of a pipeline to deliver water for domestic use on the Navajo Nation at Shiprock, New Mexico |
| Residential Development | Past, Present | Tranquilo Court located in the eastern part of Ignacio proposed 23 home sites on 4 acres. Two homes have been completed, with further construction contingent upon the housing market. Rock Creek II Subdivision located just east of Ignacio, which would encompass 80 acres and 200 home sites. This development has not occurred and is on hold indefinitely due to the economic downturn. |
| Indian Gaming on the SUIT Reservation | Past, Present | The SUIT casino and hotel on the north side of Ignacio—the hotel and casino occupies 300,000 square feet of usable space including a bowling alley, pool, day-care facilities, administrative offices, fitness center, and four restaurants. The entire casino/hotel complex is approximately 50 acres in size. |
| Business and Residential Development | Ongoing | Development of the Three Springs Neighborhood, which encompasses 681 acres in Grandview, is located within the city limits of Durango. The Three Springs Neighborhood currently includes a hospital complex (Mercy Medical Center), commercial businesses, administrative buildings, and residences. By 2030, Three Springs would be fully developed, encompassing a 76-acre park and over 300 acres of open space and trails, a middle school, and approximately 2,000 home sites. |
| Residential Development | Ongoing | The SUIT development of a 160-acre and adjoining 320-acre residential development located southwest of Ignacio, Colorado within the next 5 to 20 years. |

The temporal scope considered for cumulative impacts is as follows:

- Past actions are those that occurred between 1990 and 2010
- Present actions are those that occurred in 2012 and are continuing, and are considered in determining baseline conditions in the Affected Environment (Chapter 3)
- Future actions are those that are reasonably expected to occur after 2013 through 2026

## 5.3 Cumulative Impacts

### 5.3.1 Air Quality

The geographic extent of the cumulative impacts analysis is the San Juan airshed. The counties within the airshed are currently in attainment for all criteria pollutants as defined by USEPA.

#### 5.3.1.1 Existing Condition

The study area and its immediate surroundings are largely undeveloped. Existing SUIT projects that contribute to air quality impacts include forest and fire management practices and residential and commercial development. There are a number of regional projects and facilities that contribute to air quality impacts including existing and ongoing development associated with oil and gas, coal production, operation of the Four Corners and San Juan Generating Stations, forest management activities in the CNF and San Juan National Forest; and urban and residential development.

#### 5.3.1.2 Present and Ongoing Development

Regional air quality is affected by a number of present and ongoing projects in the region including 30,000 oil and gas wells and associated development in the New Mexico and Colorado portions of the San Juan Basin, ongoing operation of the Four Corners and San Juan Generating Stations, mining at Navajo and San Juan Mines, forest and fire management activities on the Southern Ute Indian Reservation and adjacent CNF, and residential and commercial development on and off the Reservation.

#### 5.3.1.3 Reasonably Foreseeable Development

A review of existing and reasonably foreseeable sources within the vicinity of the proposed action based on information available from government agencies including NEPA documents, land use and natural resource management plans, and private organizations was conducted. Reasonably foreseeable sources potentially contributing to mid- and far-field criteria pollutant concentrations and AQRV impacts (regional haze and acid deposition) primarily include future oil and gas development in the San Juan Basin and future modifications to the Four Corners and San Juan power plants to meet Best Available Retrofit Technology as required under the USEPA's Federal Implementation Plan for the Clean Air Act regional haze program. These requirements are expected to result in improvements to regional air quality, either through implementation of retrofit technologies or closure of some currently operating units.

#### 5.3.1.4 Proposed Action

As discussed in Chapter 4, air quality impacts from the proposed action would include increases in local concentrations of criteria pollutants ($NO_2$, $SO_2$, CO, $PM_{2.5}$ and $PM_{10}$) and ozone precursors ($NO_X$ and VOC) as well as potential changes in visibility and acid deposition in nearby Class I areas.

#### 5.3.1.5 Cumulative Impacts

The effects of the proposed action when considered along with other past, present, and reasonably foreseeable development in the airshed would be long term and additive to other regional development. The effects on regional air quality from applying Best Available Retrofit Technology requirements to the Four Corners and San Juan power plants would be long term and countervailing.

As discussed in Chapter 4, air quality impacts from the proposed action include increases in local concentrations of criteria pollutants ($NO_2$ , $SO_2$, CO, $PM_{2.5}$ and $PM_{10}$) and ozone precursors ($NO_X$ and VOC) as well as potential changes in visibility and acid deposition in nearby Class I areas.

A complete quantitative analysis of cumulative source air quality impacts was performed as part of the PEA completed for the Southern Ute 80-Acre Infill Oil and Gas Development (USDI 2009) as described in Section 4.2. Air quality impacts were analyzed in the PEA over the Four Corners region (Figure 5-1) using a photochemical dispersion model (CAMx). Three emission scenarios were modeled with CAMx:

- A 2005 base case scenario
- A 2018 "no action" scenario including emission changes from existing sources and emissions from reasonably foreseeable sources (not including the proposed action) occuring or expected to occur between 2005 and 2018
- A 2018 "full infill" scenario, which is the same as the 2018 "no action" scenario but with emissions from the 80-Acre Infill Project included.

Model results from these scenarios were used to calculate project incremental impacts (2018 "full infill" scenario impacts minus 2018 "no action" impacts) and cumulative incremental impacts (2018 "full infill"impacts minus 2005 base case impacts).

Although the proposed action was not included as a reasonably foreseeable source in the PEA, the proposed project analyzed in the PEA (i.e., the 80-acre "Full Infill" scenario) consisted of as many as 770 new CBM wells to be located in an area just west of the proposed action as illustrated by the projected distribution of new wells in Figure 5-2.[2] Thus, the cumulative analysis included in the PEA was based on a proposed project with a much larger number of CBM wells and associated facilities than the 48 wells to be completed under the proposed action. As shown in Figure 5-2, with respect to the Mesa Verde and Weminuche Class I areas, the 80-Acre Infill Project wells are located approximately within the same general area as the proposed action and many of the 80-Acre Infill wells are projected to be closer to these Class I areas than are the proposed action sources. In addition, the cumulative sources included in the PEA along with the 80-Acre Infill sources together represent over 1,700 potential new wells in the Northern San Juan Basin. Any perturbations on the combined impacts of these new developments arising from the very small (48 well) proposed action can reasonably be considered to be minor.

Information supplied by the SUIT DOE indicates that 51 infill wells have been drilled during the first 3 years of the infill project. For at least the near future, it is reasonable to assume the pace of future infill

[2] This figure assumes that the maximum number of new wells will be developed and includes the expected scenario that just under 75 percent of the infill wells will be located on existing well pads; exact locations of new well pads have not been identified.

well development will continue at the current average rate of 51/3 = 17 new wells per year. Annual emission estimates prepared for the PEA indicate that SUIT lands oil and gas engine $NO_X$ emissions (not including the proposed action) have been declining from the 2005 baseline and will continue to decline until about 2018 when they will start increasing, reaching a local peak of 3,500 tpy in 2020 (which is still below the 5,000 tpy value for 2005). As shown in Section 4.2.1, annual $NO_X$ emissions from the proposed action during the operational phase are estimated to be 64 tpy. The development phase of the proposed action is likely to be completed before the 2020 SUIT $NO_X$ emissions peak occurs. Thus, the proposed action emissions represent just a 1.8 percent (equal to 64/3500) increase in $NO_X$ over the total SUIT 2018 infill scenario emissions. In addition, the number of infill wells developed during the proposed action's 5-year development period (which corresponds to the period of maximum emissions from the proposed action as described in Section 4.2.1), is 51 + 5 x 17 = 136 new wells that when combined with the 48 wells in the proposed action makes a total of 184 wells. This is just 24 percent of the 770 wells analyzed in the PEA. As a result, emissions from the proposed action, both during the development phase and the operational phase, are minimal with respect to emissions analyzed in the PEA under the full infill scenario.

For the reasons noted above and in Section 4.2, project incremental impacts analyzed in the PEA provide conservative estimates of mid- and far-field project impacts expected to result from the much smaller proposed action. In addition, cumulative impacts analyzed in the PEA can reasonably be assumed to be comparable with cumulative impacts associated with the proposed action given the much larger size of the project and cumulative sources included in the PEA. Discussions of cumulative impacts as estimated in the PEA for the NAAQS impacts analysis and AQRV impacts analyses are presented below.

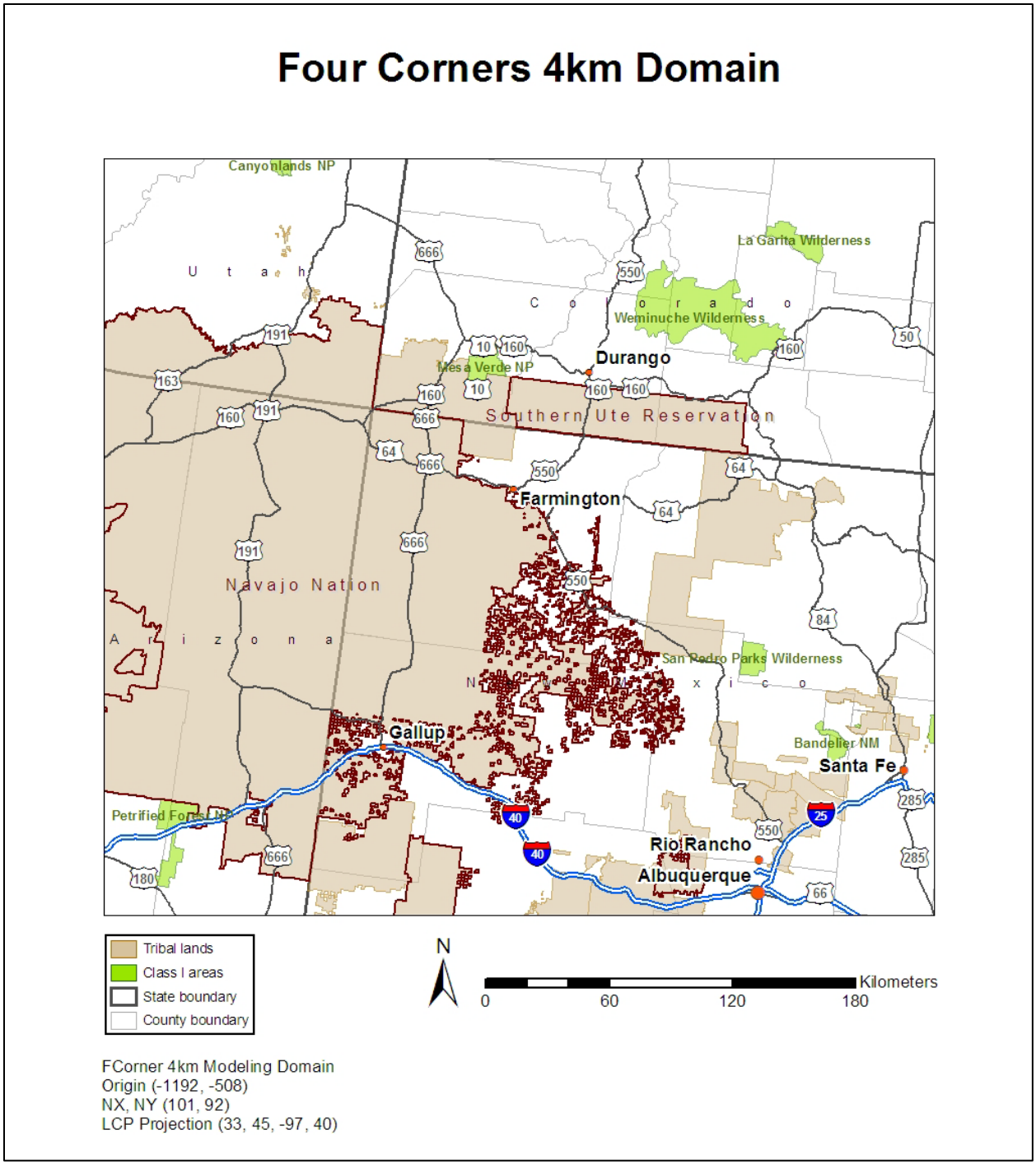


**Figure 5-1. Map covering the extent of the PEA 4 km modeling domain**

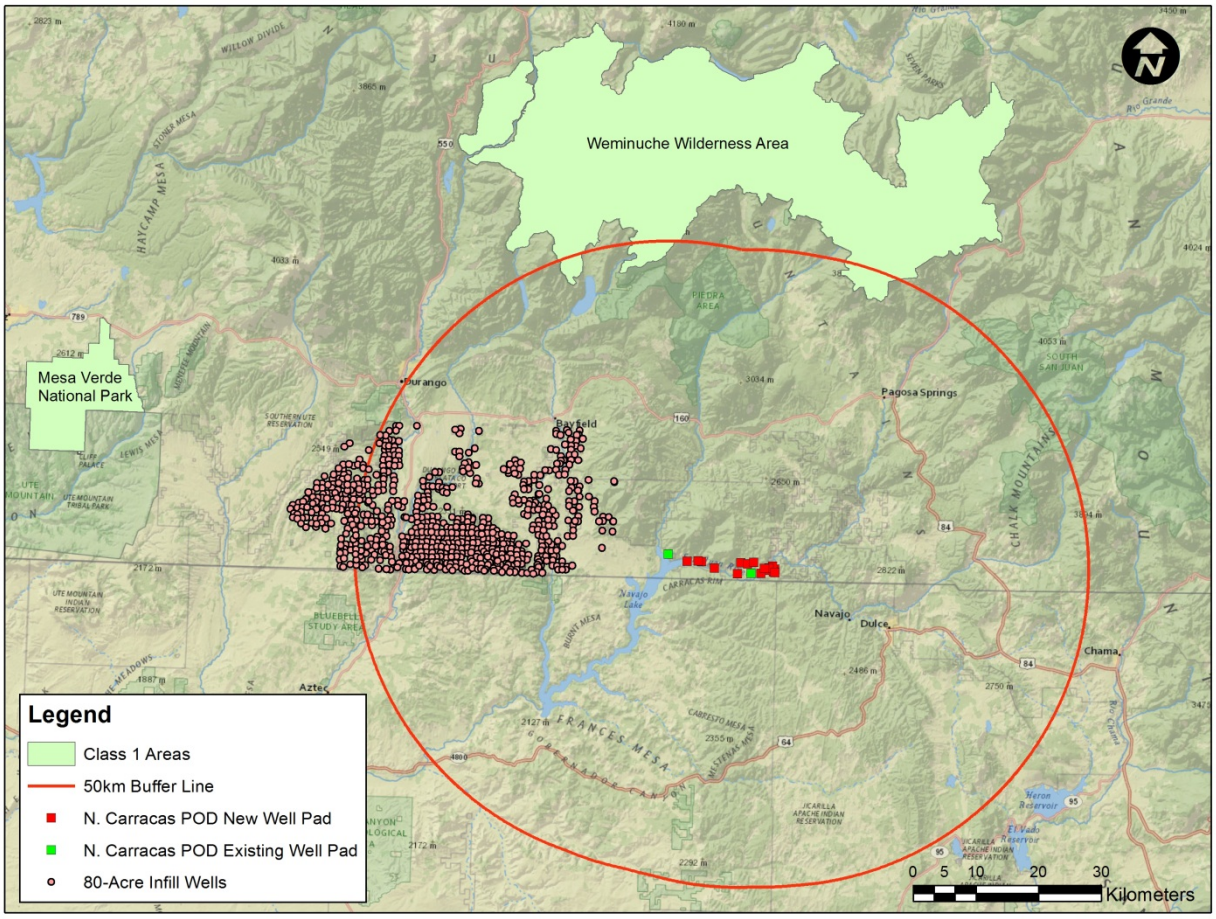


**Figure 5-2. Locations of existing well pads included in the 80-Acre Infill PEA relative to the proposed action (North Carracas POD) well pads; almost 75 percent of the 80-Acre Infill project CBM wells are projected to be drilled on existing well pads**

## Criteria Pollutant (NAAQS) Impacts

NAAQS pollutant impacts summarized in Table 4-3 do not include potential contributions from reasonably foreseeable sources. However, reasonably foreseeable sources identified above, which are located on the order of 10,000 meters or more from the proposed action sources, are not expected to contribute significantly to the maximum total impacts listed in Table 4-3, as these maximum impacts occur at locations approximately 100 meters from the proposed action sources and are thus dominated by emissions from those sources.

Future NAAQS pollutant concentrations in the Four Corners region, taking reasonably foreseeable sources into account, were modeled as part of the 80-Acre Infill PEA. PEA modeling results showed that maximum cumulative impacts under the full 80-Acre Infill scenario were estimated to not result in any NAAQS violations for CO, annual average $NO_2$, and annual average $PM_{2.5}$. The PEA did not include an analysis of the 24-hour $PM_{2.5}$ NAAQS or of the 1-hour $NO_2$ NAAQS (which was promulgated after completion of the PEA). However, the results in Table 4-1 suggest that reasonably foreseeable sources would have to substantially increase background $NO_2$ and $PM_{2.5}$ levels in the proposed action study area to produce any NAAQS violations. With regard to $SO_2$, impacts shown in Table 4-3 are very small

relative to the levels of the NAAQS and reasonably foreseeable sources are not expected to increase background $SO_2$ near the project as demonstrated by the 2018 full infill scenario modeling results presented in the PEA. With regard to $PM_{10}$, current background levels shown in Table 4-1 are low relative to the NAAQS and reasonably foreseeable sources are not expected to contribute significantly to regional $PM_{10}$ increases as demonstrated by the 2018 full infill scenario modeling results presented in the PEA.

## Ozone Impacts

Given the technical difficulties and uncertainties involved in estimating the impact on ambient ozone levels of a relatively small project such as the proposed action, a separate modeling analysis for ozone was not conducted. However, cumulative impacts of the 80-Acre Infill project on ambient ozone levels were analyzed in the PEA as described above. Results of photochemical model simulations for the 2005 "base case," 2018 "no action" and 2018 "full infill" scenarios were processed for the PEA using USEPA guideline procedures (USEPA 2007) to calculate the predicted 8-hour ozone design values under each scenario. Modeled design values were calculated at each ozone-monitoring site in the Four Corners region. Results showed that:

- Ozone design values are predicted to be below the level of the NAAQS at all locations under all three scenarios
- Ozone design values are predicted to be lower under both 2018 scenarios as compared to the 2005 base case at all monitoring sites except at Bloomfield, New Mexico, where the design value is predicted to remain unchanged
- Ozone design values are predicted to remain unchanged under the 2018 full infill scenario as compared to the 2018 no action scenario at all monitoring sites except for an increase of 1 ppb (from 63 ppb to 64 ppb) at Bondad and an increase of 1 ppb (from 71 ppb to 72 ppb) at Mesa Verde

As noted in Section 4.2, it is reasonable to assume that the incremental project impact of the proposed action on ozone design values would be less than those predicted for the much larger 80-Acre Infill Project. In addition, cumulative impacts for the proposed action are likely to be substantially the same as determined in the PEA as the combined impacts of projects included in the PEA cumulative analysis can reasonably be assumed to overwhelm any additional cumulative impacts from the 48 wells to be developed under the proposed action. Thus, the incremental and cumulative impacts of the proposed action are not projected to cause or contribute to violations of the 8-hour ozone NAAQS.

## Air Quality Related Values Impacts

### *Visibility Impacts*

Cumulative incremental visibility impact estimates were presented in the 80-Acre Infill PEA for the modeling scenarios described above. The maximum cumulative incremental visibility impact in Weminuche was estimated to be 0.7 dV while the 8$^{th}$ highest day (corresponding to the 98$^{th}$ percentile dV change) was 0.1 dV. At Mesa Verde, the maximum value was 0.2 dV and the 8$^{th}$ highest value was less than 0.05 dV. Thus, the 8$^{th}$ highest values are less than the 0.5 dV significant impact threshold established by FLAG (2010). Cumulative regional haze impacts for the proposed action are likely to be substantially the same as determined in the PEA for the reasons described above.

***Acid Deposition Impacts***

Estimates of cumulative incremental acid deposition impacts from the 80-Acre Infill Project were also presented in the PEA. Results of this analysis showed relatively large cumulative reductions in acid deposition in the Weminuche Class I area relative to the 2005 baseline level due to power plant emission reductions included in the cumulative sources. Simply adding the estimated nitrogen and sulfur deposition increases estimated for the proposed action as shown in Chapter 4 to the cumulative deposition increments modeled for the Weminuche Class I area in the PEA, still results in net estimated *decreases* in acid deposition, indicating that cumulative incremental acid deposition impacts of the proposed action are below applicable thresholds.

***Acid Neutralizing Capacity Impacts***

Cumulative incremental ANC impacts were presented in the 80-Acre Infill PEA (USDI 2009). Results of this analysis showed that ANC is expected to *increase* at sensitive lakes in Weminuche relative to the 2005 baseline due to cumulative incremental *decreases* in acid deposition. Simply adding nitrogen and sulfur deposition increases estimated for the proposed action to the cumulative deposition increments modeled for the Weminuche Class I area in the PEA, still results in net estimated decreases in acid deposition and thus increases in ANC. Thus, the cumulative incremental changes in ANC generated by the proposed action are below applicable thresholds.

## 5.3.2 Geology and Mineral Resources

The geographic scope of the cumulative impacts analysis for geology and mineral resources is the San Juan Basin.

### 5.3.2.1 Existing Condition

Past developments have impacted geology and mineral resources in the San Juan Basin, primarily fluid and solid mineral extraction.

Drilling for natural gas has been ongoing in the basin since the 1920s. Past natural gas development in the basin has resulted in long-term impacts to the Fruitland Formation from the removal of natural gas and dewatering. However, production of gas and water has not affected the strength of the geologic unit due to the structure of the coalbeds and inherent geology. Dewatering and de-gassing of the formation near the outcrop surfaces have potentially exacerbated naturally occurring methane seeps and increased the potential for coal fires. These issues have been monitored to minimize their impact and the Tribe is currently dealing with methane seeps on the Reservation through the implementation of a methane seep mitigation system.

Mineral resources in the basin from past activities have been irretrievably impacted. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for future use.

### 5.3.2.2 Present and Ongoing Development

Direct and indirect impacts to geology and mineral resources would continue to occur from oil and gas development, and coal and gravel mining in the San Juan Basin.

Aside from community development due to population growth, the primary disturbance basin-wide is anticipated to result from natural gas and oil extraction. Cumulative impacts to mineral resources would

continue to result in irretrievable impacts from extraction. Natural gas is the world's fastest-growing fossil fuel, with consumption predicted to increase at an average rate of 1.6 percent per year from 2008 to 2035 (USEIA 2011). Global natural gas demand is expected to increase by two-thirds by 2030; United States natural gas demand is expected to increase more slowly (NPC 2011). In 2010, approximately 1,260 bcf of natural gas was produced from the cumulative effects analysis area (COGCC 2011; NMOCD 2011).

#### 5.3.2.3 Reasonably Foreseeable Development

In addition to the ongoing development described above, impacts to geology and mineral resources are expected to result from development of approximately 14,000 natural gas and oil wells over the next 15 to 20 years; expansion of electric power systems including transmission lines, power plants, and renewable energy projects; and continued residential and commercial development. Additionally, implementation of best available retrofit technology requirements at the Four Corners and San Juan Generating Stations could result in closure of some units—potentially reducing local demand for coal.

The lower 48 states are estimated to have in-place CBM resources of 700 tcf. Coalbed methane is a relatively small component of the total unconventional gas resource base. The vast majority of the CBM recoverable resources (50 to 90 tcf) are located in the San Juan and Powder River basins. By the 2020s, more than 60 percent of the total United States gas supplies are likely to come from domestic, unconventional resources. The studies indicate that the smallest unconventional resource contributor will be CBM, with current production levels around 2 tcf per year and future production capacity ranging from 1.5 to 2.5 tcf per year by 2035. Three-quarters of the current production is from the Rocky Mountains, with the majority from the San Juan and Powder River basins (USEIA 2011).

The remaining tight gas recoverable resources in the Rockies (with likely estimates around 200 plus tcf) largely occur in the Greater Green River, Uinta, Piceance, and San Juan basins (NPC 2011). In the United States, one of the keys to increasing natural gas production has been the advances in the application of horizontal drilling and hydraulic fracturing technologies, which have made it possible to develop the country's extensive shale gas resources and has contributed to a near doubling of total United States technically recoverable natural gas resource estimates over the past decade (USEIA 2011). Nearly all reserves in the San Juan Basin are considered tight gas reservoirs.

Although natural gas demand may be increasing, production in the basin is expected to remain relatively steady, if not declining over the next 15 to 20 years. However, additional infrastructure from pipelines, compression, and treating facilities may be needed, particularly based on advances in extracting oil and gas from tight shales.

#### 5.3.2.4 Proposed Action

As discussed in Chapter 4, impacts to geologic and mineral resources resulting from the proposed action would include:

- Permanent removal of 5 bcf of natural gas resources annually from the Fruitland Formation
- Dewatering of the Fruitland Formation

#### 5.3.2.5 Cumulative Impacts

When added to past, present, reasonably foreseeable development, direct and indirect cumulative impacts from the proposed action would be long term and additive. There would be an irretrievable impact to natural gas reserves within the study area.

### 5.3.3 Soils

The geographic extent of the soils cumulative impacts analysis includes the Upper San Juan River and Piedra sub-basins of the San Juan River Basin watershed.

#### 5.3.3.1 Existing Condition

Past actions in the cumulative impacts analysis area that have impacted soils include oil and gas development, forest and fire management activities, agriculture, and residential and commercial development. There are no large population centers (e.g., Durango, Farmington, or Aztec) within the cumulative impacts analysis area. The western portion of Pagosa Springs occurs within the Piedra sub-basin. Due to natural ecosystem complexity and the large geographical scope of the analysis area, the types of impacts to soils and other resources, such as vegetation, are generalized.

For the purposes of this analysis, an estimation of existing disturbance associated with roads and oil and gas development within the Upper San Juan River and Piedra sub-basins was quantified using existing GIS data. Based on these data, there are currently 2,815 miles of roads within the Colorado portion of the watersheds and 4,852 miles in the New Mexico portion. Most of these roads are un-improved or improved dirt surface, although there are paved highways. It is assumed that the average road width is 30 feet since most dirt surface roads would be about 20 feet wide with paved roads ranging from 30 to 60 feet wide. Data from the New Mexico Oil and Gas Conservation Division and the COGCC show approximately 13,700 natural gas or oil wells within the analysis area. It is assumed that these wells have been partially reclaimed and the long-term disturbance associated with each location would be 1 acre. Co-location of wells was not taken into account; therefore, the assumption that each well is located on an individual well pad likely results in an overestimation of actual disturbance associated with oil and gas development. Table 5-2 shows the estimated disturbance in acres from existing roads and oil and gas well pads.

Other activities that would contribute to cumulative impacts in the watershed are not quantifiable because of lack of study and associated data. These other activities are addressed qualitatively and include construction of electrical generating facilities and transmission lines, forest and fire management, agriculture, and continued residential, commercial, and industrial development.

**Table 5-2. Estimated existing disturbance from roads and oil and gas well pads in the Upper San Juan and Piedra sub-basins**

| Watershed | Component | Quantity | Disturbance in Acres[1] |
|---|---|---|---|
| Upper San Juan | Miles of Roads | 6,873 | 24,992 |
| | Well pads | 13,625 | 13,625 |
| Piedra | Miles of Roads | 793 | 2,884 |
| | Well pads | 82 | 82 |
| Total | | | 41,583 |

[1] Based on average road width of 30 feet and 1 acre long-term disturbance per well.

Soil disturbance in the cumulative impacts analysis area has resulted in direct impacts including erosion, loss, compaction, and mixing. Changes to topography associated with leveling sites for natural gas development have been widespread. Wild fires and fire management activities on the SUIT Reservation, National Forests, and other lands have resulted in soil loss from erosion. Residential and commercial development, and agriculture have also disturbed surface soils and modified topography. In the sub-basins, these impacts have primarily occurred along river corridors.

#### 5.3.3.2 Present and Ongoing Development

Soils continue to be impacted by primarily oil and gas development, forest and fire management activities, agriculture, and community development. In the San Juan Basin, co-location (twinning) of natural gas and oil well pads has become more commonplace due to advances in drilling techniques. Well pad co-location has served to minimize impacts to soils by reducing the direct and indirect impacts from disturbing new areas for well pads, roads, and pipelines.

#### 5.3.3.3 Reasonably Foreseeable Development

It is difficult to quantify the amount of reasonably foreseeable disturbance within the Upper San Juan and Piedra sub-basins given the varied surface ownership and lack of data. Within this cumulative impacts analysis area, lands are held by private individuals, states (Colorado and New Mexico), Tribal (SUIT and Jicarilla Apache Nation), United States Forest Service, USBR, and the BLM. Because the primary activity occurring in the cumulative impacts analysis area is associated with oil and gas development on lands managed by federal agencies, reasonably foreseeable development can be quantified with a number of assumptions.

Four assessments on oil and gas development have been conducted in the last 6 years that would occur in portions of the two watersheds used in this cumulative effects analysis. A portion of the cumulative impacts analysis area occurs within the Northern San Juan Basin Coalbed Methane Project area—specifically Stollsteimer Creek and the Lower Piedra sixth-level watersheds. That analysis concluded that the reasonably foreseeable disturbance in Stollsteimer Creek would be 24.5 acres and in the Lower Piedra 304.2 acres (USDI/USDA 2006b, page 3-131 585). The BLM Farmington Field Office projected a total disturbance of 7,981 acres within the Upper San Juan watershed, of which approximately 30 percent would be reclaimed (USDI/BLM 2003, page 4-7).

The *Programmatic Environmental Assessment for 80-Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation* (USDI 2009) and the *Final Environmental Impact Statement for Surface Management of Gas Leasing and Development* (USDA/USFS 2008) on the CNF did not estimate impacts

based on watersheds. However, by extrapolating the amount of the Upper San Juan watershed located within each of these study areas, a proportional estimation of reasonably foreseeable disturbance can be quantified. This proportional estimate assumes that well locations could occur anywhere within their respective development areas and would be evenly distributed. Table 5-3 summarizes the amount of the SUIT 2009 and the CNF 2008 analysis areas that occur within the cumulative effects analysis area.

**Table 5-3. Amount of the SUIT 2009 and CNF 2008 analysis areas within the Upper San Juan and Piedra sub-watersheds**

| Watershed | Watershed Area (Acres) | SUIT 2009 Analysis Area in Watershed (Acres) | SUIT 2009 Analysis Area Total (Acres) | Percent of SUIT Analysis Area | CNF Analysis Area in the Watershed (Acres) | CNF Analysis Area Total (Acres) | Percent of CNF Analysis Area in Watershed |
|---|---|---|---|---|---|---|---|
| Upper San Juan | 2,192,690 | 130,001 | 421,450 | 31% | 125,188 | 157,828 | 80% |
| Piedra | 42,487 | 1,796 | 421,450 | <1% | 0 | 0 | 0 |
| Total | 2,235,177 | 131,797 | 842,900 | 31% | 125,188 | 157,828 | 80% |

The SUIT 2009 analysis area estimated a total long-term disturbance of approximately 1,286 acres (USDI 2009, pages 2-5 through 2-7); 31 percent of that disturbance would be 399 acres. The CNF analysis estimated a total cumulative long-term impact of 4,198 acres (USDA 2008, page xxii); 80 percent of that disturbance would be approximately 3,358 acres.

Table 5-4 summarizes the estimated reasonably foreseeable disturbance from oil and gas development within the cumulative impacts analysis area. The estimation does not include oil and gas development on private lands, due to a paucity of data.

**Table 5-4. Summary of estimated reasonably foreseeable disturbance in acres from oil and gas development within the Upper San Juan and Piedra sub-watersheds**

| Watershed | Northern San Juan Basin Coalbed Methane Project | Farmington Field Office | SUIT 2009 | CNF 2008 | Total (Acres) |
|---|---|---|---|---|---|
| Piedra | 25 | 0 | 0 | 0 | 25 |
| Upper San Juan | 204 | 4,788 | 399 | 3,358 | 8,749 |

Table 5-5 summarizes the estimated cumulative disturbance associated with roads and oil and gas development. Roads and oil and gas development could cumulatively affect approximately 2 percent of the Upper San Juan and 7 percent of the Piedra sub-basins. Albeit a rough estimate that excludes agriculture and community development, the estimation provides an indication of scale for future disturbance.

**Table 5-5. Estimated cumulative disturbance in the analysis area associated with roads and oil and gas development**

| Watershed | Watershed Area (Acres) | Existing Disturbance (Acres) | Reasonably Foreseeable Disturbance (Acres) | Total | Percent Total |
|---|---|---|---|---|---|
| Upper San Juan | 2,192,690 | 38,617 | 8,749 | 47,366 | 2% |
| Piedra | 42,487 | 2,966 | 25 | 2,991 | 7% |

Soils in the cumulative impacts analysis area would be subject to disturbance from future agriculture, fire management activities, and community development. Given the generally rural nature of the analysis area, oil and gas development is predicted to be the greatest impact contributor to soil resources. However, co-location and the drilling of multiple wells from individual well pads, which are becoming more commonplace, would be expected to result in fewer direct and indirect impacts to soils and topography through the consolidation of development and infrastructure.

#### 5.3.3.4 Proposed Action

As discussed in Chapter 4, impacts to soil resources resulting from the proposed action would include:

- Long-term localized changes to topography due to grading of well pads and the compressor site, and road and pipeline construction
- Compaction, mixing, and displacement of soils due to heavy equipment use and traffic; wind and water erosion of soils
- Loss of up to 37 acres of prime farmland in the short term and 27 in the long term

#### 5.3.3.5 Cumulative Impacts

When added to past, present, reasonably foreseeable development, direct and indirect cumulative impacts on soils from the proposed action would be long term and additive.

### 5.3.4 Water – Surface and Groundwater

The geographic extent of the water resources cumulative impacts analysis area includes the Upper San Juan River and Piedra sub-basins of the San Juan River Basin watershed.

#### 5.3.4.1 Existing Condition

The Piedra and San Juan arms of Navajo Reservoir lie within the study area, as does the San Juan River that feeds the Reservoir. There are no threatened or impaired surface waters in the study area. However, there are several impaired waters within the Upper San Juan River and Piedra sub-basins (CDPHE 2011). Table 5-6 lists the impaired waters within the two sub-basins that comprise the cumulative effects analysis area.

**Table 5-6. Impaired waters within the Upper San Juan River and Piedra sub-basins**

| Segment | Portion | Impairment |
|---|---|---|
| Tributaries to the Piedra River | Stollsteimer Creek above Southern Ute Boundary | Sediment, E. coli, iron (Trec), sulfate (SO4) |
| Vallecito Reservoir | Vallecito Reservoir | Aquatic Life Use (mercury fish consumption advisory) |
| Little Navajo River, including tributaries from the San Juan-Chama diversion to the San Juan River | All | E. coli |
| San Juan River from Fourmile Creek to Southern Ute Indian Reservation. Mill Creek from source to San Juan River. Echo Canyon Reservoir. | Echo Canyon Reservoir | Aquatic Life Use (mercury fish consumption advisory); dissolved oxygen, copper, and lead |
| Mainstem of Rio Blanco from the boundary of the South San Juan Wilderness Area to SUIT Reservation Boundary | | Silver and lead |
| Navajo Reservoir | Navajo Reservoir | Aquatic Life Use (mercury fish consumption advisory) |

Source: CDPHE 2011 and NMED 2010.

Past activities that have contributed to water quality impacts in the watershed include sedimentation resulting from surface disturbance associated with residential, commercial, agricultural, and industrial development, as well as land management activities (e.g., prescribed fires). Mercury is an extremely mobile pollutant and is emitted from natural and anthropogenic sources, occurring in several different chemical states in the environment (USEPA 2005). Mercury sources within the analysis area are derived from naturally occurring soils and from anthropogenic sources such as coal-fired power plants. *E. coli* is a fecal coliform bacteria commonly found in the intestines of animals and humans. *E. coli* sources within the analysis area are primarily agriculture and community development.

In addition to surface water, a number of geologic units in the study area contain aquifers of varying water quality. Past development has also affected both surface and groundwater quantity within the cumulative effects analysis area. Extractive industry and community development demands for fresh water have resulted in direct and indirect long-term impacts on the quantity of surface and groundwater. Dewatering of geologic formations associated with extractive industrial development has also occurred. Dewatering of the formation near the outcrop has also contributed to depletions within the San Juan, Florida, and Los Piños rivers.

Fresh water use in Archuleta County in 2005 totaled 71.45 million gallons per day. Of that total, 69.49 million gallons per day was withdrawn for industrial use (USGS 2005b).

#### 5.3.4.2 Present and Ongoing Development

Surface and groundwater quantity and quality would continue to be impacted by those activities described above.

#### 5.3.4.3 Reasonably Foreseeable Development

In addition to the expected continuation of the activities described above, development of the natural gas and oil wells could impact surface and groundwater quality and quantity. Continued population growth and subsequent community development would also impact water quality and quantity.

#### 5.3.4.4 Proposed Action

As discussed in Chapter 4, impacts to water resources resulting from the proposed action would include:

- Short- to long-term impacts to surface water quality from sedimentation to the San Juan River and waters of the U.S. from a proposed new bridge, pipeline crossings, and new roads and well pads
- Potential impacts to surface and groundwater quality from surface spills of chemicals, produced water, or flowback fluids
- A total of 92,575 bbl (approximately 1,598 gallons per day) of fresh water obtained from a commercial source would be consumed for drilling
- There would be no measurable depletions to the surface waters
- Potential impacts to fresh-water bearing groundwater quality or quantity.

#### 5.3.4.5 Cumulative Impacts

Given the minimal amount of surface disturbance and water use, coupled with design features, cumulative impacts of the proposed action on surface and groundwater resources when added to past, present, and reasonably foreseeable development are expected to be direct and indirect, short to long term, and additive.

### 5.3.5 Vegetation

The geographic scope of the cumulative impacts analysis for vegetation is Upper San Juan River and Piedra sub-basins of the San Juan River Basin watershed.

#### 5.3.5.1 Existing Condition

Sagebrush grasslands and piñon-juniper woodland comprise the majority of vegetation community types within the analysis area. Noxious weeds infestations are likely to occur throughout the study area. A number of past projects in the region have contributed to impacts on native vegetation, wetlands, and noxious weeds. Disturbance of native vegetation communities has resulted from residential, commercial and community development, agricultural and grazing land use, industrial development including extraction of oil and gas, and land management activities such as prescribed burning. Such disturbance increases the introduction and spread of noxious weeds. Though no large communities occur with the cumulative impacts analysis area, Pagosa Springs is located within the Piedra sub-basin and has more than doubled in population in the last 20 years.

#### 5.3.5.2 Present and Ongoing Development

Vegetation and wetlands would continue to be impacted by those activities described above. Noxious weed infestations would continue to establish and spread, primarily in disturbed areas.

#### 5.3.5.3 Reasonably Foreseeable Development

Within the cumulative impacts analysis area approximately 2.2 percent of the Upper San Juan sub-basin and 7 percent of the Piedra sub-basin are anticipated to be developed—primarily from oil and gas extraction. Direct and indirect impacts from removal and modification of vegetation would occur. Indirectly, these impacts could lead to altered wildlife utilization and the introduction of noxious weeds. Current federal, state, tribal, and county regulatory practices would minimize impacts to wetlands and riparian corridors with the majority of anticipated impacts to affect the common community types in the analysis area. Commercial and residential development would continue to expand resulting in long-term vegetation community losses. Wild fires and forest management activities would impact wooded vegetation communities through modification of the community type. Forest management activities would beneficially impact vegetation by reducing the potential for wildfire and the introduction and spread of noxious weeds.

#### 5.3.5.4 Proposed Action

As discussed in Chapter 4, impacts to vegetation associated with the proposed action include:

- Removal of 133 acres of native vegetation, 56 acres of which would be reclaimed during the life of the project (Table 4-10)
- Potential disturbance to wetlands, the area of which is not quantifiable given existing data. This disturbance would be avoided or minimized with the implementation of design features outlined in Section 2.2.9
- Potential for establishment and spread of noxious weeds associated with surface disturbance and increased vehicle use of the area

#### 5.3.5.5 Cumulative Impacts

The cumulative impact of the proposed action on native vegetation communities, wetlands, and noxious weeds, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be direct and indirect, additive, and long term.

### 5.3.6 Wildlife and Fisheries

The geographic extent of the cumulative impacts analysis area is the Upper San Juan River and Piedra sub-basins of the San Juan River Basin watershed.

#### 5.3.6.1 Existing Condition

A number of game and non-game wildlife species are commonly found in the vegetative communities represented in the analysis. The wildlife species occurring within the cumulative impact analysis area are generally widespread over much of the western United States. As such, those past activities that have impacted vegetative communities have also impacted wildlife through direct and indirect habitat and fragmentation. Direct habitat loss can result in a loss of carrying capacity as less overall habitat is available, or habitat suitability is reduced. Habitat loss and fragmentation can affect wildlife use of areas; displacing some species to adjacent areas creating overuse in some habitats that can result in changes to sub-populations numbers. Restricted movement and dispersal could eventually reduce genetic diversity in a population as a whole, particularly for wildlife species with small ranges or limited mobility. The introduction of noxious or invasive species can alter habitats rendering them unsuitable, outcompeting and displacing forage species, and reducing vegetative diversity.

Impacts to fisheries within the analysis area have resulted from reductions in water quality and quantity, primarily from oil and gas development, population growth and community development, and agriculture.

In the cumulative impacts analysis area, impacts to wildlife and habitat have resulted from residential, commercial, and community development; agricultural and grazing land use; industrial development including extraction of oil and gas; and land management activities such as prescribed burning. Generally, the Upper San Juan sub-basin is highly fragmented with roads and oil and gas infrastructure. Additionally, other impacts of human presence and development on wildlife include hunting, illegal harvest, and disturbance due to noise and human presence that may result in changes in habitat use (effective habitat loss), and direct mortality associated with construction and use of facilities and roads.

#### 5.3.6.2 Present and Ongoing Development

Wildlife would continue to be impacted by those activities described above.

#### 5.3.6.3 Reasonably Foreseeable Development

In addition to the expected continuation of the activities described above, a number of projects in the region could impact wildlife through direct and effective habitat loss, mortality, impacts to reproduction, and reduced water quality and quantity. These include construction of electrical generating facilities and transmission lines; continued residential, commercial, and industrial development; wildfire and fire management activities; and agriculture. The practice of co-location or drilling multiple wells from individual well pads would serve to minimize the effects of direct and indirect habitat loss from future oil and gas development. As production declines, less developed areas are likely to be impacted in order to extract existing reserves. Given the development constraints in the study area, it is expected to remain relatively undeveloped.

Boats and other watercraft using Navajo Lake and other perennial water sources have the potential to introduce non-native species into area lakes and streams. These non-native species may out-compete native species or potentially introduce disease. Fishermen may also introduce non-native species from bait sources resulting in cumulative impacts to fisheries and aquatic habitats. These impacts could extend outside the study area through stream courses or by watercraft.

#### 5.3.6.4 Proposed Action

As discussed in Chapter 4, impacts to wildlife resulting from the proposed action would include:

- Direct habitat loss including long-term loss of approximately 76.4 acres of habitat
- Indirect habitat loss exceeding the direct habitat loss and dependent upon species, habitat type, and other factors
- Habitat fragmentation from the construction of about 4.5 miles of new roads/pipeline corridors
- Mortality associated with proposed activities including increased use of roads or contact with chemicals
- Nest abandonment related to disturbance during breeding season
- Potential impacts to fish from increased sedimentation and potential for chemical spills

#### 5.3.6.5 Cumulative Impacts

The cumulative impact of the proposed action on wildlife including game and nongame species, migratory birds, and fish when considered with past, present and reasonably foreseeable activities in the region is expected to be direct and indirect, additive and long term.

### 5.3.7 Threatened and Endangered Species

The geographic extent of the cumulative impacts analysis area is the Upper San Juan River and Piedra sub-basins of the San Juan River Basin watershed.

#### 5.3.7.1 Existing Condition

Three species listed as endangered or candidates by the USFWS have the potential to occur in the study area. These include the endangered southwestern willow flycatcher and the New Mexico meadow jumping mouse and yellow-billed cuckoo—both candidates for listing and protection under the Endangered Species Act. None of these species has been recorded as occurring within the study area. These species require riparian vegetation (see Section 3.7) and as such, each has been affected throughout their ranges by loss of habitat. The range of all three of these species encompasses portions of Colorado, New Mexico, and Arizona. There is no designated critical habitat within the analysis area. A portion of the Los Piños River from the Colorado/New Mexico State line, north to the confluence with the South Fork Texas Creek, has been proposed for designation as southwestern willow flycatcher critical habitat (USFWS 2011b).

Within the analysis area suitable habitat for these three species occurs along the upper and lower San Juan, Piedra, and Los Piños rivers. Past development in the cumulative impact analysis area from oil and gas, roads and pipeline corridors, community and commercial development, agriculture, and grazing has resulted in direct and indirect habitat loss for these three species. Water management, primarily for Tribal water rights and agriculture, has also impacted habitat from development of Navajo Dam and the loss of free flowing river segments. Oil and gas development, agriculture, and population growth demands on surface water have also resulted in indirect impacts to stream channel and vegetative structure along river corridors within the analysis area. Development has also impacted water quality through increases in sedimentation in waterways.

#### 5.3.7.2 Present and Ongoing Development

Currently, impacts to these three species are most likely to occur on private lands within the cumulative impacts analysis area. Federal, state, tribal, and county regulations and mitigation measures are designed to avoid or minimize impacts to riparian corridors and wetlands. Ongoing development from community and commercial growth, agriculture, and livestock grazing would continue to result in direct and indirect habitat loss in the cumulative impacts analysis area. Indirect impacts from water use and reduced water quality for oil and gas, agriculture, and community development would continue to result in indirect impacts to potential habitat.

#### 5.3.7.3 Reasonably Foreseeable Development

Regulatory constraints on development in riparian zones and wetlands are expected to continue to avoid or minimize impacts to protected species and their habitats. Community and commercial development on private lands, agriculture, and livestock grazing could result in direct and indirect habitat loss. The amount of habitat loss cannot be quantified due to a paucity of data. Oil and gas development, population

growth, and other commercial development is anticipated to place increased demands on fresh water use and also result in changes in water quality mostly from increased sedimentation. Should the proposed segment of the Los Piños River be designated as critical habitat for southwestern willow flycatcher, beneficial impacts to the species and its habitat could occur from further regulatory protection in that area.

#### 5.3.7.4 Proposed Action

As discussed in Chapter 4, impacts to threatened, endangered, and protected species resulting from the proposed action could include the loss of habitat and disturbance. These impacts would be avoided or minimized though design features such as pre-development siting to avoid wetlands and riparian areas, and pre-construction surveys to determine the species presence/absence.

#### 5.3.7.5 Cumulative Impacts

The cumulative impact of the proposed action on protected species with the potential to occur in the area, when considered with past, present, and reasonably foreseeable activities in the cumulative impacts analysis area, is expected to be additive and long term.

### 5.3.8 Archaeological, Cultural, and Historical Values

The geographic extent of the cumulative impacts analysis is the study area.

#### 5.3.8.1 Existing Condition

There has been minimal development within the study area. Prior to the implementation of federal and tribal regulations, an unknown number of cultural resources could have been impacted. Archuleta County Road 500 has impacted much of the San Juan Extension of the Denver and Rio Grande Railroad bed as it is no longer visible in these areas. Farming and ranching in the valley bottom has likewise directly impacted much of the railroad bed, and the railroad grade can only be observed in small segments throughout its former course. Many of these segments have been impacted by use as access roads by landowners and portions may have also been lost during major flooding events.

#### 5.3.8.2 Present and Ongoing Development

Direct and indirect impacts would likely continue to impact cultural resources. However, federal and tribal regulations and guidelines would minimize the potential for these impacts.

#### 5.3.8.3 Reasonably Foreseeable Development

Based on the SUIT's management of the study area, there is minimal potential for impacts from oil and gas development on Tribal lands. Cultural resources occurring on private lands could be directly and indirectly impacted from private development, agriculture, and livestock grazing. Recreationists could also impact cultural resources on State Park lands from unauthorized artifact collecting or other site disturbances. In the future, the study area may have potential for listing as a National Register District—given the intensive Ancestral Pueblo occupation. The cultural landscape within the AMI has potential to be degraded by the oil and gas at an aesthetic level, although the sites themselves would be avoided.

#### 5.3.8.4 Proposed Action

As discussed in Chapter 4, impacts to cultural resources resulting from the proposed action would include:

- All significant and potentially significant cultural resources would be avoided by the proposed action in consultation with SUIT and BIA Southwest Regional Office and the Colorado State Historic Preservation Office
- Per SUIT guidelines, all prehistoric sites considered non-eligible to the National Register of Historic Places would also be avoided

#### 5.3.8.5 Cumulative Impacts

The cumulative impact of the proposed action on cultural resources (including historic, prehistoric, traditional cultural resources), when considered with past, present, and reasonably foreseeable activities in the region, is expected to be indirect, additive, and long term. The long-term impact on cultural resources would be negligible.

### 5.3.9 Socioeconomics

The geographic extent for cumulative socioeconomic impacts includes Archuleta and La Plata counties in Colorado and San Juan and Rio Arriba counties in New Mexico because these counties include the residents and local governments that would benefit from revenues generated by the proposed action and where the majority of the spending of these revenues would occur.

#### 5.3.9.1 Existing Condition

The oil and gas industry has been a major employer and source of government revenue in the affected area. In San Juan County, New Mexico, the county with the largest labor force in the study area—the mining and extractive industry sector—is the largest single industry driver in the county, contributing about $1.4 billion to San Juan County's economy (Economic and Planning Systems 2011). This sector accounts for 11 percent of employment, but generates 18 percent of the county's personal income.

Local governments including La Plata County and San Juan County rely on tax revenues from the oil and gas industry for a large share of their income. For example, according to Bob Zahradnik, Director of Operations for the Southern Ute Growth Fund, "About 93 percent of the tribe's annual wealth and profits each year comes from "conventional energy," or "natural gas and oil" (Durango Herald 2011).

#### 5.3.9.2 Present and Ongoing Development

Presently, the population in the study area is about 242,500. The national economic downturn has had a profound effect on the regional economy, specifically raising the unemployment rate substantially. In San Juan County, New Mexico, unemployment rose from a low of 2.6 percent in October 2007 to a high of 10.6 percent in July 2010 (U.S. Bureau of Labor Statistics 2010). During that time, San Juan County lost almost 5,000 wage and salary jobs.

#### 5.3.9.3 Reasonably Foreseeable Development

Population estimates for the study area would total over 307,000—almost twice the population in 1990. Continued development of oil and gas is expected to be the foundation of the economy for the region. However, local oil and gas industry experts believe that peak oil and gas production in the San Juan Basin occurred in the late 1990s (Economic and Planning Systems 2011). This means that future exploration and extraction will be more costly and less efficient per barrel of oil and per cubic foot of natural gas. The long-term outlook (15 to 30 years and beyond) is therefore a slow overall decline in production volume, revenues, and employment (Economic and Planning Systems 2011). Local governments, particularly the

SUIT, have targeted diversifying their revenue sources to reduce their dependence on income from oil and gas development.

#### 5.3.9.4 Proposed Action

As discussed in Chapter 4, impacts to socioeconomics resulting from the proposed action would include:

- Average annual production value of $20 million, supporting about 40 jobs
- Local government revenue of about $6 million per year to the SUIT through royalties and severance taxes and $150,000 dollars paid to Archuleta County in PILT annually

#### 5.3.9.5 Cumulative Impacts

The cumulative impact of the proposed action on socioeconomics when considered with past, present, and reasonably foreseeable activities in the region is expected to be direct and indirect, additive, and long term. The oil and gas production value from the proposed action would have the cumulative effect of sustaining revenues and spending from the oil and gas sector in the region providing stability to employment, income, and local governments as the regional economy transitions to a more diversified economic base.

### 5.3.10 Environmental Justice

The proposed action would not result in measurable or disproportionate direct or indirect impacts to minority or low-income populations in the affected area and would not contribute to any cumulative impacts. There would be no disproportionate cumulative impacts for the proposed action related to "special" exposures due to cultural or traditional use of resources in the study area.

### 5.3.11 Land Use and Ownership

The geographic extent of the analysis of cumulative impacts on land use and ownership is the study area.

#### 5.3.11.1 Existing Condition

The study area is located within the exterior boundaries of the SUIT Reservation in southwestern Archuleta County, Colorado. Land use in the study area has been directly impacted by displaced land use or restricted land use based on ownership. Past development that has affected land use includes agriculture and recreation.

#### 5.3.11.2 Present and Ongoing Development

Development would continue to impact land use and ownership similar to past development.

#### 5.3.11.3 Reasonably Foreseeable Development

Overall land use and ownership within the study area is not expected to change from reasonably foreseeable development.

#### 5.3.11.4 Proposed Action

As discussed in Chapter 4, impacts to land use and ownership resulting from the proposed action would include:

- No change to land ownership resulting from the proposed action

- Construction of wells, flow lines, compressor station, the saltwater disposal well, and roads would result in a long-term conversion of 31.8 acres of Tribal lands and 100.65 acres of private lands from undeveloped to industrial use

#### 5.3.11.5 Cumulative Impacts

The cumulative impact of the proposed action on land use and ownership, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be additive and long term.

### 5.3.12 Recreation

The geographic extent of the cumulative impacts analysis is the study area.

#### 5.3.12.1 Existing Condition

Recreational opportunities on the Reservation are limited to Tribal members and, under some circumstances, members of other tribes or permitted non-Tribal members. A number of recreational opportunities are available in the study area at Navajo Lake State Park. These include camping, hiking, biking, horseback riding, off-road vehicle use, hunting, fishing, and water sports. Past impacts to recreation are generally limited to the construction of roads to increase access.

#### 5.3.12.2 Present and Ongoing Development

The study area is minimally developed. Land ownership patterns and restrictions in the study area limit the current amount of development.

#### 5.3.12.3 Reasonably Foreseeable Development

Future development on Tribal lands is expected to be minimal given SUIT restrictions. No reasonably foreseeable developments on USBR, State Park, or private lands have been identified.

#### 5.3.12.4 Proposed Action

As discussed in Chapter 4, recreation opportunities in the study area resulting from the proposed action would remain largely unchanged:

- The proposed action would impact 31.8 acres of Tribal land in a generally undeveloped area of the Reservation, removing habitat for game and viewable wildlife species
- Noise from construction and operations of facilities, human presence, increased truck traffic, and visual changes could affect the presence of game and viewable wildlife species near the proposed facilities, as well as the quality of the recreation experience for users of Navajo Lake State Park

#### 5.3.12.5 Cumulative Impacts

The cumulative impact of the proposed action on recreation, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be direct and indirect, additive, and long term.

### 5.3.13 Transportation and Traffic

The geographic extent of the cumulative impacts analysis is the study area.

#### 5.3.13.1 Existing Condition Present and Ongoing Development

The study area is largely undeveloped. CR 500 is the main thoroughfare in the area, bisecting the study area from east to west.

#### 5.3.13.2 Reasonably Foreseeable Development

With anticipated population growth, increased road use for recreation or tourism could potentially impact traffic and transportation levels within the study area.

#### 5.3.13.3 Proposed Action

As discussed in Chapter 4, impacts to traffic and transportation resulting from the proposed action would include:

- During drilling and completion (2013 to 2016), there would be an estimated 5 percent increase in ADT on CR 500 and this increase would not exceed the road design capacity
- During operations and maintenance, there would be approximately one additional ADT above the current level of traffic.
- Approximately 4.5 miles of new road would be constructed

#### 5.3.13.4 Cumulative Impacts

The cumulative impact of the proposed action on traffic and transportation, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be direct, indirect, additive, and long term.

### 5.3.14 Noise

The geographic extent of the cumulative impacts analysis is the study area.

#### 5.3.14.1 Existing Condition

Given that the study area is generally undeveloped, noise levels in the study area are likely minimal and localized near the source. Traffic on CR 500 contributes to periodic, localized, short-term increases in noise levels. Boats or other watercraft may periodically increase noise levels in and around Navajo Lake State Park. Oil and gas development in the area in also contributes to increased noise levels.

#### 5.3.14.2 Present and Ongoing Development

Ongoing activity and development in the study area would continue to contribute to noise levels.

#### 5.3.14.3 Reasonably Foreseeable Development

Projected population growth in surrounding areas would likely increase traffic levels in the study area and recreation use at Navajo Lake State Park. No other reasonably foreseeable development has been identified that would affect noise levels in the study area.

#### 5.3.14.4 Proposed Action

As discussed in Chapter 4, impacts to noise resulting from the proposed action would be:

- As a BMP, noise levels generated by facilities and equipment for the POD would be in compliance with COGCC regulations

#### 5.3.14.5 Cumulative Impacts

The cumulative impact of the proposed action on noise, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be direct and indirect, additive, and long term.

### 5.3.15 Public Health and Safety

The geographic extent of the cumulative impacts analysis is the study area.

#### 5.3.15.1 Existing Condition

The study area is largely undeveloped. Past development that has potentially impacted public health and safety includes road development and minimal oil and gas development.

#### 5.3.15.2 Present and Ongoing Development

Impacts on public health and safety would continue to occur from road use and oil and gas development.

#### 5.3.15.3 Reasonably Foreseeable Development

No reasonably foreseeable developments that would impact public health and safety have been identified. Traffic levels could increase on area roads based on increased population growth in the surrounding areas.

#### 5.3.15.4 Proposed Action

As discussed in Chapter 4, impacts to public health and safety resulting from the proposed action would include:

- Potential risks to workers
- Public health and safety risks from increased traffic
- Potential for contamination of drinking water aquifers is unlikely due to the confining geologic layers above and below the Fruitland Formation and the relevant well completion requirements that seal shallow aquifers from well bores
- Potential for accidental spills and dumping within the project area
- Potential for well fire or explosions to occur

#### 5.3.15.5 Cumulative Impacts

The cumulative impact of the proposed action on public health and safety, when considered with past, present, and reasonably foreseeable activities in the region, is expected to be direct, indirect, additive, and long term.

# 6. LITERATURE CITED AND REFERENCES

Aalto, Tom. Personal communication between K. Siesser, Southern Ute Indian Tribe Department of Energy, and T. Aalto, U.S. Environmental Protection Agency. March 20, 2013.

Ambrose, W. A., and W. B. Ayers, Jr. 2007. Geologic controls on transgressive-regressive cycles in the upper Pictured Cliff Sandstone and coal geometry in the lower Fruitland Formation, northern San Juan Basin, New Mexico and Colorado: American Association of Petroleum Geologists Bulletin, v. 91, no. 8, p. 1099-1122.

Archuleta County. 2001. Archuleta County Community Plan. Available at http://www.archuletacounty.org/Planning/commplan.asp. Accessed November 3, 2011.

Archuleta County. 2005. Archuleta County Road and Bridge Design Standards and Construction Specifications. November 2, 2005. Available at: http://www.archuletacounty.org/Publicworks/documents.asp.

Archuleta County. 2010. Wall, Smith, Batemen and Associates. Archuleta County, Colorado Financial Statements. Available at: http://www.archuletacounty.org/Special_Projects/files/2008%20Audited%20Financials.pdf.

Archuleta County. 2011. List of Primary System Roads with breakdown of mileage for paved and non-paved roads. Available at: http://www.archuletacounty.org/Publicworks/documents.asp.

Beringer, J. J., Seibert S. G., and M. R. Pelton. 1990. Incidence of road crossing by black bears on Pisgah National Forest, North Carolina. Int. Conf. Bear Res. And Manage. 8: 85-92.

Brister, B.S. and G. K. Hoffman. 2002. Fundamental Geology of San Juan Basin Energy Resources. New Mexico Bureau of Geology and Mineral Resources. A Division of New Mexico Institute of Mining and Technology. Socorro, New Mexico.

Brogden, R.E., Hutchinson, E.C., and Hillier, D.E. 1979. Availability of Ground Water, Southern Ute Indian Reservation, Southwestern Colorado. USGS Water Supply Paper 1576-J.p. J1-28.

Coady, M. 2001. The effects of roads on black bear movements. Leading Edge 2001, Focus on the Biosphere Reserve.

Colorado BLM and COGCC (Colorado Bureau of Land Management and Colorado Oil and Gas Conservation Commission). 1991. Memorandum of Understanding between the Colorado Bureau of Land Management and the Colorado Oil and Gas Conservation Commission. August 22.

Colorado Decision Support System (CDSS). 2013. Decreed and Other Wells. Colorado Decision Support System. Colorado State Engineers Office. Available at http://www.dwr.state.co.us/WellPermitSearch/default.aspx. Accessed March 2013.

Colorado Department of Agriculture. 2011. Colorado Noxious Weed List. Noxious Weed Management Program: Lakewood, CO. Available: http://www.colorado.gov/cs/Satellite/Agriculture-Main/CDAG/1167928159176. Accessed October 21, 2011.

Colorado Department of Public Health and Environment (CDPHE). 2010. Water Quality Control Commission. Colorado's Section 303(d) List of Impaired Waters and Monitoring Evaluation List. 5 CCR 1002-93 Regulation #93. Adopted March 9, 2010.

Colorado Department of Public Health and Environment (CDPHE). 2011. Stream Classifications and Water Quality Standards. Colorado Department of Health and Environment. Water Quality Control Division. July 2011.

Colorado Division of Wildlife (CDOW). 2008. Recommended Buffer Zones and Seasonal Restrictions for Colorado Raptors. Prepared by David Klute. Colorado Division of Wildlife. Denver, Colorado.

Colorado Oil and Gas Commission (COGCC). 2011. Colorado Oil and Gas Conservation Commission Production data inquiry. Available at http://cogcc.state.co.us. Accessed November 7, 2011.

Colorado Oil and Gas Commission (COGCC). 2013. Colorado Oil and Gas Conservation Commission Amended Rules. Available at http://cogcc.state.co.us. Accessed April 11, 2013.

Colorado Partners in Flight (COPIF). 2000. Land bird conservation plan. Estes Park, Colorado.

Condon, S.M. 1990. Geologic and structure contour map of the Southern Ute Indian Reservation and adjacent areas, southwest Colorado and northwest New Mexico: U.S. Geological Survey Miscellaneous Investigations Series Map I–1958, scale 1:100,000.

Cordell, L.S. 1984. Prehistory of the Southwest. Academic Press, Inc., San Diego.

Davis, Yaraima Frias. 2011. Personal communication with Yaraima Frias Davis, Archuleta County Road and Bridge Department, Archuleta County, Colorado, Engineering Technician concerning traffic data in the study area. Electronic transmission and telephone conversation October 24, 2011.

Dickson, B. G., J. S. Jenness, and P. Beier. 2005. Influence of vegetation, topography, and roads on cougar movement in southern California. Journal of Wildlife Management 69:264-276.

Dodd, C.K., W.J. Barichivich, and L.L. Smith. 2004. Effectiveness of a barrier wall and culverts in reducing wildlife mortality on a heavily traveled highway in Florida. Biological Conservation 118: 619-631.

Durango Herald. 2011. Investing in a Green Revolution. December 18, 2011. Available at http://www.durangoherald.com/article/20111218/NEWS04/712189991/-1/News04

Economic and Planning Systems. 2011. Final Report San Juan County Economic Base Analysis Prepared for: E>P Committee Prepared by: Economic & Planning Systems, Inc. January 21, 2011. Available at http://www.sanjuaneds.com/pdfs/EPS-SJC-report-%20for-website.pdf.

Federal Land Managers' Air Quality Related Values Work Group (FLAG). 2010. Federal land managers' air quality related values work group (FLAG): Phase I report—revised (2010). U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. Natural Resource Report NPS/NRPC/NRR—2010/232. National Park Service, Denver, Colorado.

Fitzgerald, J. P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado. 407 pp.

Fletcher, J.L. and R.G. Busnel, eds. 1978. Effects of Noise on Wildlife. Academic Press: New York, New York. Pp. 7-22.

Fort, K. T. 2002. The effects of habitat disturbance on the reproductive behavior of the black-capped chickadee (Poecile atricapilla). Master's Thesis. University of Northern British Columbia.

Four Corners Air Quality Task Force (FCAQTF). 2010. Air Quality Modeling Study for the Four Corners Region. Additional Ozone Source Apportionment and Ozone Sensitivity Modeling Analyses. Prepared by ENVIRON for Four Corners Air Quality Task Force. January 22, 2010

Fox, T. 2011. Additional clarification regarding application of Appendix W modeling guidance for the 1-hour $NO_2$ National Ambient Air Quality Standard. Memorandum from Tyler Fox, EPA Office of Air Quality Planning and Standards to Regional Air Division Directors. 1 March.

Freeman, K.M., March, M.A. and D.R. Culver. 2006. Final Report: Survey of Critical Wetlands and Riparian Areas in Archuleta County. Colorado Natural Heritage Program, Fort Collins, CO.

Gold, Ilyse. 2011. Personal communication with Ilyse Gold, Wildlife Biologist with the Carson National Forest Jicarilla Ranger District concerning wild horse management on Federal lands in New Mexico. Telephone conversation November 3, 2011.

Hebblewhite, M. 2011. Effect of Energy Development on Ungulates in Energy Development, editor David E. Naugle. Island Press, Washington, DC, USA.

Hightower, D. A., 2003. Fine-scaled movements and habitat use of black bears in south central Louisiana. MS Thesis. Louisiana State University.

Hoffman, R.W., H.G. Shaw, M.A. Rumble, B.F. Wakeling, C.M. Mollohan, S.D. Schemnitz, R. Engel-Wilson, and A. Hengel. 1993. Management guidelines for Merriam's Wild Turkeys. Colorado Division of Wildlife, Division Report Number 18, Fort Collins.

Husband, M.B. 1984. Colorado Plateau Country Historic Context. Office of Archaeology and Historic Preservation, Colorado Historical Society, Denver.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: The Physical Basis (Summary for Policymakers). Cambridge University Press. Cambridge, England and New York, New York.

Johnson, Aran. 2011a. Personal communication with Aran Johnson Wildlife Biologist with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning big game studies and populations in the study area. Electronic transmission October 31, 2011.

Johnson, Aran. 2011b. Personal communication with Aran Johnson Wildlife Biologist with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning bald eagle populations. Electronic transmission November 2, 2011.

Johnson, Aran. 2011c. Personal communication with Aran Johnson Wildlife Biologist with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning big game study methods. Electronic transmission November 3, 2011.

Johnson, Aran. 2011d. Personal communication with Aran Johnson Wildlife Biologist with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning wild turkey, mountain lion, and black bear populations. Electronic transmission November 7, 2011.

Kelley, K. and H. Francis. 1994. Navajo Sacred Places. Indiana University Press. Bloomington and Indianapolis.

Lipe, W.D. and B.L. Pitblado. 1999. Paleo-Indian and Archaic Periods. In: Colorado Prehistory: A Context for the Southern Colorado River Basin. Edited by W.D. Lipe, M.D. Varien, and R.H. Wilshusen, pp. 95-131. Colorado Council of Professional Archaeologists, Denver.

Minnesota Implan Group (MIG). 2011. Implan version 3.0 model and county data sets. Available from: www.implan.com.

Motter, John. 2008. Pagosa County 1900 Boom Times. Article in Pagosa Sun. Available at http://www.pagosasun.com/archives/2008/12december/121808/pagosapast.html.

National Petroleum Council (NPC). 2011. Prudent Development: Realizing the Potential of North America's Abundance Natural Gas and Oil Reserves. Final Report approved September 15, 2011. Online at http://www.npc.org/index.html.

Neslin. 2011. Natural Gas Drilling: Public Health and Environmental Impacts. Testimony before the U.S. Senate Committee on Environment and Public Works and Subcommittee on Water and Wildlife. April, 2011.

New Mexico Environment Department (NMED). 2010. 2010-2012 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated List & Report. New Mexico Environment Department Surface Water Quality Bureau. Online at http://www.nmenv.state.nm.us/swqb/303d-305b/2010-2012/.

New Mexico Oil and Gas Conservation Division (NMOCD). 2011. Monthly production reports. Online at https://wwwapps.emnrd.state.nm.us/ocd/ocdpermitting/Report/ProductionReports.aspx

New Mexico States Parks Division. (NMSPD). Undated. New Mexico State Parks Division. Navajo Lake State Park Management and Development Plan 2003-2007. Online at http://www.emnrd.state.nm.us/prd/documents/NavajoLakeStatePark.pdf. Accessed November 7, 2011.

Oberly, Stacey. 2011 Personal communication with Dr. Stacy Oberly, Southern Ute Indian Tribe Culture Department Director concerning Native American other traditional concerns in the North Carracas Area of Mutual Interest. Telephone conversation October 28, 2011.

Parsons, J. 2006. An Assessment of Potential Direct and Indirect Impacts to Black Bear at the Proposed Deerfield Wind Farm Based Upon a Literature Review Submitted to: Deerfield Wind, LLC Prepared by: Jeffrey Parsons, Arrowwood Environmental.

Pratt, W.P. and W. C. Henkes. U. S. Geological Survey U. S. Bureau of Mines Status of Mineral Resource Information for the Southern Ute Indian Reservation, Colorado. Administrative Report BIA-19. 1976.

Ralph, C. J., G. R. Guepel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. USDA For. Ser. Gen Tech. Rep. PSW-GTR-144, P, Albany, California.

Ratliff, Frank. 2011. Archuleta County, Colorado Weed and Pest Department Supervisor. Personal communication, October 24, 2011.

Red Willow. 2013. Personal communication with Red Willow concerning water well depths and quality within the study area. Via email March 20, 2013.

SAT Initiative; Sunnyside Elementary School (Durango, Colorado). 2011. Available online at: www.epa.gov/schoolair).

Siesser, Kyle. 2013. Personal communication with Kyle Siesser, Southern Ute Indian Tribe Department of Energy, concerning injection wells within the study area. Via email March 20, 2013.

S.S. Papadopulos and Associates (SSPA). 2006. Coalbed Methane Stream Depletion Assessment Study – Northern San Juan Basin, Colorado. S.S. Papadopulos & Associates, Inc. February, 2006.

Southern Ute Indian Tribe/Bureau of Land Management (SUIT/BLM). 1991. Memorandum of Understanding between Southern Ute Indian Tribe and Bureau of Land Management and Interagency Agreement between Bureau of Indian Affairs and Bureau of Land Management. August 22.

Southern Ute Indian Tribe (SUIT). 2010a. Southern Ute North Carracas Energy Development: Guidance and Protocol to Reduce Wildlife Impacts. Southern Ute Indian Tribe Division of Natural Resources and Department of Energy.

Southern Ute Indian Tribe (SUIT). 2010b. Exploration & Production Operator's Compliance Manual for Energy Development Projects on the southern Ute Indian Reservation. Southern Ute Indian Tribe Growth Fund Energy Department.

Southern Ute Indian Tribe (SUIT). 2011. Southern Ute Indian Tribe Division of Wildlife Resource Management. Available at http://www.southern-ute.nsn.us/WRMWeb/index.html. Accessed November 7, 2011.

Southern Ute Indian Tribe (SUIT). 2012a. Natural Resources Management Plan Update. Department of Natural Resources. Ignacio, Colorado.

Southern Ute Indian Tribe (SUIT). 2012b. Threatened and Endangered Species List for the Southern Ute Indian Tribe. Confirmed by the U.S. Fish and Wildlife Service, March 6, 2012.

State of Colorado. 2010. TABLE 3. Preliminary Population Forecasts by County 2000 - 2040. Department of Local Affairs. State Demography Office. Available at http://www.colorado.gov/cs/Satellite?c=Page&childpagename=DOLA-

Main%2FCBONLayout&cid=1251593346867&pagename=CBONWrapper. Accessed on October 20, 2011.

Stone, W.J., Lyford, F.P., Frenzel, P.F., Mizell, N.H. and Padgett, E.T. 1983. Hydrogeology and water resources of San Juan Basin, New Mexico. New Mexico Bureau of Mines and Mineral Resources, Hydrologic Report 6.

Topper, R., Spray, K.L., Bellis, W.H, Hamilton, J.L., and Barkmann, P.E. 2003. Ground Water Atlas of Colorado. Colorado Geological Survey, Special Publication 53.

United States Bureau of Labor Statistics. 2010. Unemployment rate, not seasonally adjusted, for San Juan County, New Mexico. Available at http://www.google.com/publicdata/explore?ds=z1ebjpgk2654c1_&met_y=unemployment_rate&idim=county:PA350200&fdim_y=seasonality:U&dl=en&hl=en&q=san+juan+county+new+mexico+unemployment+rate. Accessed December 15, 2011.

United States Census Bureau (USCB). 2011 Median Household Income from http://quickfacts.census.gov/qfd/states/08/08007.html Accessed on January 30, 2012.

United States Department of Agriculture, Forest Service (USDA/USFS). 2008. Final Environmental Impact Statement for Surface Management of Gas Leasing and Development. Jicarilla Ranger District, Carson National Forest, Rio Arriba County, New Mexico. Forest Service Southwestern Region.

United States Department of Agriculture, Forest Service (USDA/USFS). 2011. Carson National Forest Recreational Opportunities. Available at http://www.fs.fed.us/r3/carson/recreation/index.shtm. Accessed November 7, 2011.

United States Department of Agriculture, Natural Resources Conservation Service. (USDA/NRCS). 2010. National Soil Survey Handbook, title 430-VI. Available at http://soils.usda.gov/technical/handbook/. Accessed October 28, 2011.

United States Department of Energy (USDOE). 2007. Southern Ute Indian Reservation Mineral Resources. Energy Efficiency and Renewable Energy, Tribal Energy Program. Available at: http://www1.eere.energy.gov/tribalenergy/guide/pdfs/southern_ute.pdf.

USDOE. 2009. Modern Shale Gas Development in the United States: A Primer. Prepared for the United States Department of Energy Office of Fossil Energy and National Energy Technology Laboratory. Prepared by Ground Water Protection Council Oklahoma City, Oklahoma and ALL Consulting, Tulsa, Oklahoma.

United States Department of the Interior (USDI). 2002. Oil and Gas Development on the Southern Ute Indian Reservation Final Environmental Impact Statement. Bureau of Land Management, San Juan Public Lands Center: Durango, Colorado; Bureau of Indian Affairs, Southwest Regional Office: Albuquerque, New Mexico; and the Southern Ute Indian Tribe.

United States Department of the Interior (USDI). 2004. Department Manual Part 516 National Environmental Policy Act of 1969 Procedures: Environmental Quality. Washington, DC.

United States Department of the Interior (USDI). 2009. Programmatic Environmental Assessment for 80 Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation. Bureau of Land Management San Juan Public Lands Center: Durango, Colorado; Bureau of Indian Affairs, Southwest Regional Office: Albuquerque, New Mexico; and the Southern Ute Indian Tribe.

United States Department of the Interior, Bureau of Indian Affairs (USDI/BIA). 2005. Bureau of Indian Affairs Division of Environmental Management National Environmental Policy Act Handbook. Indian Affairs Manual 59 IAM 3-H.

United States Department of the Interior, Bureau of Indian Affairs (USDI/BIA) Southern Ute Agency. 2010. Tribal membership. Available at http://www.bia.gov/WhoWeAre/RegionalOffices/Southwest/WeAre/SouthernUte/index.htm Accessed October 20, 2011.

United States Department of the Interior, Bureau of Land Management (USDI/BLM). 2003. Farmington Proposed Resource Management Plan and Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, Farmington Field Office, Farmington, New Mexico.

United States Department of the Interior, Bureau of Land Management (USDI/BLM). 2008. NEPA Handbook H 1790 1 [BLM 1/30/2008]. Washington, D.C.

United States Department of the Interior, Bureau of Reclamation (USDI/USBR). 2006. Final Environmental Impact Statement Navajo Reservoir Operations: Navajo Unit – San Juan River New Mexico, Colorado, Utah. U.S. Department of Interior. Bureau of Reclamation. Upper Colorado Region, Western Colorado Area Office, Grand Junction – Durango, Colorado.

United States Department of the Interior, Bureau of Reclamation (USDI/USBR). 2008. Bureau of Reclamation. Resource Management Plan Navajo Reservoir Area Colorado and New Mexico Final Environmental Impact Statement and Finding of No Significant Impact. June 2008. Available at http://www.usbr.gov/uc/envdocs/ea/navajo/NavajoResRMP-FEA.pdf. Accessed November 8, 2011

United States Department of the Interior and United States Department of Agriculture (USDI/USDA). 2006a. 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.

United States Department of the Interior, Bureau of Land Management and United States Department of Agriculture, Forest Service (USDI/USDA). 2006b. Final Environmental Impact Statement, Northern San Juan Basin Coal Bed Methane Project. Durango, Colorado, July.

United States Department of the Interior, Bureau of Land Management and United States Department of Agriculture, Forest Service (USDI/USDA). 2011. San Juan Public Lands Draft Land Management Plan + Draft Environmental Impact Statement: Supplement to the Draft Environmental Impact. August 2011. U.S. Department of the Interior, Bureau of Land

Management, Dolores, Columbine, and Pagosa Field Office; U.S. Department of Agriculture, U.S. Forest Service – Region 2 San Juan National Forest.

United States Department of the Interior, Fish and Wildlife Service (USDI/USFWS). 2008. Birds of Conservation Concern (BCC) 2008. U.S. Fish and Wildlife Service, Division of Migratory Bird Management. Arlington, Virginia.

United States Department of the Interior, Fish and Wildlife Service (USDI/USFWS). 2011. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Available at http://www.fws.gov/wetlands/Data/Mapper.html. Accessed October 21, 2011.

United States Department of the Interior, National Park Service (USDI/NPS). 1995. National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation. Technical information on the National Register of Historic Places: survey, evaluation, registration, and preservation of cultural resources. National Park Service, Cultural Resources, National Register, History and Education.

United States Department of the Interior/National Park Service (USDI/NPS). 2011. Federal Land Managers' Interagency Guidance for Nitrogen and Sulfur Deposition Analyses: November 2011. U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service. Natural Resource Report NPS/NRSS/ARD/NRR-2011/465. National Park Service, Denver, CO.

United States Energy Information Administration (USEIA). 2011. International Energy Outlook 2011. Report number DOE/EIA-0484(2011). Online at http://205.254.135.7/forecasts/ieo/pdf/0484(2011).pdf.

United States Environmental Protection Agency (USEPA). 1990. National Oil and Hazardous Substances Contingency Plan Final Rule. U.S. Environmental Protection Agency (55 FR 8669, 40 CFR 300.340(e)(2)(i)(A)(2). March 8.

United States Environmental Protection Agency (USEPA). 2004a. Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reserves. Office of Ground Water and Drinking Water (4606M). EPA 816-R-04-003.

United States Environmental Protection Agency (USEPA). 2004b. Guidance Document: Reasonable and prudent Practices for Stabilization of Oil and Gas Construction Sites. HJN 040027 IM. Prepared by Horizon Environmental Services, Inc.

United States Environmental Protection Agency (USEPA). 2005. Regulatory Impact Analysis of the Final Clean Air Mercury Rule. EPA-425-R-05-003.

United States Environmental Protection Agency (USEPA). 2007. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze. EPA-454/B-07-002.

United States Geological Survey (USGS). 1996. Water-Resources Investigations Report 96-4155: Hydrology, chemical quality, and characterization of salinity in the Navajo aquifer in and near the

Greater Aneth Oil Field, San Juan County, Utah. U.S. Department of the Interior. U.S. Geological Survey. Lakewood, Colorado.

United States Geological Survey (USGS). 2005a. Southwest Regional GAP Analysis Project—Land Cover Descriptions. RS/GIS Laboratory, College of Natural Resources, Utah State University.

United States Geological Survey (USGS). 2005b. Estimated Use of Water in the United States County-Level Data for 2005: Colorado. Available at http://water.usgs.gov/watuse/data/2005/.

U.S. Geological Survey, 2012a, Water-resources data for the United States, Water Year 2011: U.S. Geological Survey Water-Data Report WDR-US-2011, site 09346400 San Juan River Near Carracas, CO, accessed at http://wdr.water.usgs.gov/wy2011/pdfs/09346400.2011.pdf.

U.S. Geological Survey, 2012b, Water-resources data for the United States, Water Year 2011: U.S. Geological Survey Water-Data Report WDR-US-2011, site 09349800 Piedra River Near Arboles, CO, accessed at http://wdr.water.usgs.gov/wy2011/pdfs/09349800.2011.pdf

Utah State University. 2004. Provisional Digital Landcover Dataset for the Southwestern United States, Version 1.0. Raster digital data. USGS GAP Analysis Program, RS/GIS Laboratory, College of Natural Resources, Logan, UT. Available: http://earth.gis.usu.edu/swgap/. Accessed October 21, 2011.

Valdez, Sal. 2011. Personal communication with Sal Valdez Southern Ute Indian Tribe Environmental Programs Division concerning water quality within the study area. November 3, 2011.

Van Dyke, F. G., R. H. Brocke, and H. G. Shaw. 1986. Use of road track counts as indices of mountain lion presence. Journal of Wildlife Management 50:102-109.

Van Valkenburgh, R.F. 1941. Diné Bikéyah. United States Department of the Interior, Office of Indian Affairs, Navajo Service. Window Rock, Arizona.

Van Valkenburgh, R.F. 1974. Navajo Indians III: Navajo Sacred Places. Garland Publishing Inc., New York.

Whiteman, S. 2011. Personal communication with Steve Whiteman Division Head with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning threatened and endangered species distributions in the study area. Telephone conversation on October 31, 2011.

Zimmerman, B. 2011. Personal communication with Ben Zimmerman Fisheries Biologist with the Southern Ute Indian Tribe Division of Wildlife Resource Management concerning fisheries in the study area. Telephone conversation November 8, 2011.

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# 8. GLOSSARY

**Acidizing**—The pumping of acid into the wellbore to remove near-well formation damage and other damaging substances. This procedure commonly enhances production by increasing the effective well radius. When performed at pressures above the pressure required to fracture the formation, the procedure is often referred to as acid washing.

**Acre-foot**—Volume of water required to cover 1 acre to a depth of 1 foot; equivalent to a volume of 43,560 cubic feet, approximately 325,829 gallons, or approximately 7,758 barrels.

**Abandonment**—Termination of fluid minerals operations, production operations, removal of facilities, plugging of the well bore, and reclamation of surface disturbances.

**Affected Environment**—Surface or subsurface resources (including social and economic elements) within or adjacent to a geographic area that potentially could be affected by gas development and production activities. The environment of the area to be affected or created by the alternatives under consideration (40 CFR 1502.15).

**Allotment** (range)—A designated area of land available for livestock grazing upon which a specified number and kind of livestock may be grazed under management of an authorized agency.

**Alternative**—A combination of management prescriptions applied in specific amounts and locations to achieve a desired management emphasis as expressed in goals and objectives. One of a number of plans or projects proposed for decision-making.

**Ambient** (air)—The surrounding atmospheric conditions to which the general public has access.

**Bentonite—**An absorbent aluminium phyllosilicate, essentially impure clay consisting mostly of montmorillonite.

**Best Management Practices**—Measures that are installed on the land to reduce erosion and sedimentation before starting, during, and after ground-disturbing activities.

**Blowout preventer**—A large valve at the top of a well that may be closed if the drilling crew loses control of formation fluids.

**Bradenhead**—casing head in a well having a stuffing box packed (as with rubber) to make a gastight connection.

**Casing**—Steel pipes of varying diameter and weight, joined together by threads and couplings, "inserted" into the well hole for the purpose of supporting the walls of the well and preventing them from caving in. Surface casing is inserted from the ground surface to approximately 250 feet; production casing is inserted to the total depth of the well (smaller diameter pipe than surface casing), cemented in place, and later perforated for production.

**Cement bond log**—Documents an evaluation of the integrity of cement work performed on an oil or gas well.

**Christmas tree**—An assemblage of valves, located at the top of the casings, from which tubing in the well is suspended.

**Circulate**—To pump fluid through the whole active fluid system, including the borehole and all the surface tanks that constitute the primary system. Also referred to as circulation.

**Closed-loop system**—A typical closed-loop system includes a series of linear-motion shakers, mud cleaners, and centrifuges followed by a dewatering system. The combination of equipment typically results in a "dry" location where a reserve pit is not required for cuttings and drilling mud.

**Co-location**—A well pad that is adjacent to or slightly overlaps an existing well pad**.**

**Coal stringer**—Remnants of plant roots in a coal seam.

**Coalbed Methane**—A gas associated with a coal seam.

**Completion**—The activities and methods to prepare a well for production; includes installation of equipment for production from an oil or gas well.

**Compressor station**—A facility that helps the transportation process of natural gas from one location to another. Natural gas, while being transported through a gas pipeline, needs to be constantly pressurized in certain distance intervals.

**Conditions of Approval**—Conditions or provisions (requirements) under which an Application for a Permit to Drill or a Sundry Notice is approved.

**Corridor**—For purposes of this environmental assessment, this is a wide strip of land within which a proposed linear facility could be located.

**Cultural Resources**—Remains of human activity, occupation, or endeavor, as reflected in districts, sites, buildings, objects, artifacts, ruins, works of art, architecture, and natural features important in human events.

**Cuttings**—Fragments of rock dislodged by the bit and brought to the surface in the drilling mud.

**dBA**—Decibel A-weighting. The most commonly used frequency weighting measures simulates human sound perception and correlates well with human perception of the annoying aspects of noise.

**Directional Drilling**—The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the drilling site.

**Direct Impacts**—Impacts that are caused by the action and occur at the same time and place.

**Disposal well**—A well into which produced water or other fluids from other wells is injected into an underground formation for disposal.

**Drilling Rig**—The derrick, draw-works, and attendant surface equipment of a drilling or work over unit.

**Drilling**—The operation of boring a hole in the earth, usually for the purpose of finding and removing subsurface formation fluids such as oil and gas.

**Emission**—Effluent discharge into the atmosphere, usually specified by mass per unit time.

**Endangered Species**—Any animal or plant species in danger of extinction throughout all, or a significant portion, of its range.

**Environmental Impact Statement (EIS)**—A document prepared to analyze the impacts on the environment of a proposed action and released to the public for review and comment. An EIS must meet the requirements of NEPA, CEQ, and the directives of the agency responsible for the proposed action.

**Ephemeral stream**—A stream that flows only in direct response to precipitation.

**Erosion**—The group of processes whereby earthy or rocky material is worn away by natural sources such as wind, water, or ice and removed from any part of the earth's surface.

**Fiberspar**—Trade name for a flexible, spoolable thermoset composite (polyethylene) pipe.

**Flare**—An arrangement of piping and a burner to dispose of surplus combustible vapors; usually situated around a gasoline plant, refinery, or producing well.

**Flowback**—The process of allowing fluids to flow from the well following a treatment in preparation for a subsequent phase of treatment or in preparation for returning the well to production.

**Formation**—A body of rock identified by lithic characteristics and stratigraphic position; it is prevailingly, but not necessarily tabular, and is mappable at the Earth's surface or traceable in the subsurface.

**Fugitive dust**—Dust particles suspended randomly in the air from road travel, excavation, and/or other operations.

**Gas play**—A set of known or postulated gas accumulations sharing similar geologic, geographic, and temporal properties.

**Green completion**—During the flowback stage of completion, natural gas is produced with the water placed in a pipeline instead of being released to the atmosphere.

**Habitat**—A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

**Habitat Fragmentation**—The disruption (by division) of extensive habitats into smaller habitat patches. The effects of habitat fragmentation include loss of habitat area and the creation of smaller, more isolated patches of remaining habitat.

**Habitat Type**—An aggregation of all land areas potentially capable of producing similar plant communities at climax.

**Historic**—Archaeological and archivally known sites related to the activities of non-native peoples, whether they are of Euro-American, Afro-American or Asian-American origin, in the period after the European discovery of the New World (ca. A.D. 1492).

**Horizontal drilling**—A subset of the more general term "directional drilling," used where the departure of the wellbore from vertical exceeds about 80 degrees. Because a horizontal well typically penetrates a greater length of the reservoir, it can offer significant production improvement over a vertical well.

**Hydraulic Fracturing**—A method of stimulating production by increasing the permeability of the producing formation.

**Hydrocarbons**—Organic compounds of hydrogen and carbon with densities, boiling points, and freezing points that increase as their molecular weights increase. Although composed mostly of carbon and hydrogen, hydrocarbons exist in a great variety of compounds, owing to the strong affinity of the carbon atom for other atoms and itself. The smallest molecules are gaseous; the largest are solids. Petroleum is a mixture of many different hydrocarbons.

**Impact**—A modification of the existing environment caused by an action (such as construction or operation of facilities).

**Indirect Impacts**—Secondary effects that occur in locations other that the initial action or later in time.

**Infrastructure**—The facilities, services, and equipment needed for a community to function including roads, sewers, water lines, police and fire protection, and schools.

**Infill**—means a well in a compulsory pooled proration or spacing unit to be completed in a pool in which an existing well drilled pursuant to the compulsory pooling order has been completed and not plugged and abandoned.

**Landscape**—An area composed of interacting ecosystems that are repeated because of geology, landform, soils, climate, biota, and human influences throughout the area. Landscapes are generally of a size, shape, and pattern that are determined by interacting ecosystems.

**Lease**—(1) A legal document that conveys to an operator the right to drill for oil and gas; (2) the tract of land, on which a lease has been obtained, where producing wells and production equipment are located.

**Lease Stipulation**—A modification of the terms and conditions on a standard lease form at the time of the lease sale.

**Mineral Estate (Mineral Rights)**—The ownership of minerals including rights necessary for access, exploration, development, mining, ore dressing, and transportation operations.

**Mineral Reserves**—Known mineral deposits that are recoverable under present conditions but are as yet undeveloped.

**Mineral Rights**—Mineral rights outstanding are third-party rights, an interest in minerals not owned by the person or party conveying the land to the United States. These are exceptions in a deed that is the result of prior conveyance separating title of certain minerals from the surface estate. Reserved mineral

rights are the retention of ownership of all or part of the mineral rights by a person or party conveying land to the United States. Conditions for exercising these rights have been defined in the Secretary of the Interior's "Rules and Regulations to Govern Exercising of Mineral Rights Reserved Conveyance to the United States" attached to and made a part of deeds reserving mineral rights.

**Mitigation**—The abatement or reduction of an impact on the environment by (1) avoiding a certain action or parts of an action, (2) employing certain construction measures to limit the degree of impact, (3) restoring an area to preconstruction conditions, (4) preserving or maintaining an area throughout the life of a project, or (5) replacing or providing substitute resources to the environment. or (6) gathering archaeological and paleontological data before disturbance.

**National Ambient Air Quality Standards**—The allowable concentrations of air pollutants in the air specified by the Federal government. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare) from any unknown or expected adverse effects of air pollutants.

**National Environmental Policy Act of 1969**—An Act that encourages productive and enjoyable harmony between humankind and its environment. The Act promotes efforts to prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humankind. The Act enriches the understanding or the ecological systems and natural resources important to the Nation, and establishes the Council on Environmental Quality.

**Noxious Weed**—An undesirable weed species that can crowd out more desirable species.

**Pilot project**—A small scale preliminary study conducted in order to evaluate feasibility, time, cost, and adverse events prior to performance of a full-scale project.

**Produced water**—Groundwater pumped to the surface during reservoir production.

**Proposed action**—Construction activities, alignments, and other activities proposed by the applicant.

**Raptor**—Bird of prey with sharp talons and strongly curved beak (e.g., hawk, owl, vulture, and eagle).

**Reasonably Foreseeable Development Scenario**—The prediction of the type and amount of development that would occur in a given area.

**Reclamation**—The process of converting disturbed land to its former use or other productive uses.

**Record of Decision**—A document separate from, but associated with, an environmental impact statement that publicly and officially discloses the responsible official's decision on the proposed action.

**Reserve Pit**—Usually an excavated pit that may be lined with plastic that holds drill cuttings and waste mud. Term for the pit that holds the drilling mud.

**Reservoir** (oil and gas)—A naturally occurring, underground container of oil and gas, usually formed by deformation of strata and changes in porosity.

**Riparian**—Situated on or pertaining to the bank of a river, stream, or other body of water; normally used to refer to the plants of all types that grow along, around, or in wet areas.

**S-Shaped Well**—A well path that starts vertical, then is deviated to reach a target before being turned near vertical again to drop through the pay zone.

**Saltwater disposal well**—A well into which produced water can be injected for safe disposal. Disposal wells are subject to regulatory requirements to avoid the contamination of freshwater aquifers.

**San Juan Basin**—A large geologic basin located in northwestern New Mexico and southwestern Colorado.

**Scoping**—A term used to identify the process for determining the scope of issues related to a proposed action and for identifying significant issues to be addressed in an EIS.

**Seasonal timing limitation**—A restriction on activities for a specific annual period.

**Significant**—An effect that is analyzed in the context of the proposed action to determine the degree or magnitude of importance of the effect, either beneficial or adverse. The degree of significance can be related to other actions with individually insignificant but cumulatively significant impacts.

**Slope—**The degree of deviation of a surface from the horizontal.

**Spacing**—The area allocated to a well under a well spacing order or rule.

**Stratigraphic test well**—A geologically directed drilling effort to obtain information pertaining to a specific geological condition that might lead toward the discovery of an accumulation of hydrocarbons. Such wells are customarily drilled without the intention of being completed for hydrocarbon production. This classification also includes tests identified as core tests and all types of expendable holes related to hydrocarbon exploration.

**Swabbing**—To unload liquids from the production tubing to initiate flow from the reservoir. A swabbing tool string incorporates a weighted bar and swab cup assembly that are run in the wellbore on heavy wireline. When the assembly is retrieved, the specially shaped swab cups expand to seal against the tubing wall and carry the liquids from the wellbore.

**Threatened or Endangered Species**—Animal or plant species that are listed under the Federal Endangered Species Act of 1973, as amended (federally listed), or under the Colorado or New Mexico Endangered Species Act (state listed).

**Total dissolved solids**—A measure of the amount of material dissolved in water (mostly inorganic salts).

**Water-based drilling fluid**—A drilling fluid (mud) in which water or saltwater is the major liquid phase as well as the wetting (external) phase. General categories of water-base muds are fresh water, seawater, salt water, lime, potassium and silicate.

**Waters of the United States**—A waterway, water body, or wetland protected by the Clean Water Act.

**Wellbore**—The hole made by the drilling bit.

**Wetland**—Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support (and under normal circumstances do support) a prevalence of vegetation typically adapted for life in saturated soil conditions.

**Workover**—The process of performing major maintenance or remedial treatments on an oil or gas well.

**Zone**—A slab of reservoir rock bounded above and below by impermeable rock.