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Southwest Regional Office, Albuquerque, New Mexico

Southern Ute Indian Tribe

Oil and Gas Development on the Southern Ute Indian Reservation
Final Environmental Impact Statement July 2002

Volume 1

FINAL ENVIRONMENTAL IMPACT STATEMENT
OIL AND GAS DEVELOPMENT ON THE SOUTHERN UTE INDIAN RESERVATION
CO-SJFO-01-001EIS

Lead Agency:	U.S. Department of the Interior Bureau of Land Management
Cooperators:	U.S. Department of the Interior Bureau of Indian Affairs Southern Ute Indian Tribe
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Project Location:	La Plata, Archuleta and Montezuma Counties, Colorado
Comments on this EIS should be directed to:	Walt Brown San Juan Public Lands Center 15 Burnett Court Durango, Colorado 81301
Date by which comments must be received by the BLM:	30 days after the EPA prints the Notice of Availability for this Final EIS in the Federal Register

ABSTRACT

This programmatic environmental impact statement (EIS) analyzes the potential impacts of future oil and gas development on approximately 200,000 acres of Tribal land within a 421,000-acre Study Area. Most of the Study Area is already substantially developed for both conventional gas production and coalbed methane (CBM) production. The Study Area also supports substantial agricultural and residential surface use, with lesser amounts of commercial and recreational land use. The Study Area lies entirely within the exterior boundaries of the Southern Ute Indian Reservation (Reservation) and includes Indian mineral estate, a patchwork of Tribal and fee lands, and a small amount of State of Colorado park land. The Reservation is located in the San Juan Basin, a major oil-and-gas-producing area in northwestern New Mexico and southwestern Colorado.

Historically, development of the oil and gas resource on the Reservation has been the major source of income to the Southern Ute Indian Tribe (SUIT) and is an integral part of the local economies. The Bureau of Indian Affairs (BIA) and Bureau of Land Management (BLM), as agents of the Secretary of the Interior, have the responsibility for administering the development of oil and gas resources where the mineral estate is Federally owned and held in trust for the benefit of the Indian people. Through the auspices of the Indian Self Determination Act of 1968 and Indian Mineral Act of 1982, the SUIT has taken an increasingly active role in the management of their mineral resources.

The SUIT, BIA, and BLM prepared this FEIS in coordination to address anticipated new oil and gas development on Indian lands within the boundaries of the Reservation over a 20-year period. Leasing decisions made in earlier environmental analyses will remain valid. This FEIS and subsequent Record of Decision will provide a framework for administering future oil and gas development, ensure the long-term sustainability of resources and maintain other compatible land uses, identify new mitigation and/or better uses of existing mitigation, and facilitate the Tribe's autonomy and flexibility in the administration of programs.

Three alternatives were analyzed in detail in the FEIS: (1) continuation of present management (no action), (2) CBM infill development, and (3) CBM infill development in conjunction with enhanced coal bed methane (ECBM) recovery. ECBM recovery involves injection of nitrogen, carbon dioxide, or other fluids into the Fruitland Formation to increase gas production. Alternative 3, the Agency and Tribal Preferred Alternative, specifically considers the impacts of drilling or recompleting 70 injector wells and 636 production wells (269 conventional wells and 367 CBM wells) on tribal minerals.

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LIST OF ACRONYMS

AAAL	Acceptable Ambient Concentration Level
ACGIH	American Conference of Governmental Industrial Hygienists
ADT	average daily traffic
ALAPCO	Association of Local Air Pollution Control Agencies
ANC	acid neutralizing capacity
APD	Application for Permit to Drill
API	American Petroleum Institute
AQRV	Air Quality Related Value
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing Materials
AUM	animal unit months
BA	Biological Assessment
BACT	Best Available Control Technology
bbl	barrel = 42 U.S. gallons = 5.615 ft^3
bcf	billion cubic feet
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BTEX	benzene, toluene, ethylbenzene, xylene
btu	British Thermal Units
C_2	Category 2 Candidates
CBM	coalbed methane
CCD	Census County Division
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDP	Central Delivery Points
CDPHE-APCD	Colorado Department of Public Health and Environment - Air Pollution Control Division
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
cfs	cubic feet per second
CNHP	Colorado Natural Heritage Program
CO	carbon monoxide
COGCC	Colorado Oil and Gas Conservation Commission
CR	County Road
dB	decibels
dBA	A-weighted sound level
DEA	draft environmental assessment
DEIS	draft environmental impact statement

DOT	Department of Transportation
E&P	Exploration and Production
EA	environmental assessment
ECBM	enhanced coalbed methane
EHSs	Extremely Hazardous Substances
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ERNS	Emergency Response Notification Systems
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FLM	Federal Land Manager
FLPMA	Federal Land Policy and Management Act
ft-bls	feet below land surface
FY	fiscal year
GIS	geographic information system
GORT	Gas and Oil Regulatory Team
gpm	gallons per minute
HAP	Hazardous Air Pollutant
HAZCOM	hazard communications
IMPROVE	Interagency Monitoring of Protected Visual Environments
IWAQM	Interagency Workgroup on Air Quality Modeling
L_{dn}	day-night noise level
L_{eq} (h)	one-hour equivalent sound level
L_{eq}	equivalent sound level
LOP	life of project
LOS	level of service
mbbl	thousand barrels
mcf	thousand cubic feet
MCL	maximum contaminant level
MEI	Maximally Exposed Individual
mg/L	milligrams per liter
MLE	Most Likely Exposure
mmbbl	million barrels
mmcfd	million cubic feet per day
MMS	Minerals Management Service
MOU	Memorandum of Understanding
mph	miles per hour
MSS	Manufacturers Standardization Society
NAAQS	National Ambient Air Quality Standards
NATICH	National Air Toxics Information Clearinghouse
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act

NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NGL	natural gas liquids
NMED-AQB	New Mexico Environment Department - Air Quality Bureau
NO	nitric oxide
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOS	Notice of Staking
NO_X	oxides of nitrogen
NRCS	Natural Resources Conservation Service
O_3	Ozone
^oF	degrees Fahrenheit
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
PM_{10}	inhalable particulate matter
$PM_{2.5}$	fine particulate matter
POM	polycyclic organic matter
ppm	parts per million
PRIIP	Pine River Indian Irrigation Project
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RFD	reasonable foreseeable development
RQs	reportable quantities
SARA	Superfund Amendments and Reauthorization Action
SH	State Highway
SO_2	sulfur dioxide
SPCC	spill prevention control and countermeasures
SQG	small quantity generators
STAPPA	State and Territorial Air Pollution Program Administrators
SUIT	Southern Ute Indian Tribe
tcf	trillion cubic feet
TD	total depth
TDS	total dissolved solids
TERA	Toxicology Excellence for Risk Management
TES	threatened, endangered, and sensitive
TSCA	Toxic Substances Control Act
UIC	Underground Injection Control
UNM	University of New Mexico
US	U.S. Highway
USCOE	U.S. Army Corps of Engineers

USFS	U.S. Department of Agriculture - Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
VOC	Volatile Organic Compounds
µe/l	micro-equivalents per liter
$\mu g/m^3$	micrograms per cubic meter
µg/L	micrograms per liter

EXECUTIVE SUMMARY

INTRODUCTION

This programmatic environmental impact statement (EIS) analyzes the potential impacts of future oil and gas development on approximately 200,000 acres of Tribal land within a 421,000-acre Study Area. The Study Area lies entirely within the exterior boundaries of the Southern Ute Indian Reservation (the Reservation) and includes Indian mineral estate, a patchwork of Tribal and fee lands, and a small amount of State of Colorado park land. The Indian mineral estate is held in trust by the United States of America for the benefit of the Southern Ute Indian Tribe, and the federal government retains this trust responsibility due to historical factors (Appendix A).

Most of the Study Area is already substantially developed for both conventional gas production and coalbed methane (CBM) production, and the economic viability of drilling an optional second well or infill well in each coalbed methane spacing unit is being tested. The Study Area also supports substantial agricultural and residential surface use, with lesser amounts of commercial and recreational land use. Impacts were considered and analyzed only from future development on the Tribal trust lands, including both Tribal surface and Tribal mineral estates, except in the evaluation of cumulative impacts.

The Southern Ute Indian Tribe (SUIT or Tribe), in conjunction with the San Juan field office of the Bureau of Land Management (BLM) and Bureau of Indian Affairs (BIA), prepared this document in compliance with the National Environmental Policy Act (NEPA). The planning and environmental process began in September 1995 with scoping. Three alternative scenarios were developed for detailed analysis: 1) a no action, or current management, alternative, which includes a relatively small amount of additional CBM development, including some infill wells, and development of conventional resources; 2) a coalbed methane infill development alternative, which would include widespread development of CBM infill wells in addition to the Alternative 1 development; and 3) an enhanced coalbed methane (ECBM) alternative, which would include injection of fluids such as nitrogen or carbon dioxide into the reservoir in addition to the widespread infill and Alternative 1 development programs. The impact assessment was based on the reasonably foreseeable development of oil and gas resources under each alternative over the next 20 years.

The BLM-,BIA- and Tribal-Preferred Alternative and Proposed Action is Alternative 3. Under this alternative, a total of 706 conventional gas, coalbed methane, and injection wells would be drilled on Tribal trust land over the twenty year life of the project. Associated facilities, such as separators and compressors, would be developed on the wellpads or at currently existing facility locations. Roads and pipelines would be constructed as needed.

Key impacts are similar under all three alternatives, although the magnitude of the impacts are different. An important impact is the development of Tribal oil and gas resources. Although this development is an irretrievable commitment of resources, it would have direct socioeconomic benefits on the Tribe and the nearby communities. Significant positive impacts would occur in socioeconomic resources under the Preferred Alternative as compared to Alternatives 1 and 2. The incremental increase in oil and gas exploration and production under the Preferred Alternative would provide or maintain jobs; direct and indirect spending; and taxes to local, state, and Tribal governments.

With the incorporation of mitigation measures, including federal and Tribal policies of avoidance of cultural resources and of threatened, endangered, and special status (TES) Species, no significant negative impacts are expected under any of the three alternatives for air quality, surface water, ground water, TES Species, cultural resources, noise, traffic, or public health and safety. Some significant impacts could occur to elk severe winter and winter concentration areas from noise and activity. Significant impacts on visual resources and on land use are unlikely to impact Tribal trust acreage but may impact adjacent fee acreage, especially as cumulative impacts; i.e., in conjunction with other developments that are expected to be occurring in the Study Area in the future regardless of oil and gas resource development such as community expansion and highway construction projects. Increased traffic due to oil and gas operations is expected to be imperceptible due to increased traffic in the area caused by community expansion unrelated to oil and gas development.

On-going studies by the BLM, Tribe, and others may change the evaluation of potential future impacts from those presented here. The impact analyses presented herein were performed using the best available data. The BLM and Tribe are participating with the Colorado Oil and Gas Conservation Commission (COGCC) and operators in a long-term joint project (the 3M Project) and other multi-year surveillance and evaluation projects, all described in Sections 3.4 and 4.4, to enhance understanding of fluid movements in the Fruitland Formation and impacts from CBM production. Goals include both understanding historical movements and predicting future movements. These studies do not have firm deadlines associated with them. The BLM, Tribe, and BIA will incorporate the conclusions of those studies into future decision-making as appropriate. Resources for which impact analysis could change include biological resources, land use and ownership, public health and safety, water resources, and geology and mineral resources.

ALTERNATIVES

Three alternatives were developed and evaluated in detail for this EIS. The alternatives were developed to address the goals of this EIS, which are: 1) to provide a framework for administering future oil and gas development; 2) to ensure the long-term sustainability of resources and maintain other compatible land uses; 3) to identify impacts and associated mitigation; and 4) to facilitate the Tribe's autonomy and flexibility in the administration of programs. The alternatives that are analyzed in detail in this EIS are:

Alternative 1 - Continuation of Present Management (No Action)—Alternative 1 is the no-action alternative and represents the continuation of present management and of exploration and development at rates that are similar to recent drilling and development activity rates. A total of 350 wells would be developed, including both conventional and CBM wells. The CBM wells would include both "parent" wells, which are wells drilled to develop previously undeveloped spacing units, and "infill" wells, which are optional second wells drilled or recompleted on spacing units that already have one well.

Alternative 2 - Coalbed Methane Infill Development—Alternative 2 considers the drilling or recompletion of an optional second well, or infill well, on a majority of CBM spacing units located on Tribal trust lands within the Study Area. This would result in an effective CBM well density of two wells per 320-acre spacing unit or four wells per section. Infill has been studied in several local areas on the Reservation, and has already been approved for more than 180 spacing units (in Ignacio Blanco (Fruitland) Field) by the COGCC. The increased number of wells would allow (in Ignacio Blanco, Fruitland, Field) accelerated production of the resource, increase recoveries of the gas in place, and increase economic returns to the Tribe. The status quo development described in Alternative 1 is included within Alternative 2, resulting in a total of 636 new wells, including both conventional and CBM production wells, that would be drilled under Alternative 2. The CBM wells would include both parent and infill wells.

Alternative 3 - Enhanced Coalbed Methane Recovery (Agency-and-Tribal-Preferred Alternative)—This alternative includes all the developments included within Alternative 2 plus the addition of Enhanced Coalbed Methane (ECBM) recovery techniques; i.e., the injection of nitrogen, carbon dioxide, or other fluids into the Fruitland Formation. For the purpose of Alternative 3, ECBM was projected to occur on almost half the Tribal CBM spacing units within the exterior boundaries of the Reservation, resulting in 70 injection wells drilled or recompleted (one injection well per every two producing wells in the injection project areas) on Tribal trust lands. Some of the injection wells may be directionally drilled off existing pads to minimize impacts and costs. Additional production wells would not be required. A total of 706 wells would be developed under Alternative 3, including conventional wells, CBM production wells, and injection wells. The CBM wells would include both parent and infill wells.

AFFECTED ENVIRONMENT AND ISSUES

The Study Area includes a blend of agricultural, residential, industrial uses with a minor amount of recreational use. Chapter 3 addresses the existing condition of the human and natural environment that could be affected by oil and gas development under the alternatives. Data used to analyze the affected environment included published and unpublished reports, new modeling, maps, and digital data (geographic information system). Overall, issues relate to the more dense development of the oil and gas industry, primarily the construction of wellpads, wells, roads, pipelines, and compressors in an area that has already had fairly widespread development of both gas industry facilities and other uses, and where rural residential development density is increasing. Most impacts from the Preferred Alternative would be expected to be short term, or existing only during the 20-year life of the project, although a few impacts would be long term, or lasting more than twenty years. For example, mature trees, if removed, would not be replaced for 50 to 100 years. The following paragraphs briefly describe the issues associated with each potentially impacted resource.

Air Quality. Gaseous air pollutant emissions discharged from the wellhead (e.g., flaring) and from injector well and pipeline compression activities, as well as dust and exhaust from construction and maintenance activities, have been identified as issues of concern. Comments from scoping were received concerning potential air quality impacts at the distant mandatory federal Prevention of

Significant Deterioration (PSD) Class I Mesa Verde National Park and Weminuche Wilderness Area, administered by the USDI-National Park Service and USDA-Forest Service, respectively. The primary concerns involved potential visibility and atmospheric deposition (acid rain) impacts within these sensitive areas, particularly due to proposed natural gas compressor operations.

Biological Resources. Biological resources potentially could be disturbed by oil and gas resource development in a variety of ways. Direct impacts could come from removal of vegetation, damage to the quantity or quality of water resources, and disturbance by noise and traffic. Indirect impacts could include introduction of noxious weeds, increased erosion and sedimentation, which could degrade surface waters and impact aquatic life, and increased recreational traffic and noise on roads established for industry purposes. Particular concern exists for disturbance of wetlands, which are a relatively rare and valuable habitat in the Study Area, for TES species, for species that are culturally important, and for disturbance of breeding, nesting, and wintering areas. Cumulative impact concerns exist regarding impacts on a large area, resulting in disruption to the function of a habitat as a whole.

Methane seeps and coal fires at the outcrop, which may be linked to CBM production, could impact vegetation directly in their vicinity and impact wildlife indirectly by degrading habitat. There is a small potential for direct impact on wildlife, such as by toxic gas or forest fire, although this has not been observed in the area. The possible link between methane seeps and fires at the outcrop and CBM production is discussed in detail in Sections 3.4. and 4.4.

Geology, Minerals, and Soils. The primary impact on geology, minerals, and soils is anticipated to be the irretrievable removal or production of the Tribe's oil and gas resources. This type of development is the intent of the project because of the associated large, direct, and beneficial socioeconomic impacts, such as increased government revenues and increased employment, which are desired by the Tribe. Development of the Tribe's oil and gas resources also benefits the United States as a whole by adding to the total pool of energy available.

Potential negative impacts include loss of methane due to seeps at the Fruitland outcrop and loss of mineable coal in subterranean fires located near the outcrop, both of which may be linked to coalbed methane production and associated water production in the San Juan Basin. Impacts on soils could include increased soil erosion and loss of farmland, especially prime farmland, and associated indirect impacts on vegetation, wildlife, and the agricultural portion of the local economy.

Water Resources. Impacts on groundwater from subterranean fluid flow and on surface water from construction runoff are the key concerns. La Plata County has had isolated instances of groundwater pollution, which were tentatively linked to underground fluid flow affected by old wells with poor mechanical integrity. Remediation of old wells appears to have lessened the pollution in the vicinity of most of those wells. However, other vertical conduits potentially could impact pollution in groundwater. An indirect impact on water resources could be produced if construction activities increase runoff and erosion, potentially adding sediment to surface water. State, BIA, BLM, and Tribal stipulations on construction, operations, and abandonment activities include numerous protections for both surface water and groundwater. Also, all production wells are monitored annually for mechanical integrity. Injection wells are tested according to regulations of the under the EPA Underground Injection Control (UIC) program.

Water would be used in drilling and completing wells. Fresh water, which would be obtained primarily from irrigation sources, would be used for mixing cement and fracture stimulation fluids. Produced water, and sometimes recycled water, could be used for mixing drilling mud and in cavity completions. Concerns include water depletion volume of the San Juan River Basin and the potential related impacts on TES species. Concern for small, possibly ephemeral springs near the outcrop also exists although little data are available on such springs. The overall hydrology of the Study Area has been studied in the 3M Project and by the BLM. The Tribe and some operators are monitoring the water table near the outcrop in the western part of the Study Area via monitor wells.

Land Use and Ownership. The key land use concerns involve loss of surface use and loss of value due to location of facilities, including wells, compressors, and roads, near potential or existing residences. Such losses would be related to noise and visual impacts including impacts from well-related traffic. Where a well would be located on grazing land or irrigated agricultural land, the primary concern may be for actual economic loss of surface use. The construction of each new well disturbs 1 to 3 acres of surface area. Concerns about subsidence, which potentially could impact surface uses of all kinds, have also been raised, although there is no evidence of production-related subsidence in the Study Area. An impact on groundwater, if one occurred, also could impact land use or value.

Traffic and Transportation. Development under all the alternatives would create traffic, primarily light truck traffic (pickup trucks) involved in daily production operations. Heavy truck traffic, such as water trucks and trucks moving drilling rigs, also would be involved during construction and abandonment and occasionally during production operations. Heavy truck traffic would involve relatively few trips per year for most well locations. Potential impacts include degradation of road surfaces, especially by heavy trucks, increases in accidents, and increases in travel times due to increased traffic.

Cultural Resources. Cultural resources, including any traditional cultural properties, could be negatively impacted primarily by disruption of archeological or cultural sites, although Tribal and federal policies of avoidance and mitigation should prevent significant impacts. Positive cultural impacts may be developed indirectly through positive socioeconomic impacts of the Preferred Alternative on Tribal members and Tribal government.

Visual Resources. As discussed under Land Use and Ownership, there is a concern about the potential for increased well density to unfavorably impact visual resources. This impact issue is exacerbated by the trend of increased rural residential growth in the Study Area, overlapping the area where additional oil and gas resource development is proposed. At present, however, residential use of Tribal land is concentrated near Ignacio and Bayfield and represents only a small portion of Tribal land. Further, impacts from infill and ECBM injection wells would be relatively small and incremental in comparison with development impacts which already exist, such as spur roads off of existing roads and expansions of existing well pads. Many of the mitigation measures designed to reduce surface impacts also would mitigate impacts on visual resources.

Socioeconomics. Socioeconomic concerns include population increases that cannot be sustained by existing local services, creation of a boom-bust economy, and loss or degradation of local culture or lifestyle, especially Ute culture. The socioeconomic health of the Tribe is directly tied to the Tribe's revenues from oil and gas development on the Reservation. Because Tribal government provides numerous services to its members and the community, as well as being one of the five largest employers in La Plata County, development of oil and gas resources is significant to the socioeconomics of the area, especially for Tribal members. The preservation of Ute culture is significantly supported through programs sponsored by Tribal government. The development of gas resources also adds and maintains both direct and indirect jobs for non-Tribal employers. Evaluation of cumulative socioeconomic impacts must consider the rapid population growth in the area which is unrelated to oil and gas industry development.

Noise. Primary concerns include increased noise from traffic, well construction and operations, and compressors. The impact of a noise source depends on its size, location, location in relation to receptors, and mitigation measures which are taken. Noise associated with oil and gas operations on Tribal land is mitigated by the Tribe on a case by case basis. Noise from operations located on fee mineral estates within the exterior boundaries of the Reservation is generally under the jurisdiction of the COGCC, except when the operations are undertaken by the Tribe..

Public Health and Safety. Primary health and safety concerns include potential for injury to both oil and gas industry personnel and to residents. The potential dangers from coal fires and methane seeps include explosion, fire, toxic and caustic gases, and collapse of the surface into underground caverns. The potential link between CBM production and these environmental hazards is not proven and is complicated by the geologic setting and other variables. Concern about potential contamination of drinking water is addressed under Water Resources.

ENVIRONMENTAL CONSEQUENCES

Chapter 4 describes in detail the potential consequences, or impacts on the environment, from implementing each of the three alternatives. Because this is a programmatic EIS, the actual locations of future sites of wells and other facilities are not known. Development was assumed to occur evenly throughout the Study Area, except assuming less infill development in the fairway of the CBM play, and to occur evenly throughout the 20-year life of the project. Assessments always included conservative assumptions; i.e., were designed to predict relatively higher levels of disturbance and impacts.

The estimated impacts for many resources were evaluated based on the total acres of disturbance assumed for each alternative as a percentage of the resource in the Study Area. Construction of each new well would require a surface disturbance of 3.06 acres, including 0.25 acres for a road. Once construction is completed, one acre at each well pad would be reclaimed, resulting in a surface disturbance of 2.06 acres. If a new well is constructed on an existing pad, the existing pad would be expanded by one acre to accommodate the new well. In all three alternatives, the acreage disturbed beyond existing development is less than 1 percent of the Study Area. Under Alternatives 1, 2, and 3, the total disturbance would be 714 acres, 1,306 acres, and 1,410 acres, respectively.

As summarized in Table ES-1 below and discussed in detail in Chapter 4, no significant impacts are expected for most resources under any of the three alternatives.

Potential air quality impacts would not be significant under any Alternative, for the entire range of analyzed compressor air pollutant emission rates. Although a "just noticeable change" in visibility (1.083 deciview, just slightly above the 1.0 deciview threshold) for a single day at the Weminuche Wilderness Area was predicted under Alternative 3 (Preferred Alternative) with the maximum assumed analyzed oxides of nitrogen emission rate (2.0 gm/hp-hr), this impact is unlikely to actually occur given the very conservative assumptions used in the analyses. TES species would be protected from significant impacts by current Tribal, BLM, and BIA mitigative procedures. Similarly, soils, surface water, ground water, and cultural resources would be protected by existing standard mitigative procedures. The increased number of wells in the area should not produce a significant danger to either residents or oil and gas industry personnel provided that standard industry health and safety guidelines and procedures are followed.

The Preferred Alternative by itself would not have significant impacts on traffic, land use, noise, visual resources, or most biological resources. Development of oil and gas resources, which has already taken place, has imposed impacts on the area. The Preferred Alternative would have additional incremental impacts. However, all those resources listed above are likely to be significantly impacted by growth in the area, which is not directly related to oil and gas industry development (see Community Expansion in Section 4.13, Cumulative Impacts). Thus, the Preferred Alternative could contribute to a significant impact on those resources by being one of many activities that all occur simultaneously during the project period.

Significant impacts would result to geologic and mineral resources and to some non-TES biological resources. The primary impact of the Preferred Alternative is the irretrievable development of gas and oil resources. Approximately 380 billion cubic feet (bcf) of incremental gas are expected to be produced in the future from Tribal minerals under Alternative 3, the Preferred Alternative, as compared to Alternative 1, the No Action Alternative. Also, elk severe winter and elk winter concentration areas may be significantly impacted by noise and activity although the percentage of surface area in those resources that might be displaced by construction would not be significant.

There also is potential for a significant impact from loss of methane gas and of mineable coal at the Fruitland outcrop. These are of concern because of the potential health and safety issues they create as well as the potential economic losses associated with them. Coal fires and methane seeps are documented around the world as spontaneous, natural occurrences at coal outcrops. However, some of the coal fires and methane seeps in La Plata County have been hypothetically linked to CBM production downdip in the basin. Although numerous projects related to understanding the seeps and fires are in progress, adequate understanding does not exist to say definitively that there is a link between outcrop production and fires or to assess the potential for future impacts, especially those that might be incremental due to the Preferred Alternative. Measures that have been taken to protect human health and safety include:

1. Limiting access to certain segments of the Fruitland outcrop on the Reservation until the situations are better understood;

2. BLM and SUIT participation in the 3M (Monitoring, Mapping, and Mitigating) Project to gain better understanding of the hydrological and reservoir dynamics of Fruitland production.

The production of gas resources would have large, direct, positive socioeconomic impacts. The incremental increase in oil and gas exploration and production under the Preferred Alternative would provide or maintain jobs, direct and indirect spending, and taxes to local, state, and tribal governments. The increases in employment, spending, and taxes would have both direct and indirect benefits to individuals, especially Tribal members, and to the communities in the area. Personal income would be higher, and more services would be provided to the communities in the area from local, state, and Tribal governments. Services provided by Tribal government would include programs that support the Southern Ute Indian culture.

Table ES-1
Summary of Potential Impacts

Resource Concern	Comment
Air Quality	Significant impacts are not anticipated. Future development activities must comply with applicable state, tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans. Maximum modeled concentrations of carbon monoxide, nitrogen dioxide, particulate matter, and sulfur dioxide are all below applicable ambient air quality standards. Hazardous air pollutant concentrations and incremental cancer risks would be below significance levels. No significant atmospheric deposition (acid rain) impacts are predicted. Potential project impacts would be below applicable PSD Class I and II increment levels. Cumulative visibility impacts on Class I areas are unlikely to exceed the 1.0 deciview "just noticeable change" threshold.
Vegetation (non-Threatened Endangered and Special Status (TES) species)	Areas of vegetation that would be cleared for construction of well pads, roads, pipelines, and facilities would be insignificant compared to the quantity of vegetation in the Study Area. Wooded riparian areas would be avoided where possible. Construction areas would be minimized and would be reclaimed after production is completed. Significant impacts would result if noxious weeds were not adequately controlled at surface disturbances, so proper revegetation and weed management techniques would be required.
Wildlife and Fisheries (non-TES species)	Impacts from noise and activity disturbances could be significant for elk severe winter ranges and winter concentration areas. Impacts could be reduced by minimizing activity in sensitive areas. Small areas of habitat would be cleared for construction of wellpads, roads, pipelines, and facilities. Construction areas, including roads, would be minimized and would be reclaimed after production is completed. Water depletion volume of the San Juan River Basin (fresh water for drilling and completions) would be less than the 100-acre-feet-per-year (ft/yr) threshold for small quantity depletions established by the US Fish and Wildlife Service (USFWS).
TES species	No significant impacts are anticipated. Current Tribal, BLM, and BIA mitigative procedures provide for avoidance of impacts on TES species. If a TES species may be affected, further consultation with USFWS would be required. Water depletion volume of the San Juan River (fresh water for drilling and completions) would be less than the 100-acre-ft/yr threshold for small quantity depletions established by the USFWS.
Geology and Minerals	The primary significant impact would be the irretrievable production of gas and oil resources. There is potential for loss of gas resources by seepage at the outcrop and of mineable coal resources by coal fires near the outcrop, both of which may be linked to CBM production. Studies are ongoing to assess the potential relationship and to develop mitigation measures if appropriate. The potential impacts and their significance cannot be precisely estimated at this time. Mitigation may include more aggressive production of methane gas from the San Juan Basin.

Table ES-1
Summary of Potential Impacts

Resource Concern	Comment
Soils	No significant impacts are anticipated. Adherence to Tribal, BLM, and BIA standards and mitigative measures would minimize or avoid soil erosion and impacts on sensitive soils.
Groundwater	No significant impacts are anticipated. The Colorado Oil and Gas Conservation Commission (COGCC), Tribe, and BLM have developed stipulations and programs to prevent new wells from contaminating groundwater and have worked with operators to remediate pre-existing wells that had leakage problems. The Bradenhead Testing Program monitors pressure conditions in wells to detect any new problems with well integrity. No significant depletion of groundwater would occur. Produced water is primarily reinjected to a zone of similar or less desirable water quality.
Surface Water	No significant impacts on surface water resources are anticipated. Tribal, state, and federal regulations and stipulations on oil and gas industry operations protect surface water from contamination. The industry has a substantial history of operations in La Plata County including reporting of minor pollutant spills and appropriate remediation measures being taken. No significant depletion of surface water would occur. Fresh water for drilling and completions would be obtained primarily from irrigation sources, and depletion volumes would be below the 100-acre-ft/yr. threshold for small quantity depletions established by the USFWS for the San Juan River Basin.
Land Use and Ownership	No significant impacts on land use are expected. Most of the Tribal acreage in the Study Area is currently used for farming and ranching. Minimal acreage of agricultural land, including prime farmland, would be displaced by project construction, and prime farmland would be avoided where possible. Tribal, BLM, and BIA siting procedures provide for minimizing disruption of pre-existing uses where possible. Potential future impacts on the value of residential property cannot be quantified at this time. Impacts would occur if there were loss of surface use, high levels of noise, visual resource impacts, and/or impacts on groundwater.
Traffic and Transportation	No significant impacts on traffic and transportation are anticipated. Evaluation of projected future traffic patterns determined that incremental traffic from the Preferred Alternative would not have a significant impact on local traffic density or accident rates given the expected growth of traffic in the area from other sources.
Cultural Resources	No significant impacts on cultural resources are anticipated. Tribal, BLM, and BIA procedures provide for avoidance or mitigation of impacts on cultural resources.

Table ES-1
Summary of Potential Impacts

Resource Concern	Comment
Visual Resources	Significant impacts are not expected because the majority of Tribal land is undeveloped except for existing oil and gas production. Some impacts would occur on non-Tribal land adjacent to Tribal land. Many potential impacts can be reduced through mitigative measures such as careful site selection, although other resources (TES species, cultural resources, irrigated farmland) have priority. Well pads must necessarily be distributed throughout the Study Area in order to economically develop the Tribe's oil and gas resources.
Socioeconomics	A significant loss of employment for local workers, especially Tribal members, declines in direct and indirect spending, and a significant loss of revenues to local governments and the Tribe would result from Alternative 1. The aforementioned losses are likely in turn to have other negative impacts on the local population, especially Tribal members. Conversely, Alternative 3 would have direct positive socioeconomic impacts on the local populations, especially Tribal members, due to development and maintenance of relatively high paying jobs, increases in direct and indirect spending, and increases in revenues to local and Tribal governments, which provide jobs and services to area residents, including Tribal members.
Noise	Noise impacts from CBM facilities have been identified in the past, and mitigation efforts have been recommended and implemented. Noise impacts on the Southern Ute Indian Reservation are handled on a case-by-case basis.
Health and Safety	No significant impacts on workers or the general public are anticipated from construction, operations, or abandonment procedures provided that workers use appropriate health and safety practices. Potential for indirect impacts from coal fires or methane seepage at the outcrop is being studied. If dangerous conditions related to CBM development exist, then additional mitigation measures would be necessary. At present, the seeps and coal fires are localized and not dangerous if simple precautions, such as avoidance, are observed in their vicinity. The Tribe has taken measures to limit access to the areas of highest seepage and fires. The Tribe has also committed $900,000 to extinguishing fires on the SUIR.

CHAPTER 1—PURPOSE AND NEED

1.1 BACKGROUND AND INTRODUCTION

One of the responsibilities of the federal government is to protect Indian land and to take actions that serve the best interests of Indian tribes. The Bureau of Indian Affairs (BIA) and Bureau of Land Management (BLM), as agents for the Secretary of the Interior, are responsible for administering the leasing and development of oil and gas resources where the mineral estate is held in trust by the federal government for the benefit of the Indian people. This is referred to as the “Indian mineral estate.”

The Southern Ute Indian Tribe’s (SUIT’s) mineral estate is important to the Southern Ute Indian people. Development of the oil and gas resource historically has been the major source of income to the SUIT and is an integral part of the local economy. Although the rate of development has declined in recent years, oil and gas development will continue to be an important economic factor affecting the SUIT and local communities. The SUIT, through the auspices of the Indian Self Determination Act of 1968 and Indian Mineral Development Act of 1982, has taken an increasingly active leadership role in the management of its mineral resources.

This EIS analyzes alternative oil and gas development strategies on Southern Ute tribal land for the foreseeable future (20 years). The analysis anticipates new well drilling and the use of production enhancement processes. This chapter describes the purpose of and need for evaluating development of the Indian mineral estate for oil and gas, the land subject to environmental analysis in the EIS, relationships with other plans and programs, issues that have been raised regarding the Agency and Tribal Preferred Alternative, the purpose of this EIS, and decisions to be made and authorizing actions.

1.2 OIL AND GAS DEVELOPMENT HISTORY

The Southern Ute Indian Reservation (Reservation) is in the San Juan Basin, a large geologic feature in northwestern New Mexico and southwestern Colorado (Figure 1-1). The San Juan Basin has been extensively drilled for oil and gas and is reportedly the second-largest gas-producing basin in the continental United States. The first commercial oil and gas well in the San Juan Basin was a shallow completion (Kirtland Formation) near Aztec, New Mexico, in October 1921. This was not, however, the first discovery of oil and gas. The earliest report of natural gas was from shallow depths in a water well drilled near Farmington, New Mexico, in 1887 (Oldaker 1991).

FIGURE 1-1
8 ½ by 11 color
PROJECT LOCATION MAP

Even though many of the early well completions were made at shallow depths, most of the discoveries were not considered economic because of the lack of pipeline systems to gather the produced gas. Once gathering systems were constructed and operational (in about 1950), large-scale development of the San Juan Basin began to take place. Like many oil and gas provinces in the United States, the San Juan Basin has experienced cycles of development. These cycles were influenced by many factors but have been controlled primarily by the availability of pipeline gathering systems and natural-gas prices. From 1950 to the present, generally three peaks of development, based on number of new wells, can be identified: 1950s to early 1960s, mid 1970s to early 1980s, and late 1980s to early 1990s. The cause of each peak or boom period is related to the presence of gas-gathering-system infrastructure, the Arab oil embargo, increasing gas prices, and approval of the Unconventional Fuel Tax Credit, respectively.

For most of the San Juan Basin's production history, commercial quantities of oil and gas were produced primarily from three conventional gas reservoirs: Dakota Formation, Mesaverde Group, and Pictured Cliffs Sandstone. Even though many operators recognized the tremendous reserves associated with the coalbeds of the Fruitland Formation, the target of the coalbed methane (CBM) wells, the formation was usually bypassed because of the large amounts of water associated with the coals, making CBM development difficult to justify economically. The passage of the Unconventional Fuel Tax Credit allowed CBM development to become viable economically.

The San Juan Basin has an extensive development history. In total, there are more than 26,000 wells in the entire basin, including portions of Colorado and New Mexico. The Ignacio-Blanco Field, which encompasses the Colorado portion of the basin and is almost entirely within the Reservation, contains more than 2,000 wells, of which 1,888 were actively producing at the end of the 1998 production year (Dwight's Energydata, Inc. 1999). More than 3,000 separate completions have been made in the Ignacio-Blanco Field, with many wells having two or even three formations producing from a single well bore. As of the end of 1998, the Ignacio-Blanco Field had produced cumulatively 3.4 trillion cubic feet (tcf) of natural gas, including 1.7 tcf of gas from CBM production from the Fruitland Formation, and 115 thousand barrels (mbbl) of oil/condensate (Dwight's Energydata, Inc. 1999).

Additionally, the Four Corners Platform west of the San Juan Basin and within the Reservation has an equally long development history. The first field was the Red Mesa Field, west of the Hogback on the Four Corners Platform, which was discovered in 1950. As of the end of the 1995 production year, 166 wells were completed on the Four Corners Platform within the Reservation. The Four Corners fields have produced cumulatively roughly 145 billion cubic feet (bcf) of gas and 2 million barrels (mmbbl) of oil/condensate.

In summary, the oil and gas resources within the Reservation are substantial. About 2,000 wells exist, supported by an extensive network of pipelines and gas-processing facilities. There is more than 1,100 miles of pipeline within the Reservation, as well as numerous compressor stations or central delivery points (CDPs) and gas plants.

1.3 PURPOSE AND NEED

The purpose of activity proposed in this EIS is to economically extract, in an efficient and environmentally compatible manner, the recoverable oil and gas reserves known to exist in mineral estates held in trust by the United States for the benefit of the SUIT. Based on technical reviews, the BLM and the COGCC have determined that up to four wells per section for each producing formation in the Ignacio-Blanco Field are needed to recover the oil and gas resources from these mineral estates.

The BLM's trust responsibility to the SUIT and Indian allottees also supports the need for up to four wells per section for each producing formation in the Ignacio-Blanco Field. If additional development proceeds, the SUIT would benefit not only from accelerated income, but also from a sizeable incremental increase in revenue associated with resources that would otherwise not be recovered in any foreseeable fashion.

The technical evidence that supports the need for up to four wells per section for each producing formation in the Ignacio-Blanco Field is on file with the BLM and the COGCC. The technical evidence is the basis for the numerous Orders which allow up to four wells per section for each producing formation in the Ignacio-Blanco Field. The primary decision documents related to Ignacio-Blanco field development are COGCC Cause No. 112 Order No. 112-157 and BLM Notice of Decision and Order (May 3, 2000), which can be found in Appendix O. The Orders, Rules and Conditions for other Causes related to Ignacio-Blanco Field development are on file at the COGCC, and are also available on the Internet at http://oil-gas.state.co.us/.

The continued development of the oil and gas resource is critical to the economic well-being of the SUIT and is an integral part of the local economies. The future provides options and opportunities for the development of these resources. This final EIS has been prepared to comply with the National Environmental Policy Act (NEPA) of 1969, to evaluate a number of oil and gas exploration and development alternatives on Indian land within the exterior boundaries of the Reservation. Prior leasing decisions will remain unchanged and are not the focus of this EIS.

Management of oil and gas leasing and development is currently guided by the EA prepared by the BIA in 1990 and by several field development EAs prepared by the BLM. The BLM, BIA, and SUIT have determined that additional data and analyses are needed to identify impacts of CBM development and to determine what changes in direction, if any, are needed for the future management of oil and gas resources on the Reservation. The following points contributed to that decision:

- a more in-depth analysis of potential impacts from CBM and enhanced CBM (ECBM) recovery, including cumulative impacts, is possible now that more than a decade of production history is available;

- the recently issued *Decision Order, Well Density Fruitland Coal Seams; Tribal Allotted Minerals: Southern Ute Indian Reservation*, dated May 3, 2000, that allows an additional well per 320-acre spacing unit; and

- the apparent success of a nearby nitrogen recovery pilot project (i.e. the Tiffany Project) increases the probability for wider application of ECBM recovery.

The federal government has a trust responsibility to the Indian people when considering actions and programs that would impact tribal resources and interests. The federal government is committed to supporting and assisting tribes in the development of strong and stable tribal governments that are capable of administering quality programs and developing the economies of their respective communities. This special and unique fiduciary responsibility to assist the SUIT and allottees and to protect their interests in development of projects is very different and distinct from the federal government's role on public land. Because of this special fiduciary relationship, it is important for the federal government to remove obstacles that might hinder a tribe's autonomy or flexibility in the administration of programs.

The purposes of this EIS are as follows:

- foremost, to provide agency decisionmakers, the SUIT and the general public with a comprehensive analysis and understanding of oil and gas resource- development alternatives on the Reservation, including CBM development, and their existing and potential future impacts;

- to identify and evaluate unique impacts of CBM development;

- to identify and evaluate potential impacts of CBM infill development;

- to identify and evaluate potential impacts of ECBM recovery projects;

- to provide a better understanding of the cumulative impacts of increased development on the Reservation;

- to identify and propose mitigation measures that would minimize or prevent significant adverse impacts;

- to provide a programmatic NEPA document from which to tier future site-specific environmental analyses of development proposals; and

- to provide a framework for approval of operations for the next 20 years.

This EIS informs the public and provides the SUIT, BIA, and BLM with information upon which to base a final decision on future site-specific proposals that is fully informed and considers all factors relevant to the proposal. The EIS serves to document the analysis of the impacts of the implementation of the Agency and Tribal Preferred Alternative or alternatives and the development of environmental-protection measures necessary to reduce or eliminate environmental consequences.

The EIS is not a decision document; the decisions regarding the Agency and Tribal Preferred Alternative will be documented in a Record of Decision (ROD). The ROD will identify the alternative(s) (individually or in combination) selected by the SUIT, BIA, and BLM for future oil and gas development and will also identify mitigation and new management practices that will be used in implementing the selected alternative, or a combination of alternatives.

The EIS and ROD will allow the Secretary of the Interior to fulfill the trust responsibility to the SUIT by accomplishing the following:

- providing a management framework for administering future oil and gas development;
- ensuring the long-term sustainability of resources and maintaining other compatible land uses;
- identifying new mitigation measures and/or better uses of existing mitigation measures; and
- facilitating the Tribe's autonomy and flexibility in the administration of programs.

1.4 LAND INVOLVED IN THE ANALYSIS

The land involved in the analysis for this EIS is within the exterior boundaries of the Reservation. The Reservation is in southwestern Colorado, in the southern part of La Plata and Archuleta counties, with a small tract in Montezuma County. The Reservation is a rectangle roughly 75 miles long, east to west, and 15 miles wide, north to south. It encompasses about 685,000 acres or about 1,070 square miles (Figure 1-1). The southern boundary of the Reservation also is the Colorado-New Mexico state line. The 685,000-acre area within the exterior boundaries of the Reservation is a patchwork of Indian and non-Indian land. The area of the Reservation subject to environmental analyses in this EIS, hereinafter referred to as the Study Area, is described in the remainder of this section and is shown on Map 1. The Study Area consists of the western and central areas of the Reservation, which is in the northern portion of the San Juan Basin and the northeastern portion of the Four Corners area. The Study Area encompasses some 421,000 acres of land, including portions of La Plata, Archuleta, and Montezuma counties.

About 316,000 acres is entirely held in trust for the Tribe or its individual members by the federal government. The SUIT owns both the surface and the entire subsurface estate for 310,000 acres. Roughly 7,750 acres of trust minerals and 4,800 acres of trust surface are allotted to individual members of the Tribe (BIA 2000). The remaining acreage within the exterior boundaries of the Reservation is privately owned or administered by other government agencies. There are about 29,000 acres of Indian-owned mineral estate (oil and gas) underlying private or state-owned surface.

Production of CBM by private operators from Tribal Coal Only Lands, where the Tribe owns the coal but not the oil and gas mineral estate, does not require NEPA compliance. In 1999, the Supreme Court determined that CBM belongs to the oil and gas mineral estate and not to the coal estate (Amoco Production Company versus Southern Ute Indian Tribe, 119 S.Ct 1719 [1999]). Development of CBM by private operators on Tribal Coal Only Lands, therefore, will be administered by state authorities, does not require federal action, and is not subject to NEPA compliance. Working interests in CBM production owned by the Tribe, but not held in trust by the federal government, are treated as private interests and are not, in and of themselves, subject to NEPA compliance.

Analysis in this EIS addresses impacts on both the surface and the subsurface mineral estate. Federal administrative decisions related to oil and gas development will be made only for Indian land where BIA and BLM have a trust responsibility, which excludes CBM development in Tribal Coal Only Lands. Impacts of oil and gas development are analyzed for the practical geographical extent of the impact. Decisions for federal land outside the Tribal land, including those impacted by SUIT operations, are subject to NEPA compliance analyses and disclosure by the BLM and U.S. Forest Service (USFS) NEPA documents.

1.5 RELATIONSHIP TO POLICIES, PLANS, AND PROGRAMS

1.5.1 Tribal, BIA, and BLM

The Secretary of the Interior is authorized on behalf of the federal government to administer the leasing of oil and gas resources on Indian land through the 1909 Mineral Leasing Act for Allotted Lands, the Indian Mineral Leasing Act of 1938, and the Indian Mineral Development Act of 1982. Lease issuance and administration are the responsibility of the BIA, which acts as the surface-management agency. Once the lease is issued, The BLM is responsible for permitting (e.g., with the Application for Permit to Drill [APD]) and administering operations. This includes approval of well density, underground activities, well operations, production verification, and compliance. The SUIT is integrally involved in the decision-making processes for leasing and permitting. Final approvals are granted only with Tribal concurrence.

Tribes are viewed under federal law as quasi-sovereign nations, and the federal agencies deal with the tribes on a “nation-to-nation” basis. The federal agencies work with the tribes under a trust or government fiduciary relationship when actions may affect tribal resources. The BLM's decision-making process is significantly different on Indian land from its process on public land. On Indian land, the BLM has the added responsibility of assigning considerable weight to Indian goals and interests, whereas on non-Indian public land, the BLM’s actions are guided by the

Federal Land Policy and Management Act (FLPMA). Conflicts and ambiguities are generally resolved in favor of the Indian tribe's best interests. This is consistent with the federal government's responsibility to protect Indian land and take such action as best serves the interests of Indian constituents.

Given the SUIT's status as a sovereign nation, jurisdictions of state and local governments are limited. The coordinated undertaking of the SUIT, BIA, and BLM in preparing this programmatic EIS associated with future Tribal energy-mineral-resource development requires an understanding of the complex jurisdictional principles, laws, and practices at work on the Reservation. Appendix A presents a detailed discussion of the complex jurisdictional aspects of Tribal development of Reservation land and resources.

Under the BLM's trust relationship to the SUIT, its actions on the Reservation are independent from its actions on the public land outside the reservation. BLM's own resource management plans for the public land consider cumulative impacts on the Reservation, but do not make decisions regarding Tribal resources. To reduce or avoid conflicts among federal, state, local, and Tribal agencies, the planning documents for the adjoining land have been reviewed (see Section 1.6). Where appropriate, that information has been used in developing the Agency and Tribal Preferred Alternative analyzed in this EIS.

The principal planning document guiding mineral-resource development on the Reservation is the *SUIT Natural Resources Management Plan, 1990-2010* (1990). Existing oil and gas development conforms with this plan. Future development alternatives considered in this EIS also conform with the plan.

1.5.2 <u>Other</u>

The planning documents of agencies other than the BIA, BLM, and SUIT have been reviewed and appropriate information has been used in the preparation of this EIS. The agencies whose planning, regulatory, and resource documents were collected, reviewed, and pertinent and relevant information included in this EIS are:

- U.S. Fish and Wildlife Service,
- U.S. Forest Service,
- Environmental Protection Agency, Region 8,
- Bureau of Reclamation,
- Colorado Department of Transportation,
- Colorado Oil and Gas Conservation Commission
- Colorado Department of Local Affairs,
- La Plata County,
- Montezuma County, and
- Archuleta County.

The SUIT, BIA, and BLM are members of the La Plata County Gas and Oil Regulatory Team (GORT). Other members of GORT are La Plata County, COGCC, and revolving oil and gas industry representatives from the Colorado Petroleum Association. The team's purpose is to coordinate the activities of multiple jurisdictions, share information, and facilitate the planning and monitoring of oil and gas activities in the northern San Juan Basin. In addition, this team deals with specific issues arising from oil and gas activities in the area (e.g., concerns over groundwater contamination).

The BIA and BLM coordinate with the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA) of 1973. The USFWS has authorized designated BIA personnel to conduct various activities for scientific research and monitoring. The USFWS also routinely provides updated lists of Endangered and Endangered species to the BIA and SUIT. This EIS considers potential impacts on Threatened, Endangered, and Sensitive species on the basis of the most current listing of species. A programmatic-level Biological Assessment has been prepared for this EIS. Clearance surveys for Endangered species would be conducted as part of the NEPA process for future site-specific actions. If required, biological opinions would be prepared for site-specific actions and would follow the consultation process outlined in Section 7 of the ESA.

The SUIT, BIA, BLM, and COGCC have entered into Memorandums of Understanding (MOUs) to determine clear and consistent procedures and policies regarding the review and evaluation of proposed well spacing, pooling, and field rule requests, and to avoid duplication of effort and define jurisdiction and trust responsibility in matters related to oil and gas spacing and pooling (also see Section 2.8.3.1). It is the SUIT's position that the COGCC lacks the jurisdiction to issue an order or decision affecting Indian land within the boundaries of the Reservation. Pursuant to the MOUs, the BLM has, however, contracted with the COGCC to conduct hearings and review BLM jurisdictional matters affecting Indian land. Pursuant to the procedures in the MOUs, a decision of the COGCC that is not protested by the BLM is deemed to be a decision of the BLM.

The BIA reviews and finally approves leases for Indian minerals that are within the exterior boundaries of the Reservation. If the surface is privately owned, the private landowner is notified when an APD is filed. The landowner is invited to attend the on-site inspection, and the landowner's needs and desires are considered when the decision is made to approve the APD. The needs of the landowner also are considered if and when a plan of development is reviewed, so that field development considers the private surface and resources.

1.6 EXISTING RIGHTS

Oil and gas leases and development agreements are contractual among the federal government (Department of the Interior), Indian mineral owner, and lessee. The lease rights consist of the right to occupy as much of the lease surface as is reasonable for the extraction of the resource and the right to remove the resource (oil and/or gas). When these two rights must be restricted, a stipulation is written and becomes a part of the lease. Decisions that may be made on the basis of information contained in this EIS will not amend valid existing rights. This EIS will not amend these current leases by placing no-surface-occupancy stipulations on leases that do not contain these terms, or by canceling leases.

Standard lease terms allow the BLM's Authorized Officer to require reasonable measures to mitigate adverse impacts of proposed operations. New management practices and techniques can be incorporated in existing lease management terms, as long as they are compatible with the lease rights granted. For example, the Authorized Officer may deny use of the surface for up to 60 days to prevent environmental impacts. When adopted in the ROD, new management practices identified in the Agency and Tribal Preferred Alternative that do not violate existing rights will be used in managing existing leases, in the form of “conditions of approval” when granting permits.

1.7 ENVIRONMENTAL JUSTICE

On February 11, 1994, the President of the United States issued *Executive Order 12898 on Environmental Justice in Minority and Low-Income Populations*. The purpose of the Order is to identify and address, as appropriate, disproportionately high and adverse human health and environmental effects of programs, policies, or activities on minority or low-income populations. In the Study Area for this EIS, minority populations include Native American, Hispanic, and low- income Caucasian populations. Large segments of these populations also compose the low-income groups in this area. The construction and location of project features would not disrupt existing Southern Ute Indian, Hispanic, or other low-income communities. No disproportionate negative impact on Southern Ute Indian, Hispanic, or other low-income communities is expected. The project benefits would accrue to the Southern Ute Indian population in the area. The SUIT has allowed oil and gas operators to come onto the Reservation to develop the mineral resources for the express purpose of improving the economic and social well-being of SUIT members.

1.8 AUTHORIZING ACTIONS

A description of the various authorities and agency responsibilities for oil and gas development actions is in Appendix B.

In addition, existing engineering and environmental information and NEPA documents used for previous oil-and-gas-development approvals were reviewed and evaluated and found to be applicable and pertinent to this EIS. Many decisions related to existing oil-and-gas-development approvals were based on information contained in these documents. These documents (listed below) are incorporated by reference into this EIS:

- *Environmental Assessment for the Proposed Tiffany Enhanced Coalbed Methane Project.* (BLM,1996);

- *Environmental Assessment of Oil and Gas Leasing and Development on Southern Ute Indian Reservation.* (BIA 1990);

- *Environmental Planning Document, San Juan Basin Degas Project.* (Amoco Production Company and Woodward-Clyde Consultants 1988);

- *Environmental Impact Statement: Colorado Oil and Gas Leasing and Development and Resource Management Plan Amendment for the San Juan/San Miguel Planning Areas.* (BLM 1991); and

- *Environmental Impact Statement for the HD Mountain Coal Bed Methane Gas Field Development Project.* (BLM and USFS 1992).

Generally, to lease Tribal oil and gas, a decision must be reached by the BIA and Tribe as to which land to lease and whether stipulations are necessary for the protection of the environment and other resources. Previous leasing decisions will not be altered or changed by this EIS.

This EIS is not the final review upon which approval of all actions in the Study Area would be based. Site-specific environmental analyses and additional NEPA compliance (e.g., an EA or EIS) would be required for all site-specific actions. The scope of this additional approval process would be streamlined and facilitated by the programmatic evaluation of impacts contained in this EIS. These actions would begin when a lessee or operator submits an APD to the BLM.

When applications are received, an on-site inspection is scheduled for agency and Tribal representatives. The private surface owner, if applicable, also would be notified. The lessee/operator would show the group where each facility would be constructed. Appropriate changes or modifications of the application are made as needed. Information would be gathered by the BLM for preparation of a site-specific EA. The EA would be tiered from this EIS. Prior to the APD approval, the BIA would provide concurrence for cultural and paleontological resources, and for Threatened and Endangered species. These clearances are to be performed by approved individuals with the appropriate qualifications. If any potential adverse impacts on Threatened or Endangered species are identified during the EA process, the USFWS would be contacted and appropriate review and consultation would begin, in accordance with the ESA. Construction can begin when the BLM has completed the EA and has received the necessary Tribal and BIA clearances and concurrence, and the APD has been approved.

The same on-site process is used if the lessee submits a request for a right-of-way, and with Sundry Notices that permit surface disturbance. Sundry Notices are used to apply for activities other than the drilling of a well, such as constructing a production facility. Rights-of-way are used to authorize roads, pipelines, and other facilities on Indian land outside the oil-and-gas-lease boundaries and are submitted to the BIA. Applications for geophysical operations are handled in a similar manner.

1.9 EIS Scoping Process and Issues

The scoping process for this EIS began on September 15, 1995, with the publication in the *Federal Register* of a Notice of Intent to prepare an EIS and conduct a public-scoping meeting. A news release announcing the scoping meeting was sent to local papers and news media. The official scoping period began September 26 and ended October 26, 1995. The scoping meeting was held during the 30-day comment period on September 26, 1995, in Ignacio, Colorado. A total of 38 individuals attended; oral comments were recorded on flip charts. Eight comment letters were received during the scoping period. A scoping summary report was prepared that documented the scoping process and summarized the key issues, questions, concerns, and comments received. Table 1-1 summarizes the major issues identified during scoping and identifies where each issue is addressed in this final EIS. Chapter 5 discusses the consultation and coordination conducted for this EIS.

Public involvement continued with release of the draft EIS for public and agency review on January 5, 2001. A 75-day public-review period followed, during which time another public meeting was held in Ignacio, Colorado, on February 27, 2001. The comment period closed on March 21, 2001. One federal agency, one environmental group, and one individual each requested and was granted additional time to submit comments. Twenty-three comment letters were received. They are reprinted in full in Chapter 5, along with responses to the comments and concerns raised in the letters.

TABLE 1-1
Issues From Scoping

Topic/Resource	Issue	Section(s) in DEIS Where Issue is Addressed
EIS Scope	• Scope of EIS should include oil and gas development in the entire San Juan Basin • EIS should evaluate cumulative and synergistic impacts of development • The EIS should be programmatic • Analysis of impacts should be rigorous and forward reaching	• 2.3.2 • 4.13 • 1.11 • 1.11, Chapter 4
Nature and Effects of Enhanced Development	• Environmental consequences of spacing and nitrogen injection—noise, damage to wildlife habitat • Use existing facilities where possible • Effect of nitrogen injection on neighboring wells and aquifers • Increased production and new facility requirements • Concern about construction of new roads • Management of production wastes due to enhanced development	• 2.4.3, 4.3, 4.11, addressed throughout Chapter 4, Appendix E • 2.8.4.1, 2.8.4.2 addressed throughout Chapter 4 • 4.5.1.6 • 2.8, addressed throughout Chapter 4 • 2.8.4.1, addressed throughout Chapter 4, Appendix E • 2.8.4.4, Appendix G
Health and Safety	• Health implications of gas migration and seepage • Identify chemicals and compounds used during drilling and production • Potential effects on public health, safety, and welfare • Pipeline safety, surety bonding • Is there an overall coordinated field fire containment district?	• 3.12.7 • 2.8.4.4, 3.12.4 • 3.12, 4.10, 4.12 • 3.12.6, Appendix E • 4.12
Jurisdiction, Rules, and Regulations	• No oil and gas development on east side of Reservation (Tribal hunting area) • Monitoring schedules for all aspects of development	• 2.3.3

TABLE 1-1
Issues From Scoping

Topic/Resource	Issue	Section(s) in DEIS Where Issue is Addressed
Surface and Groundwater	• Protect water quality • Containment of surface water runoff—adequate lining and protection of seepage from reserve pits • Aquifer/water contamination • Drilling and injection impacts • Consider berming production water tanks and compressor stations • Spill prevention • Methane-contaminated wells • Risk of produced water causing groundwater contamination	• 3.5.2.4, 3.12.5, 4.5.1.3, 4.5.2.3 • 2.8.4.2, 2.8.4.4, 2.8.6, 4.5.1.3, 4.5.2.3, Appendix E • 3.5.2.4, 3.12.5, 4.5.1.3, 4.5.1.7, 4.5.2.3 • 4.5.1.3, 4.5.1.6, 4.5.2.3 • 3.12.5 • 3.12.5, 4.5.1.3, 4.5.2.3, Appendix E • 3.5.1.3, 4.5.1.3, 4.5.1.8, 4.5.2.3 • 3.5.2.4, 4.5.1.3, 4.5.1.7, 4.5.2.3
Surface and Groundwater	• Effects of benzene, toluene, ethylbenzene, xylene (BTEX), and other hydrocarbons on aquifers and human health • Does methane cause an increase in bacteria in groundwater? • Dewatering of Fruitland Formation coal may reduce quality of drinking water • Produced water—effects of deep-well injection	• 3.5.1.3, 3.12.7, 4.5.1.3, 4.5.1.8 • 4.5.1.3 • 4.4.1.3, 4.5.1.3, 4.5.1.7 • 4.4.1.3

TABLE 1-1
Issues From Scoping

Topic/Resource	Issue	Section(s) in DEIS Where Issue is Addressed
Biological Resources	• Identify critical habitat, avoid during development, minimize activities during wildlife calving, fawning, and wintering	• 4.3.1, 4.3.2, 4.3.3, Appendix E
	• Avoid riparian areas and wetlands	• 4.3.1, 4.3.2, Appendix E
	• Loss of habitat due to increase in number of well pads and pipelines	• 4.3.1, 4.3.2, 4.3.3
	• Increase in noxious weeds, cost of weed control, loss of floristic diversity	• 3.3.2.4, 4.3.1, 4.6.1.2, Appendix E
	• Impacts on Threatened and Endangered species, Western willow flycatcher, boreal toad, Mexican spotted owl, Knowlton's miniature cactus	• 3.3.4.2, 4.3.3
	• Impacts on deer and elk wintering and calving ranges, habitat fragmentation, migration pathways	• 4.3.2
	• Habitat loss for burrowing species	• 4.3.2.3
	• Early death rate of piñon pines along pipelines	• 4.3.1, 4.6.1.2
	• Effects of methane contamination on soils	• 4.4.1.3
	• Effects of current revegetation practices that result in loss of native species	
	• Departure of birds of prey due to servicing of facilities	• 3.3.3.5, 4.3.3.3
	• Big-game migration disturbance	• 4.2.2
Socioeconomics	• Impact of increased water truck traffic on quality of life	• 4.10.3.5, 4.10.4.5, 4.10.5.5
	• Cost-benefit of each alternative	• 4.10.3.2, 4.10.3.3, 4.10.4.2, 4.10.4.3, 4.10.5.2, 4.10.5.3
	• Boom/bust economy— effects on population, infrastructure, local economies, police, schools, fire, etc.	• 4.10
	• Economic impacts—real estate, safety, welfare to residents, landowners	• 4.10, 4.12
Transportation	• Road, traffic, and safety impacts of increased truck traffic	• 4.7, Appendix E
	• Impacts of road construction	• 2.8.4.1, addressed throughout Chapter 4
	• Use existing roads when possible, no construction of through roads	• 2.8.4.1, 4.10.3.5

TABLE 1-1
Issues From Scoping

Topic/Resource	Issue	Section(s) in DEIS Where Issue is Addressed
Land Use	• Land-use conflicts	• 4.6, 4.14, 4.15
	• Impacts on adjacent land	• 4.6, 4.13, 4.14, 4.15, Appendix E
	• Disruption and severance of agricultural land	• 4.6
	• Amount of surface disturbance	• 4.6
Air Quality	• Potential for nitrogen injection to increase nitrogen oxide constituents and condensate	• 2.8.5.4
	• Air-quality-related values per state and federal statutes	• 2.7, 3.2.5, 4.2.1, 4.2.6
	• Emissions from wells, pipelines, seeps, leaks, flares	• 3.2.4
	• Loss of resource through flaring	• 2.8.5.1
	• Gas-fired-compressor emissions	• 3.2.4, 3.2.5
	• Prevention of Significant Deterioration priorities (who determines priorities of curtailment or remediation)	• 3.2.5, 4.2.1
	• Air-quality impacts on wilderness areas	• 3.2.5, 4.2.7
	• Address dust control	• 3.2.4, 4.2.8
Soil	• Methane-contaminated soil	• 4.5.1.8
	• Avoid areas with soils with high erosion potential due to slope or texture	• 3.4.3, 4.4.2, Appendix E
	• Drilling fluids, produced water	• 4.4.2, Appendix, E
	• Impacted soil remediation strategy	• 4.4.2.8, Appendix E
	• Soil porosity and pipeline location	• 4.5.2.7
Noise	• Noise from compressors	• 3.11, 4.11
	• Noise pollution	• 3.11, 4.11, Appendix E
Visual/Aesthetics	• Visual impacts on landowners in basin	• 4.9
	• Quality of life/visual impacts	• 4.9, 4.10.3.5

TABLE 1-1
Issues From Scoping

Topic/Resource	Issue	Section(s) in DEIS Where Issue is Addressed
Reclamation	• Define reclamation procedures for construction and closure of gas wells, road, and pipelines • Total-disturbance measurements should take into account ongoing reclamation and revegetation practices • Land recovery issues • Reclamation after well/fieldwork ceases	• 2.8.6, 2.9, addressed throughout Chapter 4, Appendix E • 2.8.6, addressed throughout Chapter 4 • 2.8.6, 2.9, addressed throughout chapter 4, Appendix E • 2.8.6, 2.9, addressed throughout Chapter 4, Appendix G
Maintenance	• Address noxious-weed control for life of wells and after reclamation • Coordinate maintenance with local landowners • Well-pad maintenance • Corrosion control—cathodic protection • Identify agency responsible for each type of monitoring • How will monitoring requirements protect the environment?	• 4.3.1.3, 4.3.1.4, 4.3.1.5, 4.3.1.6, 4.6.1.2, Appendix E • Appendix E • 2.8.5.5, Appendix E • Appendix E • 2.8.6, 2.9, addressed throughout Chapter 4, Appendix G
Safety	• Pipeline safety—surety bonding • Is there an overall coordinated field-fire-containment district?	• 3.12.6 • 4.12

CHAPTER 2—ALTERNATIVES

2.1 INTRODUCTION

Seven alternatives were identified to address the development of oil and gas resources on the Reservation. We analyzed three of the alternatives in detail: the Agency and Tribal Preferred Alternative, a widespread coalbed methane infill development, and no action. The other four alternatives were considered but eliminated from detailed consideration; their descriptions are in Section 2.3.

2.2 POTENTIAL FOR DEVELOPMENT: "REASONABLE , FORESEEABLE DEVELOPMENT" SCENARIO

To estimate potential environmental impacts, the BLM provides guidance (BLM H-1624-1) for estimating the potential for oil and gas resources and for projecting the extent of development that is "reasonably foreseeable" over a certain period of time. In this case, the development of coalbed methane (CBM) is most likely to occur on the Reservation over the next 20 years.

The following sections contain explanations of (1) the potential for oil and gas resources within the Reservation boundaries and (2) reasonable, foreseeable development and the three different alternatives that are addressed in this EIS.

Potential for Oil and Gas Resources

An estimate of oil and gas resources is accomplished using many sources of information, including established files and databases, professional and academic literature, oil and gas maps, well- location cards, well-completion reports, production reports, and previous mineral assessments. Together they paint a picture of resource conditions and potentials to which we will refer throughout this EIS.

The Reservation is almost completely within the San Juan Basin petroleum province (Figure 2-1). The entire Reservation can be described as prospectively valuable for oil and gas. "Prospectively valuable" is a Federal classification for land meeting certain criteria, depending on the minerals involved. For oil and gas, and in the case of the Reservation, the land is underlain by sedimentary rocks within a favorable geologic and structural setting, is of sufficient thickness to contain economic volumes of hydrocarbons, and shows evidence of oil and gas potential (e.g., seeps, well tests, production).

FIGURE 2-1
STRUCTURAL ELEMENTS OF THE SAN JUAN STRUCTURAL BASIN AND ADJACENT AREA
8 ½ x 11 B&W

The potential for oil and gas resources on the Reservation is shown in Figure 2-2. Most of the Reservation is considered to have high potential for oil and gas resources. Areas of high potential are characterized by the demonstrated existence of hydrocarbon source rock, appropriate thermal-maturation regimes, reservoir strata possessing permeability and/or porosity, and traps to facilitate accumulation of hydrocarbons.

In addition, the U.S. Geological Survey (USGS) has defined several “plays” in the San Juan Basin, six of which are on the Reservation. A “play” is a target or zone that the USGS considers to have high potential for oil and gas resources. These plays fall within the area of high potential shown in Figure 2-2. A detailed discussion of each play can be found in Huffman (1988). Map 11 in the Map Volume of this EIS shows well development that has occurred within the Reservation to date. Map 11 shows that most of the exploration and development have occurred in the areas of high potential. We expect the bulk of future activity to occur in or near areas of high potential that have been explored or developed previously.

“Reasonable, Foreseeable Development” Scenario

Projections of future oil and gas development and production are difficult to make. Several variables complicate such projections, including increases or decreases in demand for oil and gas; price increases or decreases; and new exploration, development, or production techniques that may prompt larger development and production programs. For this EIS, a combination of historical trends, present activity, government and industry estimates, and professional judgements was used to estimate reasonable, foreseeable development.

For the estimate of reasonable, foreseeable development, we assumed that all development would occur evenly over the ensuing 20-year period. Because of the many different entities operating on the Reservation and the great differences in production characteristics of wells, many different strategies may be pursued in future development of CBM leases. Some operators may elect to accelerate development if they have tax-credit-qualified well bores available for recompletion as infill wells. Other operators may have equally compelling reasons to infill slowly (e.g., capital constraints). External forces, such as rig availability or gas-price changes, could also affect development timing. In short, the exact pattern of future development is impossible to predict, so a flat development profile was selected as the most reasonable model for reasonable, foreseeable development.

Throughout this environmental impact statement (EIS), we make a distinction between (1) tribal acreage, where the title both to conventional oil and gas and to CBM clearly rests with the Federal government for the benefit of the Southern Ute Indian Tribe (SUIT) or its individual members, and (2) nontribal acreage, where title to the oil and gas resources and reserves, including CBM resources and reserves, belongs to nontribal entities, primarily private citizens. Section 1.4 of this EIS contains a description and further explanation of this issue.

FIGURE 2-2
POTENTIAL FOR OIL AND GAS RESOURCES ON THE RESERVATION
8 ½ x 11 B&W

Development on tribal land is addressed in this EIS in three strategies, each of which involves different components of development: (1) continuation of the current or standard development, which would encompass both conventional and CBM development, including a component of CBM infill; (2) increased CBM production via widespread development of infill wells, in addition to the current development; and (3) development of enhanced coalbed methane (ECBM) projects, in addition to the widespread development of infill wells and current development. The anticipated numbers of wells for the three alternatives are summarized in Table 2-1 and explained below. Development on nontribal land within the Study Area [refer to pg. 2-12] is estimated for each alternative and used in assessing cumulative impacts.

TABLE 2-1
Projected Number of Wells by Alternative

	Alternative 1: Continuation of Present Management (No Action)			**Alternative 2: CBM Infill Development**			**Alternative 3: ECBM Recovery (Proposed Action)**			
	Conv	**CBM**	**Total**	**Conv**	**CBM**	**Total**	**Conv**	**CBM**	**Inj**	**Total**
Tribal Minerals	269	81	350	269	367	636	269	367	70	706
*Nontribal Minerals**	NA	70	70	NA	519	519	NA	519	67	586

Conv = Conventional
CBM = Coalbed Methane
Inj = Injection
NA = Not Applicable

* The state generally has jurisdiction over oil and gas exploration and development on nontribal land. The described development may take place regardless of the status of this EIS.

Current or Standard Development

"Current or standard development" includes conventional oil and gas production from formations including the Dakota, Mesa Verde, and Pictured Cliffs, and production of CBM from the Fruitland Formation, based on density orders in place as of January 1, 2000. The BLM spacing order issued May 3, 2000, for Indian mineral estate and COGCC spacing order issued July 11, 2000, for private mineral estate within the exterior boundaries of the Reservation allows for an additional CBM well per 320-acre spacing unit. The spacing orders do not permit drilling of the additional available drilling windows. Such decisions are accomplished through NEPA decision making at both this programmatic level and at the APD evaluation stage.

Development activity peaked in 1990, when more than 200 wells were permitted within the exterior boundaries of the Reservation, spurred by tax incentives offered for development of unconventional reservoirs, such as CBM. The window for drilling tax-credit-qualified wells closed in 1992. Activity on the Reservation between 1993 and 1998 averaged 20 newly developed wells per year on tribal land; since 1998, activity has averaged 50 new wells per year. Based on this trend, the RFD for standard development on the tribal land is projected to be some 350 wells over the next 20 years. For the RFD, only 81 of these are projected to be CBM wells; the balance would be conventional wells. On the nontribal acreage, 70 CBM wells are expected. On both tribal and nontribal acreage, many of the CBM wells that are developed could be infill wells.

Increased Coalbed Methane Development (Infill)

This component addresses the possibility of widespread infill development, essentially increasing CBM well density from one well per 320-acre spacing unit to two wells per 320-acre spacing unit over most of the Study Area. This widespread development of infill wells would be in addition to the current or standard development. Infill development would include recompletions of existing wells, drilling from existing pads, and drilling from newly constructed sites. Only about 50 percent of the infill wells are anticipated to be developed on newly constructed sites.

Known resource conditions, such as coal permeability and desorption rates that cause variations in production rates across the field and water-disposal issues, suggest that infill development is unlikely to be strategic for every 320-acre CBM spacing unit on the Reservation. For this RFD analysis, we projected that up to 367 CBM wells, including 286 infill wells, would be developed on tribal land. On the nontribal acreage, assuming the same level of development as for the tribal land, we projected that 326 CBM wells, including 264 infill wells, would be developed.

Enhanced Coalbed Methane Development Projects

We asked Industry to provide, for this EIS, projections of potential ECBM projects under best-case assumptions, such as successful results from pilot projects and a strong economic climate. Currently, nitrogen injection has been pilot tested and implemented on a small scale in BP/Amoco's Tiffany project. Other operators have indicated that they are analyzing or plan to analyze the effectiveness and economics of nitrogen injection on their acreage. Operators are also considering carbon dioxide injection, although no specific project using carbon dioxide has been proposed.

Nitrogen injection was first pilot tested on a five-spot pattern (four injection wells surrounding a producing well). Following successful pilot testing, the Tiffany project was implemented, to test nitrogen-injection feasibility on a somewhat larger scale and to investigate other injection-well / producing-well ratios. In this isolated project, there are 13 injectors and 35 producing wells, a ratio that is probably not characteristic of future, larger injection projects. Based on the judgment of the production company's engineers, an injection pattern was established for this analysis as one injector well and two production wells (three wells total).

ECBM development would occur concurrently with the standard and widespread-infill development. Consequently, we assumed for this analysis that all necessary production wells are in place and that only injection wells would be required. To date, about 50 percent of the well bores used or designed for ECBM projects have used recompletion of existing well bores, rather than drilling new injection wells. Thus, for the RFD, it is projected that approximately 50 percent of the injector wells needed would involve recompletion of existing well bores or drilling new well bores from existing pads.

Pilot test projects would not be considered separately, because they take advantage of existing wells to the maximum extent possible, and their impacts are substantially the same. As with infill development, ECBM projects are not likely to be implemented on all the available acreage, for a variety of strategic reasons. Using the above assumptions, 137 injection patterns would be expected within the exterior boundaries of the Reservation, requiring development of 137 injection wells under the RFD. ECBM development is likely to be more applicable on the tribal acreage than on the nontribal acreage, due to reservoir conditions, proximity to common gathering systems and plants, and ease of unitization. This is reflected in the distribution of injection wells to tribal (70) and nontribal (67) acreage, as shown in Table 2-1.

2.3 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

Four alternatives that we considered but did not analyze in detail were (1) placing a moratorium on development, (2) conducting a basinwide EIS, (3) developing the eastern portion of the Reservation, and (4) implementing an 80-acre well density for the Fruitland Formation. These four alternatives are described below.

2.3.1 Moratorium on Development

We dropped from detailed consideration an alternative that would not allow additional drilling or development on the Reservation, for two principal reasons. First, the SUIT intends to develop its mineral resources for the economic benefit of the tribal members in an environmentally sound manner (BIA 1990). Second, most of the tribal land in the Study Area is already leased for oil and gas exploration and development. Leases represent a contractual agreement between the lessor and the lessee (operator). The lessee has the contractual right to explore, develop, and produce oil and gas within the provisions of the lease terms. The Secretary of the Interior and the Tribe cannot arbitrarily and capriciously deny use of the lease rights.

In addition, the Secretary bears a strong trust responsibility to the Tribe, and such a moratorium would have a crippling effect on the Tribe's economy. Therefore, an alternative dealing with a moratorium on development was eliminated from further study.

2.3.2 Basinwide EIS

An alternative to develop an EIS for the entire San Juan Basin was considered and then eliminated. A basinwide EIS would not provide tribal leaders and the trust agencies with the specific, focused analysis needed to understand oil and gas development options within the SUIT Study Area. NEPA requires analysis and presentation of impacts in such a manner that the decision makers can make informed and environmentally sound decisions. We believe this requirement is best satisfied for oil and gas development on the Reservation, where the BIA and BLM have trust responsibility, by focusing this EIS on the specific actions and needs of the SUIT, while analyzing cumulative impacts within regions appropriate to each resource. A basinwide EIS would be so general by necessity that it would lose the necessary focus on development of resources within the Reservation that is sought in this document.

The portions of the San Juan Basin outside the Reservation are already covered by EISs. The Colorado portion of the basin north of the Reservation is covered by a 1991 EIS by the BLM (BLM 1991). The New Mexico portion of the basin is also covered by a 1991 EIS written by the BLM. The BLM and Forest Service recently published a Notice of Intent in the Federal Register (April 4, 2000) to prepare a new EIS for oil and gas development in Colorado north of the Reservation. Similarly, the Farmington, New Mexico, Field Office of the BLM is preparing a resource management plan (RMP) revision that, as part of a comprehensive, interdisciplinary analysis, will address future oil and gas development in the New Mexico portion of the San Juan Basin. Both of these EISs will contain comprehensive cumulative-impact and mitigation analyses.

2.3.3 Development of the Eastern Portion of the Reservation

We identified an alternative addressing leasing, exploration, and development of the eastern portion of the Reservation. The Tribe has no current plans for development on the eastern portion of the Reservation (refer to Figure 1-1); therefore, this alternative was not carried forward for further analysis.

2.3.4 Eighty-Acre Well Density for the Fruitland Formation

An alternative was identified that addresses the possibility of infilling Fruitland Formation production to four wells per 320-acre spacing unit. This alternative would result in an effective

CBM well density of one well per 80 acres. This well density was considered, but production and reservoir characteristics, as they are currently understood, indicate it is not optimum spacing for the prevention of waste and maximization of ultimate recovery. The alternative was eliminated from further detailed consideration because it is not practical or expected.

2.4 ALTERNATIVES ANALYZED IN DETAIL

The three alternatives we analyzed in detail in this EIS are (1) continuation of present management (no action), (2) CBM infill development, and (3) ECBM recovery (the Agency and Tribal Preferred Alternative). These three alternatives are described below.

2.4.1 Alternative 1: Continuation of Present Management (No Action)

A no-action alternative must be analyzed in an EIS, in accordance with NEPA regulations (40 CFR 1502.14 (d)). Alternative 1 is the no-action alternative and represents the continuation of present management. Throughout this EIS, exploration and development under Alternative 1 are referred to as “standard development.” Under this alternative, permits would be authorized within the scope of the BIA 1990 EA for the 20-year analysis period. Standard development represents continued drilling and development at current spacing, including some infill development as operators test reservoir characteristics. The alternative is analyzed to determine what, if any, changes are needed in the present management decisions, and to predict the impacts that would occur over the next 20 years in oil and gas development if there were no changes in current management. This alternative also provides a baseline for determining the incremental impacts of Alternatives 2 and 3, which both represent a departure from current management direction.

Alternative 1 involves drilling of 350 wells on tribal minerals: 269 conventional wells and 81 CBM wells. The potential CBM development outside tribal or Federal jurisdiction in the Study Area could add another 70 wells. Development of CBM on nontribal leases is likely to be pursued, in some places, in conjunction with development of CBM on tribal leases. Development of conventional wells on nontribal leases was considered outside the scope of this EIS. Development of both conventional and CBM wells on nontribal leases generally is within the jurisdiction of the COGCC (except where the operations are conducted by the Tribe), not Federal agencies, and would not require NEPA compliance.

2.4.2 Alternative 2: Coalbed Methane Infill Development

The viability and merits of allowing additional infill wells to produce from the Fruitland Formation coals have been the focus of engineering studies, COGCC hearings, and BLM decision making. Infill allows an increase in the number of wells per section. Spacing for the Fruitland Formation had been one well per 320 acres (or two wells per 640-acre section), except in units where a second well or infill well had been approved by the BLM before January 1, 2000. The BLM spacing order issued May 3, 2000, for Indian mineral estate and the COGCC spacing order issued July 11, 2000, for private mineral estate within the exterior boundaries of the Reservation now allow for an additional CBM well per 320-acre spacing unit over much of the Study Area. The spacing order does not include the “fairway,” which is in the southwest portion of the Study Area (Map 12). For procedural clarification, the spacing orders do not permit development of the additional available drilling windows. Such permitting decisions are programmatically addressed in this EIS, and decisions to permit drilling a specific location are accomplished through NEPA decision making at the APD evaluation stage. Therefore, Alternative 2 provides the mechanism for analysis of the relative merits of proceeding with widespread infill development.

This alternative addresses the infill of the Fruitland Formation to two wells per 320 acres (or four wells per section) throughout most of the Study Area. The increase in wells would allow accelerated production of the resource, increase recoveries of the gas in place, and increase economic return to the lessor/royalty owner. The standard development described in Alternative 1 (81 CBM wells and 269 conventional wells) is included in Alternative 2. This alternative does not address new ECBM recovery projects.

Alternative 2 involves drilling or recompleting 636 wells: 269 conventional wells and 367 CBM wells on tribal minerals. The potential CBM development activity on nontribal leases could add another 519 CBM wells. Development of CBM on nontribal leases is likely to be pursued simultaneously, in some places, with development of CBM on tribal leases. Development of conventional wells on nontribal leases was considered outside the scope of this EIS. Development of both conventional and CBM wells on nontribal leases is within the jurisdiction of the COGCC, not Federal agencies, and would not require NEPA compliance.

2.4.3 Alternative 3: Enhanced Coalbed Methane Recovery

Alternative 3 is the Agency and Tribal Preferred Alternative. This alternative includes all the developments of Alternative 2 with the addition of ECBM recovery through injection of nitrogen, carbon dioxide, or other fluids into the Fruitland Formation. ECBM is projected to be strategic for almost half the CBM leases within the exterior boundaries of the Reservation, resulting in 137 injection wells drilled or recompleted (one injection well per every two producing wells, in the ECBM areas). Some of the injection wells may be directionally drilled off existing pads to minimize impacts and costs. Additional production wells would not be required. Both injection and production wells are considered in the analysis of potential impacts.

Alternative 3 specifically considers the impacts of drilling or recompleting 70 injector wells and 636 production wells (269 conventional wells and 367 CBM wells) on tribal minerals. The potential CBM development activity on nontribal leases could add another 519 CBM wells and 67 injector wells. Development of CBM on nontribal leases is likely to be pursued simultaneously, in some places, with development of CBM on tribal land. Development of conventional wells on nontribal leases was considered outside the scope of this EIS. Development of both conventional and CBM wells on nontribal leases is within the jursidiction of the COGCC, not Federal agencies, and would not require NEPA compliance.

In general, the potential impacts from wells on the nontribal leases are assumed to be the same as those from wells on tribal leases. Only quantification of potential impacts will vary, due to the exact placement of individual wells.

Alternative 3 is the Preferred Alternative because the continued development of the oil and gas resource is critical to the economic well-being of the SUIT and is an integral part of the local economies. Alternative 3 best meets the trust responsibilities of the Federal government to protect Indian land and to take actions that serve the best interests of Indian tribes. The Bureau of Indian Affairs (BIA) and Bureau of Land Management (BLM), as agents for the Secretary of the Interior, are responsible for administering the leasing and development of oil and gas resources where the mineral estate is held in trust by the Federal government for the benefit of the Indian people. This is referred to as the “Indian mineral estate.” The Southern Ute Indian Tribe’s (SUIT’s) mineral estate is important to the Southern Ute Indian people. Development of the oil and gas resource historically has been the major source of income to the SUIT and is an integral part of the local economy. Although the rate of development has declined in recent years, oil and gas development will continue to be an important economic factor affecting the SUIT and local communities. The SUIT, through the auspices of the Indian Self Determination Act of 1968 and Indian Mineral Development Act of 1982, has taken an increasingly active leadership role in the management of its mineral resources.

2.5 FRAMEWORK FOR ALTERNATIVES ANALYSIS

2.5.1 Study Area Delineation

The overall Study Area for the EIS encompasses the western and central regions of the Reservation (refer to Figure 1-1 in Chapter 1). The boundaries of the overall Study Area are based on the existing oil and gas production, and on the fact that the Tribe has no current development plans on the eastern portion of the Reservation.

The Reservation is a patchwork of tribal and nontribal land and contains areas of private surface land and private (nontribal) oil and gas mineral ownership, resulting from homesteading from 1899 to 1938. The overall Study Area contains about 421,000 acres: 195,000 acres of tribal land;

5,000 acres of allotted land (i.e., owned by individual tribal members and heirs); 180,000 acres of Tribal Coal Only land; and 41,000 acres of nontribal land. This EIS addresses the potential development on jurisdictional land (tribal and allotted mineral ownership) within the Study Area. This EIS also addresses potential cumulative impacts from CBM wells on the nontribal leases. Oil and conventional gas development of nontribal leases within the Study Area is not addressed in this EIS.

2.5.2 Conventional and CBM Well Areas

We identified two sub-areas within the overall Study Area for this EIS: the Conventional Well Area and the CBM Well Area. The two areas were delineated based on the different distribution of conventional gas wells, compared with CBM wells. Conventional gas well development can occur throughout the western and central regions of the Reservation; in contrast, CBM well development can occur only east of the Hogback, because the Fruitland Formation does not occur west of the Hogback.

Conventional Well Area

The most commonly targeted conventional reservoirs in the Study Area are sandstones in the Pictured Cliffs, Mesaverde, Dakota, and Gallup formations. Since conventional oil and gas resources have been found throughout the overall Study Area, the Conventional Well Area shares the boundaries of the overall Study Area on jurisdictional (tribal and allotted) land. The Conventional Well Area encompasses 200,000 acres. For analysis purposes in this EIS, potential conventional well development was considered to occur equally throughout the Conventional Well Area, although it is likely that actual development sites would be concentrated in areas with higher production potential and would be controlled by the spacing limitations of the targeted formation and field.

CBM Well Area

The CBM Well Area is restricted to the area of occurrence of the Fruitland Formation, which is defined as east of the Hogback within the San Juan Basin. Therefore, CBM well development was not assessed west of the Hogback. The CBM Well Area can be subdivided into smaller regions, based on production and potential special-mitigation areas. The “fairway” is designated as an area where well production is high and permeability of the coal is high. The fairway probably already contains a sufficient number of CBM wells to drain the associated CBM spacing units efficiently, so infill is not expected to be economic there.

The area that corresponds to the Hogback and the first 1.5 miles downdip of the Fruitland outcrop is designated as the “near outcrop zone.” Due to the presence of natural gas seeps in the soil of the Fruitland outcrop, development of CBM wells in the near outcrop zone recently has been confined to those for mitigation and monitoring only (BLM Interim Guidelines issued August 12, 2000). Any portion of the CBM Well Area that is not within the fairway or the near outcrop zone is considered part of the “main” area. For this EIS, CBM well development was considered to occur in all three areas, but with a much lower rate of infill development in the fairway. The overall Study Area and the main, near outcrop zone, and fairway regions are shown on Maps 3 and 4 in the Map Volume.

2.5.3 Methodology for Impact Analysis

The inherent difficulty of a programmatic EIS is the need to describe potential project impacts before the exact locations of project sites are known. To be able consistently to evaluate surface resource impacts, as opposed to subsurface geology or hydrology, an impact assessment methodology was developed for the conventional wells and CBM wells.

The methodology is built around a concept of “development windows.” Each CBM spacing unit is defined as one of two types: (1) units or windows currently containing CBM wells and therefore unavailable for future CBM wells, or (2) windows containing no CBM wells and therefore available for development of such wells in the future. The available and unavailable units form a geographic information system (GIS) database that we used through GIS (ArcInfo) to derive information on the likelihood of future CBM well placement.

We also used the GIS to derive information about the presence of a particular resource and the extent of potential surface impacts on that resource. Analysis of impacts for surface resources was obtained by counting the number of development windows that contained a given resource, then multiplying the number of development windows by a construction disturbance factor consisting of 3.06 acres for development windows receiving new wells (2 acres for the new well pad and 1.06 acres for access road and pipeline right-of-way) and 1 acre for development windows containing an existing well pad that would need to be enlarged slightly to accommodate an additional well. GIS analysis obtained the number of existing wells within each resource area. Impacts of surface disturbance were calculated and presented in two ways: (1) impacts of all new well locations and rights-of-way used, and (2) impacts if available existing pads are used.

We assumed that some revegetation and reclamation of disturbed sites would occur immediately following construction, reducing the total maximum acres disturbed. Therefore, the production disturbance factor was 2.06 acres for new well pad sites, and 1 acre for sites with existing well pads. The disturbance area remaining after revegetation is the same for conventional, CBM, and enhanced-recovery injection wells. Disturbances for new facilities, such as new compressors and treatment facilities, were not considered because it was assumed that all new construction or additions to existing facilities would occur within existing disturbed areas.

Under Alternative 1, the present 320-acre well spacing was used as the development window for evaluation of impacts, even though it is predicted that some of the 81 CBM wells developed under this alternative would be infill wells. Map 3 presents the available 320-acre development windows. (Between August 1996 and August 1999, ten additional 320-acre CBM development windows were developed.

In Alternatives 2 and 3, a 160-acre development window was established. Map 4 presents the distribution of 160-acre development windows. (Between August 1996 and August 1999 more than 25 CBM infill development windows were developed.

Approximately 44 CBM wells have been developed in the Study Area between August 1999 and October, 2001. Specific locations of all wells developed to date in the Study Area and associated development windows are available on the Internet at http://oil-gas.state.co.us/.

We have presented a more detailed discussion of the impact-assessment methodology, development- window concept, determination of the number of wells, and assumptions and calculation of potential surface disturbance on a particular resource in Appendix D.

2.6 FUTURE-PRODUCTION PROFILES

Cawley, Gillespie, and Associates have developed a composite historical and estimated-future gas-production profile of the Ignacio Blanco (Fruitland Coal) Field (February 23, 1997, modified July 8, 1997). The modeled area includes essentially all of the currently developed areas of the field, the only exceptions being small areas in T34N, R6W and T34N, R5W. Future gas volumes were estimated for three scenarios: standard or status quo development (base case), infill drilling, and enhanced recovery via nitrogen injection. These gas volumes were then allocated between tribal and nontribal acreage, based on tribal mineral (oil and gas) ownership. These production profiles do not include conventional wells or new CBM wells on existing, undeveloped 320-acre spacing units because the production profiles for those two components would be identical in all three alternatives. Therefore, these production profiles model the incremental CBM gas development that would be possible through infill and ECBM development, as described in Alternatives 2 and 3.

The base case assumes continued production under current conditions for the almost 700 existing wells operated by nontribal companies. For 54 wells operated by Red Willow Production Company, which is wholly owned by the Tribe, the base case also includes gas volumes associated with planned remedial work and compression projects. (Note: Red Willow has acquired additional interests on the Reservation since the model was built, but that does not significantly affect the model.) Cumulative gas production from all existing wells was approximately 850 billion cubic feet (bcf) at the time the model was built. The ultimate base-case gas recovery is estimated to be in excess of 3,100 bcf, or 3.1 trillion cubic feet (tcf).

The infill case assumes 20 percent of the available locations in the highly productive “fairway” of the Ignacio Blanco Field would be developed, along with 80 percent of the existing locations outside the fairway. Infill well development, which could include drilling new well bores and recompletion of existing qualified well bores, was modeled to commence in 1998 and continue for 20 years at a flat rate of 25 wells per year. The incremental infill recovery resulting from the drilling of a second well on each of the above 320-acre spacing units was estimated. The incremental recovery is a function of the estimated permeability for each spacing unit and is estimated to be 570 bcf.

The enhanced-recovery case assumes incremental gas recovery through the widespread injection of nitrogen or other fluids. Although the application of enhanced-recovery concepts to CBM reservoirs is relatively new, nitrogen injection has been successfully pilot tested and a large-scale project is currently underway on the eastern side of the Study Area. The enhanced-recovery case assumes an estimated additional 25 percent recovery of the gas-in-place for each well, up to a maximum overall recovery factor of 90 percent. Based on production lease patterns and well performance histories, it was estimated that up to 274 producing wells and 137 injection wells reasonably would be included in enhanced-recovery projects on both tribal and nontribal acreage in the Study Area. Some of the injection wells may be directionally drilled from existing pads, to minimize impacts and costs. A cumulative incremental recovery of approximately 870 bcf was calculated. No enhanced recovery was assumed for wells within the fairway, due to the lack of significant incremental reserves after the base and infill cases. Figure 2-3 presents a production estimate curve over an approximate 50-year time horizon, which shows the base-case, infill, and enhanced-recovery scenarios for all acreage in the Ignacio Blanco Field.

The allocation of the historical and estimated future gas volumes between tribal and nontribal oil and gas mineral acreage was performed through a review of tribal mineral ownership by lease. For those leases with at least 50 percent tribal oil and gas ownership, the production from the associated wells was allocated to the tribal total. The remaining production was included in the nontribal summary. Figure 2-4 presents a production estimate curve for tribal acreage, and Figure 2-5 for nontribal acreage only. Although 70 percent of the base-case gas recovery is associated with tribal wells, the estimated infill and enhanced gas recoveries are split more evenly: 43 percent from the nontribal acreage and 57 percent from the tribal acreage.

FIGURE 2-3 IGNACIO BLANCO FIELD
ALL ACREAGE

8 ½ X 11 Black & White

INSERT FIGURE 2-4
IGNACIO BLANCO FIELD
TRIBAL ACREAGE

8 ½ X 11 Black & White

INSERT FIGURE 2-5
IGNACIO BLANCO FIELD
NONTRIBAL ACREAGE
8 ½ X 11 Black & White

2.7 COMPARISON OF ALTERNATIVES

Table 2-2 presents a comparative analysis of the potential impacts of the Agency and Tribal Preferred Alternative (Alternative 3), the no-action alternative (Alternative 1), and coalbed methane infill development (Alternative 2). The Table summarizes the following:

- general project description,
- issues associated with each of the resources analyzed, and
- direct and indirect impacts on resources.

Due to the programmatic nature of this EIS, a broad range of potential issues and impacts have been analyzed in the context of the development windows described in Section 2.5.3. The percent of areas affected shown in Table 2-2 represents the area of each individual resource in the Study Area for each alternative (i.e., Gambel oak [0.95 percent for Alternative 1]). The comparison focuses on the most likely impacts that would result from each alternative. The values for the acres of disturbance presented in the table represent the use of existing well pads, where available. In addition, these acres of disturbance represent 100 percent of the potential development area, when in actuality only 80 percent of the development windows are planned for development. There are no assumptions as to which of the development windows would be used in the assessment. For that reason, the values represented in Table 2-2 are overstated by about 20 percent. Table 2-2 is based on the information, analysis, mitigation and environmental protection measures presented in Chapter 3, Chapter 4, and Appendices A through N.

Table 2-2
Comparison of Impacts by Alternative
8 ½ x 11
(19 pages)

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Summary of Resource Comparisons

Air Quality - We do not expect significant air quality impacts with the development of any of the three alternatives.

Vegetation and Wetlands - Significant vegetation and wetlands impacts could result from any of the three alternatives, due to the potential infestations of noxious weeds. Appropriate revegetation techniques and weed control measures should minimize the spread of weeds. Alternative 3 would result in slightly greater losses of Gambel oak, low-density piñon-juniper, and ponderosa pine forest than Alternative 2. Alternative 2 would cause about 70 percent greater loss of Gambel oak, 80 percent greater loss of low-density piñon-juniper, and 73 percent greater loss of ponderosa pine forest than Alternative 1.

Wildlife and Fisheries - Significant wildlife and fisheries impacts could result from Alternatives 2 or 3, due to noise/activity disturbances near elk severe-winter ranges and winter-concentration areas. We anticipate no significant impacts on wildlife and fisheries from Alternative 1. Alternative 3 would cause slightly greater losses of elk summer range and elk winter-concentration areas than Alternative 2. Alternative 2 would result in about 64 percent greater loss of elk summer range and 73 percent greater loss of elk winter range than Alternative 1.

Threatened, Endangered, and Sensitive (TES) Species - No significant impacts are anticipated from any of the three alternatives. Because of the larger number of wells to be constructed under Alternative 2 or 3, however, the likelihood of disturbing bald eagle winter habitat and winter-concentration areas, wooded riparian vegetation, and aquatic species would increase with implementation of either of these alternatives. When proposed, specific projects would be analyzed under any of the three alternatives to ensure protection of TES species, in compliance with Federal, state, and tribal regulations and guidelines.

Geology and Minerals - The production of oil and gas resources is an irretrievable commitment of those resources, but is, in fact, the goal of the project. We expect no significant negative impacts on geology and mineral resources as a result of any of the three alternatives. Nor would the alternatives affect the recovery of other resources in other formations. The development of Alternative 2 would result in 75 percent more disturbance of prime farmland than Alternative 1. Alternative 3 would disturb 2 percent more prime farmland than Alternative 2. Alternative 2 would result in 74 percent more disturbance of soils with high-to-severe erosion potential than Alternative 1. Alternative 3 would disturb 2 percent more soils with high-to-severe erosion potential than Alternative 2.

Groundwater - Groundwater quality should not be impacted, given current water protection measures, but any of the three alternatives could have localized impacts. Due to the larger number of wells to be drilled for Alternatives 2 and 3, the effects would be greater than Alternative 1, but are difficult to quantify because they would occur only in an unexpected situation. Impacts from withdrawal of groundwater from the Fruitland and from reinjection of produced water into deeper zones under underground injection control (UIC) permits are not expected to be significant.

Surface Water - No significant impacts on surface water resources are anticipated to result from any of the three alternatives, with implementation of the erosion control measures described in Chapter 4. Because of the amount of surface disturbance from well pad and road construction, however, Alternatives 2 and 3 are more likely than Alternative 1 to cause surface erosion requiring mitigation.

Land Use and Ownership - Localized impacts on land use and ownership could occur, particularly on nontribal land next to development of oil and gas resources on tribal land, even when steps are taken to consider land use and value issues when siting wells under any of the three alternatives. Residential use, recreational use, and land value are sensitive to the noise, visual impact, and traffic attributable to oil and gas development activities. Farming and ranching activities are primarily affected by actual loss of surface. Due to the larger number of wells to be constructed under Alternative 2 or 3, the likelihood of directly disturbing "split-estate" situations, prime farmland, grazing areas, and recreational areas and indirectly disturbing residences would increase with the development of either of these alternatives.

Traffic and Transportation - Transportation impacts under any of the three alternatives should be less than experienced in the 1990s during the initial gas field development. Traffic caused by new development under any of the three alternatives should not degrade road capacity beyond that which is expected, due to non-industry growth in the area alone. The miles driven by lease operators, which are the biggest component of total oil and gas industry mileage, would not increase dramatically, since lease operators would be able to service more wells in a small area when wells are more densely spaced. It is also possible that the number of trips per well, per year, would decline, as the wells quit producing water and pump maintenance issues decline or as automation becomes more widely used for well monitoring and control.

Cultural - Because current tribal, BLM, and BIA procedures provide for the avoidance or mitigation of impacts on cultural resources, we expect no significant impacts from any of the three alternatives. Alternative 2 would result in 75 percent more acres disturbed within high-sensitivity historic-resources zones and 68 percent more acres disturbed within high-sensitivity prehistoric- and ethnohistoric-resources zones than Alternative 1. Alternative 3 would result in 4 percent more acres disturbed within high-sensitivity historic-resources zones and 4 percent more acres disturbed within high-sensitivity prehistoric- and ethnohistoric-resources zones than Alternative 2.

Visual - Recommended mitigation would minimize significant visual impacts from any of the three alternatives. Some visual impacts are likely to occur in specific areas where it is not possible to site a well in an unobtrusive location, e.g., due to lack of topography, lack of vegetative screens, and the presence of numerous nearby residences or roads. These impacts may be significant to specific homeowners, while remaining unknown or unobtrusive to the average county resident. Because of the larger number of wells to be constructed under Alternatives 2 and 3, the likelihood of altering scenic quality within the viewshed of sensitive viewers in residences, recreation areas, and travel routes would increase with the development of either of these alternatives.

Socioeconomic - Alternatives 2 and 3 would benefit the local economy by $253 and $282 million, respectively, over a 20-year period. Alternative 2 would contribute 45 percent more revenue to the local economy than Alternative 1, over 20 years. Alternative 3 would contribute 10 percent more to the local economy than Alternative 2, over 20 years.

Noise - No significant noise-related impacts are anticipated from any of the three alternatives, with implementation of the recommended mitigation measures. As with visual impacts, some noise impacts are likely to occur in specific areas where it is not possible to site a well or compressor in an unobtrusive location, e.g., due to lack of topography, lack of vegetative screens, and the existence of numerous nearby residences. These impacts may be significant to specific homeowners while remaining unknown or unobtrusive to the average county resident. Because of the increased well development and reduced well spacing under all alternatives, there is an increased potential for a sensitive receptor (e.g., a residence) to be affected by construction-related noise sources, such as heavy trucks and drilling and completion operations.

Health and Safety - We expect no significant health and safety impacts from development of any of the three alternatives, assuming that workers continue to use appropriate health and standard industry safety practices. Due to the larger number of wells planned to be constructed under Alternatives 2 and 3, however, the combined likelihood of health and safety incidents would increase under these alternatives. Computer modeling in the 3M Project suggests that infill, even widespread, would decrease methane gas seepage at the outcrop.

2.8 FEATURES OF AND ACTIVITIES ASSOCIATED WITH THE ALTERNATIVES

2.8.1 Introduction

This section describes the features of the three alternatives and activities associated with the three alternatives. Most of the features and activities that are described are common to all three alternatives. For example, all three include conventional methane and CBM production wells (including CBM infill wells); water disposal wells; gas and water gathering, transportation, and treating facilities; and the many varied activities that accompany those assets. Alternative 3, the Agency and Tribal Preferred Alternative, is unique in that it contains enhanced-recovery injection wells and inert gas delivery and recovery systems. Infill wells are mechanically indistinguishable from other CBM production wells, so the uncertainty about the number of infill wells in Alternative 1 is not a significant issue.

The potential impacts of development and production activities and facilities under the three alternatives are expected to differ only in magnitude relative to the differing number of wells in each alternative and to the presence or absence of ECBM facilities, including injection wells. Due to the programmatic nature of this EIS, the exact locations and timings of activities, including drilling of wells and installation of equipment and facilities, cannot be known, although they would occur within the well windows identified in Maps 3 and 4. All activities and construction related to a particular project would be evaluated in detail on a site-specific basis through the Application for Permit to Drill (APD) process, at the time each project is proposed.

All three alternatives include many basic activities and processes involved in the exploration and development of oil and gas on the Reservation. The activities take place in a sequential order that can be divided into five phases—Exploration, Preconstruction, Construction, Production, and Abandonment and Reclamation.

2.8.2 Exploration Phase

The Exploration Phase consists of the study and research to discover new resources in an area. Much of the work may be done in an office or library, but often new geological and geophysical information must be gathered in the field, as described below. If geological and geophysical investigations indicate potential, then specific locations for well drilling have to be determined through closer scrutiny of the data and possibly acquiring still more or different data. Detailed engineering, environmental, and economic evaluations are conducted, to ensure the feasibility of the project.

2.8.2.1 Geology

The surface geology of the SUIT Study Area is well known and studied; therefore, little field geology work will be required during future exploration. Geological fieldwork can be performed with minor temporary surface damage caused by transportation. Four-wheel-drive pickups, motorcycles, and all-terrain vehicles are used as transport vehicles to and within the field. However, most field work in done on foot.

Surface geology is supplemented with geological investigation of records acquired from activities that occurred in previous developments. Study of records such as well logs, well tests, and well-production history allows the interpretation of geology that cannot be inferred from outcrop data. The majority of geologic interpretation done in the Study Area today is subsurface geology.

2.8.2.2 Geophysics

Geology is often supplemented with geophysical interpretations. Geophysical-prospecting methods are used to define subsurface features. The three most commonly used geophysical-survey techniques define subsurface characteristics through measurements of the gravitational field, magnetic field, and seismic reflections.

Geophysical exploration has been performed on the Reservation, and additional geophysical surveys are anticipated in the future. Impacts from activities, when they occur, are generally caused by transportation across areas without existing roads. For a more complete description of geophysical exploration types and activities, see the *Colorado Oil and Gas Leasing and Development Final EIS (January 1991)*.

Gravity and Magnetics

Gravity and magnetic surveys indirectly measure subsurface geologic features. The fieldwork involves small, portable units, usually transported via light off-road vehicles, such as four-wheel-drive pickups and jeeps, or aircraft. Sometimes, small holes are excavated manually for instrument placement at the survey measure points. Using one of these two survey types, it is possible to make measurements along defined lines, but it is more common to acquire measurements in a grid of discrete stations.

Seismic Reflection

Seismic reflection is the most common geophysical method used today, and produces the most detailed subsurface information. The seismic method detects subsurface geologic information by producing, at or near the surface, a source wave that bounces off subsurface layers. The "echoes," or seismic reflections, are recorded as a function of travel time. The seismic reflections are detected at the surface by arrays (groups) of seismometers or geophones that are very similar to microphones. The geophone electrical signals are sent by a connecting cable to a recorder unit, and later amplified and recorded on a digital medium. The data are sent later to a processing center to be rearranged and computer enhanced, to present the subsurface reflections in a graphic form called a “seismic section” (2D) or “volume” (3D).

The seismic-reflection method requires access on the ground surface in the area being surveyed. In many places, roads provide sufficient access for the heavier vehicles used in the seismic operations. Geophones are usually laid out by personnel transported by all-terrain vehicles or on foot. To understand the subsurface structures in three dimensions, it is necessary to have seismic data recorded in a grid pattern. The grid spacing between points varies from a fraction of a mile to many miles, depending on the exploration purpose, but is generally on the order of hundreds of feet. For 2D seismic surveys, geophones and sources are arranged in near-parallel lines. In 3D surveys, geophones and sources can have a more random pattern.

The work of a geophysical crew begins with the permit agent obtaining permits from private landowners and government agencies. The survey crew next places pin flags at intervals along the seismic line and surveys the markers in relation to known geographic locations. When the complete seismic line is ready, the geophone crew places the geophones in arrays in precise locations and connects cables between the geophone arrays and the recorder unit. For a shot hole explosive seismic source, truck-mounted drilling rigs work on the seismic line. For the Vibraseis method, special trucks that vibrate the ground must drive to each source point of the survey in order to input source energy. After the seismic-reflection data are recorded, the geophone crew pick up all the geophones and cables and clean up the seismic line.

The nature of a geophysical survey’s impacts cannot be assessed without knowing exactly where the survey would be taken and when. Potential environmental impacts of a specific geophysical survey would be analyzed in detail before the approval of a project permit. Mitigation applied to potential impacts would be similar to that described herein for similar activities, such as avoidance of TES species and cultural resources, dust control, noise control, etc.

2.8.3 <u>Preconstruction Phase</u>

Upon making the decision to drill a well on a leasehold involving tribal minerals, permits from the SUIT, BIA, and BLM must be obtained by an operator before any ground disturbance can take place. Agreements have been signed by the SUIT, COGCC, BIA, and BLM to simplify the process of approving actions within the exterior boundaries of the Reservation, without compromising any agency’s jurisdiction.

2.8.3.1 Agreements Between the SUIT, BIA and BLM, and the COGCC and BLM Covering Jurisdiction Over Operations on Tribal or Federal Land

The Tribe, BIA, BLM, and COGCC have signed Memoranda of Understanding (MOU) and Interagency Agreements, as appropriate, that outline how these governments work together to control oil and gas operations within the exterior boundaries of the Reservation. These Memoranda simplify procedures for the many operators who conduct business on the Reservation and help eliminate duplication of efforts by the agencies themselves. The Memoranda state that all matters which would require COGCC approval for actions involving nontribal, non-Federal minerals shall be submitted initially to the COGCC. The COGCC must notify the BLM of applications pertaining to Federal or tribal minerals and may not hear an application regarding Indian land without the express consent of the BLM. The BLM is responsible for notifying the Tribe about applications involving tribal minerals. If the Tribe has an objection or wishes to make stipulations on approval of the application ("conditions of protest"), then the BLM must convey the details thereof to the COGCC. The COGCC must either incorporate the conditions of protest submitted by the BLM (on behalf of the BLM or the Tribe) or relinquish jurisdiction on the issue to the BLM, insofar as it relates to Federal or Indian land.

2.8.3.2 Applications for Increased Density

An application for an optional second well, or infill well, is made through formal application to the COGCC, per COGCC Rule 503. If no objection is made to the application by an interested party, then the COGCC may approve the application administratively. If there is an objection, then the Commission must hear the application at a public meeting. As of the end of 1999, the COGCC had approved infill for 188 Ignacio Blanco Fruitland Coal spacing units, the majority of which are located within the Study Area.

The COGCC originally spaced the entire Ignacio Blanco (Fruitland) pool at 320 acres per drilling unit and one well per drilling unit. On May 3, 2000, the BLM issued a decision allowing an optional second well per 320-acre spacing unit. On July 11, 2000, COGCC approved an optional second well within these 320-acre spacing units. Appendix O contains or references the applicable spacing orders for the Study Area.

2.8.3.3 Surveying

Once the COGCC has approved (and therefore, via the MOU, the BLM and SUIT have approved) a spacing order allowing a new well, the operator applies to the BIA for permits to enter tribal land for surveying purposes.

2.8.3.4 Notice of Staking or Application for Permit to Drill

The operator files a Notice of Staking (NOS) or APD with the SUIT Energy Division, BIA, and BLM.

2.8.3.5 BIA/BLM On-site Inspection Date

Next, the agencies notify the operator of a date, time, and place to meet, to perform an on-site inspection of the proposed well site.

On-Site Inspection

The attendees of the on-site inspection typically include representatives of the operator, survey crew, construction contractors (for bidding purposes), BIA, SUIT Energy Division, SUIT Natural Resources Division, BLM, contract archaeologist, contract threatened-and-endangered-species (TES) specialists, and the private landowner (if applicable). The operator shows the group where the new access road is to be situated and the orientation of the well pad. Appropriate changes or modifications then are made, if needed, to avoid conflicts with drainages, excess cut-and-fill, archaeological sites, TES, deer and elk calving areas/seasons, and excess-timber removal. The BLM gathers information needed to write a site-specific EA.

2.8.3.6 Environmental Assessment

The EA is written by the BLM to address all environmental concerns about the proposed new well site. Appropriate site-specific mitigation (in addition to standard SUIT and BLM environmental protection measures) is developed, based on the EA findings. The EA document is approved and signed by the BLM Field Office Manager.

2.8.3.7 APD Approval

The BLM receives a Concurrence Letter from the BIA, stating that all archaeological and TES surveys are approved and attaches any special surface-use stipulations from the SUIT Energy Department as Conditions of Approval for the APD. The BLM engineering staff reviews the downhole proposals and stipulations, modifying the drilling plan as needed. The APD with the attached stipulations as Conditions of Approval is then approved and signed by the BLM Area Manager. After the receipt of the approved APD, the operator can begin construction.

2.8.4 Construction Phase

The following is a description of construction techniques typically used for gas development within the SUIT Study Area. The techniques and procedures could be applicable to all access road construction, well pad construction, and well drilling. Operators may, however, use techniques and procedures that vary from those presented here. Determination of the suitability of an operator's design, construction techniques, and procedures is made by the SUIT, BIA, and BLM during the permitting process.

2.8.4.1 Access Road Construction

In order to move a drill rig and well-service equipment from one site to another, and to allow access to each site, roads may be built. Bulldozers, graders, and other types of heavy equipment are used to construct and maintain the road system. Standard cut-and-fill construction techniques are used (see Surface Operating Standards for Oil and Gas Exploration and Development; BLM, USFS, USGS; 2nd ed.; 1978). Major access roads are normally limited to one main route to serve the leases in a geographic area, with a maintained side road to each well.

The amount of surface area needed for roads depends on topography and the loads to be transported over it. Generally, main access roads are 20 to 24 feet wide and side roads 16 to 18 feet wide. These dimensions are for the driving surface of the road and not the maximum surface disturbance associated with ditches, back cuts, or fills. The difference in disturbance is simply a matter of topography. Surface disturbance in excess of 130 feet wide is not unusual in steep terrain where slopes exceed 30 percent. Given the extensive previous development on the Reservation, most road construction would consist of the smaller side roads to each new well. Very few well location access roads on the Reservation exceed 0.5 mile in length. The roads are crowned and ditched. For analysis purposes, the average road is assumed to cause a disturbance of 35 feet in width and 0.25 mile in length (1.06 acres), per well. Access road construction for the average road requires two days and a crew of three.

2.8.4.2 Drill Pad (Well Site) Construction

Before approval for drilling, but after the proposed drill pad and access road are staked, on-site inspections are conducted, to assess potential impacts and determine methods to mitigate impacts and establish them as conditions to the permit to drill. A drill "pad" (well site) from 1 to 4 acres in size, depending on topography and specific well needs, is then cleared of all vegetation and leveled for the drill rig, mud pumps, mud (or reserve) pit, generators, pipe rack, and tool house. [A typical drill pad layout is shown in Figure 2-6.] Topsoil and vegetation are usually removed and stockpiled for use in the reclamation process. A depression (cellar) is dug at the bore hole location, to accommodate the blowout preventers, and a shallow bore hole is drilled near the cellar to facilitate some of the drilling operation. Pits are dug for the mixing and storage of drilling mud. A mud pit is dug 6 to 10 feet deep. The length of the pit varies, dependent primarily on well depth and the size and shape of the location. The mud pit is lined with plastic or bentonite, to prevent fluid loss and contamination of water resources. Other facilities, such as storage tanks for water and fuel, are situated on the pad. Occasionally they may be positioned nearby on a separate, cleared area.

For the purposes of this EIS, analyses of long-term surface disturbances are calculated using 2 acres as the size of a typical drill pad, because, although 3 acres is initially disturbed, 1 acre is re-claimed once the well begins producing. A new drill pad takes a crew of three with equipment two days to construct. Sometimes the well site is not large enough for all the equipment required to rig-up (prepare the drilling rig for operation), due to restrictions on a particular site (such as steep topography), so a separate staging area may be constructed. A staging area is usually no larger than 200 feet by 200 feet and may simply be a wide, flat spot along the access road on which vehicles and equipment are parked. These areas are reclaimed immediately after the drill rig is moved off location. On the Reservation, SUIT policy calls for the drilling of wells on existing pads or previously disturbed surface areas, to the extent possible. Consequently, the average new surface disturbance for each well drilled on an existing pad is 1 acre.

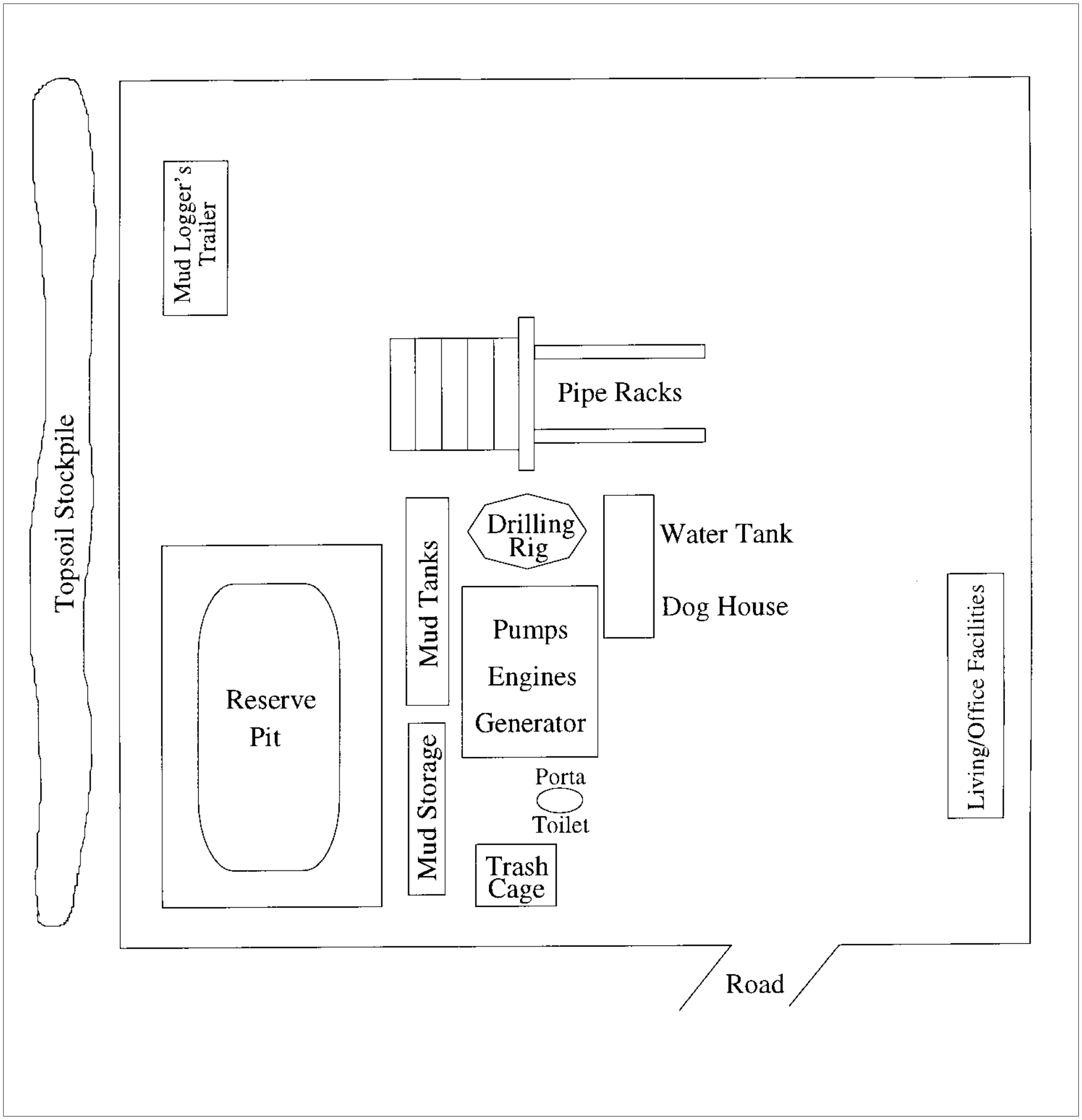

Figure 2-6: Schematic plot plan of a typical drilling pad layout.

2.8.4.3 Sand and Gravel Use

Sand and gravel are used for construction of well pads, compressor stations, roads, and pipelines, but there are no requirements that they be used in the construction process, and their use would be determined by design needs. The material is obtained at market prices from existing, permitted gravel sites on SUIT or private land. There are adequate existing sand and gravel supplies in the area to support the well development, other facility construction projects, and other users. For the purposes of the EIS, no estimate has been developed for sand and gravel use.

2.8.4.4 Well Drilling

The two methods used on the Reservation to install a producing well are to (1) drill a new well or (2) convert an existing well to produce from a different formation, by deepening the well bore or developing a formation or zone already penetrated by the existing well.

Well Drilling - New Well

Following construction of the access road and well pad, a mobile drilling rig would be transported to the well site in sections and erected on the well pad. Additional equipment and materials needed for drilling operations would be trucked into the well site.

The start of a well is called “spudding in.” The active phase of drilling would begin by setting the four tie-down anchors to guy the derrick. A short piece of tubing, called “conductor pipe,” is forced into the ground (sometimes with a pile driver) and cemented in place. This keeps surface sand and dirt from sloughing into the hole and protects the integrity of the hole at the surface. Drilling operations are conducted inside the conductor pipe.

Actual drilling operations normally include (1) keeping a sharp bit on the bottom, drilling as efficiently as possible, (2) adding a new joint of pipe at the surface as the hole deepens, (3) tripping the drill string out of the hole to put on a new bit and running it back to the bottom, and (4) installing casing and cementing it in the hole. Drilling operations are interrupted for the placement of surface pipe to protect the fresh-water aquifers. After installation of surface pipe, the actual drilling is a 24-hour operation, using three crews working eight-hour shifts. [Vehicular activity for drilling, defined as round-trip frequencies per well or per day, is discussed in Chapter 4, Section 4.7, Traffic and Transportation.] Typically, it takes about four days to drill a CBM well to the depths that are required on the Reservation.

Drilling Equipment

The drill rig is made up of four main system components: power, hoisting, rotating, and circulation. The **power system** uses diesel internal-combustion engines to provide power for the other systems to operate. The **hoisting system** is made up of the draw works, a mast or derrick, the crown block, the traveling block, and wire rope. The draw works is used to raise and lower the drill pipe and bit. The **rotating system** consists of the swivel, a four- or six-sided pipe called the "kelly," the rotary table, the drill pipe, drill collars, and the bit. The **circulation system** consists of several mechanical pumps to circulate the drilling fluid.

The bit is threaded onto the drill pipe and lowered through the rotary table by means of the draw work. The rotary table is geared to the rig diesels and rotates the drill pipe and bit, boring the hole. As the bit bores deeper, the drill string is lengthened by adding more pipe to the upper end. The circulation system is routed through the drill pipe. Drilling fluid is circulated by means of pump pressure from a pit system (either enclosed or earthen), down the drill pipe, out jets in the bit, returned up the annulus (or well bore) between the outside of the drill pipe and the well bore, and returned to the pit.

One important element of the drilling rig, not associated with the actual drilling, is a safety device referred to as the "blowout preventer." This is a manifold mounted below the rig floor that consists of manual and hydraulic rams capable of closing off the well bore, in the event that down-hole pressure exceeds the drilling mud's hydrostatic pressure and the well blows out.

Surface Casing

Typically, a 12 ¼-inch (diameter) hole is drilled to a depth of 200 to 1,000 feet, depending on the depth necessary to penetrate the fresh-water zones. Surface casing depth is determined through investigation of the resistivity properties of surrounding wells and local knowledge of the fresh-water geology. Steel casing is lowered into the hole, and specially designed cement is pumped down the inside of the casing behind a plug that wipes the casing and pushes the drilling fluid ahead of the cement. Upon reaching bottom, the plug shears under pressure and allows the cement to be circulated to the surface, between the well bore and the outside of the casing. After pumping the cement, a second plug is pumped to the bottom of the well bore, removing any residual cement from the walls of the casing and ensuring that drilling fluids do not contaminate the integrity of the cement job. The surface casing is pressure tested to ensure a seal has been created, to protect the fresh-water zones.

After setting the surface casing, drilling resumes, using a smaller-diameter bit. Depending on well bore conditions, additional strings of casings (intermediate casing) may be run, using the same cementing practices before the well reaches the objective depth (total depth [TD]).

Water Use

Drilling operations are responsible for most of the water consumed during the life of a producing well. (A small amount of water is used for dust suppression or equipment installation during other phases of exploration and development.) Up to 50,000 gallons of water may be needed for activities such as mixing drilling mud, cleaning equipment, and cooling the engines for each well. Recirculating-mud systems are used to reduce the total volume of water needed. Drilling mud can be recycled to the next drilling location, but, in this analysis, the recycling of water was not taken into consideration. Produced water from wells in the area can be used for most drilling operations except mixing cement. The primary source of fresh water is irrigation water, purchased from the owner and trucked or pumped to the well site.

Drilling with Mud

The drilling fluid, called “mud,” is a mixture of water, bentonite, caustic soda, barite, and polymers. Drilling mud serves several important functions. It cools and lubricates the bit, while lifting the well cuttings caused by the bit to the surface for disposal. The mud in the well bore prevents the hole walls from sloughing off into the hole. Equally important, mud keeps the underground pressures in check. The heavier or denser the mud, the more hydrostatic pressure it exerts. The hydrostatic pressure exerted by the column of mud in the well bore is enough to prevent formation pressure from blowing out at the surface. Finally, drilling mud seals the sides of the well bore, through formation of a thin “mud cake” composed of drilling-mud particulate matter held together by the polymer additives. This effectively protects the formation from further invasion by the water in the drilling mud, which can damage the formation and also results in loss of mud volume, which has implications for both cost and safety. Mud also serves to lift formation cuttings to the surface for geological examination.

Mud properties are carefully supervised, and several measurements of the mud are made by a mud specialist during daily visits to the well site, to ensure the mud system performs as required. **Water** is the main constituent of drilling mud. The other major components of mud are discussed below.

Bentonite, a naturally occurring clay, is used to add mass and viscosity to the drilling fluid, as well as being a primary component of the mud cake. Bentonite arrives on location in 100-pound sacks. Any amount of bentonite not mixed remains sacked and is transported to another drilling location or warehouse for eventual use.

Caustic soda is used to activate the bentonite and raise the pH of the drilling fluid. The percentage of the caustic soda in the drilling fluid is approximately 0.06 to 0.133 percent, by weight. During drilling operations, five or six 50-pound sacks would be on location at any given time. Any amount of caustic soda not used during drilling remains sacked and is transported to another drilling location or warehouse for eventual use.

Barite, an inert mineral material, is used to increase the weight of the drilling fluid. It makes up less than 22 percent, by weight, of the drilling fluid. Typically, 400 100-pound sacks would be on the well location during drilling operations. Any barite not used during drilling remains sacked and is transported to another location or warehouse.

Polymer additives are used to viscosify (keep the other material in suspension), and thereby control fluid losses. The polymers are biodegradable. They account for less than 0.1 percent, by weight, of the drilling fluid. Polymers are stored in 5-gallon buckets, and any unused polymer is transported to the next drilling location or warehouse.

The drilling mud mixed on location is stored in steel pits or earthen pits lined with plastic. Operations using enclosed steel pits eliminate the need for earthen pits and can reduce the amount of water needed, through better preservation of the mud system. Earthen pits, however, have been and will continue to be used in the future in the Study Area. The size of the pit system is determined by the depth of the well to be drilled.

In an enclosed steel pit system, drill cuttings are separated from the drilling mud and stored in a steel container until adequately dry. In an earthen pit system, the cuttings pass into a reserve pit as waste. In either case, the cuttings are ultimately buried in a trench dug on or near the well site at the end of the drilling operation. The mud in either pit system can be recycled to another drilling operation (however, in this EIS, recycling was not considered in the determination of water use). In the event the mud is not recycled, it remains in the pit until the water has evaporated, and the mud residue is buried on location.

Drilling with Air

Some wells are drilled at least partially with compressed air or natural gas as the circulating fluid. Air serves some of the same purposes as drilling mud: cooling and cleaning the bit, and evacuating drill cuttings from the hole. Drilling with air generally increases the rate of bit penetration and is cheaper than drilling with mud. Air drilling is applicable only where little water is encountered in the subsurface, however, and where the pressures of the formations to be penetrated are well known. Air is ineffective controlling high formation pressures or building mudcake and maintaining the integrity of the sidewalls of the hole.

In the Study Area, conventional wells are commonly drilled in part with air. Mud is used to drill from the surface through the Pictured Cliffs Formation. After intermediate casing is set through the Pictured Cliffs, thus sealing off the water-productive horizons, the remainder of the hole is drilled with air, if possible. Mud may be used again if water is encountered. Subsurface pressures in Ignacio Blanco are well known, and air drilling is safe.

Formation Evaluation

Formation evaluation enables the operator to determine if the well contains enough gas to make it economically feasible to complete the well. During drilling, the formations penetrated by the well bore are evaluated for the potential to produce hydrocarbons, through the analysis of any gases that are circulated up with the mud stream and by analysis of drill cuttings and drill time by geologists. Open-hole logs usually are run before any intermediate casing is set and at the end of drilling. Drill stem tests may or may not be run on a well to further evaluate its potential to produce.

Open-hole logs usually are run just once in Fruitland CBM wells, from the base of the surface pipe to the total depth of the well below the surface. Well logging uses a truck-mounted laboratory, and lowers devices called “logging tools” into the well on a wire line. The tools are lowered to the bottom of the hole and then reeled up slowly. Each logging tool takes specific, quantitative measurements of the characteristics of the rock formations as it is retrieved. Electrical signals are transmitted through the cable to the surface, where they are digitally stored in a computer. The data are used to make a log, showing the recorded measurements at all points of the well bore. These measurements are used to analyze the various rock properties of the formations, such as porosity, fluid saturation, and lithology.

During the drilling or at total depth, actual formation pressures and formation content can sometimes be ascertained with a drill stem test. The procedure uses tools threaded to the bottom of the drill pipe, instead of to the drill bit. These tools are capable of isolating the zone of interest by closing off the annulus between the well bore and the drill pipe above and below the zone. The tool, which is located next to the zone and between the seals, is opened to recover formation fluids and measure pressures. Drill stem tests can determine if a zone is capable of producing, if the formation content is hydrocarbons, or if the zone has been depleted by offsets.

Directional or Horizontal Drilling

A directionally drilled well typically involves running mud motors and steering equipment in the well bore while drilling the well. This equipment is used to “steer” the well bore in the desired direction, and ultimately into the predetermined bottomhole “target” for the drilling operation. Directional drilling has been used at the Amoco-Tiffany ECBM Recovery pilot project and in the Black Ridge area on the west side of the Reservation, where steep topography can be an issue. Due to the Tribe’s policy that existing well pads shall be used whenever possible, we expect that some wells would be directionally drilled under any of the alternatives.

Horizontal drilling is similar to directional drilling in the use of downhole motors and steering devices. Horizontal drilling, however, is a completion technique, rather than a downhole-locating method. The concept of horizontal drilling includes penetrating the formation to be completed and then continuing drilling within the plane of the formation, to maximize the surface area of the formation exposed in the completion. This is accomplished by use of downhole-directional motors and steering surveys. To date, horizontal drilling has not proven to be an economically feasible option in the San Juan Basin, but the possibility exists that the technology may be used in some element of the Agency and Tribal Preferred Alternative.

The Impacts of directional drilling and horizontal drilling are the same as for vertical-hole well drilling, except the former two types of wells take longer, due to the additional length of well bore drilled and the technique. Due to the bends required in the production casing run in directionally drilled holes and horizontal-well-bore completions, cementing techniques vary. Also, careful consideration has to be given the special challenges present, because of the need for downhole equipment, such as rods and pumps.

Conversion - Existing Well

Aside from drilling a new well, converting an existing well bore to produce from a different zone is the other method to install a producing well. This technique would be common to all alternatives in the Study Area for three reasons: (1) the Tribe requires operators to use existing well pads wherever possible; (2) with the approval of infill locations, there are existing well bores that would qualify to capture the investment tax credits associated with CBM production; and (3) recompleting an existing well bore is generally much less costly than drilling a new well.

A workover rig (a truck-mounted rig smaller than a drilling rig) is rigged up over the old well bore after the surface equipment has been removed. The hole is filled with drilling mud or water, to provide a hydrostatic head to prevent blowout. The tubing string is removed and, if the top of the cement bonding the existing casing is sufficiently below the zone to be tested, then the casing can be shot off at the top of the cement and retrieved. This would allow running casing similar to a new well [see Section 2.8.5.1]. In the event the old casing cannot be removed, the existing casing would have additional cement installed and be tested as necessary to ensure isolation of the target zone and protection for the fresh-water aquifers.

The process to install cement behind existing casing is referred to as a “squeeze job” and consists of perforating the casing and forcing cement into the annulus between the casing and the well bore. The integrity of the squeeze job is determined through running cased-hole-bond logs and pressure-testing the squeeze. In the event a complete bond is not attained, additional squeeze jobs can be performed until the bond is complete. Completion of the rest of the well would be performed as described in Section 2.8.5.

Dry Hole

In the event formation evaluation determines a well would not be economically feasible to complete, then the well would be a dry hole, and plug-and-abandonment procedures would follow. [Please refer to Section 2.8.6 for details.]

2.8.5 Production Phase

If the well can produce economically, completion operations are begun. These operations vary, depending on whether the well is conventional (Pictured Cliffs, Mesaverde, or Dakota) or CBM (Fruitland). Also, a decision may be made whether to produce a well in a primary-recovery mode or in an enhanced-recovery mode.

2.8.5.1 Completion Operations for Primary Recovery, Conventional, and CBM Wells

Cementing of Casing and Production Tubing

Casing is run to the producing zone and cemented in place. The proper cementing of the production casing string is required to provide coverage and prevent interzonal communication between oil and gas horizons and usable water zones. Fresh water, rather than produced water, is used in mixing cement, to ensure the quality of the slurry.

Cement is placed in a similar fashion to the surface casing, but a quantity of cement sufficient to cover and isolate only those zones having hydrocarbons, usable water, or other mineral values is used. Steel casing is lowered into the hole. Centralizers keep the casing in the center of the hole so that when the casing is cemented, the cement is evenly distributed around the outside of the casing. This ensures cement completely fills the annular space and precludes interzonal migration of formation fluids (i.e., groundwater). In addition, the cement protects the well by preventing formation pressure from damaging the casing and retards corrosion by minimizing contact between the casing and formation fluids.

The guide shoe, placed at the bottom of the casing string, guides the casing past debris in the hole and has an opening in its center, out of which cement can exit the casing. The float collar, placed about 40 feet above the guide shoe, serves as a receptacle for special cementing plugs and allows drilling mud to enter the casing at a controlled rate when running casing into the hole. The plugs begin and end the cementing job and serve to keep cement separated from the mud, so that the mud does not contaminate the cement.

Once the plugs are set, the slurry is allowed to harden. Allowing time for the cement to set ensures the casing will bond firmly to the wall of the hole. After the cement hardens, a cased-hole-cement-bond log is run, to evaluate the bond formed between the casing and the formation. The drill rig is typically replaced by a smaller completion rig for the final phase of completing the well.

In some wells, including CBM wells in the Colorado portion of the San Juan Basin, cementing methods are more stringent. In order to ensure isolation and protection of all zones between the surface and total depth, the BLM requires cement to be circulated from total depth to surface on the production casing, as well as on the surface casing. If cement cannot be circulated to the surface, remedial measures are taken to mitigate the potential impact on the fresh-water aquifers.

Stimulation Techniques - Acidizing and Hydrofracturing

If formation pressure can raise oil/gas to the surface, the well would be completed as a flowing well. Several downhole acid or fracture treatments may be necessary to enhance the formation permeability, to make the well flow. Water requirements for these treatments range from 1,800 to 3,000 barrels (42 gallons per barrel). Almost all of the water used for this purpose is purchased. At the end of the treatment, the treatment water flows back to the surface and is captured in temporary tanks on location. This fluid is hauled to injection wells or evaporation ponds for disposal with other produced water.

Acidizing a well involves placing acid in the well bore across the productive interval, which causes the solution of some of the mineral materials (e.g., calcite, dolomite, etc.) around the pore space. Upon solution and removal of these minerals, porosity and permeability are enhanced.

When a well is **hydrofractured**, it simply means fluid, usually gelled water, is pumped down the well through perforations in the casing and into the formation. Fresh water is used with gels to ensure the quality of the fractured fluid. Pumping pressures are increased to the point that the formation fractures or breaks, and sand is added to the injection fluid to “prop open” the crack, once the pressure is released. The pressure required to fracture a given formation is generally quite predictable, based on rock type and depth. Abnormally high pressures are required to fracture some formations, especially coals.

Control is maintained throughout the fracture operation. Pressures, volumes, and rates are all measured and monitored. These parameters provide information on how the formation is responding, and whether or not the fracture is propagating within the desired interval. This is especially true in coal, as sustained high injection pressure indicates the fracture is moving through the coal. If pressures fall off, it indicates the fracture has extended beyond the coal, and the operation can be halted.

In addition to using the foregoing parameters to monitor fracture behavior, other methods for determining fracture geometry and extent are available (e.g., tracer and tiltmeter surveys).

Cavitation

Cavitation is an open hole completion technique that can be used on CBM wells drilled in the Study Area. This technique allows increased surface area exposure of the coal and better permeability through the natural fracture system, while preventing formation damage caused by drilling mud plugging the permeability. With this completion technique, the well is drilled to the top of the coal zone and the production casing is set and cemented back to surface. The conventional drilling rig is released and a modified completion rig is then brought in to complete the “cavitation” process. The well is then drilled through the coal zone(s) with air/mist or produced water from a CBM well. The actual cavitation process can utilize either natural surging into the wellbore, where the well is shut-in (closed) followed by blowdown, or injection surging; which requires air and/or water to be injected between blowdowns. Injection cavitation is the preferred method in the Study Area. This method involves the injection of air/water mixture into the exposed coal interval for one to six hours, after which time a surface valve is opened (30 - 60 minutes), allowing the rapid release of pressure as fluids are produced through one or more blooie lines to a pit. Injection/blowdown results in increased natural gas volumes by creating cavities (tensile/shear failure) in the coal seams beyond the physical cavity created by drilling. This release of the built up pressure (surge decompression) results in the flow of gas, fluid and coal fines to the surface via the blooie line. The initial opening of the surge results in large amounts of gas controlled through a flare. This flare burns off the excess gas, usually 20-100 feet in height, and is contained by siting of a flare wall (beret) which forces the flare upward. Fluids, primarily water, and coal fines (chunks and dust) are collected in the lined reserve pit. Approx 15-100 barrels (bbls) of water are used in the cavitation procedure each time shut-in occurs. Water is used to suppress the chance of a down hole fire in addition to potentially assisting the stimulation process. This water is collected in the reserve pit with coal solids. Coal fines collected in the reserve pit represent approximately 90-95% of the coal extracted from the cavitation procedure. The remaining 5-10% of the coal is burned or lost to the localized atmosphere. The well is surged/cleaned out intermittently on a 24-hours basis determined by the amount of coal encountered. Cleanouts are initially longer (approximately 48 hours) with time decreasing as the well cleans up and coal quits running. Pressure associated with cavitation are recorded and evaluated on a chart recorder. The cavitation process typically involves 20-30 injections over a 10 to 15 day period and could take place day and night.

Flaring and Testing

Flaring is the process of igniting and burning produced gas rather than directing that gas to sales. Flaring is commonly done during completion and testing of CBM wells to safely remove gas from the vicinity of the rig. To flare, gas is piped away from the immediate vicinity of the well bore and ignited at the end of the pipe, into a pit constructed on the well pad for this purpose. A berm is usually constructed around the pit to aid in containing the flame and any materials, such as cuttings or fluid, which might be blown out with the gas stream.

In a cavitation completion, as previously described, a CBM well is cycled for days or weeks between periods of pressure build up and periods of flowing. Flaring commonly occurs while the well is flowing. In completion of conventional wells, flaring may occur when flowing to test the well's productivity once the well is completed.

Artificial Lift

A free-flowing well is simply closed off with an assembly of valves, pipes, and fittings (called a "Christmas tree") to control the flow of oil and gas to other production facilities. A gas well may be flared for a short period to measure the amount of gas per day the well can produce, then shut in or connected to a gas pipeline.

If the well is not free-flowing, it would be necessary to use artificial-lift (pump) methods. These are explained, along with well production equipment and procedures, in the following section on production. After a pump is installed, the well may be tested for days or months, to see if it is economically justifiable to produce the well and to drill additional development wells.

Field Development

The most important development-rate factor may be the quantity of production. If the discovery well has a high rate of production or if it is determined that infill development is feasible, development drilling usually proceeds at a fairly rapid pace. If there is some question whether reserves are sufficient to warrant additional wells, development drilling may occur at a much slower pace. An evaluation period to observe production performance may follow between the drilling of successive wells.

Other factors affecting the rate of developmental well drilling include (1) whether the field is operated on an individual-lease basis or unitized, (2) the availability of drilling equipment, (3) protective drilling requirements (drilling requirements to protect Indian land from subsurface hydrocarbon drainage by offsetting non-Indian wells), (4) economics, and (5) the degree to which limits of the field are known. Special tax credits spurred the CBM drilling surge in the late 1980s and early 1990s. The qualifying period on newly drilled wells has ended, and the window for earning tax credits, even on production from recompletions of previously drilled wells, will close at the end of 2002. Due to the number of variables and uncertainties, we assumed for analysis purposes that the projected wells would be drilled and developed over the estimated life of the EIS (20 years).

Development on an individual-lease basis usually proceeds more rapidly than under unitization, since each lessee must drill his own well to obtain production from the field. On a unitized basis, however, all owners within the participating area share in a well's production, regardless of whose lease the well is on. Spacing requirements are not applicable to unit wells in Colorado. The unit is developed on whatever is considered to be the optimal spacing pattern to maximize recovery.

2.8.5.2 Conventional Gas Production

Production begins just after the well is completed and is usually concurrent with development operations. Temporary facilities may be used at first, but as development proceeds and reservoir limits are determined, permanent facilities are installed. The extent of such facilities is dictated by the number of producing wells; expected production; volume of gas, oil, and associated water produced; the number of leases; and whether the field is to be developed on a unitized basis.

“Dry gas” is a term applied to any natural gas containing little or no hydrocarbons commercially recoverable as liquid product. Gas wells usually have some water associated and may have a small amount of light liquid hydrocarbons, called "drip" or condensate. This type of production represents the majority of production on the Reservation. Dry-gas wells typically have only a "Christmas tree" or valve/gauge assembly at the well head, showing aboveground.

The produced stream requires separating the water in a two-phase separator, or dehydrator, that yields gas and produced water at the well site. Production facilities may include a pit or tank for the collection of separated, produced water and a small tank for the storage of the liquid hydrocarbons. If the volume of produced water is small (less than 5 barrels per day), then it may be evaporated on site. Larger volumes are transported to a disposal facility.

Measurement of gas is usually through a differential-pressure recorder on the well pad. From there, the gas is introduced into a gathering system for transport to a compressor facility.

Figure 2-7 is a plot plan of a producing conventional well. Some operators also use free-standing, solar/electric-powered telemetry panels to monitor and control well operations. In a few cases, separation, clean-up, and storage facilities are situated off of the well pad, for common use by more than one well.

Figure 2-8 shows a typical layout of a CDP, or treating facility, used to process gas stream from several wells. In the great majority of the wells in the Study Area, all facilities are situated on the same pad on which the well was drilled.

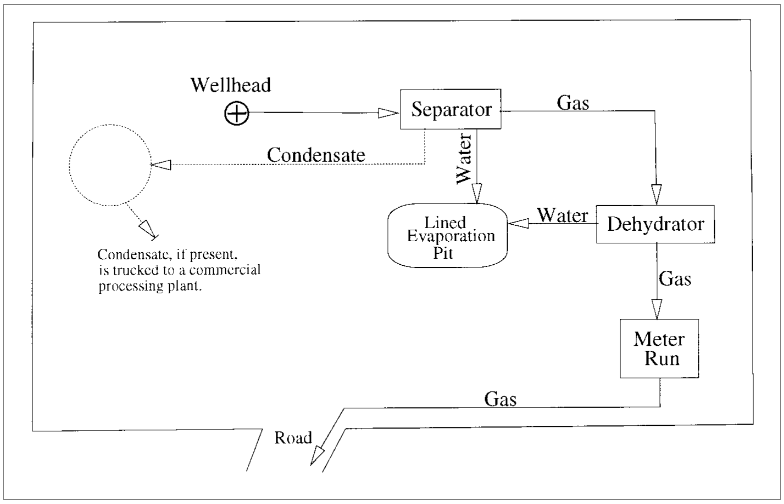

Figure 2-7: Schematic plot plan of a producing, conventional well. Small amounts of produced water are evaporated on-site. Amounts of produced water greater than 5 barrels per day are trucked to a disposal facility.

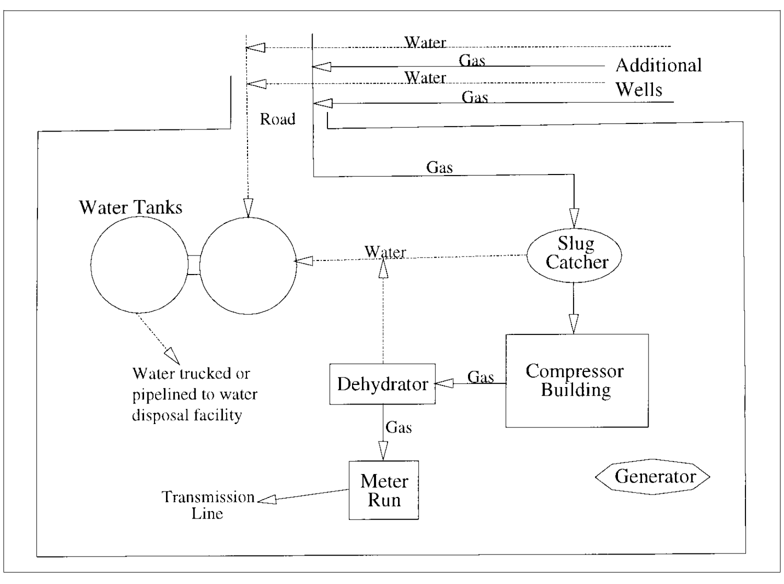

Figure 2-8: Schematic plot plan of a CDP, or treating facility, used to process the gas stream from several wells before delivery into the main transmission pipeline.

[Figure 2-9 shows a typical gas production process for a conventional well. The processes and facilities illustrated in the figure are described in the following paragraphs.]

Hydrogen Sulfide in Gas Production

Hydrogen sulfide (also known as H_2S or “sour gas”) has been found in one well near the Fruitland Formation outcrop, in a shallow production well that is now shut in. There is no known hydrogen sulfide production outside the 1.5-mile near-outcrop zone, nor is any known hydrogen sulfide produced in conjunction with the drilling and development activities on the Reservation.

Hydrogen sulfide that is detected at the Fruitland outcrop may be generated by microbial action on methane in the soil, rather than being a component of the reservoir fluids.

Production Pipelines

Natural gas pipelines (gathering or flow lines) transport gas from the wells to a trunk line, which connects to the main transmission line from the area. Flow lines are usually 2 to 4 inches in diameter and may or may not be buried. Trunk lines are generally 6 to 8 inches in diameter and are buried, as are transmission lines which vary in diameter from 10 to 36 inches. On the Reservation, most of the new pipelines would be the smaller flow lines to the individual wells. Some trunk lines would be constructed, but we don’t anticipate that any large transmission lines would need to be built.

The area required to construct a pipeline varies from about 15 inches wide (for a 2- to 4-inch surface line) to more than 75 feet in width for the larger-diameter transmission lines (24 to 36 inches). Surface disturbance is primarily dependent on the size of the line and the topography of the area in which the line is being constructed. Construction of a pipeline requires excavating and hauling equipment, a temporary and/or permanent road, possibly pumping stations, clearing the right-of-way of vegetation, and possibly blasting if areas of rock are encountered. Most often, the pipelines are required to be placed near the access road or buried under it, to limit additional surface disturbance.

Steel pipe is strung along the route, welded together, and inspected using X-rays before being lowered into the trench. Pipeline segments are tested for integrity using a standard hydrostatic-pressure-testing technique. More than one pipeline (gas, produced water, injection gas) can be placed in the same trench, with an appropriate distance between each line. Suitable subsoil or sand is placed around the pipelines for padding, as needed. The depth of excavation provides for approximately 4 feet of cover over the pipe. In the event a stream crossing is required, a permit is obtained from the U.S. Army Corps of Engineers, as required by Section 404 of the Clean Water Act. Reclamation efforts are initiated as favorable growing conditions permit. Pipelines are routinely monitored for leak detection using field balances, pressure maintenance, and gas sniffer methods.

INSERT FIGURE 2-9
SOUTHERN UTE EIS COALBED METHANE GAS PRODUCTION PROCESS FOR A TYPICAL CONVENTIONAL WELL
11 x 17 B&W

Production Facilities

Reservoirs that produce both oil and natural gas require the siting of facilities for the production, cleanup, and storage and/or transportation of the products on location (i.e., the well pad). There is currently very little oil production on the Reservation; however, the condensate is handled in a similar manner. If the well produces naturally (that is, the gas and oil flow to the surface under natural pressure), only a series of pipes and valves at the well head is required to regulate the flow of product to the surface. If there is no, or insufficient, natural pressure, a pump is installed to lift the product to the surface.

Once the oil and gas reach the surface, they travel through pipes to separation equipment where water and other gases such as carbon dioxide are removed, and the hydrocarbon gas and oil are separated. The water and oil are piped to respective storage facilities, and the gas is put into a gathering system or transmission pipeline.

Trucking and Pipelining

Trucking and pipelining are the two methods used separately or in conjunction to transport oil or condensate out of a lease or unitized area. Trucking is used to transport crude oil or condensate from small fields where installation of pipelines is not economical and the natural gas in the field is not economically marketable. It is not practical to truck natural gas.

Oil/Condensate

Oil or condensate is placed into either a tank on the well pad or a common tank near several wells. It is measured for sale from these tanks and transported to distribution points by special trucks. Condensate accounts for all the oil production on the Reservation at this time.

In the case of some highly productive fields in other areas, pipelines may be laid to a distribution point. In these cases, there is a network of pipelines to each well similar to that for the gas-gathering system. The gathering lines are usually 4 to 6 inches in diameter, and measurement is either through a sales tank or a sales meter attached to the line. Construction of the lines is similar to those for gas pipelines.

Compressors

Compressor stations are necessary to increase production pressure to the same level as the transmission-pipeline pressure. Gas under well-head pressure moves through the gathering system to a compressor facility. Compression increases pipeline pressures as necessary to introduce the gas into the existing transmission pipeline. This function is accomplished using natural gas-fired engines or electric motors that can drive reciprocating-type piston compressors, screw compressors, or centrifugal compressors. Associated equipment may include dehydration and amine systems for water and carbon dioxide removal, respectively.

Compression stations in the Study Area vary in size from roughly 1 acre to as much as 20 acres for a very large compressor facility. We expect that additional facilities, to accommodate future compression needs for increased production brought about by the Agency and Tribal Preferred Alternative, would be sited at existing compressor stations with little or no additional surface disturbance. However, it is possible new facilities could be built within the Study Area.

Glycol Dehydration

The dehydration process consists of water-saturated gas entering the bottom of the dehydrator unit and traveling upward, counter to a current of liquid glycol stream moving downward. As the glycol flows downward it absorbs water from the gas stream. Once the process is completed, the dehydrated gas leaves the top of the unit. The water-rich glycol leaves the bottom of the absorber and is piped to the heated reboiler system where the water is evaporated. Glycol is completely contained in a closed vessel.

Glycol Regeneration

The water-rich liquid glycol is heated, and the water is vaporized and separated from the glycol until the desired concentration of lean glycol is produced. The water-lean liquid glycol is then recirculated to the dehydration system in a continuous process. Again, the glycol is contained in a closed vessel.

Amine Treatment System

A common process for treating gas uses a chemical solution called amine to remove carbon dioxide from the gas. Different compositions of amine solution can be used, but diethanolimine (DEA) is most typical. Amine systems consist of two distinct phases: treating and regeneration. During treating, the produced gas stream and liquid amine DEA are contacted countercurrently in the amine contactor. As a result of chemical reactions between the produced gas stream and amine, the carbon dioxide in the produced gas is absorbed into the amine solution. The amine solution containing the carbon dioxide then passes to the amine regenerator for carbon dioxide removal. The amine solution is contained in the closed vessel.

Amine Regeneration

During amine regeneration, the chemical reaction that took place in the contactor is reversed by adding heat. The vaporized carbon dioxide is released and vented. The amine, which is now regenerated, is then recirculated to the treating section to continue the process. Again, the amine solution is contained in a closed vessel.

Chemical Use and Maintenance

All of the alternatives would use a variety of chemicals, including solvents, lubricants, paints, and additives. [Table 3-50 in Chapter 3 presents a list of chemicals that likely would be used during the production phase, based on current CBM requirements in the Study Area.] None of the chemicals proposed for use meet the criteria for a hazardous material/substance, or the quantities criteria per BLM Instruction Memorandum No. 93-344.

Potentially hazardous substances used in the development or operation of wells could be kept in limited quantities on well sites and at the production facilities. Operators are required to follow the Materials Safety Data Sheets for use of such substances. The EPA and Occupational Safety and Health Administration regulate these materials.

2.8.5.3 Coalbed Methane Gas Production

Methane is commonly found in association with coal. It is produced either from the coalbeds themselves or from nearby reservoir rock to which it has migrated from coalbeds. It is produced by the same drilling and production techniques as other gases. One difference between CBM wells and conventional ones is that CBM wells generally require artificial lift (i.e., a pump) to remove formation water. This reduces the fluid pressure and causes gas to be released (desorbed) from the coals. Once the gas is freed from the coal surfaces, it moves toward the "pressure sink," which is the well bore. Once gas is liberated, it flows preferentially to water (i.e., relative permeability is higher for gas), thereby reducing water production rates and increasing gas production rates. The artificial-lift equipment is no longer needed once sufficient gas flow is established. [Figure 2-10 shows the typical gas production process for a Fruitland CBM well. The processes and facilities illustrated in the figure are described in the following paragraphs.]

Produced Water

Due to the relatively high volumes of produced water and concentrations of carbon dioxide, CDPs, or treatment facilities, are often used to treat the CBM production. After leaving the well, the production is sent to a well-site separator, which splits the stream into separate gas- and water-gathering lines before entering the CDP or treatment facility. The separate pipelines are usually contained in the same trench along the right-of-way. At the facility, the produced gas enters a slug catcher used for additional water and gas separation. The water that drops out combines with the produced water stream from the field and is stored in tanks. Water tanks usually have a tank heater that is used during the winter months to prevent freezing. The produced water is then pumped to an injection well for disposal. After leaving the slug catcher, the produced gas enters compressors before passing through the glycol dehydrator unit equipped with a natural gas fired reboiler to further dry the gas.

FIGURE 2-10
COALBED METHANE PRODUCTION PROCESS FOR A TYPICAL FRUITLAND WELL
11 X 17 B&W

Figure 2-11 is a plan view of a typical producing CBM well with additional pipeline compression on-site.

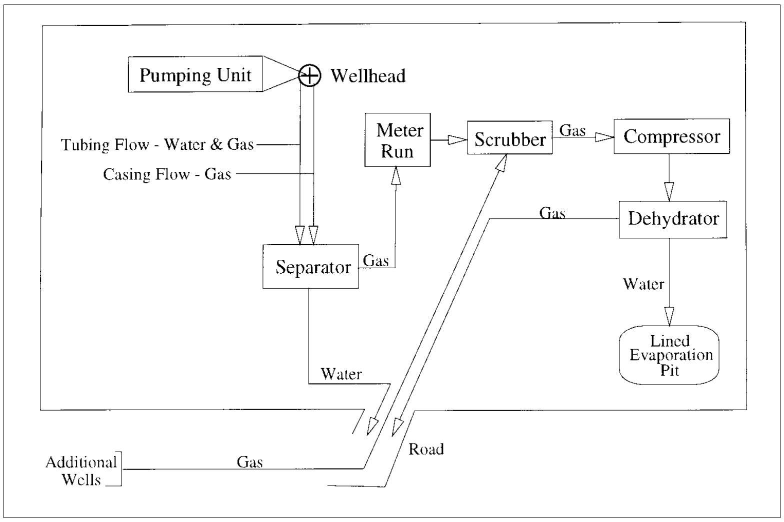

Figure 2-11: Schematic plot plan of a producing CBM well with additional pipeline compression on-site. If larger amounts of produced water are present, it may be transported to a disposal facility via truck or pipeline.

<u>Produced-Water</u> <u>Disposal</u>

Some wells drilled in the Study Area produce enough water that it must be disposed of during the operation of the well. Produced waters are evaporated from lined surface pits on location when the produced waters average less than five barrels per day. Almost all of the conventional wells and several of the CBM wells fall within this category. The average amount of produced water for all CBM wells on the Reservation (Indian, Federal, and nontribal) was 89 barrels per day in 1995 and 56 barrels per day in 1996.

The primary means of removing water from a well in the Study Area is by pumping jacks (familiar "horsehead" devices). The pumps are powered by electric motors or by gas-fired internal-combustion engines. CBM wells with appreciable produced water generally use this method to help establish better methane production.

Most produced waters are brackish to highly saline, although some are fresh enough for beneficial use. If produced water is to be discharged to the surface waters inside the exterior boundaries of the Reservation, it must be authorized under the General National Pollutant Discharge and Elimination System Permit issued by the Environmental Protection Agency (EPA) for the Reservation. To qualify for authorization, the produced water must meet specific water quality standards defined in the permit.

Several operators have experimented with reverse osmosis for treating produced water before disposal. This method generally has been found uneconomic, however. No reverse-osmosis units are in operation on the Reservation at this time.

Produced water may be trucked or transported via pipeline to a disposal site. Pipeline construction techniques and procedures are essentially the same as those described for conventional gas production (natural gas). Economics usually dictates the method of choice. A small percentage (5 percent ±) of the produced water not evaporated on-site is trucked to permitted evaporation ponds. Most of the produced water (95 percent ±) from the Reservation is disposed of in deep injection wells. Figure 2-12 is a plot plan of a producing CBM well with produced water stored in water tanks and trucked offsite to a disposal facility. Figure 2-13 is a plot plan of an injection-well site used for the disposal of produced water.

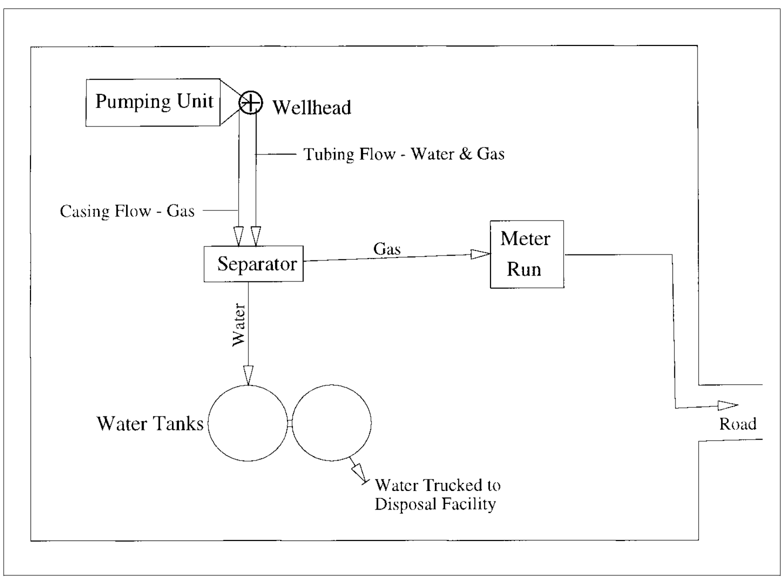

Figure 2-12: Schematic plot plan of a producing CBM well with produced water trucked off site to disposal facility.

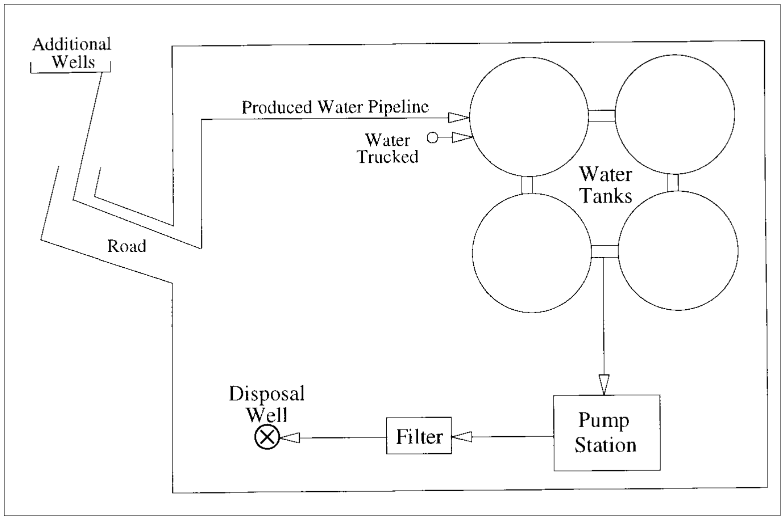

Figure 2-13: Schematic plot plan of an injection well site used for the disposal of produced water. Produced water may be transported to the disposal site via truck or water pipeline.

Water Disposal Injection Wells

On the Reservation, injection-disposal wells are authorized by the EPA. BLM engineers and the Tribe have review responsibility for injection proposals, to determine if there would be impacts on other minerals and groundwater; however, they have no approval authority over the well or target zone. Similarly, the BIA and Tribe review the injection well for surface concerns.

When water is disposed of underground, it is always introduced into a formation containing water of equal or poorer quality, or into a formation that has been specifically exempted by the EPA or COGCC. It may be injected into the producing zone from which it came or into other producing zones. In some cases, it could reduce the field's productivity and may be prohibited by regulation or mutual agreement of operators. In some cases, dry holes or depleted producing wells have been used for salt water disposal, but this practice generally no longer occurs on the Reservation. The deeper Entrada Sandstone is currently regarded as the best zone for disposal purposes on the Reservation. Cement is squeezed between the casing and sides of the well to prevent the salt water from migrating up or down from the injection zone into other formations.

There are currently 60 to 70 disposal wells (Indian, Federal and nontribal) on or near the Reservation. As water production declines from older CBM wells, the available capacity of the injection wells to accept production water from new wells should increase. Consequently, it is anticipated that very few if any additional disposal facilities would be necessary.

Non-Methane Components

If carbon dioxide levels exceed quality limits, the gas would go through an amine treatment to remove the carbon dioxide. Gas analysis has indicated that the CBM produced in the Study Area is extremely low in aromatics and natural gas liquids. Only negligible amounts of hydrogen sulfide are associated with producing CBM wells, making removal unnecessary.

Custody Transfer Sites/Additional Compression Sites

Before leaving the facility, the gas is sent through a custody transfer/sales meter. As with dry-gas production, additional compression may be necessary to facilitate entry of the produced gas into the existing transmission pipeline system. We expect that most of this compression would be placed at the 85 to 100 existing sites, although some new facilities may have to be built in the future.

2.8.5.4 Enhanced Recovery (Nitrogen and Carbon Dioxide Underground Injection)

Traditionally, methods of increasing recovery from oil reservoirs generally involve pumping additional water or gas into the reservoir, to maintain or increase the reservoir pressure. This process is called “secondary recovery.” Recently, this technique has been considered for use to enhance CBM production. The Tiffany project is testing the concept and feasibility of injecting nitrogen gas into the Fruitland Formation. It is estimated that recovery of gas in place can be increased from two to four times over conventional, primary production methods.

Methane adsorbed to coal can be stripped by a less sorbing gas. To date, most of the industry research and testing has been with nitrogen. Essentially, the methane that is sorbed on the coal is stripped by reducing the partial pressure of the methane, rather than reducing the total pressure of the reservoir. As injection gas is injected into the coal cleats, it reduces the concentration of the methane in the gas phase while maintaining, or even increasing, the total system pressure. Methane is desorbed from the coal matrix when the partial pressure of the methane is reduced and diffuses to the cleat network. The methane and injection gas, along with any water, then flows to the well bore.

Early results from pilot projects with nitrogen seem to show nitrogen stripping would recover significantly more gas than reservoir depletion alone, without depleting the total reservoir pressure. Since the total reservoir pressure does not have to be depleted as much, the volume of produced water is also less. More recently, carbon dioxide, which could improve methane recovery from coalbeds through a slightly different mechanism, also may be evaluated as an injection gas.

Surface disturbance from an enhanced-recovery system is similar to drilling and development of an oil and gas well itself (i.e., a drill pad and access road are constructed). Surface use is increased, since an additional injection well may be used for each group of three to four gas wells in the project area. Existing wells are often evaluated for possible conversion to injectors to minimize environmental disturbance and cost. In projects to date, half or more of the needed wells have used conversion or recompletion of existing wells.

Nitrogen for injection would be obtained from ambient air, using an air separation facility. The process produces 14 to 42 barrels of water per day, or 0.2 to 0.6 barrels of water per million cubic feet of air. The residual air mixture is returned to the atmosphere. Carbon dioxide is readily available from existing production, and a transmission pipeline crosses the Study Area. Additional compression would be required to ship the injection gas via pipelines to the injection wells. These pipelines would mostly occupy the same corridor as the other lines and roads to the wells. A separation/compression station for a project similar to the Tiffany Unit (13 injector wells) would require about 2 acres.

Based on the Tiffany ECBM pilot project (1996), injection rates may range between 2 and 2.5 mmcfd per injection well. Methane gas would not be produced from injection wells, except during flowback and completion. Subsequently, injection wells would deliver only injection gas to the coal seams. A possibility exists that, at the conclusion of the project, consideration would be given to converting the injection wells to production wells, after a technical evaluation.

Initially, the well production would have the water separated and the CBM would be produced and treated as described in Section 2.8.5.3. Methane gas ultimately would be introduced into the existing transmission system. Produced water would also be handled as previously described.

Major pipeline companies have a total nonproduct specification limit of 2 to 3 percent. Eventually the injection gas would “break through” and exceed this limit. The production stream would then be diverted from the third-party sales system, due to both contractual and practical necessity. Additional compression may be necessary to facilitate this transport. The carbon dioxide would be removed using an amine treatment, and nitrogen would be removed using a closed, regenerating process. The injection gas could then be recycled into the injection system or returned to the atmosphere. CBM would be produced into the existing transmission system, as previously described. The total compression need for enhanced recovery is estimated to be 40,000 horsepower. Most of this compression would probably be very large compressors placed at some of the 85 to 100 existing sites, although some new facilities may have to be built in the future.

The Tiffany project is currently being developed as a field demonstration project for enhanced recovery. The *Environmental Analysis for the Tiffany ECBM Project* (BLM 1996) contains a more thorough description of the ECBM process.

2.8.5.5 Maintenance and Workover Operations

Routine production operations occur throughout the year, or as ground and site conditions permit. Operations require use and maintenance of access roads and well pads on a periodic, as needed basis. Maintenance of the various mechanical components used in production occurs at intervals recommended by manufacturers or as needed, based on site inspections.

A pumper visits each producing well almost every day to ensure that equipment is functioning properly. Some operators supplement these efforts with off-site computer-based automation systems. This allows monitoring of operations at each well to determine if abnormal conditions exist. Solar panels are the power source for the radio telemetry. If a problem is identified, a pumper can be dispatched. Control and monitoring of well production by radio telemetry can reduce regular site inspections of each well, and vehicular traffic.

Periodically, a workover on a well is required. A workover uses a unit similar to a completion rig to perform a variety of maintenance procedures and keep the well operating as efficiently as possible. Workovers can include repairs to the well bore equipment (casing, tubing, etc.), the well head, or the production formation itself. These repairs occur during daylight hours only and are usually completed in one day. Some situations may require several days to finish a workover. The frequency for this type of work cannot be accurately projected, since workovers vary well by well and depend on site-specific circumstances. One workover per year, per well, is anticipated for purposes of the EIS analysis.

2.8.6 Abandonment-and-Reclamation Phase

This section describes the activities associated with the abandonment of wells and production facilities, and the reclamation of the affected land.

The life spans of fields vary, because of the unique characteristics of any given field. Reserves; reservoir characteristics; the nature of the hydrocarbon; subsurface geology; and political, economic, and environmental variables all affect a field's life span from discovery to abandonment. The life of a typical field is 15 to 25 years. Abandonment of individual wells may start early in a field's life and reach a maximum when the field is depleted.

Well plugging and abandonment requirements vary with the rock formations, subsurface water, well site, and well. In all cases, all formations bearing useable-quality water, oil, gas, or geothermal resources, and/or prospectively valuable deposits of other minerals, would be protected. Generally, in a dry (never produced) well, the hole below the casing is filled with heavy drilling mud, a cement plug is installed at bottom of the casing, the casing is filled with heavy mud, and a cement cap is installed on top. A pipe monument, giving the location, lease number, operator, and name of the well, is required, unless waived by the appropriate agency. If waived, the casing may be cut off and capped below ground level. In irrigated fields, the casing would be cut off and capped below plow depth (18 to 24 inches). Protection of aquifers and known oil- and gas-producing formations may require placement of additional cement plugs.

In some cases, wells that formerly produced are plugged as soon as they are depleted. In other cases, depleted wells are not plugged immediately, but are allowed to stand idle for possible later use in a secondary-recovery program. Truck-mounted equipment is used to plug former producing wells. In addition to the measures required for a dry hole, plugging of a depleted producing well requires a cement plug in the perforated-casing section in the producing zone. If the casing is salvaged, a cement plug is put across the casing stub. The cement pump jack foundations, if any, are removed or buried below ground level. Surface-flow and injection lines are removed, but buried pipelines are usually left in place and plugged at intervals as a safety measure. Subsurface power lines are also abandoned in place. All surface equipment (meter houses, dehydrators, separators, and telemetering arrays) is removed.

After a dry hole is drilled, the hole is plugged, and the reserve pits (the part of the mud pit in which a reserve supply of drilling fluid and/or water is stored) must be evaporated or pumped dry and filled with stockpiled material. There is little leakage if the pit is lined with plastic or bentonite. All surface equipment is removed; pipelines and subsurface power lines are abandoned in place. The disturbed surface area is restored to the requirements of the Tribe and BIA. This may involve the use of dozers and graders to raconteur those disturbed areas associated with the drill pad, plus the access road to the particular pad. The area would be reshaped to a useful layout and in a manner that would allow revegetation to take place, restore the landform as near as possible to its original contour, and minimize erosion. After grading the subsoil and spreading the stockpiled topsoil, the site would be seeded with a seed mixture that would establish a good growth, offer wildlife forage, and prevent erosion. A fence may be erected to protect the site until revegetation is complete, particularly in livestock-concentration areas. Final abandonment would not be approved until noxious weeds were under control.

On producing wells, the reserve pit is reclaimed after drilling. Interim reclamation is then undertaken to the extent possible. The goal of interim reclamation is to stabilize the pad, reduce erosion potential, address any safety concerns, control weeds, and at the same time allow adequate access for production operations, maintenance, or workovers. At the end of the well's useful life, final plugging and abandonment follow the previously described process of recontouring and revegetation, after surface equipment has been removed and buried pipelines and powerlines have been properly abandoned in place.

On all BIA- and BLM-jurisdiction oil and gas facilities (compressor stations, central facilities, custody transfer stations, pipelines, etc.), similar reclamation procedures as described above would be required before final abandonment were approved.

2.9 ENVIRONMENTAL PROTECTION MEASURES

2.9.1 Introduction

General environmental-protection measures for well development and production activities that are common to all alternatives include implementation of the measures, design features, and procedures that are described in the five phases of exploration, preconstruction, construction, production, and abandonment-and-reclamation in Sections 2.8.2 to 2.8.6, and are included herein by reference.

Appropriate and prudent site-specific environmental-protection measures and mitigation would be developed and made a requirement of each project during the APD approval process. This would consist of site-specific mitigation based on the findings of project-specific EAs, special surface stipulations from the SUIT Energy Department, and BLM stipulations modifying the drilling plan (if needed) as Conditions of Approval for the APD. The APDs submitted by an operator should be consistent with the information provided in this EIS, as modified by the on-site inspection of the proposed well site to identify specific problems and potential environmental impacts and make appropriate changes or modifications in the APD, to mitigate or avoid the impacts. Mitigation and approval conditions for individual APDs would be tiered off the protection measures and mitigation presented in this EIS and modified for site-specific conditions.

A complete APD normally consists of a surface-use plan, drilling plan, evidence of bond coverage and other information that may be required by the Tribe, applicable regulations, and BLM Orders or Notices. A surface-use plan contains information describing the surface uses, access, water supply, well-site layout, production facilities, waste disposal, and restoration/revegetation or reclamation associated with the site-specific well-development proposal. The drilling plan typically includes information describing the technical drilling aspects of the specific proposal, including subsurface resource protection and royalty accountability.

The SUIT has developed standard environmental protection measures and conditions of approval that will be applied to all future development within the Study Area, and to all alternatives presented and evaluated in this EIS. These general condition would be augmented with special conditions for a site-specific project whenever conditions warrant. The SUIT General Well Site Conditions of Approval and General Pipeline Right-of-Way Stipulations are presented in Appendix E. In addition, BLM Onshore Oil and Gas Orders and Notices to Lessees will be applied as standard operating procedures to individual projects and operators. The applicable orders and notices are listed in the following section.

2.9.2 Existing Environmental Protection Measures for Oil and Gas Operations on the Southern Ute Indian Reservation

The following regulations and orders are the basis for oil and gas development on the Southern Ute Indian Reservation:

43 CFR 3160; Onshore Oil and Gas Operations Regulations, which include the following Onshore Oil and Gas Orders:

- Onshore Order #1; Approval of Operations,
- Onshore Order #2; Drilling Operations,
- Onshore Order #3; Site Security,
- Onshore Order #4; Measurement of Oil,
- Onshore Order #5; Measurement of Gas,
- Onshore Order #6; Hydrogen Sulfide Operations,
- Onshore Order #7; Disposal of Produced Water.

The following documents contain existing environmental protection measures applicable to oil and gas activities on Southern Ute Indian Tribal and, and are included in Appendix E:

Notices to Lessees:

- NTL-88-1; Well Abandonment and Bonding Requirement Revisions.
- NTL-88-2-Colorado; Paying Well Determinations and Venting and Flaring Applications on Jurisdictional Coal Bed Methane Wells.
- NTL-MDO-91-1 (Change 1 and Change 2); Bradenhead Testing.
- IB 95-1; Prevention of Potential Bird and Bat Mortalities.

SUIT General Well Site Conditions of Approval;

SUIT General Pipeline Right-of-Way Stipulations ; and

Mitigation Measures from the Environmental Assessment of Oil and Gas Leasing and Development on Southern Ute Indian Reservation, BIA, 1990.

CHAPTER 3—AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the existing environmental resources within the SUIT Oil and Gas EIS Study Area. In accordance with NEPA regulations codified in 40 CFR 1502.15, the affected environment sections discuss the existing conditions of the human and natural environment that potentially could be affected, beneficially and adversely, by the proposed alternatives. This chapter also discusses the general methods used to gather and interpret baseline information for the affected environment. Baseline resource information was collected for the Study Area primarily within the boundaries of the Reservation. The area of influence for the socioeconomic analysis included the five counties encompassing or bordering the Study Area, including La Plata, Archuleta, and Montezuma counties in Colorado, and Rio Arriba and San Juan counties in New Mexico.

Baseline data were collected by reviewing existing documentation, consulting with various individuals and agencies, and conducting field reconnaissance for some of the resources. GIS data used in the preparation of the baseline descriptions and maps were obtained from the BIA and BLM. Other sources of information included the SUIT, USFWS, Colorado Division of Wildlife (CDOW), U.S. Geological Survey (USGS), Colorado Historical Society, local counties, and other private and public sources. Chapter 5 provides a list of the agencies, organizations, and individuals contacted during the preparation of this EIS. A comprehensive list of references used in the preparation of the EIS is provided in Chapter 7. Maps illustrating existing conditions of various resources are provided in a separately bound map volume.

The following critical elements of the human environment (BLM Manual Handbook 1790-1, Appendix 5) are not present in the Study Area and are, therefore, not discussed in the descriptions of the affected environment:

- Wild Horses;
- Wilderness Areas;
- Wild and Scenic Rivers; and
- Areas of Critical Environmental Concern.

3.2 AIR QUALITY AND METEOROLOGY

3.2.1 Introduction

The air quality of any region is controlled primarily by the magnitude and distribution of pollutant emissions and the regional climate. The transport of pollutants from specific source areas is strongly affected by local topography. In the mountainous western United States, topography is particularly important in channeling pollutants along valleys, creating upslope and downslope circulations which entrain airborne pollutants, and blocking the flow of pollutants toward certain areas. In general, local effects are superimposed on the general synoptic weather regime and are most important when the large-scale wind flow is weak.

3.2.2 Topography

The Reservation is located in the northern portion of the San Juan Basin and the eastern area of the Colorado Plateau in southwestern Colorado (Figure 1-1). The Colorado Plateau is a vast physiographic province extending throughout western Colorado, northwestern New Mexico, most of northern Arizona, and southern and eastern Utah. This physiographic province is characterized by generally flat-lying sedimentary deposits divided by faults and monoclines that form cliffs and individual plateaus. Steep-sided mesas and buttes capped by erosion-resistant rock layers are common.

The topography of the Study Area varies from moderately steep to steep mountains, canyons, and mesas in the north-central and south-central portions, to rolling hills and gently sloping river valleys in the eastern and western regions. Elevations range from about 6,000 to 9,000 feet. Map 5 shows the elevation ranges of the Study Area topography.

3.2.3 Climate and Meteorology

Temperature and precipitation data from Ignacio, Colorado, are considered to be representative of climatic conditions within the Study Area. However, because elevation, slope and aspect affect precipitation and temperatures, the complex terrain of La Plata County, Colorado, creates considerable climatic variability. The Reservation was classified into six climatic zones (BLM 1996):

- Zone 1 - semi-desert grasslands at elevations below 6,000 feet; average annual precipitation less than 12 inches;
- Zone 2 - sagebrush savanna at elevations from 6,000 to 6,300 feet; average annual precipitation 12 to 13 inches;
- Zone 3 - pinion-juniper woodland at elevations from 6,000 to 7,200 feet; average annual precipitation 13 to 17 inches;
- Zone 4 - pinion-juniper/mountain browse at elevations from 6,100 to 8,400 feet; average annual precipitation 14 to 20 inches;
- Zone 5 - ponderosa pine at elevations from 6,500 to 8,800 feet; average precipitation 16 to 23 inches; and

- Zone 6 - fir-spruce/aspen at elevations from 6,600 to 9,000 feet; average precipitation 18 to 27 inches.

Annual precipitation measurements at Ignacio during the period from 1961 through 1990 averaged 14.4 inches. From 1993 through 1996, precipitation was well distributed throughout the year, with the months from April to June receiving the lowest average amounts (0.5 to 0.9 inches) and August the highest levels (1.7 inches). December and January were the coldest months, with average lows of about 10 degrees Fahrenheit (°F) and highs of about 40 °F. The warmest months were July and August with average minimum and maximum temperatures of 50 °F and 85 °F, respectively. Based on 30-year climate data (National Oceanic and Atmospheric Administration 1992), the norm minimum temperature (about 6 °F) occurs in January and the normal maximum temperature (88 °F) occurs in July.

Given the general lack of representative wind measurements within the Study Area, wind speed and direction values were derived from the 1990 MM4 (mesoscale model) and CALMET meteorological models (Earth Tech 2000). The distribution of these wind values is shown in Figure 3-1. Note that the direction associated with any bar in this figure is the direction from which the wind blows. From the standpoint of dispersal of airborne pollutants, better dilution and dispersion would be expected to occur along ridges and high elevation areas than in protected valley locations.

3.2.4 Existing Air Quality

Although specific air quality monitoring is not conducted throughout most of the Study Area, air quality conditions are likely to be very good, as characterized by limited air pollution emission sources (few industrial facilities and residential emissions in the relatively small communities and isolated ranches) and good atmospheric dispersion conditions, resulting in relatively low air pollutant concentrations.

Known contributors to pollutant levels within the Reservation include the following:

- exhaust emissions (primarily carbon monoxide [CO] and oxides of nitrogen [NO_x]) from existing natural gas fired compressor engines used in production of natural gas; gasoline and diesel vehicle tailpipe emissions of combustion pollutants (Volatile Organic Compounds [VOC], CO, NO_x, particulate matter less than ten microns in effective diameter [PM_{10}], and sulfur dioxide [SO_2]).

- dust (particulate matter) generated by vehicle travel on unpaved roads and windblown dust from neighboring areas and road sanding during the winter months.

- transport of air pollutants from emission sources located outside the Reservation.

The most complete air quality monitoring data available within the Study Area are from the SUIT station near Ignacio (Table 3-1), which has provided continuous measurements since 1987, and are considered to be the best available representation of background air pollutant concentrations throughout the Study Area (SUIT 1997, 1998 and 2001). These data are used in the air quality impact analysis to define background conditions, affected by existing sources inside and outside the Reservation.

The maximum pollutant concentrations recorded at Ignacio are well below applicable National Ambient Air Quality Standards (NAAQS) for most pollutants, although hourly concentrations of ozone approaching the federal standard have been observed occasionally.

The pollutant levels indicated by the Ignacio data are consistent with estimated baseline concentrations provided by the Colorado Department of Health and Environment-Air Pollution Control Division (CDPHE-APCD) for rural Southern Colorado (CDPHE-APCD 1997). The CDPHE-APCD also provided estimated baseline levels for CO, which is not measured at Ignacio. The recommended baseline levels for both one-hour and eight-hour CO concentrations are 2,300 micrograms per cubic meter ($\mu g/m^3$).

Although the available Ignacio monitoring data represent regional background conditions, they do not adequately represent the areas immediately adjacent to large existing gas field sources (e.g., compressor stations) within the Study Area. Therefore, the near-field air quality impact dispersion modeling analysis explicitly includes these existing sources, in addition to the assumed development emission sources (see Section 4.2.5).

3.2.5 Regulatory Framework

The Clean Air Act directs the EPA to promulgate the Tribal Authority Rule, establishing tribal jurisdiction over air emission sources on both trust and fee lands within the exterior boundaries of Indian reservations. Pursuant to this rule, the SUIT has submitted a “Treatment as a State” application to the EPA. This application requests the EPA treat the SUIT in the same manner as a state for the purposes of Clean Air Act Section 105 grants and to formally recognize the SUIT as an affected state when permits are written for sources within 50 miles of the Reservation boundaries (per 40 CFR 70.8 and 71.2). Affected state status would allow the SUIT to review these permits and supply comments to applicable air quality regulatory agencies which have emission source authority.

As a result of the Tribal Authority Rule, the SUIT has the option to develop an Operating Permits Program under Title V of the Clean Air Act. A delegation of authority would allow the SUIT to write permits for air pollutant emission sources located within the Reservation boundary, including sources located on fee lands. At the present time, this program is in the developmental stages and an evaluation has shown that such a program is economically feasible. The CDPHE-APCD has also claimed jurisdiction over air emission sources on fee lands within the

Table 3-1 Measured Concentrations of Regulated Air Pollutants at the SUIT Monitoring Station near Ignacio, Colorado (in µg/m^3)

Pollutant	Year	Averaging Time	Maximum Concentration	Second Max Concentration	NAAQS
Sulfur Dioxide	1992	3-hour	52.7	54.6	1,300
	1992	24-hour	23.4	23.4	365
	1992	Annual	1.8	N/A	80
Nitrogen Dioxide	1996	Annual	9.4	N/A	100
	1997	Annual	9.4	N/A	100
	1998	Annual	9.4	N/A	100
	1999	Annual	9.4 [1]	N/A	100
	2000	Annual	7.5	N/A	100
Ozone	1996	1-hour	164	163	235
	1997	1-hour	149	147	235
	1998	1-hour	157	153	235
	1999	1-hour	153	151	235
	2000	1-hour	151	147	235
PM_{10}	1991	24-hour	50.2	25.2	150
	1991	Annual	11.0	N/A	50
	1992	Annual	10.2	N/A	50
	1993	Annual	11.3	N/A	50
	1994	Annual	10.8	N/A	50
	1995	Annual	14.1	N/A	50
	1996	Annual	14.6	N/A	50
Carbon Monoxide	N/A	1-hour	2,286 [2]	2,286 [2]	40,000
	N/A	8-hour	2,286 [2]	2,286 [2]	10,000

Source: (SUIT, 1997, 1998, and 2001)
N/A - not applicable
µg/m^3 - micrograms per cubic meter
[1] Less than 75 percent data capture
[2] Assumed Carbon Monoxide levels based on CDPHE (1997) ozone approaching the Federal standard have been observed occasionally.

Reservation exterior boundary, and has issued some air pollutant emissions permits, but has not received formal Title V permitting authority from EPA for these sources. In late 1999, the SUIT and the CDPHE-APCD signed an agreement to jointly develop an air quality program for the Reservation. The agreement specifies formation of a joint Tribal-state commission. However, if the EPA does not authorize a delegated authority plan, then EPA is obligated to limit emissions from air pollutant emission sources located within the Reservation through a formal Federal Implementation Plan. Recently, EPA Region 8 began issuing Major Source Permits for sources located on tribal lands regardless of previous permitting by the CDPHE-APCD.

The NAAQS (and, where applicable, Colorado and New Mexico standards) set the absolute upper limits for specific air pollutant concentrations at all locations where the public has access. Existing air quality of the Study Area is in attainment with all ambient air quality standards, as demonstrated by the relatively low concentration levels presented in Table 3-1. The analysis of the potential CBM development alternatives must demonstrate that they would continue to comply with applicable state, tribal and Federal air quality standards. Colorado's ambient standards are not applicable within the Reservation but apply to adjacent areas off the Reservation. Similarly, the New Mexico standards apply to the area immediately south of the Reservation. Finally, although the EPA recently revised both the ozone and particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$) NAAQS, these revised limits will not be affective until the Colorado and New Mexico State Implementation Plans are formally approved by EPA.

Given the Study Area's current attainment status, future development projects (including any Alternative) which have the potential to emit more than 250 tons per year of any criteria pollutant (or certain listed sources that have the potential to emit more than 100 tons per year) would be required to undergo a regulatory Prevention of Significant Deterioration (PSD) Increment Consumption analysis under the Federal New Source Review and permitting regulations. Development projects subject to the PSD regulations must also demonstrate the use of Best Available Control Technology (BACT) and show that the combined impacts of all PSD sources will not exceed the allowable incremental air quality impacts for NO_2, SO_2, or PM_{10}. A regulatory PSD Increment Consumption analysis may be conducted as part of a major New Source Review, or may be performed by the responsible air quality regulatory agency (or EPA) in order to determine minor source increment consumption. The determination of PSD increment consumption is a responsibility of the applicable air quality regulatory agencies (with EPA oversight). Finally, an analysis of cumulative impacts due to all existing sources, and the permit applicant's sources, is also required to demonstrate that applicable ambient air quality standards will be complied with during the operational lifetime of the permit applicant's operations.

For example, the CDPHE-APCD recently conducted a detailed review of NO_2 PSD increment consumption in southwest Colorado (CDPHE-APCD 1999a) indicating that Class I increment values "are probably not violated" at the Mesa Verde National Park or the Weminuche Wilderness Area, but that preliminary results "suggest that there is one isolated hot spot in La Plata County where there is an apparent Class II PSD increment violation." The CDPHE-APCD is working closely with emission source operator to better understand the specific situation, and will conduct additional analyses to resolve the source-specific PSD Class II increment issues.

Mandatory Federal Class I areas were designated by the U.S. Congress on August 7, 1977, and include wilderness areas greater than 5,000 acres in size and national parks greater than 6,000 acres in size. Most other locations in the country were designated as PSD Class II areas with less stringent requirements. Table 3-2 shows the relevant ambient standards and PSD increment values.

In addition, sources subject to the PDS permit review procedure will be required to demonstrate that impacts to Air Quality Related Values (AQRV) will be below Federal Land Managers' "Limits of Acceptable Change." The AQRVs to be evaluated include degradation of visibility, deposition of acidic compounds in mountain lakes, and effects on sensitive flora and fauna in the Class I areas. The allowable incremental impacts for NO_2, PM_{10}, and SO_2 within the two nearby mandatory Federal PSD Class I areas (Mesa Verde National Park and the Weminuche Wilderness Area) are very limited.

This NEPA analysis compares potential air quality impacts from the Proposed Action and Alternatives to applicable ambient air quality standards, PSD increments, and AQRVs, but it does not represent a regulatory PSD permit analysis. Comparisons to the PSD Class I and II increments are intended to evaluate a "threshold of concern" for potentially significant adverse impacts and do not represent a regulatory PSD Increments Consumption Analysis. The Reservation is currently designated a PSD Class II area, while the Weminuche Wilderness Area and Mesa Verde National Park are protected by more stringent Class I increment thresholds. Even though the proposed activities would occur within the Class II area, its impacts and those of other new regional sources are not allowed to cause incremental effects greater than the stringent Class I thresholds to occur inside Mesa Verde National Park or the Weminuche Wilderness Area.

3.3 BIOLOGICAL RESOURCES

3.3.1 Introduction

This section describes the existing biological resources that occur within the Study Area. Characterization of the biological resources establishes baseline conditions from which environmental consequences can be analyzed by predicting the type and amount of change that is likely to occur to biological resources from proposed project alternatives.

Biological resource descriptions are broken down into the following major categories:

- vegetation and wetlands;
- wildlife and fisheries; and
- threatened, endangered, and sensitive species.

3.3.2 Vegetation and Wetlands

This section describes vegetation types, wetlands, culturally important plants, and noxious weeds that occur in the Study Area. Vegetation types are described and mapped to provide information on vegetation distribution and composition, and to assist in characterizing wildlife habitat types. Available information on the distribution, abundance, and types of wetlands was collected to provide data for assessing potential impacts of alternatives and to determine wetlands potentially under the jurisdiction of Section 404 of the Clean Water Act. Culturally important plants and noxious weeds were inventoried to address issues and concerns identified during the EIS scoping process.

3.3.2.1 Vegetation Types

Vegetation of the Study Area is typical of the plateau and foothill zones of the southern Rocky Mountains. The Study Area is characterized by six structurally dominant vegetation types: grassland/shrubland, Gambel oak (*Quercus gambelii*), piñon (*Pinus edulis*)-juniper (*Sabina osteosperma* [*Juniperus osteosperma*]) woodlands, ponderosa pine (*Pinus ponderosa*) timberlands, wooded riparian, and agricultural lands. The distribution of vegetation types within the Study Area is provided in Map 6. The approximate extent of each vegetation type in non-Tribal and Tribal lands is shown in Table 3-3. Original vegetation primarily consisted of piñon-juniper woodlands on slopes and coarse soils with sagebrush (*Seriphidium* [*Artemisia*] spp.)-grass savannas on level areas. However, much of the area has been significantly altered due to impacts from conversions to agriculture, prescribed burning, weed introduction, livestock grazing, range seeding, and irrigation activities. Additionally, alterations have occurred from introduction of non-native grasses, such as crested wheatgrass (*Agropyron cristatum*) and smooth brome (*Bromopsis inermis* [*Bromus inermis*]), which have been seeded in disturbed areas to prevent erosion and provide livestock and game forage. Each of the vegetation types is described in the following text.

Grassland/Shrubland

Areas of annual and perennial grasses (including out-of-production agricultural fields) with varying proportions of Great Basin shrubs occur throughout the Study Area. Grasslands with Indian ricegrass (*Achnatherum hymenoides* [*Oryzopsis hymenoides*]), wildrye (*Elymus* spp.), western wheatgrass (*Pascopyrum smithii* [*Agropyron smithii*]), galletagrass (*Hilaria jamesii*), blue grama (*Chondrosum gracile* [*Bouteloua gracilis*]), and squirreltail (*Elymus elymoides* [*Sitanion hystrix*]) with occasional sagebrush stands, are present along valley and canyon bottoms at elevations of 6,000 to 6,200 feet. Sagebrush dominates areas of deteriorated range. Other shrubs characterizing this vegetative association include bitterbrush (*Purshia tridentata*), saltbush (*Atriplex* spp.), snakeweed (*Gutierrezia sarothrae*), and rabbitbrush (*Chrysothamnus nauseosus*). In limited areas at elevations below 6,000 feet where annual precipitation averages less than 12 inches, grasslands dominated by galletagrass, alkali sacaton (*Sporobolus airoides*), and Indian ricegrass occur in association with shrubs including saltbush, snakeweed, rabbitbrush, and yucca (*Yucca* spp.)

Table 3-2 Applicable Ambient Air Quality Standards and PSD Increment Values (in μg/m³)

Pollutant	Averaging Time [1]	National Primary	National Secondary	Colorado	New Mexico	PSD Class I Increments	PSD Class II Increments
Sulfur Dioxide	3-hour	N/A	1300	695	1300	25	512
	24-hour	365	N/A	365	260	5	91
	Annual	80	N/A	80	53	2	20
Nitrogen Dioxide	24-hour	N/A	N/A	N/A	50	N/A	N/A
	Annual	100	100	100	100	2.5	25
Ozone	1-hour	235	235	235	235	N/A	N/A
PM_{10}	24-hour	150	150	150	150 [2]	8	30
	7-day	N/A	N/A	N/A	110 [2]	N/A	N/A
	30-day	N/A	N/A	N/A	90 [2]	N/A	N/A
	Annual	50	50	50	60 [2]	4	17
Carbon Monoxide	1-hour	40,000	40,000	40,000	14,971	N/A	N/A
	8-hour	10,000	10,000	10,000	9,667	N/A	N/A
Lead	Quarterly	1.5	1.5	1.5	1.5	N/A	N/A

μg/m³ - micrograms per cubic meter
N/A - not applicable
1 Annual standards are not to be exceeded; short-term standards are not to be exceeded more than once per year.
2 New Mexico particulate matter standards refer to Total Suspended Particulate Matter

Baseline information on vegetation and wetlands in the Study Area was provided by SUIT. Additional vegetation resource information was obtained from area EIS and EA documents (Animas-La Plata Project 1996; Environmental Assessment for the Proposed Tiffany Enhanced Coalbed Methane Project), USFS, USFWS, BLM, CDOW, Colorado Natural Heritage Program (CNHP), and La Plata County. Field reconnaissance of selected locations within the Study Area was conducted to verify existing data. SUIT provided a 1991 vegetation map, and the BIA produced 1996 Landsat™ satellite imagery. Plant nomenclature follows Weber and Wittman (1996); previous nomenclature is provided in brackets.

TABLE 3-3 Distribution of Vegetation Types on the Study Area	
Vegetation Type	**Acreage**
Grasslands/Shrublands	168,018
Gambel Oak	10,751
Low Density Piñon-Juniper Woodlands	14,617
Medium, High Density Piñon-Juniper Woodlands	136,483
Ponderosa Pine Timberlands	16,904
Wooded Riparian	8,156

Gambel Oak

Gambel oak vegetation occurs at elevations of approximately 4,500 to 8,500 feet, often in association with piñon-juniper woodlands, ponderosa pine timberlands, or in previously burned areas. Associated understory shrubs include snowberry (*Symphoricarpos* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.).

Piñon-Juniper Woodlands

Between elevations of approximately 6,000 and 8,400 feet, piñon-juniper woodlands with a mixed grass and shrub understory dominate much of the Study Area uplands. Canopy cover is quite variable, ranging from less than 5 to 70 percent crown cover. Low density piñon-juniper areas have a crown cover of 10 to 30 percent. Associated grasses include muttongrass (*Poa fendleriana*), Indian ricegrass, western wheatgrass, needle-and-thread (*Hesperostipa comata* [*Stipa comata*]), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), and galletagrass (*Hilaria jamesii*). Typical shrubs consist of sagebrushes, bitterbrush, and mountain mahogany. Scattered to dominant stands of big sagebrush (*Seriphidium tridentata* [*Artemisia tridentata*]) occur in deteriorated range areas along valley bottoms and in upland parks.

Ponderosa Pine Timberlands

The climax community of the Study Area occurs at elevations between 6,500 and 8,800 feet where annual precipitation generally equals or exceeds 16 inches. The dominant vegetation type is ponderosa pine timberlands, with an understory of mountain muhly (*Muhlenbergia montana*), pine dropseed (*Blepharoneuron tricholepis*), needle-and-thread (*Stipa comata*), muttongrass (*Poa fendlerania*), and slender wheatgrass (*Elymus trachycaulus* [*Agropyron trachycaulum*]).

Associated shrubs include Gambel oak, serviceberry, mountain mahogany, fendlera (*Fendlera rupicola*), and mountain juniper (*Sabina scopulorum* [*Juniperus scopulorum*]). Douglas-fir (*Pseudotsuga menziesii*) also occurs on some north-facing slopes at higher elevations of the Study Area. Small, scattered areas of aspen also are present but are not identified on project maps. Valley bottoms in these areas are dominated by grasses and shrubs including wheatgrasses, needle-and-thread, and mountain muhly, with big sagebrush present in areas of deteriorated range.

Wooded Riparian

Narrow bands of wooded riparian areas occur within the Study Area along perennial and intermittent stream courses. Characteristic tree species primarily consist of cottonwoods (*Populus* spp.) associated with shrubs including alder (*Alnus incana* subsp. *tenuifolia*), ash (*Fraxinus anomala*), and willow (*Salix exigua, Salix* spp.). Further discussion of wetland systems is provided in the section below on wetlands.

Agricultural Lands

Agricultural lands within the Study Area include irrigated and dryland croplands, orchards, and subirrigated pastures. Occasional stands of ponderosa pine or piñon-juniper woodlands occur in these areas along drainages or on rocky, steeper sites that have not been farmed. Grass and grass/alfalfa mixes for hay compose a significant portion of the crops grown in the Study Area. Other typical agricultural crops farmed in the Study Area include winter wheat, dry beans, alfalfa, field corn, and oats.

3.3.2.2 Wetlands

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration to support a prevalence of vegetation that is adapted to saturated soil conditions (U.S. Army Corps of Engineers [USCOE] 1987). Wetlands are important in providing water quality improvement, fish and wildlife habitat, flood attenuation, stormwater detention, stream bank erosion control, and groundwater recharge and discharge. The USCOE and EPA administer activities to protect wetlands under Section 404 of the Clean Water Act. Wetland areas within the Study Area were broadly identified from available GIS vegetation maps and aerial photographs. Wetland areas are contained within the wooded riparian vegetation type shown on Map 6.

Wetlands make up less than 1 percent of the landscape in the Study Area. They generally occur adjacent to irrigation and wastewater ditches, water impoundments, and perennial streams, as well as in small isolated areas of high groundwater in flat valley bottoms. Types of wetlands occurring within the Study Area include emergent, forested, and scrub-shrub classes of the palustrine system and emergent and aquatic bed classes of the lacustrine system (Cowardin et al. 1979). Typical native wetland plants characterizing wetlands within the Study Area include sedges (*Carex* spp.), rushes (*Juncus* spp.), tufted hairgrass (*Deschampsia cespitosa*), bluejoint reedgrass (*Calamagrostis canadensis*), redtop (*Agrostis gigantea*), slender wheatgrass, cattail (*Typha* spp.), willow, and cottonwoods.

3.3.2.3 Culturally Important Plants

Culturally important plants are species that are reported by tribal members to occur in the Study Area and that have been historically or are currently used for food, medicine, crafts, or tribal ceremonies. Plant species identified as culturally important are listed in Table 3-4.

TABLE 3-4
Culturally Important Plants

Common Name	Scientific Name
Bear root, Osha, Snakeroot	*Ligusticum porteri*
Cattail	*Typha* spp.
Knowlton's miniature cactus	*Pediocactus knowltonii*
Narrowleaf cottonwood	*Populus angustifolia*
Peppermint	*Lamiaceae* spp.
Piñon	*Pinus edulis*
Rocky Mountain Juniper	*Sabina* [*Juniperus*] spp.
Ute lady's tresses	*Spiranthes diluvialis*
Wild banana yucca	*Yucca baccata*
Wild thorns	unknown
Willow with red stems	*Salix* spp.
Yarrow	*Achillea lanulosa*

3.3.2.4 Noxious Weeds

Weeds are invasive, nearly always alien plants that have been introduced to Colorado accidentally or have spread opportunistically after being planted for another purpose. Rapid and adaptive growth, vegetative reproduction, efficient seed dispersal, grazing deterrents, and lack of natural controls allow weeds to rapidly out-compete desirable vegetation and to persist as a monoculture or as the dominant plant species. Once weeds are established in an area, they can infest areas of undisturbed, healthy vegetation (Bedunah 1992; Forcella and Harvey 1983; Harris 1991; Tyser and Key 1988). Weed spread in the Study Area is associated with and exacerbated by surface disturbances from pipelines, gas wells, roads, and ditches; overgrazing; contaminated hay and gravel; and transport by vehicles, animals, and people.

Weed invasions into agricultural fields, rangeland, and wildlife habitat are an issue of considerable management concern for public and private property owners and managers throughout the western United States. An estimated 100 million acres are weed infested in the United States with a current rate of spread of 8 to 20 percent annually.

In southwestern Colorado, weed infestations usurp soil and nutrients from such local crops as beans, hay, wheat, corn, oats, and barley, reducing yields by up to 30 percent. Harvesting a weed infested crop can damage equipment, spread weed seeds, and greatly reduce market value. On rangeland, noxious weed infestations of knapweed (*Centaurea diffusa*) and thistle (*Crisium* spp.) or leafy spurge (*Euphorbia esula*) can decrease animal unit months (AUMs) by 65 to 90 percent, respectively (one AUM is 750 pounds, the amount of forage required to sustain a cow, cow/calf, or equivalent for one month). Furthermore, Russian knapweed is toxic to horses, and leafy spurge can cause blindness in cattle. Noxious weeds replace preferred deer and elk forage plants, reducing or displacing game herds. Locally, property values may decrease by $300 per acre on weed-infested land (San Juan National Forest Association 1994).

Weeds are present throughout the Reservation and the Study Area. The most heavily infested areas are those associated with disturbance from gas and oil development, agricultural and irrigation ditches, and grazing. The Reservation is divided in 10 management units to provide direction for BIA and tribal staff. See Section 3.6.3 for descriptions of each unit. Within the Study Area, the most serious weed infestations occur within the Animas, Picnic Flats, Florida Mesa, and Pine River management units (SUIT Natural Resource Plan 1990).

Since prevention is more efficient than control of established weed communities, the Colorado State Undesirable Plant Management Act (CRS 35-5.5-115 [1996 Suppl.]) and the La Plata County Undesirable Plant Management Plan mandate landowner management of noxious weeds. However, SUIT has no legal responsibility to comply with the Colorado State Undesirable Plant Management Act or the La Plata County Undesirable Plant Management Plan because neither the state nor the county has jurisdiction over Tribal lands. The Tribe has assumed responsibility for all weed control on the Reservation. Noxious weeds on agricultural lands are mainly controlled through the Tribal Noxious Weed Program jointly funded by SUIT and BIA. In 1989, BIA established a 10-year cost share program between the federal government and tribes to help control noxious weed infestations on Indian reservations throughout the United States. By the end of the 1995 growing season, $226,342 had been spent to treat more than 1,500 acres of the Reservation. The SUIT Natural Resources Department is seeking additional long-term funding for weed control.

La Plata County Noxious Weeds Present on the Study Area

Weeds that are within the Study Area and designated as noxious by La Plata County under the Colorado State Undesirable Plant Management Act include the following:

Leafy spurge (*euphorbia esula*) contains a milky latex that is irritating to the mouths, digestive tracts, and hooves of cattle. A highly adaptive species, leafy spurge forms monocultures on rangeland, pasture, irrigation ditches, and riparian areas. Major infestations are present along the La Plata River drainage in the Animas-La Plata Management Unit. See Section 3.6.3 for a discussion of management units.

Russian knapweed (*centaurea repens*) is a creeping perennial that is toxic to horses. By secretion of biochemicals (allelopathens) that inhibit growth of other species, Russian knapweed forms monocultures that may survive 75 years or longer. Russian knapweed occurs in pastures, agronomic crops, roadsides, waste places, irrigation ditches, and some rangeland in the Study Area. This weed occurs throughout the Reservation. Major infestations are present in the Pine River and Mesa Mountain management units.

Spotted knapweed (*centaurea maculosa*) is a short-lived perennial that reproduces from seed, with a single plant producing up to 18,000 seeds. Spotted knapweed invasion of grasses is responsible for loss of elk winter grazing habitat as well as degradation of cattle range. This species is present in dry meadows, pastures, stony hills, roadsides, and sandy or gravelly floodplains of the Study Area. Major infestations are present in the Pine River and Florida Mesa management units as well as at the north end of Navajo Dam.

Yellow toadflax (*linaria vulgaris),* also known as "butter and eggs," is an aggressive invader that replaces desirable grasses in rangeland, cultivated fields, roadsides, and waste areas. The extensive root system, effective seed dispersal, and early vigorous growth make yellow toadflax difficult to control. Infestations are present in the Animas-La Plata Management Unit.

Dalmation toadflax (Linaria genistifolia spp. *dalmatica*) spreads rapidly, out-competing desirable range plants. Reproduction is by seed, with a single plant capable of producing 500,000 seeds. Dalmation toadflax is scattered at the lower elevations where it occurs on the drier rangeland within the Study Area.

In addition to these species that are designated as noxious by the County, other species are designated by the State for management concern (Table 3-5). Species on the State Noxious Weed List must be considered by each local advisory and governing body in the development, adoption, and enforcement of their noxious weed list and noxious weed management plan (8CCR 1203-15). Species on the State Noxious Weed List can be a resource management problem and should be considered locally for inclusion in noxious weed lists and management plans (8CCR 1203-15).

TABLE 3-5
SUIT Weeds of Management Concern

Common Name	Scientific Name	Management Units with Major Infestations	Comments
Bindweed	*Convolvulus arvensis*	Pine, Florida	State Noxious Weed List. Invades cultivated fields and waste areas
Black Henbane	*Hyoscyamus niger*		State Noxious Weed List. Common in pastures, fence rows, roadsides, and waste areas; poisonous to livestock and humans
Canada Thistle	*Cirsium arvense*	Pine, Florida, Mesa	State Top Ten Noxious Weed List. Invades cultivated fields, riparian areas, pastures, rangeland, forests, lawns, gardens, roadsides, waste areas
Chicory	*Cichorium intybus*		State Noxious Weed List. Common in roadsides and disturbed areas
Curlycup Gumweed	*Grindelia squarrosa*		Common in pastures, rangelands, roadsides, waste areas; drought resistant; native to western United States
Curly Dock	*Rumex crispus*		Present in wet meadows, ditchbanks, waste areas
Houndstongue	*Cynoglossum officinale*		State Noxious Weed List. Present in pastures, roadsides, disturbed areas; toxic to livestock
Jointed Goatgrass	*Cylindropyrum clindricum (Aegilops cylindrica)*		State Noxious Weed List. Present in roadsides, well sites, waste areas, winter wheat and alfalfa fields, pastures
Musk Thistle	*Carduus nutans*	Picnic, Florida, Mesa, Pine, Capote Lake	State Top Ten Noxious Weed List. Forms dense stands in pastures, rangeland, roadsides and non-crop areas; capable of tolerating a wide variety of growing conditions
Ox-eye Daisy	*Chrysanthemum leucanthemum*	Pine	Becoming common in meadows, roadsides, waste areas, and along irrigation ditches from low to high elevation; replaces species of cattle forage
Scotch Thistle	*Onopordum acanthium*		State Noxious Weed List. Becoming common in pastures and roadsides; replaces species of cattle forage
Sulphur Cinquefoil	*Potentilla recta*		State Noxious Weed List. Becoming common in pastures and roadsides
Whitetop (Hoary cress)	*Cardaria draba*		State Top Ten Noxious Weed List. Irrigated areas
Whorled Milkweed	*Asclepias subverticillata*		Present along roadsides; toxic; native to western United States

Source: BIA 1990

3.3.3 Wildlife and Fisheries

This section describes wildlife populations and habitat that are present in the Study Area. Species descriptions are defined by management groups and include elk, mule deer, other game species, non-game species, eagles and other raptors, and fish. Species of cultural or financial significance to the SUIT are discussed individually.

The following descriptions and all subsequent discussions of wildlife and fisheries in this EIS are based on information provided by SUIT, including the SUIT Natural Resources Plan for the Years 1990-2010 (1990). Additional information was provided by the CDOW (Adams 1996; Wade 1997), and field reconnaissance was conducted by members of the EIS preparation team.

The Reservation provides important habitat for resident wildlife populations as well as migratory populations of elk, deer, and raptors that range throughout the Four Corners region. More than 300 species of fish and wildlife potentially occur in the Study Area (BIA 1990), as shown in Appendix F. The variety of habitats that exist on the Reservation support a wide diversity of wildlife. Each of the six major vegetation types discussed in Section 3.3.2 may characterize one or more habitats, based on elevation, aspect, moisture, and plant species composition. In addition, management practices, such as irrigation and farming, add to the diversity of habitats that occur on the Reservation.

3.3.3.1 Elk

The entire Reservation is designated as elk habitat. The Study Area contains mostly winter range, as well as some range that is used throughout the year, as shown in Map 7. The CDOW and SUIT Wildlife Department differentiate big game winter habitats into winter range, winter concentration areas, and severe winter range, all of which are present in the Study Area. Large game seasonal range definitions are provided in Table 3-6.

TABLE 3-6
Definitions of Large Game Seasonal Ranges

Range/Activity	Definition
Winter Range	That part of the home range where 90 percent of the individuals are located during a time-specific period of winter during the average five winters out of ten.
Winter Concentration Areas	That part of the winter range where population densities are 200 percent greater than the surrounding winter range during the same period used to define winter range in the average five winters out of ten.
Severe Winter Range	That part of the range where 90 percent of the individuals are located when annual snowpack is at its maximum in the two worst winters out of ten.
Migration Corridors	A specific mappable site through which large numbers of animals migrate and loss of which would change migration routes.

Elk (*Cervus elaphus*) are primarily grazers and prefer habitats where grass forage is available throughout the year. The level of habitat use by elk throughout the Reservation varies with the quality of the resources available. Elk habitat must provide forage, cover, water, and be relatively free of human disturbance. Areas within 0.5 mile of water and with less than 1.5 miles of road per square mile are preferred. As seasons change, elk requirements and resource availability change, and a variety of habitat types are required to meet their year-round needs.

Winter range must provide food and cover in proximity to prevent excessive energy use traveling between foraging areas. Low snow cover areas, such as low elevations and southern exposures, are preferred. Because of its relatively low elevation, the majority of the Study Area is utilized as elk winter range; grasslands, shrublands, riparian zones, and agricultural areas receive the most intensive use. As winter conditions become more severe, elk are forced into areas where forage is most available, even if cover is lacking and disturbance is high. Agricultural areas are often heavily used in the Study Area under severe winter conditions. During the summer, low density piñon-juniper and ponderosa pine stands, as well as Gambel oak, shrubland, and riparian areas are utilized by elk in the Study Area.

In addition to distinct summer and winter requirements, pregnant females have special needs for calving. Habitat with high quality forage and dense cover within 1,000 feet from water is required for successful calving and nursing during the three weeks after the calf is born. Any vegetation type where these requirements are met may be used, but forest types such as Gambel oak and piñon-juniper are most likely to meet these criteria in the Study Area.

The Picnic Flats Management Unit functions primarily as winter range, supporting between 60 and 120 elk during the winter months and may provide some limited calving and fawning areas in the northern portion (Map 18). The northern portion of this management unit also provides some year-round range. About 75 percent of the Pine River Management Unit is designated as a winter concentration area; some elk also winter there routinely. Roughly one-quarter of the Study Area, generally equated to the Florida Mesa Management Unit, is designated as severe winter range. Elk use of concentration areas and severe winter range varies with winter severity. Harsh winters result in heavy use whereas mild winters may result in little or no use. The Mesa Mountain Management Unit, utilized year-round by elk, provides winter range, as well as calving habitat and summer range. The resident herd in the Mesa Mountains was estimated to include approximately 80 animals in 1995 (Diswood 1996).

The Reservation provides winter habitat for both resident and migratory elk. Migratory elk begin moving into the Reservation and Study Area from their summer ranges to the north as early as late September and, depending on weather conditions, stay into April. Nonresident elk may travel up to 35 miles during fall migration to take advantage of winter range located in the Study Area. Additionally, elk from areas north of the Reservation may winter south of the Reservation.

Elk ranges and migration patterns are shown on Map 7. The Animas and Morgan management units as well as the western portion of Picnic Flats Management Unit are mapped by the CDOW as elk migration corridors. Table 3-7 lists acreages of available elk habitat within the Study Area and the surrounding region.

Elk and their habitat constitute a significant wildlife resource in the Study Area, providing both cultural and financial resources to SUIT. Elk is a traditional game species that is hunted by Tribal members. The Tribe issued 252 bull and 250 cow licenses to Tribal members in 1995. In addition, the Tribe actively manages elk and their habitat to provide quality hunts for non-Tribal hunters. In 1995, 11 bull elk hunts were sold for $2,310 each. One hundred and fifty cow elk hunts also were available for $275 each.

3.3.3.2 Mule Deer

More than 90 percent of the Reservation is designated as winter range for mule deer (*Odocoileus hemionus*), and the remaining areas are used year-round. Like elk, deer require forage, cover, and water, and the ranges delineated for mule deer on the Reservation are similar to designations for elk. However, deer are more tolerant of human disturbance than elk, and they are primarily browsers, as opposed to grazers (elk). Like elk, deer winter throughout the Study Area using agricultural areas, grasslands, shrublands, and riparian zones most intensely. However, deer are more likely to remain in grasslands and shrublands under harsh winter conditions.

The winter range on the Reservation is an important resource for mule deer throughout the region, with more than 1,000 mule deer wintering there (Diswood 1996). Migrants arrive beginning in late September and, depending on weather conditions, remain until April. The southern portion of the Picnic Flats, Florida Mesa, and Pine River management units are all designated as some combination of winter range, winter concentration area, and severe winter range. Mule deer ranges and migration patterns are shown on Map 8. Concentration areas generally correlate to shrublands, and severe range generally correlates to agricultural areas. The northern portion of the Picnic Flats Management Unit and the Mesa Mountains are used by deer year-round, and Picnic Flats provides important fawning habitat. Table 3-8 lists acreages for mule deer habitat within the Study Areas and the surrounding region.

Mule deer and their habitat constitute another significant wildlife resource in the Study Area. More than 1,000 resident and migratory deer utilize the Reservation throughout the year, and they provide an important cultural and financial resource to SUIT. In 1995, Tribal permits were issued for 252 buck deer. In addition, 43 non-Tribal buck permits, valued at $1,810 each, were issued. One hundred non-Tribal doe permits, valued at $75 each, also were issued.

TABLE 3-7 Acreages of Elk Habitat Types Within the Study Area and the Region				
Habitat Type	**Reservation Tribal Lands (Acres)**	**Reservation Non-Tribal Lands (Acres)**	**Reservation Total (Acres)**	**Regional Acreage (Includes Reservation) (Acres)**
Elk Summer Range	52,168	21,196	73,363	NA
Elk Winter Range	173,030	218,279	391,309	1,224,320
Elk Severe Winter Range	444,462	113,904	158,365	516,480
Elk Winter Concentration Areas	16,919	34,056	50,974	112,640

TABLE 3-8 Acreages of Mule Deer Habitat Types Within the Study Area and the Region				
Habitat Type	**Reservation Tribal Lands (Acres)**	**Reservation Non-Tribal Lands (Acres)**	**Reservation Total (Acres)**	**Regional Acreage (Includes Reservation) (Acres)**
Mule Deer Summer Range	197,907	218,587	416,495	NA
Mule Deer Winter Range	172,981	218,269	391,250	1,040,640
Mule Deer Severe Winter Range	50,223	115,725	165,949	507,520
Mule Deer Winter Concentration Areas	27,189	44,857	72,046	139,520

3.3.3.3 Other Game Species

Listed as a game species, but not hunted on the Reservation because of traditional and religious views, the black bear (*Ursus americanus*) inhabits only a portion of the Reservation. The majority of black bear habitat is primarily east of the Study Area in forested and woodland areas although bear damage has been documented at compressor station sites in the Blackridge area (Stroh 1998).

Another game species of cultural, recreational, and financial significance to SUIT is the turkey (*Meleagris gallopavo*). The majority of the turkey population on the Reservation occurs outside of the Study Area. Although food sources are available in the Study Area, essential roosting habitat is rare. Turkeys require mature ponderosa pine stands with open canopies for roosting, and this cover type is much more common in the ponderosa pine forest that occurs outside the Study Area east of the Pine River. Recent surveys show an increasing turkey population in the Bridge Timber, Florida River, and Mesa Mountain areas although relatively small in numbers (Stroh 1998).

The entire Reservation also serves as mountain lion (*Felis concolor*) habitat. The Tribe has developed quota harvest systems for Tribal and non-Tribal sportsmen. In 1997, the Tribe had a harvest quota of two lions on the west side of the Reservation and one lion on Mesa Mountain. In the past, the Tribe offered limited non-Tribal mountain lion permits for $3,000 per permit. The SUIT Wildlife Department is currently conducting a radiotelemetry study of mountain lion movements within the Reservation (Stroh 1998).

3.3.3.4 Non-game Species

A wide variety of species present in the Study Area are placed in the non-game category because SUIT does not actively manage them for harvest. The wide variety of habitat types present potentially provide resources to over 300 species of mammals, birds, amphibians, and reptiles, more than half of which are bird species (BIA 1990). Non-game mammals present within the Study Area include porcupine, coyote, fox, raccoon, badger, and bobcat, as well as several species of skunk, squirrel, jack rabbit, cottontail, prairie dog, and other small mammals. Reptiles and amphibians occurring within the Study Area include snakes, turtles, and lizards, as well as frogs, toads, and salamanders, respectively. All the major groups of bird species are represented, including water fowl, raptors, and passerines. A list of potential species that are expected to be present in the Study Area is provided in Appendix F.

3.3.3.5 Raptors

Raptors utilize the Study Area as wintering and/or nesting habitat. The Study Area provides prime nesting habitat for golden eagles (*Aquila chrysaetos*), bald eagles (*Haliaeetus leucocephalus*), red-tailed hawks (*Buteo jamaicensis*), and prairie falcons (*Falco mexicanus*).

Other known nesting species include Cooper's hawk (*Accipiter cooperii*), turkey vultures (*Cathartes aura*), American kestrels (*Falco sparverius*), peregrine falcons (*Falco peregrinus*), and a variety of owls. Swainson's hawks (*Buteo swansoni*) and northern goshawks (*Accipiter gentilis*) also nest in the area, but in very low densities.

Cliffs, rocky outcrops, and mature cottonwoods are preferred nesting areas, and occur mostly in river corridors in the Study Area. Eagles and red-tailed hawks may nest occasionally in mature conifers as well. Raptors generally defend the area within 0.25 to 0.5 mile of a nest against conspecifics (Johnsgard 1990), although nesting pairs of other species may be tolerated. Thus, in suitable nesting habitat where food resources are abundant, a raptor nest could occur approximately every mile along linear habitats such as cliff bands and riparian cottonwood forests. Adjacent habitats within a radius of up to 10 miles are used as hunting territory by adult birds feeding young (Johnsgard 1990). Hunting territories are not defended, however, and are shared with other nesting pairs.

Wintering species include sharp-shinned (*Accipiter striatus*), Cooper's, red-tailed, and ferruginous (*Buteo regalis*) hawks; American kestrel; northern harrier (*Circus cyaneus*); northern goshawk; both falcon species; and both eagle species. Wintering densities of all species are relatively low, with the exception of eagles. Bald eagles will roost communally during winter, and both eagle species will gather to feed at concentrated food sources. The Bureau of Reclamation (BOR) has documented several communal winter roost sites on both the Animas and La Plata rivers starting in 1993; however, communal sites are also likely to occur on the Pine and Florida rivers. The SUIT documents raptor sites within the Reservation boundaries.

3.3.3.6 Fish

Significant rivers occurring in the Study Area include the Animas, Florida, La Plata, and Pine, which support extensive native fisheries as well as a variety of introduced species. Common species include carp (*Cyprinus carpio*), suckers (*Catostomus* sp.), mottled sculpin (*Cottus bairdi*), and fathead minnows (*Pimephales promelas*). The Animas and Pine rivers are also stocked regularly with native and non-native trout (*Salmo* sp.) to support a viable sport fishery. Because of impacts related to irrigation, siltation, and high temperatures, there is little, if any, trout reproduction in these streams (BOR 1996). Other smaller streams in the Study Area are perennial or intermittent, have excessive siltation, are heavily influenced by withdrawals for irrigation and return irrigation flows, and generally do not support fisheries. In all, approximately 20 species of fish potentially occur in the Study Area. A list of fish species that are present in the Study Area is provided in Appendix F.

The Tribe provides angling opportunities to both Tribal and non-Tribal people on the Animas and Pine rivers within the Study Area. The Tribe offers two-day, five-day, and season permits to non-Tribal people and generates approximately $13,000 annually from the direct sale of non-Tribal permits.

3.3.3.7 Indicator Species

The Southern Ute Gas Development Study Area is comprised of six primary vegetative cover types (3.3.2.1). These cover types, individually and collectively, provide habitat opportunities for a large variety of wildlife species (Appendix F). While it is not practical to address the potential impacts represented by the alternatives to each of these species individually, potential effects can be inferred, to some degree, through the analysis of a select group of species (indicator species) that depend on specific project area cover types for their primary biological requirements. It is recognized that few species will confine all of their activities to any one cover type, but for many species, one specific cover type plays a critical biological role in the maintenance of species population viability.

The analysis in Chapter 4 of potential project effects to these indicator species is intended to provide a qualitative and quantitative comparison of the alternatives as they relate to these species, and to infer a trend of potential effects to other wildlife species that may depend on similar habitats. Appendix F provides a broad grouping of many of the species found in the study, segregated by their primary habitat, as represented by the vegetative cover types within the Study Area.

Indicator species are generally selected on the basis of their specificity of dependence on basic habitat characteristics as represented by the individual vegetative cover types found in the Study Area. A general description of the species' distribution, biology and management sensitivities is used to predict how a particular species may respond to the disturbance regimes expected to occur under the proposed alternatives.

The following species were selected to represent the vegetative cover types that would be affected through project implementation:

- Grassland/Shrubland - Golden eagle, Brewer's sparrow
- Gambel Oak - Virginia's Warbler
- Pinion-Juniper - Black-throated gray warbler, Gray flycatcher
- Ponderosa Pine - Abert's squirrel, Grace's warbler
- Riparian Woodland - Yellow warbler
- Wetland/Marsh - Striped chorus frog
- Habitat Generalist - Deer and Elk,

<u>Grassland/Shrubland</u>

The grassland/shrubland vegetation type represents approximately 39.9% of the Study Area. This vegetative cover type occurs at elevations below 6,000 feet where annual precipitation averages less than 12 inches. It includes areas of annual and perennial grasses (including out-of-production agricultural fields) occurring in association with varying proportions of the Great

Basin shrubs including sagebrush, saltbush, snakeweed, rabbitbrush, bitterbrush and yucca. Grasslands are dominated by galleta grass, alkali sacaton, and Indian ricegrass and also include a variety of other gramanoides including wildrye, western wheatgrass, blue grama, and squirreltail. Sagebrush stands are present along valley and canyon bottoms at elevations of 6,000 to 6,200 feet. Sagebrush also dominates areas of deteriorated range. Other shrubs characterizing this vegetative association include bitterbrush, saltbush , snakeweed, and rabbitbrush.

Brewer's sparrow (*Spizella breweri*)

Status: The Durango Bird Club (DBC) lists the Brewer's sparrow as an uncommon nester within the local area. The Colorado Natural Heritage Program (CNHP) has no ranking for this species. The Breeding Bird Survey (BBS) shows a possible population decline for this species within the Southern Rocky Mountains between 1966-1996.

Distribution: The distribution of Brewer's Sparrows generally coincides with the distribution of sagebrush in the West, from east-central British Columbia, southeast to southwestern Saskatchewan, then south to southern California and east to central New Mexico. The Brewer's sparrow (*S. b. breweri*) is primarily a Great Basin species, but it occurs in shrub habitats in all western states. It breeds throughout Utah and Nevada, as well as Montana, Wyoming, western Colorado, northern New Mexico, northern Arizona, eastern California, eastern Oregon, eastern Washington, and southern Idaho. Brewer's sparrows winter in southeastern California, southern Arizona, and southern New Mexico, south into Baja and the central states of Mexico (Rotenberry et al. 1999).

Life History: Brewer's sparrows are considered neotropical migrants, though some populations may travel only a short distance between breeding and wintering ranges. Northern populations migrate farthest south (Rotenberry et al. 1999). Brewer's sparrows typically arrive in southwestern Colorado in mid-April and depart in mid-October (Behle and Perry 1975).

This species inhabits open, shrub-dominated habitats; arid sagebrush country in the West and bunchgrass prairie with rabbitbrush, dry, brushy mountain meadows, and pinion-juniper woodlands. Brewer's sparrows are closely associated with sagebrush, where they breed in tall, dense stands or in stands broken up by grassy openings. They prefer large, contiguous sagebrush stands. Isolated stands of sagebrush smaller than 5 acres are not likely to be utilized as nesting habitat (Knick and Rotenberry 1995). They also nest in other shrubs, such as willows, mountain mahogany, or rabbitbrush. These sparrows prefer an abundance of shrub cover and their probability of occurrence increases with increasing cover densities. (Andrews and Righter 1992, Rotenberry et al. 1999)

Brewer's sparrows are primarily insectivorous during the breeding season but shift to a mainly herbivorous diet of grass and weed seeds in winter. They consume a wide variety of insects including spiders, leaf bugs, cicadas, snout beetles, caterpillars, crane flies, ants, and grasshoppers (Rotenberry et al. 1999). Nestlings are fed a similar diet (Petersen and Best 1986). Insects are gleaned from shrub foliage and bark and seeds are taken from the ground. The diet of Brewer's sparrow changes throughout the breeding season and between years probably in relation to food availability.

Male Brewer's sparrows establish territories averaging 1.2 acres in size, which are vigorously defended both vocally and physically (Reynolds 1981). Females arrive a few days after males and form mating pairs within a few days. Cup nests are constructed from grass and forbs lined with finer materials such as hair. Nests are typically located between 8 and 20 inches from the ground, usually in the upper portion of the shrub (Peterson and Best 1985, Harrison 1979). Nests are usually located in patches of sagebrush that are taller and denser, with more bare ground and less herbaceous cover, than the surrounding habitat. Although the vast majority of Brewer's sparrow nests are located in sagebrush, other shrubs are occasionally used (Rotenberry et al. 1999). Brewer's sparrows are susceptible to brood parasitism from brown-headed cowbird and often abandon parasitized nests (Rotenberry et al. 1999).

Factors Of Concern And Management Implications: Brewer's sparrow habitat loss occurs primarily through the removal of sagebrush and other shrub. Removal of shrubs over large areas causes individuals to abandon the treated area (Schroeder and Sturges 1975). Prescribed burns that remove no more than 50% of the sagebrush may result in a decline in local Brewer's Sparrow populations for 1-2 years, but populations should rebound after that (Petersen and Best 1987).

Associated Species: Other bird species that may use habitat in a similar way and/or respond similarly to management, activities include sage grouse, sage thrasher, green-tailed towhee, and sage sparrow. (CPIF)

Golden eagle (*Aquila chrysaetos)*

Status: The golden eagle is considered a culturally significant Tribal wildlife species. It is not listed by the USFWS but is federally protected under the Bald Eagle Protection Act of 1962. The CNHP ranks this species as G5 globally, which means it is apparently secure on a global level but is quite rare in some portions of its range, especially on the periphery. The state ranking of S3S4, which indicates it is watch-listed to determine if more active tracking is warranted. The DBC considers this species as a common year-round resident to Southwestern Colorado. The BBS indicates a slight increasing population trend in the southern Rocky Mountains, although this trend is not statistically verifiable. Significant declines in golden eagle populations have occurred in some western states.

Distribution: The golden eagle is found in North America, Eurasia and northern Africa. The breeding range in North America includes north-central Mexico, the western United States east to the Dakotas, Kansas and Texas, also Alaska, and across northern Canada. During the winter they can be found in southern Alaska and Canada, the western United States and Mexico. There are approximately 500 nesting sites in Colorado but only half of those are active in any one year (Andrews and Righter 1992). Craig (1981) reported that there were 39 active nests in southwestern Colorado in 1979. Nesting sites for this species are known to occur within the Study Area.

Life History: This species is found in a variety of habitats in the western U.S. including mountainous areas, canyons, shrub-land and grasslands. The golden eagle inhabits open country from barren areas to open coniferous forests. They are primarily in hilly and mountainous regions, but also in rugged deserts, on the plains, and in tundra. A pair requires up to 35 square miles of territory. The golden eagle prefers cliffs and large trees with large horizontal branches for roosting and perching (Wassink 1991). During the winter they are found primarily in shrub-steppe vegetation.

The golden eagle generally forages in open habitats where rabbits and small rodents are available. They are most efficient as predators in open areas and are less efficient in areas where shrub or tree cover is dense. Hunting activities are often based from perches. Both living and dead trees are often used for perches if they are near open areas where prey can be easily seen. Abundant shrub cover provides hiding and escape cover for prey making hunting difficult (Matchett and O'Gara 1991). A variety of mammals make up the primarily prey base for the golden eagle. The most common species taken include marmots, prairie dogs, ground squirrels, weasels, woodrats, skunks, mice, and rarely, large mammals. They also occasionally eat grouse, pheasants, owls, hawks, rock dove, magpies and other birds, as well as rattlesnakes, frogs, carrion, and occasionally, fish (Brown 1992, DeGraaf et al. 1991).

Golden eagles mate for life. The breeding season generally begins in mid-January and continues into mid- September, varying according to geographic region. Some pairs use the same nest each year, while others use alternate nests year after year. Some pairs will have up to 10 nests, but only 2-3 are actively used in rotation. During the nesting season they usually forage within 4.4 miles of the nest (Cooperrider et al. 1986). In the western mountains the golden eagle nests on cliff ledges, preferably overlooking grasslands; 10 to 100 feet above ground in dead or live trees; in artificial structures; or on the ground at elevations up to 10,000 feet (Veneer and Boss 1980, DeGraaf et al. 1991).

Factors of Concern and Management Implications: Direct and indirect human-caused mortality, disturbance, and the elimination of prey by habitat alteration are the main factors limiting golden eagle populations (Wassink 1991). Golden eagles are sensitive to human disturbance and are likely to abandon their nests during the incubation period if disturbed (Dunstan 1989, Palmer

1988). Other losses occur through shooting, poisoning, trapping, electrocution and collision with power lines, and pesticide contamination. In addition to breeding disruptions, human activities may disturb wintering and migration activities, which may reduce populations (Dunstan 1989).

Habitat management for the golden eagle primarily consists of protecting areas used for nesting, resting, and foraging, and protecting habitat used by the prey base (Dunstan 1989). Some researchers suggest placing 0.25 to 2-mile buffer zones around nest sites in areas undergoing energy development or increased recreational use (Richardson and Miller 1997). Nest-site protection is only advantageous if the prey base remains adequate following development. If nesting sites and important prey concentrations such as ground squirrel colonies are avoided, golden eagles should be able to coexist with oil and gas development (Suter and Joness 1982)

<u>Associated Species:</u> Species that use similar habitats or species that may respond similarly to management activities would include the Swainson's hawk, red-tailed hawk, northern harrier, peregrine falcon and prairie falcon.

<u>Gambel Oak</u>

This cover type comprises approximately 2.6% of the Study Area. Gambel oak vegetation occurs at elevations of approximately 4,500 to 8,500 feet, often in association with piñon-juniper woodlands, ponderosa pine timberlands, or in previously burned areas. Associated understory shrubs include snowberry (*Symphoricarpos* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.).

Virginia's Warbler (*Vermivora virginiae)*

<u>Status:</u> The DBC considers the Virginia's warbler a common nester in southwestern Colorado. The CNHP has no ranking for this species. BBS trend data indicate a slight decrease in Colorado but there is no indication of decline on the continent. Virginia's Warblers are on the national Partners in Flight 1998 Watch List, indicating a high conservation need throughout their range (CPIF).

<u>Distribution:</u> The Virginia's warbler's breeding range lies almost entirely within the southwestern United States. They breed primarily in the Four Corners states of Colorado, Utah, New Mexico, and Arizona, with extensions into Nevada and extreme eastern California and the Guadalupe Mountains of western Texas. In Colorado, these warblers nest primarily between 5,000-9,000 ft in elevation. Virginia's warbler winters primarily in dense, semi-arid scrub and savannah in the highlands of west-central Mexico. (Bent 1953)

Life History: This species is typically associated with relatively dense shrublands (especially Gambel oak) located on slopes of mesas, foothills, open ravines, and mountain valleys in semiarid country (Andrews and Righter 1992). Virginia's warblers require dense undergrowth for both foraging and nesting. They also use pinion-juniper woodland, and occasionally open ponderosa pine forests with well-developed shrubby understories. Breeding may also occur in aspen or Douglas-fir forests where a good under story of shrubs is present. In portions of Colorado, the species seems to require steep slopes with litter cover and shrub species richness for nesting (Curson et al. 1994). In Colorado, these warblers nest primarily between 5,000-9,000 ft in elevation.

Diet of Virginia's warbler consists primarily of invertebrates year round, although it also feeds on nectar in winter (Curson et al. 1994; Rappole et al. 1995). Foraging activities typically occur on or near the ground.

Virginia's warbler begins its breeding cycle in mid-May to early June with pairs beginning nesting activities by early June. Males defend large territories. Breeding territories have been estimated at 1 acre with an estimated home range of 3 acres (Hoover and Wills 1984). Nests are typically located on the ground and are well hidden under grass and leaves below dense brush. The nest, which is built primarily by the female, consists of a shallow cup lined with hair and grasses

Factors of Concern and Management Implications: Virginia's warblers have a small breeding range, and in many places within their range their habitat has been severely altered. Activities such as mining, road construction, hiking trails, fire, development of rural areas, and range improvement for livestock can result in habitat fragmentation and degrade nesting, resting, and foraging habitat for this species. Virginia's Warbler is vulnerable to brown-headed cowbird parasitism and the rate of parasitism may be increasing (Kingery 1998). Due to the narrow breeding range of this species, Colorado plays an important role in protecting the habitat of this species. (CPIF)

Associated Species: Other bird species that may use similar habitats in a similar way and/or respond similarly management activities include common poorwill, broad-tailed hummingbird, house wren, blue-gray gnatcatcher, green-tailed towhee, spotted towhee and black-headed grosbeak. (CPIF)

Piñon - Juniper

Piñon-juniper woodlands dominate much of the Study Area uplands. This cover type occurs between elevations of approximately 6,000 and 8,400 feet within the area. Canopy cover is quite variable, ranging from less than 5 to 70 percent crown cover. Low-density piñon-juniper areas have a crown cover of 10 to 30 percent. The low-density piñon- juniper cover type comprises approximately 3.5% of the Study Area and the medium to high density Piñon -juniper, approximately 32.4%. Associated grasses include muttongrass, Indian ricegrass, western wheatgrass, needle-and-thread, blue grama, sideoats grama, and galleta grass. Typical shrubs consist of sagebrushes, bitterbrush, and mountain mahogany. Scattered to dominant stands of big sagebrush occur in deteriorated range areas along valley bottoms and in upland parks. The black-throated gray warbler was selected to represent the medium-high density Piñon -juniper and the gray flycatcher was selected to represent the low-density pinion-juniper.

Black throated grey warbler (Med.-High Density PJ)
(*Dendroica nigrescens*)

Status: The Durango Bird Club considers the black-throated gray warbler (BTGW) an uncommon nester in southwest Colorado, while unpublished BLM records seem to indicate that it is a fairly common nester in the region. The BBS trend data shows a steady to slightly increasing population between 1966 and 1996.

Distribution: The breeding range of the BTGW extends from southwestern British Columbia, western Washington, and central Oregon across southern Idaho to western Wyoming, south (primarily in the mountains) to Arizona, southern New Mexico, northern Baja California, and northeastern Sonora, Mexico. In winter it is found primarily in Mexico including Baja California Sur and the Pacific Slope and interior of Sonora, Durango, Zacatecas, and Coahuila south to central Oaxaca. It also winters in small numbers in California and southern Arizona; and casually along the Gulf Coast of U.S.

In Colorado the BTGW it is a summer resident of piñon-juniper woodlands across the southwestern half of the state, but are rare in the piñon-juniper around the San Luis Valley. They are occasionally seen in migration on the eastern plains of Colorado to the Kansas state line (Andrews and Righter 1992).

Life History: The BTGW in the southwest is primarily associated with piñon/juniper woodlands (occasionally with scattered ponderosa pine) and mixed oak-pine woodlands. Andrews and Righter (1992) consider this species to be a piñon/juniper obligate in Colorado. It appears to favor dense woodlands in which piñon pine is dominant in density over juniper and prefers stands with taller dominant trees. It also seems to prefer areas with poorly developed shrub layers beneath the woodland canopy, although Gambel oak is often a component of occupied habitat.

The BTGW's diet consists almost exclusively of insects, especially caterpillars (Dunn and Garrett 1997). Forage occurs at the mid-canopy level by gleaning foliage, or occasionally by hover gleaning and sallying for flying insects. This species may be important in the control of pine and piñon needle scales, juniper scales, leaf miners, oak lace bugs, fruitworm caterpillars, and tree crickets among other potential pests (Furniss and Carolin 1977). This species is not social during the breeding season, but will join mixed-species flocks with other insectivorous birds during winter and migration (Dunn and Garrett 1997).

Migrating birds return to their breeding grounds in Colorado in mid April. By the second week of May the males have established breeding territories. Based on estimates made by researchers an individual breeding territory is estimated at 2-3 acres in size (Hoover and Wills 1984, Stahlecker 1989). The nest is built in the low to mid canopy of a tree on a horizontal limb within 4 to 35 feet from ground. The nest is constructed with dry leaves, bark shreds, bits of cocoons, dry leaves, plant down, and lined with small feathers, hair, plant cotton and fine grass. These materials are held together and to twigs with spider webs (Harrison 1979). The young hatch in June and most have fledged by the beginning of July.

The BTGW is subject to predation from sharp-shinned hawks and Cooper's hawks (Reynolds and Meslow 1984). Likely predators of eggs and young include jays, crows, and snakes (Bent 1953). It had been thought that this species was not seriously threatened by brood parasitism from the brown-headed cowbird. However, recent data seems to indicate that parasitism may be higher than originally thought and rates may be as high as 11% - 21% (Guzy and Lowther 1997).

Factors of Concern and Management Implications: This species appears to tolerate some level of alteration in its habitat. However, there have been no detailed studies of responses to habitat alteration, such as changes in densities, breeding success, and habitat use (Guzy and Lowther 1997). Land management practices that remove overstory trees from piñon-juniper woodlands, may adversely affect habitat use by BTGW (Sedgwick 1987). Continued alteration and loss of habitat may have cumulative effects unidentified to date. For example, land management practices that increase contact between black-throated gray warblers and brown-headed cowbirds may have a substantial impact on breeding success.

Associated Species: Other bird species that may use habitat in a similar way and/or respond similarly to management, activities include mourning dove, scrub jay, stellar's jay, black-billed magpie, western tanager, black-headed grosbeak and dark-eyed junco.

Grey flycatcher (Low Density PJ)
(Empidonax wrightii)

Status: The DBC indicates an inadequate amount of species information to classify the gray flycatcher on a local basis. The CNHP does not rank this species. BBS data suggest a slight declining population trend in Colorado between 1966 and 1996.

Distribution: The gray flycatcher breeds from south-central Washington and south-central Idaho to central Colorado, south to south-central California, central Arizona, and south-central New Mexico. It winters in central Arizona and Mexico, and rarely in southern California. In Colorado, it is found Moffat County southward in the western portion of the state and Fremont County southward to New Mexico in the eastern portion of the state (CPIF).

Life History: Gray flycatchers are a summer nester in this portion of its range. The species is considered a pinyon-juniper obligate in Colorado. They nest in open pinyon-juniper woodlands, especially where these woodlands are adjacent to or intermixed with sagebrush and/or greasewood openings. They use stands with large decadent and dead trees, whether dominated by juniper or by pinyon. Less frequently they occur in sagebrush scrub or in dense brush near streams in semi-arid areas (Johnsgard 1986).

Gray flycatchers are strict insectivores. They frequently forage for insects flying low to the ground. They make short sallies for flying insects, usually from exposed perches in tall shrubs. A large variety of insects ranging in size from small beetles to butterflies are taken (Bent 1942).

Gray flycatchers begin arriving at their Colorado breeding grounds in May, forming loose colonies in favorable habitats. In California, Johnson (1963) reported territory sizes of 1.2 to 3.6 ha (3-9 ac). The nesting cycle begins soon after arrival. An open cup nest is constructed of bark, grass, and other plant materials and lined with feathers and hair. Nests are typically located in the crotch of a shrub or tree within 3 feet of the ground. Gray flycatchers may produce two broods during the nesting season with 3-4 eggs in each clutch (Harrison 1979). In Oregon, Friedmann et al. (1977) found 20-30% of nests parasitized by brown-headed cowbird.

Factors of Concern and Management Implications: Gray Flycatchers appear to be relatively tolerant to disturbance and partial fragmentation within their habitats. They will occur in small stands of less than 2.5 ac, but will not use these smaller stands if they are isolated from larger stands by more than roughly a half-mile (CPIF). This species is sensitive to loss of the shrub component within their habitats. Activities such as heavy annual grazing and significant reductions in shrub cover within nesting habitat may also increase the risks of nest parasitism by brown-headed cowbirds (CPIF, Robinson et al. 1993).

Associated species: Other bird species that may use similar habitat and/or respond similarly to threats, management, and conservation activities include ash-throated flycatcher, gray vireo, pinyon jay, juniper titmouse, and Bewick's wren. (CPIF)

Ponderosa Pine

This plant community occurs at elevations between 6,500 and 8,800 feet within the Study Area where annual precipitation generally equals or exceeds 16 inches. This cover type comprises approximately 4.0% of entire Study Area. The dominant vegetation type is ponderosa pine timberlands, with an understory of mountain muhly, pine dropseed , needle-and-thread, muttongrass, and slender wheatgrass. Associated shrubs include Gambel oak, serviceberry, mountain mahogany, and mountain juniper. Douglas-fir also occurs on some north-facing slopes at higher elevations of the Study Area. Small, scattered areas of aspen also are present but are not identified on project maps. Valley bottoms in these areas are dominated by grasses and shrubs including wheatgrasses, needle-and-thread, and mountain muhly, with big sagebrush present in areas of deteriorated range.

Abert's squirrel *(Sciurus aberti)*

Status: There is no Colorado State listing for this species. Abert's squirrel is listed on the Utah Sensitive Species List due to its limited distribution in the state. Population declines may have occurred in some areas of its range due to management practices in the ponderosa pine forest type.

Distribution: The Abert's squirrel inhabits a narrow range within the lower-middle montane regions of Arizona, New Mexico, Utah, and Colorado. In Colorado it occurs primarily within the ponderosa pine zone along the Front Range to the northern part of the state, south through the Sangre de Cristo range, and in the San Juan Mountains and Grand Mesa in the southwest portion of the state.

Life History: This species is found primarily in the ponderosa pine cover type, although it does use other types such as pinyon-juniper and Gambel oak for foraging activities. Hoover and Wills (1984) describe ideal habitat as "uneven-aged stands of ponderosa pine having 11 to 36 inches d.b.h., 200 stems per acre with basal areas of 150 to 200 square feet per acre, canopy closure greater than 80% with interlocking branches, and crowns 30 to 50 feet above the forest floor". The estimated size of an individual territory for this species is approximately 14.3 acres (Hoover and Wills 1986). Other researchers have reported a range of 10-18 acres with an overlap of territories between individuals. Territory size seems to fluctuate, to some degree, on a seasonal and annual basis (Hoffmeister 1986).

The nests are usually located 30–50 feet above the ground in mature ponderosa pine. The nest trees are typically centrally located within a group trees. Nests are usually built of sticks but tree cavities and witch's brooms are also occasionally used. Nests are utilized for reproductive purposes, as well as resting cover throughout the year. (Keith 1965) Abert's squirrels select nest site locations to (1) maximize accessibility and (2) maximize structural stability, which may provide protection from wind and rain.

The Abert's squirrel uses a wide variety of foods. Primary foods include inner bark, seeds, terminal twigs, buds and cones of ponderosa pine. For up to six months of the year Abert's squirrels only eat the ponderosa pines' phloem, which is a high fiber, low quality diet (Murphy 1999). Other foods taken by this species includes fungi, acorns, carrion, bones, antlers, bird's eggs and terminal buds and seeds of pinion pine. Although a proximity to water is not a necessary feature for survival of this species, higher population densities near water sources suggest that it may be a beneficial characteristic of suitable habitat.

Factors of Concern and Management Implications: Significant reductions in stocking in well-stocked ponderosa pine stands through timber harvesting or other activities can have a detrimental effect on this species. Habitat fragmentation through clearing or road building would also reduce habitat quality. Individuals often suffer mortality near well-traveled roads. Hoover and Wills (1984) consider that it would take approximately 30 individuals to provide a minimum viable population, which would require 429 acres of optimal habitat.

Associated Species: Other species that may use habitat in a similar way and/or respond similarly to management, activities include flammulated owl, grace's warbler, Merriam's turkey, pygmy nuthatch, porcupine, and western tanager.

Grace's warbler *(Dendroica graciae)*

Status: The DBC characterizes this species as an uncommon nester in Southwestern Colorado. The CNHP global ranking for Grace's warbler is G5 (demonstrably secure). The BBC data lacks adequate sample sizes to permit analysis of trends in Colorado. Continent-wide results do not show a statistically significant annual rate of change between 1966 and 1996 (CPIF).

Distribution: Grace's warbler breeds from southern Nevada, southern Utah, southwestern Colorado, northern New Mexico, and western Texas south through the mountains of western Mexico to Nicaragua. It winters in northern Mexico and is resident from central Mexico southward. It is an uncommon summer resident in the southwestern mountains of Colorado and rare or accidental in other parts of the state. (Andrews and Righter 1992)

Life History: Grace's warbler, a neotropical migrant, is primarily a resident of the ponderosa pine forest type in its breeding grounds. It is found at elevations ranging from 6,000 to 9,000 feet (Griscom and Sprunt 1979). It has low tolerance to ecological change due its dependence on tall pines in its breeding habitat (USFS 1982). There appears to be a preference for ponderosa pine forest with a significant shrub component, usually Gambel oak (CPIF).

This warbler is primarily an insectivore. It forages in the upper levels of the tree canopy where insects are gleaned directly for the limbs and foliage. It will occasionally take insects in flight within proximity to forage trees (Johnsgard 1986).

Grace's warbler arrives at its breeding grounds in the southwest in mid to late April. Mating activities presumably occur shortly thereafter, though singing males have been reported as late as the end of June (Johnsgard 1986). Breeding territories range from 0.5-1.8 acres (Szaro and Balda, 1979). Nests are typically located on limbs of pine trees from 20-60 feet above the ground, sometimes hidden in the middle of a cluster of pine needles. Nests are constructed with a variety of grass fibers and other vegetable matter, animal hair, and cobwebs and lined with hair or feathers (Harrison 1979). Graces warbler appears to be a rare host of the brown-headed cowbird.

Factors of Concern and Management Implications: There is a relative paucity of information regarding the ecology of this species. Any activities that significantly affect the integrity of the pine habitats, such as significantly reducing stand densities, would probably have an effect on breeding and foraging success.

Associated Species: Other species that may use similar habitat and/or respond similarly to threats, management, and conservation activities include flammulated owl, olive-sided flycatcher, violet-green swallow, pygmy nuthatch, and western tanager (CPIF).

Riparian Woodland

Narrow bands of wooded riparian areas occur within the Study Area along perennial and intermittent stream courses. Characteristic tree species primarily consist of cottonwoods (*Populus* spp.) associated with shrubs including alder, ash, hawthorn and willow (*Salix exigua, Salix* spp.). Further discussion of wetland systems is provided in the section below on wetlands. The vegetative cover type comprises approximately 1.9% of the total Study Area acres.

Yellow warbler (*Dendroica petechia*)

Status: The DBC identifies the yellow warbler as a common nester in southwestern Colorado. The BBS indicates that species populations appear stable in Region 6 of the USFWS, including Colorado, but show signs of serious declines in other regions (Andrews and Righter 1992).

Distribution: This species has an extraordinarily broad distribution for a warbler species and show great geographical variation. More than 40 recognized subspecies form three general groups that range from the northern limits of shrubby habitat in Canada to northern South America. The yellow warbler breeds from northwestern and north-central Alaska and northern Yukon to northern Ontario, central Quebec, and southern Labrador south to Mexico, central and northeastern Texas, northern Arkansas, central Georgia, and central South Carolina. It winters from southern California, southwestern Arizona, Mexico, and southern Florida south to South America. In Colorado it is considered a common summer resident and spring and fall migrant to the western valleys and rare on the eastern plains and higher mountains (Andrew and Righter 1992).

Life History: This warbler generally prefers moist habitats, such as riparian woodlands and brush, the shrubby areas of marsh, swamp or ponds. It will occasionally inhabit drier areas if the vegetative cover is adequate. A combination of open areas and dense shrubbery seem to be a factor in suitable habitat for breeding. (Johnsgard 1986) Tall singing posts may also be a component of good habitat.

The yellow warbler is primarily an insectivore. It forages for insects and spiders on the limbs of shrubs and trees by gleaning and sometimes by hawking (DeGraff et al. 1980). It will occasionally supplement its diet with berries. Among its favorite meals are small larvae and caterpillars (Ehrlich 1992).

The yellow warbler arrives at its breeding ground in early to mid May. Egg records in Colorado are from June 18 to July 6. (Johnsgard 1986) Nests are built by the female in the upright crotch of a tree or shrub between 2 and 12 feet from the ground. Nests are constructed of a variety of materials including milkweed fibers, grasses, plant down and hair. (Harrison 1979) The average size of a breeding territory for the yellow warbler is estimated at 1 acre (Hoover and Wills 1986)

This species is often the victim of nest parasitism by the brown-headed cowbird. When cowbird eggs have been deposited into the nest the female will build another layer over the corrupted nest and lay another clutch of eggs (Harrison 1979).

Factors of Concern and Management Implications: Activities that alter the structure of riparian woodland habitat through tree or shrub removal could have an impact on the breeding and foraging success of this species. Fragmentation of contiguous tree and shrub canopies may increase parasitism by brown-headed cowbird.

Associated Species: Other species that may use similar habitats and/or respond similarly to management, activities include bald eagle, Bullock's oriole, yellow-breasted chat, blue grosbeak, willow flycatcher and Lewis woodpecker.

Wetland/Marsh

The wetland/marsh cover type comprises less than 1% of the Study Area. It is occurs along perennial streams, irrigation and wastewater ditches, water impoundments, as well in small areas isolated areas of high groundwater in flat valley bottoms. These areas are found dispersed within the previously discussed vegetative cover types. Typical vegetation in these areas includes sedges, rushes, tufted hairgrass, bluejoint reedgrass, redtop, cattail, willow and cottonwood. Since wetlands typically occur in low-lying areas they can be affected by activities that occur at quite a distance from the site. Reductions in surface and ground water flow can have significant adverse affects to these systems. Additionally, sediments and contaminants entering hydrologic systems will move toward and tend to concentrate in these areas. These changes can result in commensurate effects to wildlife habitat found in these areas. Sections 4.5.1 and 4.5.2 provide a comprehensive discussion of potential effects to groundwater and surface water resulting from proposed project-related activities.

Striped Chorus Frog *(Pseudacris triseriata)*

Status: The CNHP has no ranking for this species. Populations in some areas of the state have experienced a significant decline for unknown reasons (Hammerson 1986).

Distribution: The striped chorus frog ranges throughout much of eastern and central North America. In Colorado, it is found in most of the state's counties from 3,500 to 12,000 feet in elevation but is rare in the extreme western portion of the state and the southeastern corner (Hammerson 1986).

Life History: This small frog (generally <1½ inches in length) inhabits small ponds, marshes, pools and other bodies of non-flowing water during the spring and early summer. However, it may spend the post-breeding period of summer in wet meadows as far as ⅓-mile away from its breeding pools (Spencer 1964). Chorus frogs seem to occur in isolated populations with larger population sizes occurring at lower elevations (Hammerson 1986).

Seasonal cycles of breeding are also highly dependent on elevation and apparently on seasonal temperatures. In lowland areas frogs begin calling in March or April and egg-laying females are present from early May to June. At higher elevations breeding begins immediately after spring thaw in late May or early June (Matthews and Pettus 1966).

The female lays eggs in loose clusters, which are attached to vegetation in shallow water. Chorus frogs metamorphose as early as June in lower areas. It appears that survival rates are much higher through metamorphosis in lower elevational populations than in mountain populations (Spencer 1964, Miller 1977). Frogs reach adult size about 78 days after metamorphosis (Hammerson 1986).

Individuals can live up to five years. However, mortality is very high, especially in the younger stages of life. A number of species prey on the chorus frog including birds, snakes, and fish (Hammerson 1986).

Factors of Concern and Management Implications: The chorus frog would be sensitive to changes in the hydrologic processes that would affect availability of breeding habitat. This species appears to be quite tolerant of human activities, considering its presence in agricultural and suburban areas. However, contaminants in runoff can concentrate in breeding ponds, making eggs and larvae susceptible to detrimental effects (Harding 1997). The permeable skin of the western chorus frog also makes it susceptible to contaminants and other external stimuli. Changes in morphology or ecology of this species might indicate high levels of pollution or other activity detrimental to their well-being.

Associated Species: Species that use similar habitats or species that would be affected in similar ways from management activities include the tiger salamander, northern leopard frog, Woodhouse toad, New Mexico spadefoot toad, and painted turtle.

3.3.4 Threatened, Endangered, and Sensitive Species

Threatened, endangered, and sensitive (TES) species include federal- and Colorado state-listed threatened, endangered, proposed, and candidate species; SUIT sensitive species; and CNHP species of concern. Federally listed threatened and endangered species are protected by the ESA (50 CFR 17) of 1973, as amended, which is administered by the USFWS.

Federal endangered species are classified based on vulnerability of becoming extinct throughout all or a significant portion of their range. Federal threatened species are classified based on the probability of becoming endangered in the foreseeable future. Federal candidate species are those for which the USFWS has sufficient information on biological vulnerability and threats to support proposals to list them as endangered or threatened.

State threatened or endangered species include species that have been recognized as being rare within the state. Colorado State Statutes 33-2-105 Article 2, which is administered by the CDOW, provides protection to Colorado threatened and endangered species, although it does not protect habitat for such species. SUIT sensitive species have been identified as species of concern by the SUIT Wildlife Department. Although no specific protection is provided for these species, SUIT sensitive species do receive special management attention from the Tribe, ultimately for the purpose of avoiding the need for federal protection in the future. The CNHP identifies species of global and state-wide concern and ranks species by rarity, although CNHP designation does not provide protection to species. Species of concern have been identified by the USFWS and CDOW. Many of these species were previously designated as Federal Category 2 Candidates (C2), but are no longer considered candidates and are not provided protection.

A Biological Assessment (BA) was prepared to assess impacts on federally listed threatened, endangered, and candidate species more thoroughly. This process provides a means of reviewing proposed alternatives or activities in sufficient detail to determine how a proposed project may affect any plant or animal species that is listed under the ESA. This BA was submitted to the USFWS and a copy is provided in Appendix G of this EIS.

3.3.4.1 TES Plant Species

Eleven TES plant species were listed by the USFWS and CNHP as potentially occurring in the Study Area. These species are listed in Table 3-9 by common and scientific name, legal status and/or CNHP state rank, and likelihood of occurrence in the Study Area. Likelihood of occurrence was determined by previous records and identification of areas of suitable habitat.

TABLE 3-9
Threatened, Endangered, and Sensitive Plant Species Potentially Occurring in the Study Area

Species	Status/ Rank	Presence	Comments
Knowlton's cactus *Pediocactus knowltonii*	FE, S1	Present	Associated with piñon-juniper on Tertiary alluvial deposits
Mancos milkvetch *Astragalus humillimus*	FE	Unlikely	Mesa Verde Group outcrops, Four Corners area
Mesa Verde cactus *Sclerocactus mesas-verdae*	FT, S2	Unlikely	Sparsely vegetated shale or adobe clay badlands in Fruitland Formation and Mancos Shale; only known location in Colorado is in Montezuma County
Ute lady's tresses *Spiranthes diluvialis*	FT, S2	Possible to unlikely	Seasonally moist soils and wet meadows usually near streams; reported to be in Reservation but siting has not been verified; nearest known distribution in Capitol Reef National Park, Utah
Aztec milkvetch *Astragalus proximus*	S2	Possible	Soils derived from Lewis or Mancos Shale; sited in Allison area, 1899
Arboles milkvetch *Astragalus oocalycis*	S3	Possible	Selenium soils in sagebrush flats, La Plata and Archuleta counties; sighted in vicinity of Allison, Tiffany, Ignacio, Bayfield, and Weasel Skin Bridge, 1960s through 1980s
Compact gilia *Ipomopsis congesta* spp. *crebrifolia*	S1	Possible	Sighted in Tiffany area, 1985
Abajo penstemon *Penstemon lentus*	S2	Unlikely	Associated with piñon-juniper on adobe hills; sighted in Allison area, 1899
Little penstemon *Penstemon breviculus*	S2	Possible	Associated with sagebrush and piñon-juniper communities on soils derived from Ojo Alamo Sandstone or Nacimiento formations; Montezuma County and New Mexico; sighted in vicinity of Mesa Verde National Park, 1963
Showy collomia *Collomia grandiflora*	S2	Possible	Gravely/rocky ground with piñon-juniper or shrubs; sited in Ridges Basin area, 1979
Wood lily *Lilium philadeliphicum*	S3	Unlikely	Moist woods, thickets, and wet meadows; sighted in area, 1917

Status:
FE - Federally listed as endangered
FT - Federally listed as threatened

CNHP Rank:
S1 - Critically imperiled in state
S2 - Imperiled in state
S3 - Rare in state

Knowlton's cactus (*Pediocactus knowltonii*), a federally listed endangered species, occurs in piñon-juniper woodlands in association with rocky alluvial soils and black sage (*Seriphidium novum*) at elevations of approximately 6,300 to 6,350 feet. This species is one of the rarest of the genus and one of the rarest plants in the United States, with illegal collections contributing to its decline (Ecosphere 1995). The main population occurs south of La Boca at the New Mexico border. Small populations are present within the Study Area. Exact locations of these populations are not provided in this EIS in order to protect the species.

Mancos milkvetch (*Astragalus humillimus*), a federally listed endangered species, is present only on ledges and mesa tops in slickrock communities of the Mesa Verde Group in the Four Corners area. This species has been observed in Montezuma County, Colorado and in San Juan County, New Mexico. Mancos milkvetch has not been observed in the Study Area, but Mesa Verde outcrops are present.

Mesa Verde cactus (*Sclerocactus mesas-verdae*), a federally listed threatened species, occurs in salt desert scrub communities in the Fruitland Formation and Mancos Shale in the Four Corners area. This species has been observed in Montezuma County, Colorado and in San Juan County, New Mexico, but not in the Study Area.

Ute lady's tresses (*Spiranthes diluvialis*), a federally listed threatened species, is an orchid that occurs in Colorado primarily along the Front Range below 6,500 feet elevation in seasonally moist soils and wet meadows near springs, lakes, or perennial streams and their associated floodplains. Typical sites include old stream channels and alluvial terraces, sub-irrigated meadows, and other sites where the soil is saturated within 18 inches of the surface at least temporarily during the spring or summer growing seasons (USFWS 1992). The plant also may occur on heavily disturbed sites such as old gravel mines that have developed into wetlands. Although this species was probably once common in low elevation riparian areas of Colorado, Utah, and Nevada, it is now considered to be very rare and is not known to occur in habitats with dense, weedy vegetation, or in areas that have been overgrazed (Coyner 1990; Jennings 1990). The channelization of rivers, alteration of stream hydrology, overgrazing, and mowing for hay are believed to be the cause of the demise of this species. Potential habitat for this species is present on the Reservation, but the presence of Ute lady's tresses within the Study Area has not been verified. Since no southwestern Colorado populations have been observed, the USFWS no longer requires Ute lady's tresses surveys in this area of the state.

Species of concern, as identified by CNHP, which may occur in the Study Area include Arboles milkvetch (*Astragalus oocalycis*), Aztec milkvetch (*Astragalus proximus*), compact gilia (*Ipomopsis congesta* spp. *crebrifolia*), Abajo penstemon (*Penstemon lentus*), little penstemon (*Penstemon breviculus*), showy collomia (*Collomia grandiflora*), and wood lily (*Lilium philadeliphicum*). Arboles milkvetch is endemic on soils containing selenium. This species occurs within the Study Area in the vicinity of Allison, Tiffany, Bayfield, Ignacio, Oxford, and Weasel Skin Bridge. The compact gilia was identified in 1985 in the vicinity of La Boca on the Pine River, and the showy collomia was identified in 1979 in the Ridges Basin area. Abajo penstemon, Aztec penstemon, little penstemon, and wood lily historically occurred in the Study Area, but the last verified sitings occurred more than 25 years ago.

3.3.4.2 TES Wildlife and Fish Species

TES wildlife and fish species that could potentially occur in the Study Area are listed in Table 3-10. The status and distribution of the TES species listed in Table 3-10 is described in the following text. Selected habitats for TES wildlife species are shown on Map 9.

TABLE 3-10
THREATENED, ENDANGERED, AND SPECIAL STATUS FISH AND WILDLIFE SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Species	Status/Rank	Presence	Comments
Black-footed ferret *Mustela nigripis*	FE	very unlikely	extirpated throughout most of its range
Whooping crane *Grus americana*	FE, SE	migrant	may use suitable habitat during migration
Bald eagle *Haliaeetus leucocephalus*	FT	resident	confirmed breeder, winter population
Peregrine falcon *Falco peregrinus*	ST	resident	confirmed breeder, winter population De-listed Federal Species-Required monitoring for 5 years
Southwestern willow flycatcher *Empidonax traillii extimus*	FE	potentially present breeder	presence unconfirmed, but reservation contains suitable habitat
Gunnison Sage Grouse Centrocercus minimus	FC	very unlikely	reservation contains suitable habitat on southern and northern borders
Mexican spotted owl *Strix occidentalis lucida*	FT, ST	potentially present	marginal suitable habitat in eastern edge of Study Area
Colorado pikeminnow *Ptychocheilus lucius*	FE	not present	critical habitat downstream from Study Area in San Juan River
Razorback sucker *Xyrauchen texanus*	FE	not present	critical habitat downstream from Study Area in San Juan River
Western boreal toad *Bufo boreas boreas*	FC, SE	not present	no suitable habitat due to elevation
Lynx *Lynx canadensis*	FT	not present	no suitable habitat
Greater sandhill crane *Grus canadensis tabida*	ST	migrant	may use suitable habitat during migration
Long-billed curlew	SC	migrant	may use suitable habitat during migration

TABLE 3-10
THREATENED, ENDANGERED, AND SPECIAL STATUS FISH AND WILDLIFE SPECIES POTENTIALLY OCCURRING IN THE STUDY AREA

Numenius mercana			
Roundtail chub *Gila robustus*	SUIT SC	present	occurs in Florida River
Flannelmouth sucker *Catostomas latipinnis*	SC	presence likely	project area is within known distribution
Rio Grand chub *Gila nigrescens*	SC	presence likely	project area is within known distribution
Ferruginous hawk *Buteo regalis*	SC	resident	rare breeder, winter population
Mexican vole *Microtus mexicanus*	SC	present	distribution, population size unknown
Yuma myotis *Myotis yumensis*	SC	present	distribution, population size unknown
North American river otter *Lutra canadensis*	SE	present	distribution, population size unknown
Southern plateau lizard *Scelopoms indulatus tristichus*	SC	present	distribution, population size unknown

FE = Federally Endangered
SE = State Endangered
SC = Species of special concern
FC = Federal Candidate Species
SUIT SC = Southern Ute Indian Tribe Species of Concern
FT = Federally Threatened
ST = State Threatened
PT = Proposed for Federal listing as Threatened

Federally Listed Threatened, Endangered, and Protected Species

Bald eagle (*Haliaeetus leucocephalus*), a federal threatened and state threatened species, is known to both nest and winter in various locations throughout the Study Area. Three known active eagle nest sites occur within the Study Area: one located near the town of Allison west of the Navajo Reservoir, and the other two located on the Pine River north and south of the town of Ignacio. All nests have been documented in large, mature cottonwood trees (Stroh 1998). Winter range, including habitat designated as a winter concentration area by the CDOW, occurs along all major drainages in the Study Area, as well as between the Florida and Pine rivers along the Reservation's northern boundary (Map 9). As many as 10 bald eagles may be present along the Pine River in winter (Diswood 1996). Also present within the Study Area are resident reproducing populations of golden eagles (*Aguila chrysaetos*). Golden eagle nest sites receive similar protection as bald eagles under the Bald Eagle Protection Act (16 USC 668-668c). Golden eagles have been documented nesting in the Study Area on rock-cliff faces, ponderosa pine trees, and in large piñon trees (Stroh 1998). Both bald and golden eagle feathers are sought by Tribal members for use in religious ceremonies. Tribal members may apply for eagle parts using the USFWS eagle repository.

Mexican spotted owl (*Strix occidentalis lucida*), a federal and state threatened species, is unlikely to be living in the Study Area. It requires multi-layer mixed conifers with high canopy closure and high stand density located in deep canyons, for nesting. Wintering owls may also occur in piñon-juniper stands where wood rats (*Neotoma* spp.) are abundant.

Peregrine falcon (*Falco peregrinus*), a state species of concern, requires areas with tall cliffs for both nesting and perching, with adjacent coniferous and riparian forests for hunting. This raptor feeds primarily on other birds and is designated as federal endangered and state threatened. Adequate habitat and a suitable food base for peregrines are available on the Reservation in some areas. One to two pairs breed on the Reservation, and a number of birds winter there as well. The locations of peregrine nests is confidential information (Craig 1996).

Southwestern willow flycatcher (*Empidonax traillii extimus*), is federally and state listed as endangered. Potential southwestern willow flycatcher habitat consists of thickets of willow or other large shrubs, possibly with an overstory of cottonwood or other trees, with dense ground and midstory vegetative cover. Preferred habitat provides surface water, a boggy or swampy condition, or saturated soil underlying or adjacent to the stand during the midsummer breeding season. Areas of potential southwestern willow flycatcher habitat are identified as wooded riparian vegetation and are shown on Map 9. Additionally, large willow stands associated with irrigation canals may provide additional suitable nesting habitat. Although comprehensive surveys to confirm the presence of this species have not been conducted, the Study Area lies within its range, suitable breeding habitat is present, and so it is likely that this bird breeds in the Study Area.

Whooping crane (*Grus americana*), a rare migrant in the western valleys of Colorado, may occasionally utilize the Study Area, although no records exist. A federal and state endangered species, whooping cranes have been transplanted from the last remaining wild population to nesting grounds in Idaho. It is these transplanted birds that occasionally migrate through western Colorado. Cranes that migrate through Colorado use mudflats around reservoirs and agricultural areas.

Black-footed ferret (*Mustela nigripes*), a federal and state endangered species, historically inhabited prairie dog (*Cynomys* spp.) ecosystems throughout the state of Colorado. No known black-footed ferret populations currently occur in Colorado. Poisoning programs over the last century have severely reduced prairie dog distributions, and consequently black-footed ferret populations. Black-footed ferrets feed exclusively on prairie dogs, and generally require a prairie dog town at least 80 acres (for black-tailed prairie dogs) in size to provide an adequate prey base. Although the Study Area is within the historic range of the black-footed ferret, it is extremely unlikely that these ferrets occur in the Study Area.

Lynx (*Lynx canadensis*), is a federal threatened and state endangered species. Lynx inhabit high elevation spruce-fir trees with uneven-aged stands of trees with relatively open canopies and well-developed understories. The principal food of the lynx is the snowshoe hare. Lynx are unlikely to occur in the Study Area because of lack of suitable habitat.

Colorado pikeminnow (*Ptychocheilus lucius*), is a federally endangered and state threatened species. A small reproducing population of these fish occurs downstream in the San Juan River of Shiprock, New Mexico. During surveys in 1991, nine pikeminnow were captured approximately 5 miles upstream of Shiprock. No Colorado pikeminnow are known to occupy any of the rivers in the Study Area. Critical habitat for this species exists downstream from the Study Area in the San Juan River in San Juan County, New Mexico and San Juan County, Utah. Specifically, critical habitat has been designated for the Colorado pikeminnow within the 100-year floodplain of the San Juan River from the State Route 371 Bridge (T. 29 N., R. 13 W., Section 17) in the Neskahai Canyon up to the full pool elevation in the San Juan arm of Lake Powell (T. 41 S., R. 11 E., Section 26; USFWS 1994).

Razorback sucker (*Xyrauchen texanus*), is a federally and state listed endangered species that historically existed in the lower Animas River. During a 1987 to 1990 study, razorback suckers were observed within the San Juan River Basin in the vicinity of Lake Powell. This fish species is not known to occur in the Study Area; however, critical habitat exists for this species downstream from the Study Area in the San Juan River in San Juan County, New Mexico and San Juan County, Utah. Specifically, critical habitat has been designated for the razorback sucker within the 100-year floodplain of the San Juan River from the Hogback Diversion (T. 29 N., R. 16 W., S 9) to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell (T. 41 S., R. 11 E, Section 26; USFWS 1994).

Western boreal toad (*Bufo boreas boreas*), a federal candidate species and state endangered species, occurs in a wide variety of wetland areas at elevations between 8,500 and 11,000 feet. Although this species is known to occur in southwestern Colorado, the Study Area's lower elevations minimize the potential for occurrence.

<u>State Listed Threatened and Endangered Species</u>

North American river otter (*Lutra canadensis*), a state of Colorado endangered species, is present within the Study Area in the Piedra and Pine rivers (SUIT National Resource Plan 1990). River otters were extirpated from Colorado near the turn of the century and were reintroduced in the

1970s and 1980s through CDOW programs. River otters also have been reintroduced to the following rivers within the state: Colorado, Gunnison, and Dolores.

Greater sandhill crane (*Grus canadensis tabida*), a state of Colorado species of concern, is a rare migrant through western valleys of the state of Colorado. It is considered to be an abundant spring and fall migrant in the San Luis Valley and nesting occurs in northwestern areas of the state in Moffat, Route, Jackson, Rio Blanco, Grand, and Meeker counties (Andrews and Righter 1992). Habitat used by migrant birds includes mudflats around reservoirs, moist meadows, and agricultural areas.

<u>SUIT Sensitive Species</u>

Roundtail chub (*Gila robusta*), a state species of concern and a SUIT sensitive species, occupy deep, slow-moving water in small to large rivers and are known to occur in the Study Area in the lower Florida River and lower Rock Creek. Although not confirmed, they are likely to occur in lower reaches of the Pine River and Spring Creek where appropriate habitat is present. A roundtail chub was collected and documented in the lower stretch of Rock Creek south of the town of Ignacio in 1977 (T. Stroh, SUIT Wildlife Department, personal communication).

<u>Species of Concern</u>

Both the ferruginous hawk and long-billed curlew may use the Study Area during migration, and ferruginous hawks may winter here as well. The Yuma myotis inhabits semi-arid canyons and mesas; therefore, it is likely that this species is present within the Study Area. The flannelmouth sucker (*Catostomas latipinnis*) is present in the La Plata, Animas, Pine, Piedra, and San Juan Rivers.

3.4 GEOLOGY, MINERALS, AND SOILS

3.4.1 <u>Geology</u>

3.4.1.1 Physiography and Topography

The Reservation is located in the northern portion of the San Juan Basin and the northeastern portion of the Four Corners Platform on the eastern Colorado Plateau. The Colorado Plateau is a vast physiographic province extending throughout western Colorado, northwestern New Mexico, most of northern and northeastern Arizona, and southern and eastern Utah. This physiographic province is characterized by generally flat-lying sedimentary deposits divided by faults and monoclines that form cliffs and individual plateaus. Steep-sided mesas and buttes capped by erosion-resistant rock layers are common.

The San Juan Basin is an asymmetric structural basin in northwestern New Mexico and southwestern Colorado (Figure 3-2). The Hogback, a steep monoclinal ridge, is a prominent feature forming the western, northern, and eastern boundaries of the San Juan Basin. All CBM activities associated with the alternatives would occur east of the Hogback monocline within the San Juan Basin. To the west and northwest of the San Juan Basin is the Four Corners Platform. The Four Corners Platform is intermediate in height between the surrounding basins and uplifts and consists of several domes and anticlines. The topography of the Study Area varies from moderately steep to steep mountains, canyons, and mesas in the north-central and south-central portions, to rolling hills and gently sloping river valleys in the eastern and western regions. Mountain and river valley elevations range from about 8,000 to 6,000 feet, respectively.

3.4.1.2 Tectonics and Structural Regime

The Colorado Plateau is structurally unique in the western United States because it has been only moderately deformed (i.e., folded and faulted) compared to the more intensely deformed regions that surround it. Monoclines are the most distinctive structural features of the Plateau, and most of the deformation has occurred along these features. A monocline is a fold structure with only one tilted limb; the beds on either side of the tilted limb are horizontal.

San Juan Basin

The Study Area east of the Hogback monocline is within the San Juan Basin. The San Juan Basin appears circular in plan view, but the basin in cross-section is an asymmetrical basin of sedimentary rocks ranging in age from Cambrian to Quaternary, underlain by Precambrian rocks (refer to Figures 3-2 and 3-3). These sedimentary rocks are up to 14,000 feet thick at the deepest part of the basin, which is located near the Colorado-New Mexico state line. In this portion of the basin, the elevation of the top of the Precambrian basement rocks is more than 7,500 feet below sea level (Woodward and Callendar 1977). The basin is about 200 miles long (north to south) and 130 miles wide.

The San Juan Basin is bounded on the southeast by the Puerco fault zone; on the east by the Nacimiento uplift; and on the south, west, north, and northeast by the Zuni, Defiance, and San Juan uplifts and Archuleta Anticlinorium, respectively, of the Colorado Plateau. The Hogback monocline is a horseshoe-shaped feature that rims the basin on the northwest, north, and east sides with a maximum elevational rise of 700 feet above the surrounding area. In the southern and southwestern parts of the basin there are no sharp structural boundaries. The rocks dip gently toward the basin axis across the Chaco Slope. The central part of the basin is a dissected plateau,

FIGURE 3-2
Structural Elements of the San Juan Structural Basin
And Adjacent Areas
8.5 x 11, b & w

gently dipping to the west. Deep, steep-sided canyons have been formed within the basin from streams.

Formational dips within the central basin are generally less than 4 degrees. However, around the basin edge at the monocline, dips are typically 10 to 40 degrees in the Study Area, and have been measured up to 60 degrees at the monocline outside the Study Area (Woodward and Callendar 1977). The change in dip from the monocline to the central portion of the basin, locally termed the "flexure" or "hingeline," is fairly abrupt and within the Fruitland Formation occurs approximately 1.5 miles basinward of the exposed rock outcrop.

Four Corners Platform

The Study Area west of the Hogback monocline is within the Four Corners Platform. The Four Corners Platform is located along the northwestern border of the San Juan Basin and is primarily a monoclinal feature, with its strata dipping at moderate angles to the east, southeast, and south. The Paradox Basin of southeastern Utah and southwestern Colorado forms the northwestern boundary of the platform. The overall trend of the platform is to the northeast, connecting the Defiance and San Juan uplifts. The Hogback monocline distinctly marks the southeast boundary of the platform within the Study Area. The Four Corners Platform is intermediate in structural height relative to the surrounding uplifts and basins. Approximately 4,000 feet of structural relief across the Hogback monocline separates the Four Corners Platform from the San Juan Basin (Fassett and Hinds 1971; Kelley 1955; Woodward and Callendar 1977).

3.4.1.3 Stratigraphy

The stratigraphy of the Study Area is primarily the result of a long geologic history of inundation by epicontinental seas between periods of major uplift. Depositional environments of the various rock units include deep marine, shoreline, continental, and fluvial.

Map 10 shows the surface geology of the Study Area. The surficial geology of the Study Area primarily consists of Quaternary to Cretaceous-aged (Table 3-11) alluvium (unconsolidated silts, sands, clays, and gravels), sandstones, siltstones, shales, limestones, conglomerates, and coal. The lithologic units in the Study Area range in age from Cretaceous to Quaternary. They consist primarily of sedimentary rocks, but also include igneous rocks. Descriptions of these units and their stratigraphic relationship are described in Appendix H.

San Juan Basin

Figure 3-3 presents a north-south stratigraphic cross-section indicating the rock unit relationship across the San Juan Basin (refer to Figure 3-2 for location of the cross-section). The lithology of the San Juan Basin, represented by the Cenozoic and Mesozoic periods, includes mainly shales and sandstones of varying grain size but also includes coals, especially in the Fruitland and Menefee formations, and some carbonates.

TABLE 3-11
Major Geologic Time Divisions

Era	Period	Series or Epoch	Age Estimates (in million years before present)
Cenozoic	Quaternary	Holocene Pleistocene	0.01 1.8
	Tertiary	Pliocene Miocene Oligocene Eocene Paleocene	5.0 22.5 37.5 53.5 65
Mesozoic	Cretaceous		136
	Jurassic		190-195
	Triassic		225
Paleozoic	Permian		280
	Pennsylvanian		320
	Mississippian		345
	Devonian		395
	Silurian		430-440
	Ordovician		500
	Cambrian		570
Precambrian			> 570

Source: U.S. Geological Survey, 1994b

The younger Paleozoic units, representing the Permian period through the Pennsylvanian period, consist mainly of shales and sandstones but also include the carbonates of the Paradox Formation. The Paradox Formation is the oldest rock unit within the basin that has a potential to be a source of oil and gas. The older Paleozoic units are represented by carbonates of the

Mississippian and Devonian periods and the Ignacio Quartzite of the Cambrian period. The Precambrian deposits consist of igneous and metamorphic rocks.

The geologic units of Cretaceous age are the primary oil- and gas-bearing horizons within the San Juan Basin. The Tertiary and Quaternary units are the primary potable groundwater sources. The following discussion describes the geologic units of the Cretaceous, Tertiary, and Quaternary ages.

The Cretaceous-age rocks represent 6,000 feet of sandstones, siltstones, shales, and coals. The predominant hydrocarbon reservoirs of the San Juan Basin are all Cretaceous age. These include the Dakota Sandstone, Mancos Shale, Mesaverde Group, Pictured Cliffs Sandstone, Fruitland Formation, and Kirtland Formation.

The Dakota Sandstone is a transgressive sequence composed of sandstone, shale, minor conglomerates, and coal. The upper sandstones in the Dakota represent shoreline and offshore marine sand deposits. The Mancos Shale that overlies the Dakota is a thick sequence of shale with minor sandstones.

The Mesaverde Group consists of the following formations, from oldest to youngest: the Point Lookout Sandstone, Menefee Formation, and Cliff House Sandstone. The Mesaverde Group represents a single regression and transgression cycle of the epicontinental Cretaceous sea. The Point Lookout Sandstone, the upper, regressive member of the cycle, is typically 200 to 250 feet thick and is the primary gas reservoir in the Group within the Study Area (Aubrey 1991). The Menefee Formation consists of shale, carbonaceous shale, coal, and siltstones alternating with lenticular beds of sandstone. The Menefee Formation thins to the northeast and pinches out in the eastern part of the Reservation. The Cliff House Sandstone, known best for the 400-foot-thick sandstone at Mesa Verde National Park, is a transgressive sequence of very fine- to fine-grained cross-bedded sandstone, massive to very thick-bedded or interbedded with shale and siltstones (Aubrey 1991). The Cliff House Sandstone is typically a secondary Mesaverde gas reservoir in the Study Area and has been used for water disposal when hydrocarbon products are not present in significant quantities (Molenaar and Baird 1991).

The Lewis Shale overlies the Mesaverde Group and consists of thick sequences of shale with isolated sandstone lenses that can be gas-bearing. The shale sequence has a maximum thickness within the Study Area of 2,400 feet (Aubrey 1991). The Lewis Shale represents the maximum transgression of the last Cretaceous sea in the Study Area. Correspondingly, the Pictured Cliffs Sandstone, which overlies the Lewis Shale, represents the last Cretaceous regressive shoreline within the Study Area (Fassett 1988). The Pictured Cliffs Sandstone is a shoreline sandstone consisting of an upper medium- to thick-bedded ledge-forming sandstone and a lower thick, very fine-grained sandstone with interbedded shales and siltstone.

FIGURE 3-3
North-south Time and Rock-stratigraphic Framework
And Nomenclature for the San Juan Basin
8 ½ x 11 (B/W)

The Fruitland Formation overlies and interfingers with the Pictured Cliffs Sandstone. The interfingering is due to minor local transgression and regression of the Cretaceous shoreline. The Fruitland Formation consists of coastal swamp, alluvial, and lacustrine deposits that accumulated inland of the prograding and aggrading shoreline deposits of the Pictured Cliffs Sandstone (Fassett and Hinds 1971). The Fruitland Formation is composed of interbedded sandstones, siltstones, shale, carbonaceous shales, and coal, and contains the coal resources that produce CBM as well as the majority of the mineable coal within the Study Area. In some areas of the San Juan Basin, a shoreline sandstone is identified near the bottom of the Fruitland Formation but above coals. Some operators call this sandstone the "Fruitland Sand" and map it as part of the Fruitland Formation, but others identify it as part of the Pictured Cliffs Sandstone.

The depth of the Fruitland Formation ranges from near or at ground surface along the Hogback monocline in the west-central portion of the Study Area to greater than 4,000 feet below land surface (ft-bls) in the south-central portion of the Study Area south of the town of Ignacio (Zimpler et al. 1988). The depositional strike of the Fruitland coals is northwest-southeast. The greatest total net thickness of Fruitland coal, approximately 90 feet, in the Study Area is found in the northwest. The thickest individual coals are found in the southwest. The individual coalbeds range in thickness from thin stringers to 40 feet. Coal resources in the Fruitland Formation have been grouped into three packages and associated with three stalling episodes within the regression of the Pictured Cliffs Sandstone shoreline (Sandberg 1988). The lowermost zone contains the thickest coalbeds. The coal zones and individual coalbeds are arranged en echelon and rise 1,200 feet stratigraphically from southwest to northeast.

The Fruitland Formation is overlain by the Kirtland Shale, a thick sequence of alluvial shales with some sandstones representing overbank floodplain and stream channel deposits, respectively (Fassett and Hinds 1971). The Kirtland Shale ranges from about 1,065 feet thick on the western side of the Study Area near the Colorado-New Mexico border to 1,200 feet thick near Durango. The Kirtland Shale is predominantly characterized by upper and lower shale members and a sandstone middle member.

In the subsurface, the Kirtland Shale may be overlain in the southernmost portion of the Study Area by the Tertiary Ojo Alamo Sandstone. The Ojo Alamo is a cross-bedded, pebbly sandstone that was deposited by braided streams. Throughout most of the Study Area, the Kirtland Shale is unconformably overlain by the Cretaceous-Tertiary Animas Formation. The lower part of the Animas Formation is the McDermott Member, which is found locally in the northern part of the San Juan Basin. Of fluvial origin, the McDermott Member is composed of very coarse breccia, volcanic conglomerates, coarse tuffaceous sandstones, shales, and thick beds of massive fine- to coarse-grained tuff with andesite cobbles and pebbles. The member thins to the southeast, ranging from 290 feet thick in the western part of the Study Area (15 miles south of Durango) to 127 feet thick near the Colorado-New Mexico state line in the eastern portion of the Study Area. The upper part of the Animas Formation consists of a lower conglomeratic sequence grading into a sand and shale sequence with thin carbonaceous and coaly shales, probably representing alluvial fan deposits. Generally grading laterally from the southwest, and locally overlying the upper part of the Animas Formation, is the Tertiary Nacimiento Formation (Aubrey 1991; Levings et al. 1990). The Nacimiento Formation is mainly west of the Animas River and east of the Hogback monocline. Within the Study Area, the Nacimiento Formation is composed of nonresistant shale and very fine-grained sandstones, representing a variety of alluvial environments including channels, floodplain alluvial fans and lacustrine environments. The Nacimiento Formation is approximately 1,450 feet thick at the Colorado-New Mexico state line (Aubrey 1991).

The San Jose Formation of Tertiary age overlies both the Animas Formation in the northern and eastern portion of the Study Area and the Nacimiento Formation in the southwestern portion of the Study Area. The San Jose Formation was deposited in various fluvial environments and consists of interbedded arkosic sandstones, siltstones, and variegated shales (Levings et al. 1990). One thousand feet thick a few miles south of Durango, the formation is typically as much as 2,000 feet thick elsewhere within the Study Area, except where eroded or downcut in the major river valleys.

Unconsolidated deposits within the Study Area consist of alluvial terrace and floodplain deposits. Florida Mesa, located between the Animas and Florida rivers, is a large, extensive 60-foot-thick terrace deposit. Quaternary floodplain deposits are located in the valleys of the present day streams and are thinnest in the Animas River valley (Brogden et al. 1979). The Animas, Nacimiento, and San Jose formations and the unconsolidated deposits are the primary potable groundwater sources in the San Juan Basin portion.

Four Corners Platform

Within the Study Area, the Four Corners Platform contains the complete Study Area stratigraphic section of the San Juan Basin through the Mesaverde Group-Cliff House Sandstone. The platform was uplifted during the Laramide orogeny and served as a source of sediment through most of the Tertiary. Consequently, any rock units above the Cliff House Sandstone that were deposited on the platform have been eroded away. As in the San Juan Basin, the unconsolidated deposits consist of alluvial terrace and floodplain deposits. A large terrace deposit approximately 80 to 100 feet thick is located between the towns of Redmesa and Breen in the La Plata Valley. These floodplain deposits are thin in the valleys of the present-day streams.

The geologic units of the Paradox Formation, as well as the Dakota Sandstone Formation and Mesaverde Group, are the primary oil and gas horizons within the platform. Upper Cretaceous sandstones and Quaternary sands and gravels are the primary groundwater sources for potable water in the platform area.

3.4.2 Minerals

Mineral resources within the Study Area consist primarily of oil, natural gas, coal, sand, and gravel. Development of natural gas has been important to the economy of the area since about 1951. Natural gas fields and coalbeds occur throughout extensive areas within La Plata County. Sand and gravel resources are generally found in river valleys and on gravelly terrace edges throughout the region.

Within the Study Area, the predominate hydrocarbon reservoirs within the San Juan Basin include sandstones, siltstones, shales, and coals associated with the Dakota Sandstone Formation, Mesaverde Group, Pictured Cliffs Sandstone, and Fruitland Formation. The Fruitland Formation contains coals that produce CBM as well as the majority of mineable coal resources in the Study Area. The Paradox Formation, Dakota Sandstone Formation, and Mesaverde Group are important sources of oil and gas in the Four Corners Platform area (Condon 1992; Fassett and Hinds 1971).

3.4.2.1 Oil and Gas Resources

Oil and gas resources within the Study Area are found in both the San Juan Basin and the Four Corners Platform. The first field discovery on the Reservation was in 1924 in the Pennsylvanian reservoir of the Red Mesa field on the Four Corners Platform. In 1950, the Ignacio-Blanco field was discovered in the San Juan Basin. Oil and gas statistics by field and reservoir have been tabulated by the COGCC (1996a,b) through the 1995 production year. Table 3-12 presents the cumulative production by field and reservoir for all the La Plata County fields within and partially within the Study Area, as well as the field discovery date and the number and status of production wells. Map 11 presents the conventional well locations within the Study Area. Map 12 shows the locations of the Fruitland CBM wells. A description of oil and gas drilling and production techniques is included in Section 2.8.

San Juan Basin

As of March 1996, the COGCC (1996a,b) reported that 2.08 trillion cubic feet (tcf) of natural gas had been produced in La Plata County, Colorado. Most of this production has been from the Study Area. The San Juan Basin of Colorado and New Mexico is the second largest natural gas field in the United States. Natural gas is found within the geologic formations and is produced by conventional and CBM production methods. In the San Juan Basin, the conventional reservoir rocks are sandstones primarily of the Dakota Sandstone, Mesaverde Group, Pictured Cliffs Sandstone, and Fruitland Formation. The Fruitland Formation also contains coals that produce CBM. Production methods for conventional gas and CBM are distinctly different. A description of the formation of CBM and CBM production is provided in Appendix I. Oil and gas resources are discussed below based on conventional and CBM production scenarios.

TABLE 3-12
Cumulative Production for La Plata County[1], Colorado
Through Production Year 1995

Field (discovery year)	Formation/ Reservoir[2] (Geologic Map Symbol)	Number of Wells[3]					Cumulative Oil/ Condensate Production (barrels)	Cumulative Gas Production (mcf)[5]
		PA	RC	SI	TSI[4]	Prod		
Alkali Gulch (1957)	Barker Creek (PPp)				1	2	0.00	9,586,600
	Dakota (Kd)	1					135	0.00
	Gallup (Kmv)	1					351	0.00
	Molas (PPm)	3					0.00	7,448,551
	Paradox (PPp)	2				1	0.00	15,216,597
	TOTAL	7			1	3	486	32,251,748
Alkali Gulch West (1981)	Ismay (PPp)					1	669	516,448
Barker Dome (1948)	Hermosa-Ismay (PPp)	1				1	349	489,687
	Desert Creek (PPp)					1	0.00	5,796
	Ismay-Desert Creek (PPp)					2	3,354	1,173,516
	Paradox (PPp)			1	1	5	87,280	107,717,297
	TOTAL	1		1	1	9	90,983	109,386,296
Cinder Buttes (1966)	Dakota (Kd)				3		1,245	226,029
	Gallup (Km)		1					42,130
	Mesaverde (Kmv)	1						3,626
	TOTAL	1	1		3		1,245	271,785
Hay Gulch (1990)	Dakota (Kd)	1					1,687	0.00
Ignacio-Blanco (1950)	Dakota-Gallup (Kmd)	1				1	0.00	46,158
	Dakota (Kd)-Morrison (Jm)	4		2		2		25,278,111
	Dakota-Sanastee (Kd)		1				0.00	1,697
	Dakota (Kd)	19	26	23	15	188	469	280,861,799
	Fruitland (Kf)	1	1		4	4	55	2,653,809

TABLE 3-12
Cumulative Production for La Plata County[1], Colorado
Through Production Year 1995

Field (discovery year)	Formation/ Reservoir[2] (Geologic Map Symbol)	Number of Wells[3]					Cumulative Oil/ Condensate Production (barrels)	Cumulative Gas Production (mcf)[5]
		PA	RC	SI	TSI[4]	Prod		
	Fruitland Coal (Kf)	2		64	34	835	1,418	729,089,233[6]
	Fruitland-Pictured Cliffs (Kfp)	55		7	3	14	753	37,069,384 (174,291)[6]
	Gallup (Km)				1		0.00	109,498
	Kirtland (Kk)	1			1		0.00	9,384
	Lewis (Kl)	1				1	0.00	2,750,836
Ignacio-Blanco (1950) cont.	Mancos (Km)					1	0.00	13,634
	Mesaverde-Sanastee (Kmv)		1				0.00	39,929
	Mesaverde-Dakota (Kmvd)				2	5	0.00	3,326,771
	Mesaverde (Kmv)	24	4	67	14	587	39,527	677,610,035
	Niobrara (Km)					1	0.00	48,041
	Nacimiento (Tn)				1		0.00	43,883
	Pictured Cliffs-Mesaverde (Kpmv)				1	4	51	2,893,019
	Pictured Cliffs (Kp)	5		16	5	87	60,016	50,707,627
	Pictured Cliffs-Mesaverde-Dakota (Kpmvd)				1		0.00	827
	Point Lookout (Kmv)					2	0.00	347,700
	Sanastee (Kmv)		1				0.00	4,806
	TOTAL	113	34	181	91	1735	102,287	1,813,674,698 (729,263,524)[6]
Redmesa (1924)	Barker Creek (PPp)	1					0.00	237,624
	Carlile (Km)					3	21,012	0.00
	Dakota (Kd)-Morrison (Jm)					2	24,046	15,894

TABLE 3-12
Cumulative Production for La Plata County[1], Colorado
Through Production Year 1995

Field (discovery year)	Formation/ Reservoir[2] (Geologic Map Symbol)	Number of Wells[3] PA	RC	SI	TSI[4]	Prod	Cumulative Oil/ Condensate Production (barrels)	Cumulative Gas Production (mcf)[5]
	Dakota (Kd)	5	3	8	7	55	1,139,269	1,156,397
	Gallup (Km)	6	2	2	2	16	610,150	169,504
	Menefee Coal (Kmv)	1		3			0.00	42,532 (28,364)[6]
	Mancos (Km)	2	1			2	112,415	96,467
	Morrison (Jm)					1	8,472	1,076
	Mesaverde (Kmv)			3		10	7	507,641
Redmesa (1924) cont.	Point Lookout (Kmv)				1		0.00	168,371
	TOTAL	15	6	15	10	89	1,915,371	2,395,506 (28,364)[6]
TOTAL		138	41	199	106	1,836	2,112,739	1,958,496,481 (729,291,888)[6]

[1]COGCC (1996a,b) production statistics for the entire La Plata County, including the Study Area.

[2]See Appendix H

[3]Number of wells based on 1995 production statistics
- PA - Plugged and abandoned includes temporarily abandoned wells
- RC - Recompleted
- SI - Shut In
- TSI - Temporarily Shut In
- Prod - Producing well

[4]Temporarily Shut In - the well has a cumulative production statistic but production status was not reported to the COGCC; typically the well did not report production for 1995

[5]mcf - thousand cubic feet

[6]Proportion of cumulative production designated as CBM

Conventional Gas Production - San Juan Basin - The majority of the existing conventional wells in this field are located within the boundaries of the Reservation, although the field extends north beyond the Study Area limits. Until the early- to mid-1980s and prior to CBM production, gas production in the San Juan Basin was conventional. Conventional gas production in the San Juan Basin involves both structural and stratigraphic plays for most of the productive horizons, with the structural plays focused on the Ignacio and Bondad anticlines. However, stratigraphic plays continue to increase in importance in the Ignacio-Blanco conventional gas field (SUIT Energy Resources Division 1996). Production statistics reported by the COGCC (1996a,b) through 1995 for the three main producing horizons (Dakota Sandstone, Mesaverde Group and Pictured Cliffs Sandstone) are provided in Table 3-13 and discussed below. Well locations are presented in Map 11. All three formations typically produce a dry gas with little associated hydrocarbon liquids, and relatively small quantities of produced water.

Dakota Sandstone Production - The first productive gas well in the Dakota Sandstone was drilled in 1950 and is still producing. Based on the SUIT Energy Resources Division database, 421 wells have penetrated the Dakota Sandstone in the Ignacio-Blanco field, and 189 wells are currently producing. The COGCC (1996a,b) reported that by the end of 1995, the field had produced 279 billion cubic feet (bcf) of gas from the Dakota Sandstone. Ignacio-Blanco fieldwide spacing is currently 640 acres, with the option to infill three wells, for a possible total of four wells per section. Estimated ultimate recovery is 85 percent of original gas in place, with gas expansion as the primary drive mechanism along with possible limited water drive (a "drive mechanism" is the physical force or mechanism that allows the gas to be delivered to the well head for extraction). The Dakota Sandstone pool reached peak production in 1966. Production data from the early 1980s indicate that the Dakota still has potential for limited development (SUIT Energy Resources Division 1996).

Mesaverde Group Production - The Ignacio-Blanco Mesaverde pool was discovered in 1952 and is probably the most developed conventional reservoir in the northern San Juan Basin. Between 1952 and 1995, 678 bcf of gas and 40,000 barrels of condensate were produced from various sandstones of the Mesaverde Group. Most of the gas is found in stratigraphic traps, typically in the Point Lookout Sandstone, but the two other formations (the Menefee and Cliff House) of the group are also productive. Only 18 Mesaverde Group dry holes (wells drilled that did not produce) have been drilled in the Ignacio-Blanco field (SUIT Energy Resources Division database). There were 611 producing wells at the end of 1994 (COGCC 1996a,b). Estimated ultimate recovery is 85 percent with gas expansion as the only drive mechanism. Fieldwide spacing is 320 acres with one possible infill well, for a total of four wells per section. The field reached peak production in 1963. Renewed activity in the early 1980s created another production peak in 1988, almost equal to the 1963 production.

Pictured Cliffs/Fruitland Sand Production - The Pictured Cliffs reservoir was discovered in 1951. This pool of the Ignacio-Blanco field contains production from wells reporting completions in the Pictured Cliffs Sandstone, Fruitland Sand, or commingled Pictured Cliffs Sandstone-Fruitland Sand. Field development on the Ignacio-Blanco anticline was primarily a structural play in the 1950s. Water coning in the wells forced premature plugging and abandonment by the early 1960s. Further field development has consisted mostly of operators taking advantage of stratigraphically trapped gas found in deeper Mesaverde or Dakota prospects. The COGCC (1996a,b) indicates that, as of 1994, there have been 200 Pictured Cliffs/Fruitland

Sand completions, with 101 wells currently producing. The field produced 88 bcf of gas by the end of 1995 (COGCC 1996a,b). Gas expansion is the primary drive mechanism. Fieldwide spacing is 320 acres with one possible infill well, for a total of four wells per section. The field reached peak production in 1955 but has subsequently been declining.

CBM - San Juan Basin - CBM is formed during coalification, or the formation of coal. The process of coalification encompasses physical and chemical changes that occur in coal beginning shortly after deposition, continuing throughout the burial history. During coalification, natural gases are generated from organic matter through biogenic (peat), early thermogenic (subbituminous to bituminous), and late thermogenic (bituminous-anthracite) processes. Although methane is the major gas component in coalbed gases, water, carbon dioxide, wet gases (ethane, propane, butane, etc), nitrogen, and liquid hydrocarbons also are generated (Scott et al. 1994; Scott 1994).

The San Juan Basin is the most prolific CBM basin in the world; it is estimated that available resources total approximately 50 tcf and proven reserves of more than 6 tcf exist (Scott 1994). As of 1995, the Ignacio-Blanco field has produced over 729 bcf of CBM (COGCC 1996a,b). Field spacing was originally one well per spacing unit (usually 320 acres). For over 175 units, the COGCC has approved the drilling of an optional second well, also known as an infill well (COGCC 2000). Additional information on spacing orders for the Study Area can be found in Appendix O. Map 12 indicates the locations of the wells completed in the coals of the Fruitland Formation by late 1996. Current information regarding well numbers and locations can be obtained from the Colorado Oil and Gas Conservation Commission or obtained from the Internet at http://oil-gas.state.co.us/. The Menefee Formation also contains coals that may produce methane; however, relative to the Fruitland Formation, only minor production has been recorded (Table 3-13).

The Fruitland Formation CBM wells produce a very dry gas with a variable carbon dioxide content and very little other hydrocarbon (ethane or propane). The primary drive mechanism for CBM production is reservoir pressure depletion with an ultimate methane recovery rate not expected to be greater than 50 percent gas-in-place (Puri and Yee 1990). Recovery from individual units may be much greater or less than 50%, however.

The Ignacio-Blanco Fruitland CBM pool contains an area termed the "Fairway," which trends west-northwest out of New Mexico (through T32N R10W just west of the town of Bondad) and to the monocline. The Fairway is characterized by high coal thickness, good permeability, and high cumulative production from individual wells, resulting in effective drainage of most 320-acre spacing units by a single CBM well. The relationship of high cumulative individual well production to an associated thick coalbed development does not always occur. Thick coals occur in other parts of the field but do not have the same production characteristics, i.e., the ability to drain as large an area as the Fairway wells. The nature of the enhanced permeability of the

Fairway is not completely understood, but the extent of the area has been mapped and is shown on Map 12.

Changing environmental conditions, specifically methane seeps at the Fruitland outcrop, with associated vegetation mortality and development of hydrogen sulfide gas, and contamination of domestic water wells were noted both on and off the Reservation in the 1990s. The SUIT, BLM, COGCC, and various operators have developed numerous programs to study potential links between these conditions and coalbed methane production and to develop mitigation measures for them. These efforts are documented in a 1999 report by the San Juan Field Office BLM titled *Coalbed Methane Development in the Northern San Juan Basin of Colorado* and incorporated herein by reference.

Seeps of methane have been observed from the Fruitland Formation outcrops along the Hogback. In April 1995, the natural gas seeps in the Valencia Canyon area (T33N, R11W) were increasing in intensity and new gas seeps were developing. The seeping gas is composed primarily of methane with carbon dioxide and hydrogen sulfide occurring locally. It is hypothesized that nearby gas production activities have intensified the seep activity. Specifically, lowering of the water table in the monocline by downdip dewatering of coalbeds is postulated to allow CBM to desorb from coalbeds near the outcrop. The desorbed gas could then migrate buoyantly up dip to the outcrop and seep. The details of this potential process are not well understood at this time. However, the SUIT Energy Resources Division, BLM, and industry are monitoring the seeps and water table and developing mitigation measures (see Section 3.5.2.4. and Section 4.4.1.8 for further information).

In the late spring of 1998, two underground coal fires were discovered in the Fruitland Formation in the Hogback in the southwestern portion of the Reservation. These underground fires are approximately two miles apart and, based on the evidence, are believed to be small. In late 1998, a third underground coal fire was discovered in the Fruitland Formation on the Hogback, approximately eight miles north of the first two fires. The evidence of underground fire in the coal includes smoke, gases, and heat emanating from cracks in the ground adjacent to localized areas of subsidence. The subsidence is hypothesized to have been caused by earlier burning. Ample evidence of ancient in situ (i.e., in place) coal fires, such as ash and clinker in the immediate vicinity of these two active fires as well as elsewhere in La Plata County, indicates that in situ coal fires are a natural phenomenon in the Fruitland Formation. Fires also are a hazard in both active and abandoned coal mines. One other small coal fire is currently active at the La Plata mine in New Mexico. At this time, no other Fruitland Formation coal fires are known in the Study Area, and no direct correlation of these fires to coalbed methane production can be shown. A relationship between the coal fires and dewatering of the coalbeds has been hypothesized. The SUIT is in the process of assessing these fires and planning for their mitigation to protect mineable coal resources, vegetation and wildlife resources, and human safety. For example, the existence of coal fire “clinker” on the top of the two buttes located one half mile west (updip) of two of the fires coupled with archeological evidence demonstrates that the outcrop burned hundreds of years ago. Several miles of Fruitland coal seams were re-mapped at the outcrop as ash rather than coal in 1995 and 1996.

The Energy Department of the Southern Ute Indian Tribe has been monitoring the coal fires on the Reservation and in 2000 spent $865,000 in an attempt to delineate and to mitigate one of the fires by pumping foamy cement into the subsurface cavern where the fire is active. This action was supposed to block oxygen from reaching the fire. The contractor hired by the Tribe, Goodson and Associates, has extinguished subsurface coal fires in Colorado's Front Range using this method. On the Southern Ute Indian Reservation, the contractor pumped 4400 cubic yards of cement into the cavern without any noticeable impact on the fire. After that, the project was ended. Smoke and fumes continue to emit from the surface vents. Scientists associated with the project concluded that the underground cavern is too big to be filled by an affordable amount of cement. No other efforts have yet been made to mitigate the fires, although the Tribe continues to monitor them and to consider other mitigation methods.

In 1999, the COGCC kicked off the 3M (Mapping, Modeling, and Monitoring) Project. Goals of the 3M project include identification of current methane seepage areas, surface water features (springs and wetlands) along the outcrop, and to predict changes in methane seepage with time due to CBM development. Various development scenarios were modeled to determine if seepage rates were sensitive to well densities. The computer modeling in the 3M project included a hydrogeologic model and a reservoir model for the Ignacio Blanco Fruitland Coal Field. These models were designed through collaboration among the COGCC, BLM, SUIT, industry representatives, and modeling consultants. The mapping component identified where the various coals in the Fruitland Formation crop out and correlated coal outcrops to coals penetrated by down dip CBM production wells. The monitoring component will include installing clusters of shallow monitor wells in which water and gas pressures will be measured in individual coal zones.

Most of the funding for the 3M project came from state severance taxes in budgets allocated to the COGCC. However, the Colorado Geological Survey contributed to the mapping costs and performed the fieldwork for the mapping. The SUIT, BLM, and COGCC are sharing the costs of the modeling. The BLM is contributing funds for one of the eight clusters of monitoring wells. The SUIT allocated over $700,000 in its 2000 budget to fund the drilling of similar monitor well clusters on the Reservation, which are not part of the 3M project but will provide valuable data concerning the potential impacts of CBM development on the outcrop (SUIT 2000).

The mapping results were presented in the Colorado Geological Society open-file report 00-18, issued in July, 2000. The modeling studies prepared with BLM, SUIT and COGCC oversight were issued in December 2000 and January, 2001 (Applied Hydrology Associates, 2000 and Questa Engineering Corp., 2001). The monitoring of soil vapor tubes and monitor wells by the BLM, SUIT and COGCC is ongoing. Additional monitoring locations will be constructed over the next several years.

Four Corners Platform

The fields listed in Table 3-13, with the exception of the Ignacio-Blanco field, are found within the Study Area in the Four Corners Platform. Production from these fields is primarily conventional gas, with some liquid hydrocarbons from the Molas Formation, Paradox Formation, Dakota Sandstone, and Gallup Sandstone member of the Mancos Shale. Minor production also is found in the Morrison Formation and from the Point Lookout Sandstone and the Menefee Coal of the Mesaverde Group.

Molas Formation Production - The Molas Formation produces dry gas with no hydrocarbon liquids at Alkali Gulch field. Through production year 1995, Molas production of 7,448,551 thousand cubic feet (MCF) has been reported from three wells to the COGCC. No wells are currently producing from the Molas Formation.

Paradox Formation Production - Oil and gas was first discovered in the Study Area in the Paradox Formation. Four fields—Alkali Gulch, Alkali Gulch West, Barker Dome, and Red Mesa—have reported production from the Paradox Formation, including the Paradox, Ismay, Desert Creek, Barker Creek, and Hermosa members. As of 1995, 135 bcf of gas and 91 MBBL of oil was produced from 18 wells in the Paradox (COGCC 1996a,b). As of 1994, 11 wells were still producing. Paradox oil wells are drilled on 40-acre spacing for a possible maximum number of sixteen oil wells per section. Gas wells are drilled on 160-acre spacing for a possible maximum number of four gas wells per section.

Dakota Sandstone Production - The Dakota Sandstone is also productive in the Four Corners Platform, producing more oil than in the San Juan Basin. The Dakota is exclusively oil-bearing in the Alkali Gulch and Hay Gulch fields. Both oil and gas are produced in the Dakota field of Cinder Buttes and Redmesa. As of 1995, 1.4 bcf of gas and 1.1 MBBL of oil were produced from the Dakota (COGCC 1996a,b).

Mancos Shale Production - The Mancos Shale formation is represented by production from the Gallup Sandstone and other members of the Mancos. The Mancos produces at Alkali Gulch, Cinder Buttes, and Red Mesa fields. Cumulative production through 1995 for Mancos members totals 743,928 barrels of oil and 308,000 mcf of gas.

3.4.2.2 Coal Resources

Coal occurs within many of the Cretaceous and some of the Tertiary formations in the Study Area. The Dakota Sandstone, Menefee Formation, and Fruitland Formation contain coals that have been mined from the Durango coal field of La Plata and Montezuma counties (Murray 1980). However, only the Menefee and Fruitland formations contain coalbeds thick enough to be considered a viable coal resource within the Study Area. To the north and northeast of the town of Durango, the Dakota coals are relatively thin, discontinuous, and contain a high ash content. In the subsurface to the south and west of Durango, the Dakota coals have been mined to some extent at relatively shallow depths, but the resource exists to a depth of 8,000 feet or more in the Colorado portion of the San Juan Basin (Murray 1980). The 2,000-foot overburden line is used as the differentiation between high to moderate development potential and low development potential for subsurface mining.

Coalbeds of the Menefee Formation are the most significant in the Durango field (Murray 1980). The Menefee coals are high-volatile A and B bituminous. In local areas of structural complexity near Durango, they are of coking quality (Murray 1980). The coals within the Menefee Formation are generally less than 6 feet thick and are found only within the Four Corners Platform area at depths less than 200 feet. At depths greater than 200 feet, surface mining of coal is not considered economical (Murray 1980; Sandberg 1988). Most of the coal currently being mined in the Durango coal field is used locally for domestic and industrial purposes (Murray 1980).

The Fruitland Formation coals range from high-volatile A bituminous to medium-volatile bituminous. Ash content generally is high, slightly less than 8 percent to as high as 40 percent, with a general increase in ash content eastward (Fassett 1988; Kelso and Wicks 1988). High ash content prevents the Fruitland Formation coals from being classified as a premium grade coking coal (Sandberg 1988, 1990). Sulfur content is typically low, averaging less than 1 percent with a range of 0.5 to 2.5 percent. Heating values range from 9,000 British Thermal Units (BTU) to greater than 13,000 BTU on an as-received, pure coal basis, exclusive of non-coal partings (Fassett 1988).

Fruitland coal resource estimates for the Reservation, uncorrected for ash content, are 39 billion tons over 612 square miles (Kelso and Wicks 1988). Coal resources not including impure coalbeds with 33 percent ash or more are estimated at 16 billion short tons (Sandberg 1988, 1990). Eighty-eight percent of the coal reserves are deeper than 2,000 feet beneath the surface. The strippable coal, which varies on thickness and overburden, makes a narrow band along the monocline outcrop; however, as the dip is generally greater than 15 degrees, the actual area of potential mineable coal is highly discontinuous (Sandberg 1990). Small private coal mines are located within the Study Area along the outcrop in the Hogback monocline and date back to the 1920s and earlier (SUIT Energy Resources Division 1996). The Fruitland Formation coals are being strip mined in New Mexico up to the Colorado-New Mexico state line at La Plata Mine. A future extension of this mine into the Study Area is feasible (SUIT Energy Resources Division 1996).

3.4.2.3 Sand and Gravel

Alluvial floodplain deposits and gravelly terrace deposits contain mineable quantities of sand and gravel within the Study Area with several quarry operations existing on both Tribal and fee land.

Mineable deposits typically contain gravel, cobbles, and sand with minor amounts of silt and boulders. Mined sand and gravel are used extensively for construction and road maintenance both on and off the Reservation, and mining will continue as the area grows. However, few new mines are anticipated.

In July 1999, there were 43 gravel sites operating in La Plata County. These mines produced over 600,000 tons of gravel annually in recent years (County Assessor's Office Abstracts). Transportation is a major part of the cost of gravel. Most gravel mines are located on topographic terraces. They are relatively small, localized in both time and space and commonly are open for decades.

Federal, state, and local authorities control sand and gravel mining. Permitting of gravel mines depends on the location of the mine. Gravel mining on Tribal lands requires a lease approved by the BIA, which contains stipulations regarding NEPA compliance and avoidance or mitigation of environmental impacts. Gravel mining on non-Tribal lands is administered by the State of Colorado through its Mine Land Reclamation Board and the Division of Mines and Geology and requires a Reclamation Permit. Additional permits for discharges into the water or air, as well as county use permits, may be required for operations on non-Tribal lands. Mines must be abandoned in compliance with federal and state stipulations.

3.4.3 Soils

The soils in the Study Area typically consist of loam, silty clay loams, and sandy, gravelly, or cobbly loams. Rock outcrop is also common. The soils have formed from the sandstones and shales of the region. Erosion potential varies based on soil type, slope, and vegetation cover. Some of the soils may be classified as prime farmland if there is a dependable water supply.

Major federal legislative acts that address the protection of soils and prime farmland include the Federal Land Policy and Management Act of 1976 (FLPMA), Farmland Protection Policy Act of 1984, Clean Water Act of 1972, and Soil and Water Resources Conservation Act of 1977.

The Study Area consists primarily of mesas, foothills, valleys, and some mountains. The Animas, Florida, La Plata, and Pine rivers flow through the Study Area, joining with the San Juan River to the south, in New Mexico. The climate in the area is mild and semi-arid to sub-humid. The summers are dry, and the winters often have heavy snow, particularly in the mountainous areas to the north of the Study Area. The growing season is about 100 days. Many of the valleys and mesas are irrigated by various irrigation ditches and laterals established in the later 1800s and 1900s by farmer-owned water irrigation districts. The irrigation ditches and laterals carry water from snowmelt and rainfall in the high mountains to these irrigation districts.

The soils in the La Plata County portion of the Study Area have been mapped in detail by the Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service). Soils present in the Study Area are shown on Map 13. Characteristics of the soil map units are presented in Appendix J, which describes the soils, erosion potential, pH, shrink-swell potential, risk of corrosion, and prime farmland suitability.

The soils in the area that are nearly level to sloping and consist of deep, well-drained loams, clay loams, sandy loams, gravelly to cobbly loams, and sand and gravel deposits occur on river terraces, floodplains, and alluvial valley floors. Some of these soils are subject to wind and water erosion. Soils that are gently sloping to steep, shallow to deep, well-drained loams, clays, silty clay loams, and stony loams occur on mesas, foothills, upland valleys, and escarpments. The erosion potential of the soils derived from sandstone is typically slight to moderate, while those formed from shales generally have moderate to high water and wind erosion potential. Soils that are gently sloping to steep, shallow to deep, and well-drained occur on mesa tops, foothills, and ridges. These soils generally consist of cobbly loams, clay loams, and sandy to gravelly loams. These soils are subject to wind and water erosion. The erosion potential is typically moderate to high, depending primarily on surface slope and vegetation. The erosion potential increases with greater slope and less vegetation.

The erosion potential of a soil is the result of several factors including slope, parent material, vegetation cover, climate, and the physical/chemical characteristics of the soil. Erosion potential designations of slight, moderate, high, and severe have been determined and defined by the NRCS and are used to indicate how susceptible soils are to increases in erosion rates due to disturbances such as removal of vegetation, construction activities, and vehicular activity.

Those areas where the soils have high to severe erosion potential occur primarily in the clays, clay loams, and silty clays of the south-central, southwestern, and scattered parts of the eastern portions of the Study Area. Areas of steeper slopes, minimal vegetation, and silty or clayey soils are often subject to high or severe erosion hazards.

Some of the soils in the Study Area may be suitable as prime farmland if a dependable and adequate water supply (e.g., irrigation) is available. Prime farmland soils are defined by the U.S. Department of Agriculture as having properties that are best suited for the economic production of sustained high yields of crops (food, seed, forage, fiber, and oilseed). These soils have a sufficiently long growing season and need only to be treated and managed using acceptable farming methods. Prime farmland soils produce the highest yields with minimal amounts of energy and economic resources. Farming of these areas results in the least damage to the environment. Those soils that may be classified as prime farmland are identified in Appendix J. Map 14 indicates those prime farmland soils with irrigation facilities.

The greatest extent of prime farmland occurs in the clay loams between the Animas and Florida rivers. Additional prime farmland has been developed in loams and clay loams in smaller areas in the northeastern and eastern portions of the Study Area. Other soils may be suitable to be classified as prime farmland if a dependable water supply is developed.

3.4.4 Paleontology

The FLPMA of 1976 and NEPA charge the BLM with the management, protection, and use of paleontological resources on public lands. Paleontological resources constitute a fragile and nonrenewable scientific record of the history of life on earth.
The geologic units that crop out across the Reservation are primarily Cretaceous to Tertiary in age with Quaternary alluvial deposits in the major drainages. The Cretaceous rocks consist of marine, marginal-marine, and coastal plain deposits. The Tertiary sedimentary rocks are mostly fluvial in origin. Many of these siltstones, sandstones, shales, and conglomeratic deposits are interbedded as a result of deposition during transgressive-regressive cycles of an epicontinental sea (refer to Section 3.4.1 for a more detailed discussion of the Study Area geology).

Discovery of paleontological resources on the Reservation has been quite limited, although several of the formations may yield important fossil resources. Table 3-13 lists known fossil resources by geologic unit within the BLM's San Juan Resource Area, which includes the Reservation. The type area of the Tiffanian, a North American Land Mammal Age, is located near the town of Tiffany in the eastern portion of the Study Area.

TABLE 3-13
Paleontological Resources of the San Juan Resource Area

Major Geologic Units	Known Fossil/Resources
Quaternary alluvium	Shrub ox
San Jose Formation	None known; various Eocene fossils in southern part of San Juan Basin
Nacimiento Formation	Brachiopods; fish, crocodiles, turtles, various mammals, and temperate flora in central San Juan Basin
Animas Formation	59 species of fossil plants comprised of 3 ferns, 1 palm, 55 dicots; various vertebrates including Triceratops, Discoscaphites, and Sphenodiscus
Kirtland Shale	Baculites; various vertebrates, invertebrates, and plants in western and southern San Juan Basin
Fruitland Formation	Baculites, vertebrates including dinosaurs; various vertebrates, invertebrates, and plants in western and southern San Juan Basin
Pictured Cliffs Sandstone	Ammonites, cephalopods, baculites
Lewis Shale	Ammonites, baculites, partial skeleton of a mosasaur, *Exiteloceras*
Mesa Verde Group, undivided	Theropod dinosaur tracks, baculites, scaphites

TABLE 3-13 Paleontological Resources of the San Juan Resource Area	
Major Geologic Units	**Known Fossil/Resources**
Cliff House Sandstone	Ammonites, crustaceans, clams, oysters, snails, starfish, sea urchins, shark teeth, amphibians, turtles, mosasaur, plesiosaur
Menefee Formation	Leaf impressions, palm fronds, conifers, reptile bones, fossil tree trunk
Point Lookout Sandstone	Worms, crustaceans, clams, ammonites, various animal tracks, driftwood
Source: Armstrong 1996; Aubrey 1991; Fassett and Hinds 1971	

3.5 WATER RESOURCES

3.5.1 Groundwater

3.5.1.1 Introduction

With regional population and industrial development expanding, constraints on the groundwater resource in the Study Area are increasing. Groundwater quantity is limited and quality varies widely. Concern over methane contamination in groundwater in the Study Area has increased concurrently with development of the Fruitland CBM wells and an overall population increase in the general area (BLM-San Juan Resource Area, personal communication 1996). To characterize the groundwater resource for the Study Area, this section describes groundwater occurrence, general groundwater quality trends, and available information on methane contamination.

3.5.1.2 Groundwater Occurrence and Water Quality

Usable groundwater is defined in 43 CFR 3160 as that which can be used for domestic and stock water supplies. Usable groundwater is found throughout the Study area in various aquifers. Map 15 presents all water well locations as recorded with the Colorado State Engineer's office, BLM, or SUIT.

Groundwater occurs within the Study Area in the unconsolidated alluvial deposits of Quaternary age and in the sandstones and shales of Cretaceous and Tertiary age. The highest yield wells on the Reservation are completed in the alluvial and terrace deposits as well as sandstone aquifers (water-bearing units) in the San Jose and Animas formations. These aquifers are extensively used for domestic and livestock water consumption (Butler et al. 1993). Salinity and low water yields preclude pre-Cretaceous rocks from being considered principal aquifers within the Study Area. Hydrogeologic descriptions of the rock units within the Study Area are listed in Table 3-

14, which also provides a general assessment by formation of water type and water quality. Table 3-15 presents water quality standards for selected constituents.

The unconsolidated alluvial deposits consist of sand, gravel, silt, and clay, and are associated with the present river valleys as floodplain or terrace deposits. These deposits are typically characterized by a thin saturated layer, and are highly dependent upon recharge from natural and anthropogenic (e.g., irrigated fields) sources.

Both unconfined and confined aquifers are present within the Study Area. The direction of groundwater movement within the Study Area is generally to the south. The consolidated Cretaceous and Tertiary rocks (bedrock) consist of interlayered beds of sandstone, siltstone, and shale. Porous or fractured sandstones form the principal bedrock aquifers. Relatively impermeable shales form confining units between aquifers. Near the margins of the basin, usable water is commonly present in the Dakota Sandstone, Point Lookout Sandstone, Cliff House Sandstone, Pictured Cliffs Sandstone, Farmington Sandstone member of the Kirtland Shale, and in the Animas, Nacimiento, and San Jose formations. Thick confining units that are almost impermeable and generally do not yield water include the Mancos and Lewis marine shales. (Isolated siltstones and/or sandstones in these formations have been found to produce small amounts of water locally.) Thinner confining units of the slightly more permeable fluvial shale, coal, and thin sandstone beds are present in the Menefee Formation, Fruitland Formation, lower and upper shale members of the Kirtland Shale, and in numerous local shaly beds in the Animas, Nacimiento, and San Jose formations. Non-usable water is present in sandstone formations at depth in the basin.

Rainfall and snowmelt are the principal sources of natural recharge to the aquifers in the Study Area. However, these sources generally supply only small volumes of water to the aquifers because annual precipitation is minimal, and runoff, evaporation, and transpiration divert much of the water before it can percolate to sufficient depth to recharge an aquifer. In areas where irrigated lands are present, a significant source of recharge occurs seasonally from irrigated fields and leakage from unlined canals and ditches (BOR 1996b; Robson and Wright 1995).

TABLE 3-14
Hydrologic Characteristics of Geologic Units of the Southern Ute Indian Reservation[1]

Age	Formation	Thick-ness (feet)	Physical Character (see Appendix H for greater lithologic detail)	Hydrologic Characteristics	Water Quality
Quaternary	Flood-Plain Deposits	50	Clay, silt, sand, gravel, and boulders. Generally poorly sorted and confined to present day stream valleys. Includes low-level terraces, alluvial fans, and eolian material.	Average well yield is 10 gpm with maximum yield of 25 gpm reported.	Water quality is variable, depending on underlying rock and sources of alluvial material. Sodium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 148 to 5390 mg/L, but 400 mg/L is common. Arsenic, fluoride, iron, manganese, selenium, sulfate, and TDS have exceeded recommended drinking water standards locally.
Quaternary / Tertiary	Terrace Deposits	100	Clay, silt, gravel, and boulders. Sediments are poorly sorted, with coarser materials being well rounded. Includes higher level stream valleys, eolian materials, and remnants of alluvial fans.	Average well yield ranges from 5 to 10 gpm with maximum yield of up to 50 gpm reported.	Calcium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 205-1000 mg/L, but 400 mg/L is common. Fluoride, chlorides iron, selenium, sulfides, and TDS can exceed recommended drinking water standards locally.
Tertiary	San Jose	250-2500	Sandstone, shale and conglomerate. Sandstones are arkosic and massive and are interbedded with red, maroon, and gray shales.	Average well yield ranges from 1 to 10 gpm with maximum yields of 75 gpm reported.	Calcium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 117-2,910 mg/L. Arsenic, chloride fluoride, iron, manganese, nitrate, selenium, sulfate, and TDS concentrations locally can exceed recommended drinking water standards.
Tertiary	Nacimiento	350	Sandstone and shale. Sandstones are arkosic, white, medium to coarse grained, and are interbedded with black and gray shale.	Reported well yields commonly range from 2 to 15 gpm.	Calcium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 200 to 2,500 mg/L, but 500 mg/L is common.
Tertiary / Upper Cretaceous	Animas	1100-2600	Varicolored shale, with interbedded breccia, conglomerate, and tuffaceous sandstone. The sandstone varies from light to rusty brown and contains abundant silicified wood and clay balls.	Average well yields range from 1 to 10 gpm with maximum yields of 75 gpm reported. Artesian wells are present in areas where sandstones are overlain by impermeable shales. Transmissivities 100 ft^2/day.	Calcium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 115 to 3,490 mg/L. Arsenic, chloride, fluoride, iron, manganese, nitrate, selenium, and TDS can exceed recommended drinking water standards locally.

TABLE 3-14
Hydrologic Characteristics of Geologic Units of the Southern Ute Indian Reservation[1]

Age	Formation		Thick-ness (feet)	Physical Character (see Appendix H for greater lithologic detail)	Hydrologic Characteristics	Water Quality
Upper Cretacecus (cont)	Kirtland Shale	Upper shale member	up to 500	Sandy shale and interbedded light-gray sandstone.	No data	No data
		Farmington Sandstone Member	up to 500	Sandstone, light gray, fine to medium grained, massive, interbedded with siltstone and shale.	Well yields typically range up to 5 gpm, yields have been reported up to 10 gpm.	Calcium bicarbonate type with hardness ranging from hard to very hard. TDS concentrations range from 1,120 to 4,450 mg/L. Arsenic, iron, manganese, and TDS have exceeded recommended drinking water standards locally.
		Lower shale Member	up to 500	Shale, dark gray.	No data	No data
	Fruitland		100-600	Varying proportions of interbedded sandstone, shale, and coal. The fine-to medium-grained sandstone beds, which are gray brown, and olive in color, grade laterally and vertically into shales and siltstones. The upper sandstones are well indurated and form resistant ledges.	Limited well information available. Sandstones in the outcrop area may be aquifers, with well yields estimated at less than 5 gpm. Well yields with the coal seams are 10 gpm or greater with transmissivities of 25 ft^2/day. Transmissivities of the shales 0.3 ft^2/day.	Sodium bicarbonate type in the Central Basin with hardness ranging from hard to very hard. Water from two springs sampled had TDS concentrations of 400 to 6000 mg/L. Iron, manganese, sulfate, and TDS concentrations can exceed recommended drinking water standards.
	Pictured Cliffs Sandstone		125-400	Sandstone, light-olive gray to grayish orange and orange, well sorted. Fine to medium grained, medium to thick bedded, and cliff-forming. Interbedded with small amounts of shale and siltstone.	Reported well yields up to 5 gpm. Transmissivity 0.001^{-3} ft^2/day Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	Calcium bicarbonate type with hardness ranging from hard to very hard. TDS concentrations range from 222 to 1,830 mg/L. Fluoride, sulfate, and TDS can exceed recommended drinking water standards.
	Lewis Shale		100-2500	Shale, light to dark gray and black. Contains interbeds of light-gray sandstone, sandy to silty limestone, and several calcareous concretions.	Reported well yields are as much as 3 gpm. Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	Sodium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 428 to 3,370 mg/L. Chloride, iron, nitrate, selenium, sulfate, and TDS can exceed recommended drinking water standards.

TABLE 3-14
Hydrologic Characteristics of Geologic Units of the Southern Ute Indian Reservation[1]

Age	Formation		Thick-ness (feet)	Physical Character (see Appendix H for greater lithologic detail)	Hydrologic Characteristics	Water Quality
Upper Cretaceous (cont)	Mesaverde Group	Cliff House Sandstone	350-1000	Gray, calcareous sandstone and silty shale; crossbedded and massive in places. Sandstones are very fine to fine grained and well sorted.	Reported well yields are as much as 17 gpm, but yields of 5 to 10 gpm are more common. Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	Sodium bicarbonate or sulfate type with hardness ranging from soft to very hard. TDS concentrations range from 250 to 3,500 mg/L. Fluoride, iron, manganese, sulfate, and TDS can exceed recommended drinking water standards.
		Menefee Formation	up to 350	Varying proportions of light-gray sandstone, siltstone, and shale with several interbedded coal seams.	Reported well yields are as much as 15 gpm. Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	Sodium bicarbonate or sulfate type with hardness ranging from soft to very hard. TDS concentrations range from 210 to 7,170 mg/L. Fluoride, iron, sulfate, and TDS can exceed recommended drinking water standards.
		Point Lookout Sandstone	up to 400	Light-gray to brown sandstone, massive and cliff-forming. Contains interbedded siltstone and shale in the lower part.	No wells sampled; well yields and water quality may be similar to Cliff House Sandstone. Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	
	Mancos Shale		400-2000	Dark-gray silty and sandy shale. Contains some interbedded sandstones and limestones. Lower 200 feet is calcareous and locally fossiliferous.	Yield from one well reported as 1 gpm.	Sodium bicarbonate type with hardness ranging from soft to very hard. TDS concentrations range from 600 to 5,000 mg/L. Selenium, sulfate, and TDS can exceed recommended drinking water standards.
	Dakota Sandstone		175-275	Sandstone, light gray to yellowish brown, with interbedded siltstone, black carbonaceous shale, and coal. Contains many conglomerate lenses near the base.	No wells sampled on the Reservation. Data from wells immediately north of the Reservation indicate that well yields may be as much as 5 gpm. Flowing wells may be developed in areas where sandstone is overlain by impermeable shale.	Calcium to sodium bicarbonate type with hardness ranging from hard to very hard. TDS concentrations may range from 273 to 440 mg/L.

[1] Source from Brogden et al. 1979; Brooks 1985; Levings et al. 1990; Robson and Wright 1995; BLM-San Juan Resource Area, 1997

TABLE 3-15
Water Quality Standards for Selected Parameters

Water Quality Parameters	National and Colorado Drinking Water Standards[1]
Major Inorganic Constituents (mg/L)	
Sulfate	250 [2]
Chloride	250 [2]
Fluoride	4 [3] or 2 [2]
Dissolved Solids (total) (TDS)	500 [2]
Nitrate (as nitrogen)	10 [3]
Trace Elements (µg/L)	
Arsenic	50 [3]
Barium	2,000 [3]
Iron	300 [2]
Lead	15 [4]
Manganese	50 [2]
Selenium	50 [3]
Zinc	5,000 [2]

[1]EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143.

[2]Secondary maximum contaminant level. These control contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance of drinking water. The regulations are not federally enforceable, but are intended as guidelines for the states.

[3]Maximum contaminant level (MCL). These are the maximum permissible levels of a contaminant in water at the tap, are health related, and are legally enforceable.

[4]Action level, maximum contaminant level goal for lead is zero, 40 CFR 141 and 142, (56 FR 26460; 6/7/97) and 57 FR 28785 effective 6/29/92.

The type of rock through which the water has percolated strongly influences the water quality in the aquifers. Sandstone, terrace, and floodplain aquifers generally contain calcium-bicarbonate type water; whereas, shale aquifers yield primarily sodium-bicarbonate type water. Rocks containing interbeds of coal or carbonaceous shales may contain either calcium or sodium sulfate type water (Brogden et al. 1979). Total dissolved solids (TDS) concentrations in water from 45 of 51 wells and springs sampled by the USGS within the Reservation exceeded the recommended limit of 500 milligrams per liter (mg/L) for community drinking water supplies (Brogden et al. 1979). Groundwater with elevated selenium concentrations is generally associated with formations that contain volcanic rock, such as the San Jose and Animas formations. Selenium concentrations in groundwater in the Study Area are highly variable and range from less than 10 to 13,000 micrograms per liter (g/L) (Brogden et al. 1979).

<u>Alluvial Aquifers</u>

The unconsolidated alluvial deposits are generally Quaternary in age and associated with the present river valleys composed of floodplain and older terrace deposits. These aquifers are recharged by streamflow, infiltration of precipitation, leakage from irrigation ditches and irrigated fields, and discharge from bedrock (consolidated) aquifers (Brogden and Giles 1976; USGS 1994; Robson and Wright 1995; BOR 1996b).

In the La Plata and Animas river valleys, well yields from floodplain alluvial deposits typically range from 1 to 10 gallons per minute (gpm). Deposits are thicker in the Piedra and Pine river valleys and well yields are correspondingly higher, ranging from 5 to 25 gpm (Brogden et al. 1979). Terrace alluvial deposits are characteristically only partially saturated and generally have well yields of 10 gpm or less; however, yields of 50 gpm have been reported (Brogden et al. 1979; Robson and Wright 1995).

Alluvial deposits within the study are typically characterized by TDS concentrations ranging from 148 to 985 ppm, exceeding the community drinking water supplies secondary maximum contaminant level (MCL) of 500 ppm in 51 percent of wells and springs noted in Brogden et al. (1979). Some alluvial wells and springs within the Study Area contain chemical concentrations which exceed primary and secondary drinking water standards (refer to Table 3-15) of arsenic (7 percent in the USGS study Brogden 1979), chloride (4.5 percent), fluoride (26 percent), iron (8 percent), nitrate (3 percent), manganese (9 percent), selenium (28 percent), and sulfate (18.5 percent).

<u>Bedrock Aquifers</u>

Two distinct bedrock aquifers are present within the Study Area. Tertiary aquifers are located only within the San Juan Basin portion of the Study Area. Deeper Cretaceous aquifers are present throughout the Study Area. This section discusses characteristics of these aquifers. Specific aquifer characteristics of the Cretaceous Fruitland Formation are also addressed due to its significance for CBM production.

Tertiary Aquifers - In the Study Area, potable water from bedrock aquifers is most commonly found in the Tertiary San Jose, Nacimiento, and Animas formations. These aquifers typically consist of sandstone and are exposed at the land surface throughout most of the San Juan Basin portion of the Study Area, or are overlain and potentially hydraulically connected to the alluvial sediments and aquifers. The formations typically exhibit low porosity and permeabilities and are generally low-yielding (1 to 10 gpm). The most transmissive and best potential aquifer is the Animas Formation, which has recorded yields of 50 gpm near Durango, and 75 gpm within the Reservation (Brooks 1985).

Unlike the Cretaceous aquifers, the Tertiary bedrock aquifers are generally not overlain by thick confining layers, and precipitation recharges the aquifers over a broad area. These aquifers are naturally recharged by infiltration from precipitation and leakage from streams where the overlying alluvial aquifers are hydraulically connected. However, the largest source of recharge in some portions of the Study Area occurs from infiltration of water from irrigated fields and leakage from unlined canals and ditches. Groundwater discharges occur due to consumptive use of groundwater withdrawn from wells, seeps, and springs connected with the Florida, Animas, and Pine rivers and associated alluvial aquifers (Robson and Wright 1995).

Water quality within the Tertiary aquifers is dependent upon the depth of the formations (refer to Table 3-15). Groundwater in the upper portions of these formations is readily recharged from surface sources and is of better chemical quality than deeper water. Water quality measurements have indicated TDS concentrations ranging from 115 to 3,490 ppm. Primary and secondary drinking water standards have been exceeded in some areas due to naturally occurring concentrations of arsenic, chloride, fluoride, iron, manganese, nitrate, selenium, and sulfate (refer to Table 3-15) (Brogden et al. 1979; Robson and Wright 1995).

Selenium concentrations exceeding the MCL of 50 mg/L can be found throughout the Reservation in water from the Animas Formation. Within the San Jose Formation, groundwater with selenium concentrations exceeding the MCL has been found to be associated with two areas in the central portion of the Reservation: the Oxford Tract (bounded by the Durango-La Plata County Airport to the west, Oxford to the north, and Ignacio to the south and east), and an area located near the northwest shore of the Navajo Reservoir in the vicinity of Arboles, Colorado. The only known case of human selenium poisoning in the United States was reported from the Oxford Tract. Selenium poisoning of livestock has been reported but not documented throughout the Reservation. Selenium concentrations in water are highest in formations that contain volcanic rock, and the San Jose and Animas formations both contain fragments of rocks of volcanic origin. However, it should be noted that the occurrence of selenium is variable even in the areas characterized by high selenium concentrations, probably due to the relative oxidizing conditions of the groundwater (Brogden et al. 1979, BOR 1996b Appendix B).

Cretaceous Aquifers - Cretaceous aquifers within the Study Area are predominantly fine- to coarse-grained sand cemented with calcium carbonate, resulting in aquifers with low porosities and permeabilities, and thus low well yields (Brogden et al. 1979). In some areas Cretaceous bedrock aquifer yields may be higher depending on fracture porosity and permeability (Brogden and Giles 1976). The Cretaceous aquifers are typically under confining conditions due to the presence of thick confining units such as the Mancos and Lewis shales.

Except west of and along the Hogback (refer to Map 10, Section 3.4), most Cretaceous aquifers are generally greater than 3,000 feet below land surface and tend to be too deep to be reached by a water well (Robson and Wright 1995). Some younger coals and sandstones are limited to the San Juan Basin portion of the Study Area and can be found less than 3,000 feet below land surface.

Small rates of natural infiltration are the principal recharge sources to the confined aquifers. In the deeper parts of the basin, thick confining layers above and below the aquifers prevent most direct water movement to or from the land surface. The potentiometric surface within the Cretaceous aquifers is generally from the outcrops north of and within the western portion of the Study Area into the San Juan Basin. Within the Study Area, the principal direction of groundwater movement within the confined units is generally to the south, from the points of recharge (outcrops) down the dip of the beds (refer to Figure 3-3 for general dip direction). The confining units between the aquifers retard the water loss (or discharge) between aquifers and to the land surface (USGS 1994, Robson and Wright 1995).

Water within the Cretaceous formations is highly mineralized, and TDS concentrations may exceed the secondary MCL of 500 ppm for drinking water (Brogden et al. 1979). As the Cretaceous aquifers dip deeper into the basin, TDS concentrations increase (Oldaker 1991; Kaiser et al. 1994). In general, data indicate that groundwater in these formations below approximately 500 feet is not suitable for domestic or potable use (BLM 1996b). As measured from water wells within the Study Area, TDS ranges from 222 to 7,130 ppm (Brogden et al. 1979). Water produced in association with gas development within the Cretaceous formations has yielded higher TDS concentrations (>10,000 ppm) (Kernodle et al. 1990; Robson and Wright 1995).

Natural gas historically has been produced from Cretaceous formations. Development of groundwater resources can be hindered or precluded in these gas-bearing formations due to depth and poor water quality which can adversely affect taste, odor, and appearance. Additionally, water from these formations could be a safety hazard if gas is present in sufficient quantities and not allowed to naturally dissipate from the pumped water (Robson and Wright 1995).

Fruitland Formation

Because this EIS evaluates the potential impacts of development of the Fruitland CBM, the hydrogeology within the Fruitland Formation and the potential interaction with surrounding formations is addressed in greater detail than the other aquifers. The Fruitland Formation is a source of water for domestic and livestock use in areas where drilling depths and pumping levels are economically feasible and where water quality is acceptable (Kernodle et al. 1990). However, no Fruitland water wells are known to be current sources of potable water within the Study Area. The depth of the Fruitland Formation ranges from near or at ground surface along the Hogback monocline in the west-central portion of the Study Area to more than 4,000 feet below land surface in the east-central portion of the Study Area south of the town of Ignacio (Zimpler et al. 1988). Except near the outcrop, the Fruitland coals are under confining conditions (Kaiser et al. 1994; Oldaker 1991). The confining conditions extend to within two miles of the northern Fruitland outcrop (Ayers 1988; BLM 1996a). The hydrology of the Fruitland, including the effect of dewatering of CBM wells, has been modeled in the 3M study (Section 3.4.2.1).

Within the Study Area, the portion of the Fruitland Formation that is confined is typically overpressured (i.e., artesian). Reviews of the San Juan Basin as a whole indicate a structural hingeline is present in New Mexico that may coincide with a transition within the confined Fruitland coals from overpressured in the north to underpressured in the south (Kaiser and Ayers 1994). Some authors attribute this change to a no-flow permeability barrier at the hingeline preventing recharging water from the northern recharge areas from flowing to the south (Kaiser and Ayers 1994; Kaiser et al. 1994). Where confined, the Fruitland Formation is a closed system and not directly hydraulically connected with the surrounding formations.

Within the Study Area, water quality trends support the conclusion that the Fruitland Formation is locally interconnected to the underlying Pictured Cliffs sandstone, and that there is minimal communication between the Fruitland Formation and the overlying Kirtland Shale. Near the northern outcrop of the Fruitland Formation, Fruitland groundwater is characterized by calcium-magnesium bicarbonate and low TDS concentrations (500 mg/L). Fruitland water further south in the basin is characterized by sodium-bicarbonate with high TDS concentrations (20,000 mg/L) (Ayers et al. 1988). Similar variations of water type and concentrations are noted near the western outcrop (personal communication, SUIT Energy Resources Division 1996).

The change in water type and TDS appears to correspond with the flexure, a change of dip of the Fruitland Formation from the monocline to the central basin. The TDS concentrations observed in springs and wells (both water and gas wells) from the outcrop to the flexure in the Colorado portion of the basin are measured in only hundreds of ppm, representing meteoric and fresh recharging water, versus thousands of ppm in wells basinward from the flexure which could be a mixture of meteoric or connate water (SUIT Energy Resources Division, personal communication 1996; Kernodle et al. 1990). Connate water is water entrapped in the pores of sedimentary rocks at the time of sediment deposition or water that has been out of contact with the atmosphere for at least an appreciable part of a geologic period (Bates and Jackson 1980). The changing water type and increase in TDS with depth and distance away from the outcrop strongly suggest a very slow moving hydrologic system, with fresh water recharge occurring at the periphery of the basin throughout geologic time in the Fruitland Formation (BLM 1989, Kaiser et al. 1994). With the possible exception of the area between the outcrop and the flexure, groundwater within the Fruitland Formation is too deep and of quality too poor to be a viable or economic groundwater supply.

It is possible that the substantial volumes of water which have been withdrawn from the Fruitland Formation have in some way impacted drainage and runoff patterns or near outcrop springs. Since 1995, the Tribe, BLM, and some operators have been gathering data concerning the water table in the Fruitland on the western side of the Reservation. The data is primarily comprised of observations of water levels in various monitoring wells and at springs. It appears that ground water levels along the outcrop, and just basinward of the outcrop have decreased considerably as CBM development progressed. Soda Springs is dry, and several artesian boreholes tapping the Fruitland coal seems are no longer flowing water to the surface.

3.5.1.3 Methane Contamination

From the mid-1980s into the 1990s, public officials received increasing reports and complaints of methane in groundwater (BLM, San Juan Resource Area, personal communication 1996). These reports coincided with both an increase in the development of CBM in the Fruitland Formation and an increase in population in the area. Methane seeps and reports of methane in groundwater are not new for the area. Historical reviews of reported methane seeps have been conducted by Oldaker and Chuhey (BLM, San Juan Resource Area, personal communication 1996). In the late 1800s, settlers in the area noted gas seeps in rivers, and between the discovery of the natural gas seeps and the development of gas fields in the 1950s, methane gas was encountered when shallow boreholes and groundwater wells were drilled. Reports of seeps and methane in groundwater continued to occur throughout the Ignacio-Blanco field development (Finch 1994).

Natural gas entrained in groundwater can exsolve from solution and cause fire or explosion hazards in confined or poorly ventilated spaces. Although methane (the principal component of natural gas) is tasteless, odorless, colorless, and nontoxic to humans, its presence in groundwater can create an anoxic environment that may lead to geochemical reactions and foster bacterial growth that adversely affect the taste, odor, and appearance of the pumped water. When water containing entrained natural gas is exposed to the air, gas is released from solution and can dissipate rapidly with adequate ventilation. However, in confined or poorly ventilated spaces, natural gas may rise (methane is less dense than air) and accumulate, creating a fire or explosion hazard. Because methane has no taste, odor, or color, the presence of hazardous accumulations can be difficult to detect (Robson and Wright 1995).

Many studies were undertaken in the early 1990s to identify the origin of methane in groundwater and to evaluate CBM development as a potential source of the contamination (BLM 1994b; COGCC and BLM 1995; USGS 1994; Finch 1994; Finch et al.1994; Ignacio-Blanco Groundwater Task Force 1993). In 1991, the BLM-San Juan Resource Area also began a monitoring program of CBM and conventional gas wells. Surface casing pressures (bradenhead testing) were evaluated to identify wells that might provide vertical conduits for gas migration (BLM 1993b, 1994a, 1995a, and 1996a).

Within the Study Area most of the pre-1993 water well studies were concentrated in the Bondad area. In the fall of 1993, the BLM conducted 201 water quality tests from domestic and livestock water wells in the HD Mountains Study Area (located north of the Reservation) and within 0.5 mile of selected jurisdictional lands within La Plata County to detect changes in entrained methane. The purpose of the program was to establish baseline conditions so groundwater quality could be monitored periodically to detect changes in dissolved methane concentrations and to identify areas of concern (i.e., areas exhibiting high methane concentrations) (BLM 1994b). Methane concentrations greater than 1.0 mg/L in groundwater can theoretically create an explosive hazard under confined conditions. The actual practical limit of methane concentration in ground water required to create explosive hazards is probably higher than 1.0 mg/L as conditions must exist to exsolve the methane at a rate to sustain the explosive atmosphere and to collect the gas. There are no acute (immediate) or chronic (cumulative) toxic hazards known for methane other than asphyxiation (Finch et al. 1994). Monitoring results indicated dissolved methane concentrations greater than 1.0 mg/L in 24 percent of the samples from 13 areas of concern (BLM 1994b).

In 1994, the BLM, in conjunction with the COGCC expanded their water quality study to sample water wells in portions of the San Juan Basin in Colorado that had not been previously sampled or had been omitted in 1993 due to BLM jurisdictional restraints. This 1994 study, termed a comprehensive infill, was conducted to provide predictive patterns of water quality for the northern San Juan Basin. One representative water well per land grid section was tested, as much as feasible within access constraints (COGCC and BLM 1995). Based on this comprehensive analysis, the number of critical study areas was redefined from 13 to 17 areas, 6 of which are located within the Study Area. Map 15 shows the water wells that were sampled within the Study Area. Map 28 shows the locations of the critical study areas in La Plata County, Colorado. The critical study areas were established with a one-mile peripheral buffer zone extending from any groundwater wells exhibiting 1.0 mg/L or greater methane concentration.

During this 1994 study, if the methane concentration in the groundwater was greater than 1.0 mg/L, a water sample was collected and analyzed for the stable carbon isotope of the methane molecule and major cation/anion constituents. These results were compared to the carbon isotopic results of production gas samples gathered from current gas wells. The carbon isotope ratio indicates whether the collected gas was likely of thermogenic or biogenic origin. Gas of thermogenic origin is isotopically heavy and indicates gas generation under high temperature and pressure, generally the type of gas associated with commercial gas production. Biogenic gas is isotopically light and indicates a shallower gas source produced near the ground surface as a result of bacterial decomposition of organic matter (see USGS 1994 and/or COGCC and BLM 1995 for a full explanation of carbon isotope ratios and calculations).

The testing program indicated that both biogenic and thermogenic gases are found in some northern San Juan Basin water wells. Within the Study Area, six areas were identified; the Sunnyside and Bondad area gas contamination clearly displayed a thermogenic character, with the exception of one well in the Bondad area. The Ignacio and southern Florida Mesa areas were within the biogenic range. The Piedra River area showed an isotopic character at the low end of the thermogenic range or the upper end of the biogenic range. Biogenic and the thermogenic characters were both exhibited in the Salt Creek-Yeager Canyon areas (T34N, R8W) and the southeast Durango area along the Animas River southeast of the town of Durango (COGCC and BLM 1995).

Local sources of biogenic gas have not been as well studied as the thermogenic gas source. Possible sources of biogenic gas include residential leach fields, local landfills, and other surficial decaying plant matter.

While the source of the thermogenic gas is generally associated with gas producing horizons such as the Pictured Cliffs Sandstone, Mesaverde Group, and Dakota Sandstone as well as CBM, another possible source is indigenous gas from the San Jose Formation, Nacimiento Formation, and Animas Formation (including the McDermott Member), or the Kirtland Formation (refer to Figure 3-3). Secondary alteration of gas may also lead to an erroneously mature gas signature, clouding the accuracy of thermogenic carbon 13 determinations. Additional analysis of deuterium and oxygen are sometimes used to clarify ambiguous issues. The migration pathway of gas to a particular water well from the deep thermogenic sources cannot be as easily determined due to the complex geologic character of the strata. Possible vertical pathways of thermogenic gas migration include the following (BLM 1993b; USGS 1994):

- open annular space (between the casing and borehole wall) in some older conventional wells (typically prior to 1988) that allows gas to migrate vertically and then laterally into permeable aquifers;
- incomplete isolation in conventional wells that could allow gas migration vertically through a microannulus (wells such as the Fruitland and disposal wells are required to have cement to the surface around all casing and have a lower potential for pathway development);
- plugged and abandoned wells where zonal isolation of the hydrocarbon-bearing units is not complete or effective;
- shallow well penetrations such as cathodic protection wells, exploration test holes, and/or water wells;
- shallow boreholes from seismic and geologic investigations, pylons and piers used in bridge construction, and septic systems; and
- natural fractures and faults.

The BLM and COGCC work together to identify and remediate wells that lack mechanical integrity. If the operator of such a well cannot make the suggested remediation, then the COGCC may use bond money and Environmental Response Fund to accomplish the remediation. At this time, the COGCC has no wells awaiting remedial work in La Plata County. One well is being closely monitored to judge the effectiveness of remediation work performed by the COGCC in 1998.

Additional discussion of methane sources and migration pathways is provided in Section 4.5.2.

3.5.2 Surface Water

3.5.2.1 Introduction

The Reservation occurs within the southwestern Colorado portion of the San Juan River Basin, a structural and hydrologic depression located in southwestern Colorado and northwestern New Mexico. With seven principal watershed areas, the Reservation drains approximately 5,800 square miles in Colorado. Of these, the La Plata, Animas, Pine, and Florida rivers flow through the Study Area. In addition, Trail Canyon tributary is a smaller stream emanating from the south-central section of the Study Area. Maps 1 and 5 show the major surface water features within the Study Area.

3.5.2.2 Watershed Characteristics

The Study Area consists of portions of three major river systems. From west to east, the La Plata, Animas, and Pine River watersheds are distributed evenly across the Study Area. The La Plata River flows southwest from the La Plata Mountains and the San Juan National Forest across the western portion of the Study Area, joining with the San Juan River in New Mexico. Cherry Creek, the primary tributary to the La Plata River, flows south from the northwest corner of the Study Area and joins with the La Plata River northwest of Redmesa.

The La Plata River and Cherry Creek drain mesa lands characterized by low- to high-density stands of piñon-juniper woodland. As with most of the streams in the Study Area, the La Plata River flows through wooded riparian areas, a combination of mixed grasses and shrubs, and agricultural lands. The highest density of agricultural development within the Study Area occurs in the eastern portion of the watershed, near the town of Kline, as well as in the southern portion of the watershed as the river crosses into New Mexico.

The Animas River drains the central portion of the Study Area and is the largest of the three rivers. It flows south from the San Juan Mountains through Durango, and joins with the San Juan River in New Mexico. The confluence of the Animas River and its primary tributary, the Florida River, is within the Reservation boundaries near Bondad, Colorado.

The Animas River watershed is separated from the La Plata River by Black Ridge, which is a north-south-trending mountain range. Within the Study Area, the Animas watershed is dominated by a wide river valley. The western portion of the watershed is characterized by upland hills with medium- to high-density stands of piñon-juniper, and the eastern portion consists of the Florida Mesa, primarily an agricultural area. The southern river valley flattens out and is shared by agriculture as well as mixed grasses and shrubs and wooded riparian areas. The southeastern section of the watershed has minimal agricultural development and is dominated by low- to high-density stands of piñon-juniper woodland with mixed shrubs and grasses.

The easternmost portion of the Study Area is drained by the Pine River, which flows south from the Vallecito Reservoir area and enters Navajo Reservoir about 10 miles south of the Reservation in New Mexico. The main tributary to the Pine River is Spring Creek, with the confluence near La Boca, Colorado. The Pine River watershed also has a great deal of agricultural development, primarily in the eastern rolling hills. Piñon-juniper communities are found in the uplands to the east in low- to high-density stands, and to a lesser degree on the southeastern side of the valley.

The climate in the Study Area is semi-arid, with an average annual precipitation of 12 to 16 inches (Colorado Climate Center, 1984). Precipitation falls primarily as snow from November through April. Average snowfall can range from 60 to 200 inches in the San Juan Mountains to the north but is considerably less at the lower elevations including the Study Area (HD Mountain Coalbed Methane Study).

Annual snowmelt runoff in each of the three primary rivers begins in March or April at the higher elevations of the Reservation. As temperatures rise in the San Juan Mountains, the streamflow steadily increases through May with peak flows typically occurring in June. Streamflow slowly recedes for the remainder of the summer and through the fall and winter. The flow characteristics of the three primary rivers on the Reservation are strongly affected by irrigation practices both inside and outside the Reservation. Seasonal high flows are reduced by diversions and low flows are increased by return flow from irrigation.

Flowing from the San Juan Mountains, the La Plata, Animas, and Pine rivers lose elevation quickly before crossing the northern border of the Reservation. The majority of the La Plata River watershed is located within the Reservation. In fact, the watershed extends only about 10 miles north of the Reservation boundary, thus it derives a considerable portion of its flow within the Study Area. The majority of the Animas River drainage is outside the Study Area, and a considerable amount of water is diverted before reaching the Reservation. The Pine River has a relatively large number of perennial tributaries within the Reservation. While the subject rivers generally flow from steeper canyons, they become wide river valleys as they enter and pass through the Study Area. The primary population centers and agricultural areas characterize the wide valleys and high plateaus of the river watersheds.

Numerous creeks emanating from the Study Area, most of which are ephemeral, flow into the three major drainages on the Reservation. Ephemeral streams flow only during wet periods that can include summer rain storms and spring snowmelt. The remaining acreage of the Study Area not included in the three major watersheds (approximately 40 square miles) consists of the watershed of the Trail Canyon tributary, which flows into the San Juan River in New Mexico. Trail Canyon's headwaters are in the Mesa Mountains, southwest of Ignacio and east of Bondad in the south-central portion of the Study Area. This area is characterized by upland hills with low to high density piñon-juniper woodland stands.

3.5.2.3 Hydrology

Streamflow records for the portion of the San Juan River Basin located in the Study Area are available from USGS gauging stations for the three principle rivers (La Plata, Animas, and Pine). A summary of average annual runoff from these gauges is presented in Table 3-16. In addition, instantaneous streamflow measurements at 24 water quality stations have been recorded by SUIT since 1992. A variety of other studies undertaken over the years have yielded limited information generally consisting of instantaneous flow measurements in areas of local interest.

TABLE 3-16
Summary of Average Annual Runoff

USGS Gauging Station	Gauge Elevation (feet above sea level)	Drainage Area (square miles)	Period of Record	Average Annual Runoff (acre-feet)	Average Runoff per Square Mile
La Plata River at CO/NM Border	5,975	331	1920-1995	26,230	79

Animas River near Cedar Hill, NM	5,960	1,090	1933-1995	676,000	620
Pine River at La Boca, CO	6,142	510	1950-1995	177,500	348
Source: USGS Water Resources Data - Colorado, Volume 2, 1995 (USGS 1995)					

La Plata River

The drainage area of the La Plata River at the USGS gauging station at the Colorado-New Mexico border covers 331 square miles. The La Plata River decreases in elevation from approximately 7,400 to 5,979 feet across the Study Area and flows through a wide river valley near the towns of Breen, Kline, Marvel, and Redmesa, and narrows with steeper relief near the New Mexico border. Cherry Creek, one of the largest tributaries, joins with the La Plata River within the Study Area at a location northwest of Redmesa. Cherry Creek drains the high-elevation northwestern area of the watershed. Long Hollow, another tributary within the Study Area, enters the La Plata River about 3 miles south of Redmesa. Long Hollow is fed by ephemeral streams and flows from a series of northeast-trending steep canyons. Of the total 331 square-mile La Plata River drainage, approximately one-half or 165 square miles are located within the Study Area.

The primary use of the La Plata River is irrigation. During the irrigation season, flows are diverted via the Hay Gulch Ditch to the Mormon Reservoir located northeast of Redmesa. In combination with possible losses to groundwater, this diversion located 20 miles north of the Reservation boundary near Hesperus, effectively depletes the river of flows as it passes through the Study Area between the town of Breen and the Cherry Creek confluence (BOR 1996a). In general, the discharge of the La Plata River decreases as it flows downstream, losing the majority of its flow to the Hay Gulch Ditch. Several other irrigation ditches, both within and outside the Study Area, also receive water from the La Plata River. Upstream diversions provide irrigation water for about 15,000 acres. The average annual discharge of the La Plata River at the Colorado-New Mexico border was less than the average discharge upstream at Hesperus; 36 and 45 cubic feet per second (cfs), respectively, for water years 1921 through 1994 (USGS 1995).

Animas River

The Animas River drains 1,090 square miles at the USGS gauging station near Cedar Hill, New Mexico. Approximately 150 square miles are within the central portion of the Study Area. The Animas River decreases in elevation 500 feet across the Reservation, flowing through an incised channel across a wide river valley. Runoff to the Animas River within the Study Area consists of ephemeral streams flowing from steep valleys of Basin Mountain (8,245 feet elevation) to the west, and the high elevation low-relief rolling hills of Florida Mesa (6,500 feet elevation) to the east. The Florida River drains the eastern portion of the Animas River watershed. The Florida River joins the Animas River within the Study Area near Bondad, Colorado. Downstream of Bondad, the Animas River flows through a canyon typical of the Florida Basin and the surrounding tributaries.

The Animas River is primarily used for irrigation, but also provides water for municipal and industrial use. Lemon Reservoir, located on the Florida River 30 miles upstream from the Animas-Florida confluence, controls flows in the Florida River and the Florida Canal, the latter passing through Pastorius Reservoir. Pastorius Reservoir is located near the northern border of the Reservation and lies within the Study Area. Irrigation water for about 20,000 acres is provided by these and other upstream diversions. Return flows from irrigation cause some ephemeral streams within the central portion of the Study Area to flow throughout the summer months, and may raise the water table, thereby increasing the baseflow of the Animas River during the winter months. The average annual flow rate of the Florida River at the USGS gauge near the confluence with the Animas River was 75 cfs (water years 1968 through 1983). The average annual flow rate of the Animas River at the USGS gauge near Cedar Hill, New Mexico was 926 cfs (water years 1934 through 1994). Peak flows typically occur in late May to early June, but generally maintain seasonal fluctuations throughout the year.

Pine River

The drainage area of the Pine River at the USGS gauging station near the southern border of the Reservation near La Boca, Colorado is 510 square miles. Of this total, approximately 95 square miles are located within the Study Area. Spring Creek, a major tributary to the Pine River, drains nearly 45 square miles encompassing most of the remaining Study Area to the east. The Spring Creek area consists of rolling hills with fewer streams and canyons as are found near the La Plata and Animas rivers. The Pine River watershed is also characterized by rolling hills with low relief and a wide river valley at the northern edge of the Study Area. As it nears the New Mexico border, the terrain becomes more mountainous.

Flows in the upper Pine River are controlled by Vallecito Reservoir, which is located outside the Study Area, 24 miles upstream of the La Boca gauge. Pine River flows are diverted primarily to two irrigation ditches south of the town of Bayfield, just north of the Reservation boundary. The irrigation diversions decrease flows of the Pine River, although return flows sustain streamflow throughout the summer in some otherwise ephemeral streams. The Pine River provides irrigation water for more than 30,000 acres. Although the drinking water supply throughout the Study Area is derived primarily from groundwater wells, Ignacio derives its supply from the Pine River approximately 2 miles upstream of town. The average annual flow rate of the Pine River at Bayfield, Colorado was 358 cfs but decreased to 240 cfs within the Study Area downstream near La Boca (water years 1951 through 1994). Flows vary considerably throughout the year depending on irrigation use, but peak flows generally occur in late May to early June as a result of snowmelt from the San Juan Mountains.

Surface water in the Spring Creek area is primarily used for recreation, wildlife, fish habitat, and agriculture. Spring Creek gains much of its flow as irrigation return during summer. Flows vary considerably throughout the year.

Trail Canyon

The Trail Canyon headwaters border the Animas and Pine River watersheds in the southern half of the Study Area. A comparatively minor drainage, it is made up of several ephemeral streams flowing southeast. Trail Canyon joins with Pump Canyon, a tributary of the San Juan River, south of the Colorado-New Mexico border and outside the Study Area.

3.5.2.4 Surface Water Quality

Past water quality studies in the San Juan River Basin have not evaluated the potential impacts of oil and gas development on surface water quality within the Study Area, or in Colorado. No data are available to assess existing effects, if any, of gas extraction activities on surface waters of the Reservation. There currently is a lack of surface water quality information for streams in this area that can be used to establish baseline concentrations of hydrocarbons in surface water or sediment.

Other studies conducted in the San Juan River Basin determined that surface water quality in the Study Area can be affected by depletions and return flow from irrigation, naturally occurring minerals, and from historic and current mining. Parameters associated with these activities such as selenium, salinity, agricultural pesticides, and sediments have been identified as degrading surface water quality within the Study Area (BOR 1996a). More recently there has been concern that polycyclic (or polynuclear) aromatic hydrocarbons (PAHs) associated with petroleum production could affect surface water quality in the basin (BLM 1995b).

Water Quality Within Study Area

Historic water quality data for inorganic chemical constituents and metals from within the Study Area are available primarily for the Pine River, Florida River, and Spring Creek, and from several studies conducted within localized areas. More recently, the SUIT has implemented surface water quality data collection activities within the Reservation. This program includes water quality sampling on the Pine and La Plata rivers beginning in June 1992 and on the Animas River in June 1993. The SUIT data are compared to both state and SUIT water quality standards, and the frequency of exceedence is shown in Table 3-18. The detection limits used for several of the metals in SUIT samples were greater than the state and SUIT standards including silver, mercury, and lead. These results show that water quality in Study Area streams is generally good with minimal exceedence of established water quality standards. However, water quality in various stream segments within the Study Area are affected by irrigation return flows, runoff from erosive soils, and other natural phenomena. General surface water quality conditions found within the Study Area are discussed below.

Dissolved Solids

Runoff from agriculture, mining, ground water inflow, and naturally occurring sediments can affect TDS concentrations in Study Area streams. In the La Plata River, TDS concentrations ranged from 48 to 276 mg/L in 21 samples collected from 1992 to 1996 at the upstream sampling location near Breen (Table 3-17). Downstream on the La Plata River near Long Hollow Creek, the average TDS concentration was 789 mg/L. The highest TDS measured at this location was

1,408 mg/L (Table 3–17). These data suggest an increase in TDS with distance downstream on the La Plata River, due to the inflow of Cherry and Long Hollow creeks. Several measurements (15 of 22 samples) in the lower reaches of the La Plata River exceeded EPA's recommended TDS secondary standard of 500 mg/L for drinking water (Table 3-15; Drinking Water Regulations and Health Advisories, EPA 1995).

Although samples occasionally exceeded the EPA-recommended drinking water quality secondary standard of 500 mg/L, average concentrations were 324 and 331 mg/L for the upstream and downstream locations, respectively. These data suggest lower TDS concentrations in the Animas River as compared to the La Plata River, probably due to the difference in geology between the two basins. Regarding Animas River aquatic life, the Animas-La Plata EIS states that "Average concentrations of trace elements did not exceed EPA water quality criteria for the protection of aquatic life. No acute toxicity to aquatic life or wildlife was indicated; irrigation-related flow reduction was the most significant limiting factor to native fishes" (BOR 1996a). During 1988 and 1989, a reconnaissance investigation of water quality and associated impacts from irrigation was carried out by the USGS in the Pine River area. Water quality, bottom sediment, and biota were sampled at seven sites on the Pine River and at 27 sites on tributaries and other streams. The study concluded that irrigation did not appear to be a major source of TDS in Study Area streams. These data suggest that TDS concentrations in the Pine River are lower overall when compared to the Animas and La Plata rivers.

Metals

Trace metal concentrations in the La Plata River were generally low, and did not exceed state or SUIT water quality standards (SUIT preliminary data 1992-1996). Of the samples collected, total recoverable selenium and zinc were low (at or near detection limits in every instance), with no exceedences of standards even when comparing total values to standards based on dissolved metals. Occasional exceedences were noted for copper and iron in the La Plata River.

With respect to the Animas River, the Animas-La Plata EIS states that "A heavy metal problem exists in the Animas River, primarily as a result of natural erosion of mineral bearing strata and early-century mining activities and seasonal high flows which cause sediment movement and erosion of mine tailings into the river system" (BOR 1996a). Research also has shown that as the Animas River flows through the Study Area there is an increase in selenium concentrations. The Animas-La Plata EIS states that "Fish tissues collected from the Animas River do not suggest biomagnification of selenium to concentrations that would be expected to reproductively impair fish."(SUIT preliminary data 1992-1996).

Preliminary data collected by SUIT indicate that samples collected at the lower Animas River sampling location near Twin Crossing show a slightly increased incidence of detection of selenium concentrations compared to upstream locations, but most were at or below the detection limit and all were below water quality standards (SUIT preliminary data 1992-1996).

TABLE 3-17
Number of Exceedances of State of Colorado or Suit Water Quality Standards for Trace Element Concentrations (g/l) (1992 - 1996)

Station Name	No. of Obser-vations	TDS Range (mg/l)	Arsenic[2]	Chromium VI[1]	Copper[1]	Iron[3]	Manganese[3]	Nickel[1]	Selenium[1]	Zinc[1]
La Plata River										
SUIT Standards			100	11	21	300	50	280	5	190
State Standards			100	25 (Tot.)[2]	10 (Tot.)[2]	1000 (Tot.)[2]	1000 (Tot.)[2]	100 (Tot.)[2]	20 (Tot.)[2]	140[2]
Near Breen	21	48-276	0	0	2	2	0	0	0	0
Near Long Hollow Creek	21	188-1408	0	1	3	5	0	0	0	0
Animas River										
SUIT Standards			100	11	21	300	50	280	5	190
State Standards			50	11	21	1000 (Tot.)[1]	50	280	35	190
Near Basin Creek	20	108-526	0	0	3	4	0	0	0	0
Near Twin Crossing	15	88-770	0	0	1	2	0	0	0	0
Pine River										
SUIT Standards			100	11	21	300	50	280	5	190
State Standards			50	11	21	1000 (Tot.)[1]	1000 (Tot.)[1]	280	10 (Tot.)	190
Near Bayfield	16	45-98	0	0	0	0	0	0	0	0
Near La Boca	21	52-218	0	0	1	9	0	0	0	0

Note: Standards are for dissolved metals unless otherwise noted.
SUIT sample data are for total recoverable metals.
[1] Chronic aquatic life standard is based on 200 mg/l hardness-dissolved.
[2] Agriculture standard (total recoverable).
[3] Drinking water standard (total recoverable).
Data Source: SUIT preliminary Water Quality Data. State Standards Reference: Colorado Department of Health, Classifications and Numeric Standards for San Juan River and Dolores River Basins, August 30, 1995.
SUIT Standards Reference: Water Quality Standards for the Southern Ute Indian Reservation, Southern Ute Tribe Water Quality Department, October 1997.

Based on data generated for the Animas-La Plata EIS, silver and dissolved manganese in the Animas River exceeded the standard 38 to 41 percent of the time, and zinc represented a moderate hazard to the aquatic environment (BOR 1996a). SUIT data from samples collected within the Reservation boundaries between 1992 and 1998 show no incidence of detection of silver in any form in the water column, and no incidence of detection of manganese in exceedance of standards. Preliminary data collected by SUIT indicate that total recoverable copper and iron concentrations in the Animas River occasionally exceed water quality standards. Both total recoverable and dissolved zinc concentrations were below both state and SUIT standards for all designated uses. The standard for dissolved zinc was calculated based on 200 mg/L hardness. Actual hardness values in the Animas ranged from 58 to 304 mg/L. A lower hardness concentration would result in a lower zinc standard value at that point in time (SUIT preliminary data 1992-1996).

A USGS study in the Pine River watershed shows that certain trace metals were detected, with the highest concentration of selenium detected in Rock Creek, "...an area known to have large selenium concentrations in groundwater" (Butler 1989). Manganese also was detected in Pine River samples, and the study concluded that the source of manganese may be from groundwater sources. SUIT data indicate detectable mercury levels at two locations in the Pine River. Some samples contained selenium and zinc concentrations above the detection limit but below state and SUIT water quality standards. Occasional exceedences of standards for copper and iron were measured on the lower Pine River (SUIT preliminary data 1992-1996).

Other Studies Related to Oil and Gas Development

The HD Mountains CBM project study, part of which included the Pine River, reviewed historic data to assess impacts from historic and contemporary mining, irrigation, and wastewater discharge. The study indicated high erosion and sediment yield and moderate potential for sources of saline runoff, citing as major point sources the five wastewater treatment plants along the Pine River, all of which are outside the Study Area. (HD Mountain Coalbed Methane Study, BLM/USFS, 1992).

The Tiffany ECBM Project covered the Spring Creek drainage, a tributary to the Pine River in the Study Area, and reviewed the SUIT water quality database. According to the Tiffany study, "Selenium has been recognized as a problem in water, soil, livestock feed, and rangeland on parts of the SUIT Reservation. No elevated selenium concentrations have been recorded from surface water data collected at Spring Creek" (BLM 1996, 1996a).

The 1988 San Juan Basin Coal Degas Project Environmental Planning Document analyzed potential environmental impacts from CBM production in the Fruitland Formation. The document assessed existing data as well as data collected specifically for the project. The study concluded that "Water quality appears to be good in the Animas, Florida, and Pine rivers. Occasional elevated dissolved solids concentrations are present, and predominant ions are sodium, bicarbonate, and sulfate. Nutrient and [biological oxygen demand] BOD levels appear to be fairly low" (Woodward-Clyde 1988).

The unpublished 1996 version of the Bureau of Reclamation's Animas-La Plata EIS contains a relatively comprehensive water quality database for the Reservation, although it does not address the entire Study Area of this EIS (BOR 1996a). The report covers the La Plata and Animas rivers as related to the potential construction of the Animas-La Plata project, and the ensuing predicted water quality and quantity changes. The EIS states that water quality conditions on the Animas River are much improved near Durango, Colorado, in large part due to dilution from higher quality streams. As the river flows from Durango through the Study Area until it meets with the San Juan River, there is an increase in selenium, which may or may not increase to toxic concentrations (BOR 1990).

Beginning in April 1995, when greater than normal amounts of methane were discovered seeping from the Fruitland Formation coal outcrop on the west side of the Reservation, the Tribe, BLM, and adjacent operators have actively sought hydrologic data that would help them to understand the seeps. It was determined that two types of data would be useful: surface discharge from springs and shallow subsurface pressures.

Surface discharge from two natural springs and three man-made springs have been monitored. The springs have been periodically observed and measured by Tribal personnel. Photographs have been taken. Temporary weirs were set up to measure flow. Field personnel were instructed to observe the springs on a daily basis. No formal reports have yet been written based on this data.

Between 1995 and 1997, twelve relatively shallow production wells were converted to pressure observation wells. These wellbores do not have zonal isolation between coal seams and thus monitor total effective reservoir pressure. Data from these wells is very difficult to interpret.

In late 1996, two new monitor wells were installed by a cooperative effort between operators and the Tribe offset the Valencia Canyon Gap seep. These wells are configured so that reservoir pressure can be measured separately for each coal zone.

In 1998, as an offshoot of a coal mining study in the Cinder Buttes area, four additional monitoring sites were obtained. Each site consists of two wells, and each well monitors one of the two major coal seams that are present in that area. Data from these wells is collected by measuring the distance between the ground surface and the standing water level in the wellbore. This level is considered a function of reservoir pressure.

Water Quality Studies Within the San Juan River Basin

A study referred to as the San Juan River Seven Year Fisheries Research Plan was initiated in 1990 by the University of New Mexico (UNM) and the New Mexico Ecological Services Office of the USFWS. This study was undertaken to guide data collection efforts in support of investigations for the conservation of the San Juan River's native fish. Included among the plan's goals was a water quality and contaminants review for the San Juan River and its tributaries, including the La Plata, Animas, and Pine rivers which emanate from the Study Area. The results of this information review were published in a report titled *San Juan River Basin Water Quality and Contaminants Review, Volume I, April 1994* (UNM 1994).

With respect to oil and gas development in the basin, the potential exists for contamination of surface and ground water with PAHs, hydrocarbons, and salts (UNM 1994). Brine discharged to the surface from well pads was observed to be intermixed with irrigation return flows (Blanchard 1991). Water produced from well operations typically has dissolved solids concentrations ranging from 1,200 to 295,000 mg/L. The secondary drinking water standard for dissolved solids is 500 mg/L. New Mexico, Utah, and Colorado have each promulgated extensive rules and regulations for development of oil and gas and in each case, discharges to surface water are heavily restricted but fewer precautions are taken for the protection of groundwater.

According to the UNM (1994) report, as of 1991 the produced water from CBM wells in New Mexico had not been found to contain appreciable amounts of dissolved hydrocarbons, but CBM wells increase the chance of methane contamination of groundwater. The disposal of gas well and processing plant wastes in surface pits is still practiced in some areas. The potential for groundwater and subsequent surface water contamination is greater where natural gas wells and associated surface pits are located in floodplains and river valleys (Eiceman 1987). Most CBM wells discharge all waste fluids into tanks for disposal at approved sites.

The transport of natural gas from the field to the processing plants also poses potential indirect threats to surface water quality from pipeline leaks or breaks, and subsequent soil, groundwater, or surface water contamination (UNM 1994). Hydrostatic testing is conducted to assess structural integrity and to clean natural gas pipelines. The method of testing involves filling the pipeline with water and pressurizing it to locate flaws in the pipeline. The potential exists for contamination of surface water as a result of discharge of water used in the process of hydrostatic testing. New pipelines are expected to contain virtually no condensate, whereas pipelines 2 to 15 years in age may contain significant volumes of condensate composed of large molecular weight organic compounds including PAHs, benzene, and alkylated derivatives (Eiceman 1984, 1987). Eiceman analyzed the discharge water from two natural gas pipelines and detected three classes of organic compounds based on benzene, disulfides, and alkanes. Over 100 PAHs and alkylated PAHs also were detected in the discharge water at concentrations that were often an order of magnitude or more higher than PAH concentrations in natural gas.

Historically, discharge water from hydrostatic testing was disposed of on the ground surface, into holding ponds, or into rivers. This practice poses a potential threat to groundwater quality, and discharge to rivers results in contamination similar to oil spills (Eiceman 1984; Jercinovic 1982). New Mexico, Utah, and Colorado each have their own regulations for discharge of hydrostatic test waters. Colorado regulations, including for the Study Area, for disposal of discharge water from hydrostatic testing state that the discharge must not degrade ground or surface water quality beyond state standards (UNM 1994).

Oil, gas, and coal extraction activities are widespread in the basin, yet there has been no recent research aimed at determining their effects on surface water quality (UNM 1994). It is stated that this research gap is particularly significant because elevated PAH levels have been recorded in basin fish, and fossil fuels are the most probable sources of PAHs. Irrigation has the potential to move contaminants associated with the byproducts of fossil fuel extraction and transport activities. Documented contamination of groundwater from gas well disposal pits, and Animas River fish disease observations suggest that surface water quality may be impacted by natural gas wells. Hydrostatic testing of natural gas pipelines is probably not a current concern for significant contamination of surface water because of recent awareness of proper disposal methods for discharged water, although specific discharge standards have not been set in Colorado or in the Study Area.

The UNM (1994) report also states that additional work is needed to determine where natural gas activities are acting as contaminant sources. Lack of studies of surface water contamination caused by oil and gas development may represent the largest research gap for contaminants in the San Juan River Basin. State agencies in Colorado and New Mexico are taking stronger actions to protect surface and groundwaters during extraction activities; however, these actions normally do not pertain to abandoned oil and gas wells of which there are thousands. Future research may be best directed at abandoned wells since these wells are not highly regulated.

The BLM, Farmington District, has conducted testing of surface water and streambed sediment in the Animas, La Plata, and San Juan rivers and selected tributaries in New Mexico for the presence of PAHs (BLM 1995b). The purpose of the study was to collect information and investigate possible sources of PAHs due to the federal oil and gas leasing program in New Mexico.

PAHs are produced by high-temperature pyrolitic reactions such as municipal incineration, forest fires, and fuel combustion (USGS 1988). Their residues also have been detected in fossil fuels and wastewater sludge. PAHs enter the surface water systems in a variety of ways including atmospheric deposition, surface runoff and soil leaching, industrial discharges, and municipal wastewater effluents. However, because of their low solubilities, they strongly partition from water into biota and particulate and dissolved organic matter, and aqueous residues of PAHs in natural systems are typically low relative to sediment and biological concentrations (USGS 1988). Environmental fate processes include sorption and bioaccumulation, and the ultimate fate of PAHs in surface water systems may be sorption to sediments followed by slow biodegradation.

A 1993 Formal Section 7 Consultation and Biological Opinion issued to BLM by the USFWS states the following:

> "the ongoing and proposed oil and gas leasing and development activities are likely to jeopardize the continued existence of the Colorado squawfish and the razorback sucker by reducing the likelihood of both the survival and recovery of the species through degradation of the aquatic habitat in the San Juan River."

In response to USFWS concerns, the BLM, Farmington District, agreed to develop a sampling and monitoring program that would investigate possible sources of PAHs due to the federal oil and gas leasing program in New Mexico. A description of this monitoring plan was finalized on July 12, 1993 and included the collection of samples from oil and gas well locations within the focused vulnerable zone, ephemeral streambeds, perennial streams, and air samples.

The "focused vulnerable zone" was developed based on an order issued by New Mexico Oil Conservation Divison (No. R-7940-C, effective March 1, 1993) mandating the elimination of all discharges (such as hydrocarbon liquids, produced waters, and associated fluids) into unlined surface impoundments in vulnerable areas of the San Juan Basin in New Mexico (BLM 1993a). The Order provides for the protection of surface and groundwater in the following areas:

- within 100 vertical feet above the channels of the San Juan, Animas, and La Plata rivers;
- within 50 vertical feet of the major tributaries of these river systems;
- within 50 vertical feet of remaining tributaries to these river systems; and
- wellhead protection areas within a 200-horizontal-foot radius of private and domestic water sources, and within a 1,000-horizontal-foot radius of all other water sources.

The baseline phase of sampling for the PAH study was conducted from May through September 1994. The results of data collection activities are provided in a draft report. However, no data were provided in the draft report.

As part of the BLM (1995) study, water and sediment samples were collected at 25 stream locations within the San Juan River Basin in New Mexico. Sediment in ephemeral streams was also sampled. No water samples contained detectable concentrations of PAHs, and one in 30 sediment samples had detectable levels of PAHs. The sampling program was continued during 1995 and 1996, and included monitoring of 30 river locations two times to assess seasonal changes in water column and bottom sediment PAH concentrations.

During 1995, one Animas River bottom sediment sample contained detectable levels of PAH, but no PAHs were detected in any of the sediment samples collected in 1995 or 1996. Two arroyos contained detectable levels of PAHs. Based on the data collected from 1994 to 1996, the BLM, Farmington District, concluded that the oil and gas leasing program is not imputed to be contributing PAHs to the Colorado pikeminnow and razorback sucker habitat via surface water runoff (Odell 1997).

3.6 LAND USE AND OWNERSHIP

3.6.1 Introduction

This section describes the regional land use inventory conducted to assess the sensitivity and effects from the construction, operation, maintenance, and abandonment of oil and gas development on the Reservation. Land use data for this study were organized into the following five general categories:

- land ownership;
- Reservation management plan and units;
- existing land uses;
- future land uses; and
- utilities and rights-of-way.

The purpose of the inventory was to identify and map all regionally significant land uses contained in the Study Area. This was accomplished by reviewing regional planning and previous environmental studies that provided coverage of the Study Area. In addition, aerial photographs, existing maps, and federal, state, and local planning agencies' management plans were reviewed. The combination of these data created a regional database used for conducting the land use resource sensitivity analysis and evaluating potential impacts in Section 4.6. Maps showing land ownership, Reservation management planning units, existing land use, and transportation and utilities within the Study Area have been prepared and are described in the following sections.

3.6.2 Land Ownership

The Study Area encompasses approximately 421,297 acres of land in southwestern Colorado including portions of La Plata, Archuleta, and Montezuma counties (see Map 17). The land ownership in this area resembles a checkerboard pattern of Tribal and non-Tribal lands resulting from homesteading activities that occurred from 1899 to 1938. Within this area SUIT owns approximately 199,652 acres, including trust lands and allotted lands. Private lands, also referred to as fee lands, occur on approximately 221,325 acres within the Study Area. These lands are defined as follows:

- Trust Lands: lands including mineral interests, held in trust by the federal government for the SUIT, or individual Tribal member.

- Allotted Lands: lands that have been transferred or allotted to individual Tribal members as a result of Congressional action. Such lands are held in trust by the federal government for the individual Tribal members to whom the lands have been allotted.

- Private/Fee Lands: surface or mineral estates that are owned by non-Indians, individual Tribal members, or the Tribe. Fee land that is owned by individual Tribal members or by the Tribe is land that is not held in trust by the United States but is owned outright by individual Tribal members or the Tribe.

The land beneath and immediately surrounding Navajo Reservoir is owned by the federal government. The Bureau of Reclamation has jurisdiction over this land and manages it for the purposes of the Navajo Unit of the Colorado River Storage Project. The Bureau of Reclamation has a Memorandum of Understanding with the State of Colorado to manage the recreational use of this land that is within the Study Area.

Colorado state lands encompass the remaining portions of the Study Area. The ownership divisions indicated on Map 17 show the perimeter boundaries only, and generally omit inholdings, lease agreements, or areas of joint ownership.

3.6.3 Reservation Management Plan and Units

The Reservation is divided into 10 management units, eight of which are within the Study Area as shown on Map 18. Each of the management units have established priorities that provide management direction for BIA and Tribal staff. Oil and gas development has previously occurred in each of the management units. The following is an overview of the eight SUIT management units (SUIT 1990).

3.6.3.1 Animas-La Plata Management Unit #1

This unit consists of a total area of 67,096 acres, of which 15 percent is owned by the Tribe and the other 85 percent is privately owned. Tribal lands are relatively undeveloped within this unit. Only a few Tribal members reside in this area and rural residences are scattered throughout the surrounding private lands. Most of the unit is used for dryland and irrigated agriculture. SUIT management priorities for this area include identifying and developing irrigated farm lands, and developing a land consolidation plan.

3.6.3.2 Morgan Canyon Management Unit #2

Approximately 65 percent of the 12,379 acres in this unit is Tribal land and the remainder consists of fee and private lands. There is little potential for farming in this unit due to poor soils and lack of irrigation, and grazing has not occurred here for several years due to lack of watering facilities. There is one residence on Tribal lands, and several homes exist on private lands. SUIT management priorities for this area include consolidating land.

3.6.3.3 Picnic Flats Management Unit #3

This is the largest management unit on the Reservation (134,225 acres) and approximately 60 percent of the unit consists of Tribal land. The other 40 percent is privately owned or fee land. There is a small amount of dryland farming within this area. Oil and gas development has already occurred in the southern part of this unit. There are six grazing units within this area. SUIT management priorities for this area include identifying and setting aside areas for future residential communities, as well as developing a plan for roads to service existing and planned areas of residential use, oil and gas development, and forest resources.

3.6.3.4 Florida Mesa Management Unit #4

This large management unit encompasses a total area of 74,564 acres. Approximately 7 percent of the unit is Tribal land, and the other 93 percent is privately owned or fee land. Management priorities for this area include establishing residential community sites and protecting them from conflicting uses, as well as developing the potential for recreational uses and fisheries along the Animas River.

3.6.3.5 Mesa Mountains Management Unit #5

This unit includes 54,010 acres. Approximately 77 percent is Tribal land and 23 percent is privately owned or fee land. There are four grazing units within this area. SUIT management priorities for this unit include creating new animal water sources preferably within 1.5 miles of all major forage areas, identifying and closing unnecessary roads, and limiting gas development disturbances by utilizing existing access corridors for roads and pipelines.

3.6.3.6 Pine River Management Unit #6

This unit has a total area of 64,609 acres. Approximately 39 percent is Tribal land, and the remaining 61 percent is fee land. Within this unit most Tribal members reside near the town of Ignacio and along the Pine River corridor. The land is used primarily for agriculture and livestock grazing. Management priorities include developing a land consolidation plan, and keeping agricultural land in production by avoiding development of oil and gas facilities in irrigated fields. There are plans in the Pine River Corridor-Ignacio subunit to enhance river recreation.

3.6.3.7 Sambritos Management Unit #7

This unit includes a total of 63,864 acres, of which only 9,704 acres are within the Study Area. Approximately 42 percent of this unit is Tribal land, and 11 percent is fee land. The remaining 47 percent of this unit is located on USFS land outside the Study Area. There are three grazing units within this area. Management priorities for this unit include developing a road plan to serve future areas of timber production and oil and gas development, and reacquisition or stewardship of USFS lands north of Sambritos.

3.6.3.8 Piedra Management Unit #8

This unit includes a total of 37,344 acres, of which only a small area (3,901 acres) of the southern portion is within the Study Area. The southern portion of this unit includes part of the Navajo State Park. The Tribe does not currently own any land adjacent to the state park. Navajo Reservoir, which is part of the state park, is a popular site for fishing, boating, waterskiing, and other water-related activities. SUIT's management priorities for this area include creating a plan to develop lands adjacent to Navajo Reservoir, and developing a road plan to limit and control access for multiple use.

3.6.4 Existing Land Uses

The inventory of existing land uses within the Study Area includes residential, commercial and public use areas, recreational areas and facilities, industrial/extraction areas, agriculture, grazing, and forest resources. These categories are briefly described below and are shown on Map 19.

The four major rivers within the Study Area include the La Plata, Animas, Florida, and Pine rivers. The majority of towns and clustered residential developments are located adjacent to these rivers. Agricultural and rangeland areas extend outward from the centrally developed areas. Rural residences are dispersed throughout the agricultural areas. Specific emphasis is given in this EIS to those land uses that potentially could conflict with oil and gas exploration and development. Sources used to map land use features include land use data from the BIA, La Plata County, satellite imagery, and aerial photo interpretation (see Chapter 7, References, for specific data sources for land use resources).

3.6.4.1 Residential

Residential development includes single-family and multi-family dwellings, and mobile homes, and occurs on approximately 6,472 acres within the Study Area. Most residential development within the Study Area occurs in small communities, including Breen, Kline, Redmesa, La Posta, Oxford, Ignacio, La Boca, Tiffany, Allison, and Arboles. Ignacio is the only incorporated town, and is the largest of these communities, with a population of 720 (SUIT 1990). Other rural residences are dispersed throughout the Study Area on both Tribal and private lands. The coincidence of oil and gas and residential development is listed in Table 3-19. The number of oil and gas wells estimated to occur on residential land uses is likely understated. Consistent residential lot boundaries were not available, therefore, residential development was interpreted from 1993 aerial photography, and it is likely that residential properties extend past the mapped boundaries. Therefore, there are likely more occurrences of oil and gas development within residential lot boundaries.

3.6.4.2 Commercial/Public Uses

Commercial land uses are located primarily in the town of Ignacio. These include retail establishments, offices, and warehouses. Public facilities are also located primarily in Ignacio, including schools, local government buildings, and the Tribal police. There are approximately 351 acres of land within the Study Area considered as commercial or public development. The Durango-La Plata County Airport is located approximately 10 miles northwest of Ignacio.

3.6.4.3 Developed Recreation Facilities

Approximately 1,815 acres of developed facilities for recreational activities, including cultural events, are located within the Study Area, primarily in Ignacio. Recreational facilities include the Ignacio City Park, Shoshone Park, Sky Ute Downs rodeo and fairgrounds, and Bear Dance Grounds. Ute Park is located 1 mile north of Ignacio. Sky Ute Lodge attracts tourists and visitors for recreation.

Navajo State Park, with 71 developed campsites, averages a 70-percent occupancy rate during a 150-day use season (May through September). The park experiences normal occupancy fluctuations of high use on weekends and holidays and low use on weekdays. The number of visitors has increased 10 to15 percent each year since 1990, and in 1994 the park received 153,000 visitors.

3.6.4.4 Dispersed Recreation

Dispersed recreational activities occurring on the Reservation include gathering activities for items including firewood, chokecherries, piñon nuts, crafts, and ceremonial materials. Fishing and recreational water activities, such as rafting, occur on the principle rivers that traverse the Reservation. Big game hunting occurs on the Reservation for species such as mule deer, elk, and bear. The CDOW manages several hunting units that encompass the Reservation, including Units 73, 741, 75, 751, 771 and 78. The SUIT issued 44 big game hunting permits to non-Tribal people. Tribal hunting units (Johnny Pond, East and West units) may be closed in the near future to non-Tribal people. Additional information on Tribal hunting activities is provided in Section 3.3.3, Wildlife and Fisheries.

3.6.4.5 Industrial/Extraction

Industrial land uses primarily include manufacturing facilities, landfills, material processing plants, and oil and gas fields. Extractive uses consist of major active surface mining operations such as sand and gravel quarries. There are approximately 223 acres of developed industrial facilities within the Study Area not including oil and gas well development. Oil and gas development is the most prevalent and widespread industrial land use in the Reservation. In 1995, there were approximately 2,320 producing, shut-in, temporarily abandoned, and plugged and abandoned oil and gas wells in the Study Area, requiring approximately 4,640 acres of surface. Of the total wells, 1,112 were conventional located east of the Fruitland Formation outcrop, 437 were conventional wells located west of the Fruitland Formation outcrop, and the remaining 771 were Fruitland wells. Between 1995 and 2000, 122 wells were spudded on Tribal land, of which 49 were conventional wells and 73 were CBM wells. Construction of well pads occurs in combination with many other land uses (Table 3–18) within the Study Area, and are partially reclaimed during operation, typically reducing the constructed well pad from 2 to 1.5 acres.

TABLE 3-18
Oil and Gas Development Occurrences Within Other Land Use Developments

Residential	22
Commercial	1
Public	4
Recreation	1
Agriculture	141
Prime Farmland	74
Grazing	212
Tribal and Fee Multi-use Lands	1,865

For the purpose of this inventory, oil and gas fields are considered to be areas with reserves of recoverable petroleum or natural gas. Concentrations of wells, storage facilities, and compressor stations are typical structures associated with these fields. Infrastructure supporting these oil fields includes access roads, pipelines, and electrical transmission lines.

3.6.4.6 Agriculture

Farming on the Reservation includes both irrigated and non-irrigated lands. Non-irrigated crops include winter wheat, dry land beans, barley, dryland oats, and alfalfa, and are farmed on approximately 38,177 acres of the lands within the Study Area. Irrigated crops include corn, oats, barley, and alfalfa. Almost all irrigated Tribal land is planted in grass and managed as pasture or hay. Some of the agricultural lands in the Study Area meet criteria for prime farmland if a dependable and adequate water supply (e.g., irrigation) is available. Approximately 25,383 acres of lands within the Study Area are thought to be suitable for prime farmland. Prime farmland soils, as defined by the U.S. Department of Agriculture, are those with properties that are best suited for the economic production of sustained high yields of crops (food, seed, forage, fiber, and oilseed). Areas that may be classified as prime farmland are identified in Appendix J. Maps 14 and 19 indicate those prime farmland soils with irrigation facilities.

The Pine River Indian Irrigation Project is located principally in the Pine River Management Unit #6 (Map 18) and consists of 175 miles of canals, laterals, and related structures to convey irrigation water to approximately 13,000 acres of irrigated lands owned by the Tribe, allottees, and fee property owners.

There are additionally 1,054 acres of Tribal and allotted irrigated lands within the Florida Water Conservancy District that need to be taken into consideration. Lemon Dam is the principal feature of the Florida Project, which is a participating project of the Colorado River Storage Project. The dam is located in southwestern Colorado on the Florida River, approximately 14 miles northeast of the city of Durango in La Plata County. Floodwaters of the Florida River are stored in the reservoir formed by the dam, and regulated releases can provide supplemental irrigation water for 19,450 acres. In addition to Lemon Dam, the Florida Water Conservancy District includes the Florida Farmers Diversion Dam, the Florida Farmers Ditch and the Florida Canal, and associated lateral systems and small ditches. Benefits associated with the Florida Water Conservancy District include irrigation, flood control and recreation.

Some agricultural lands are leased by two different types of permits—short and long term. Short-term permits are applicable to leases that are six months or less in duration, and are primarily used for pasture lands. Long-term permits are applicable to leases extending from six months to five years and are generally used for cropland and pasture.

3.6.4.7 Grazing

Grazing on Tribal lands within the Study Area occurs on range units that encompass both rangelands and woodlands. The Study Area encompasses a total of 11 range units, which occur primarily in areas that are unsuitable for agriculture due to soil type and topography. Range units are located in the Picnic Flats (winter range), Mesa Mountains (summer range), and Sambritos (summer range) management units ([SUIT 1990], [Forest Management Plan 1992]).

Range units in the Study Area comprise 101,276 acres, with a total of 7,593 authorized AUMs (F. Ellenbecker, personal communication 1996). One AUM is equivalent to approximately 900 pounds of air-dry forage. Recommended stocking rates among the different range units vary from a low of 20 head of cattle per range unit to a high of 320 head of cattle, depending on the amount of forage available in the unit. In practice, however, stocking rates vary with range condition and market demand for cattle. Current stocking rates are below those authorized because dependable water supplies and fencing to facilitate livestock distribution are not available in many areas. Seventy-nine percent of available range acres are currently used to graze cattle. Range units with poor forage, lack of water, and/or extremely rough terrain are not stocked but are utilized by wildlife (F. Ellenbecker, personal communication 1996). Future development of water and fencing would allow some of the currently ungrazed areas to be stocked with cattle.

Currently, cattle ranching does not provide an important financial resource to the SUIT (F. Ellenbecker, personal communication 1996). As of March 1998, one range unit in the Study Area was leased to non-Tribal entities, and the remainder were being grazed under Tribal permits.

3.6.4.8 Forest Resources

The eight natural resource management units encompassed by the Study Area contain only small, widely scattered stands of commercial timberland. Active Tribal timber management areas are currently outside the Study Area. However, the SUIT Forest Management Plan (SUIT, 1992) identifies areas of woodlands, which can be commercial or noncommercial forest land within the Study Area.. Woodlands are generally defined as forest lands not classified as timber but which are capable of producing forest products other than lumber (25 CFR, 163.1). A large portion of the forest in the Study Area is classified as woodlands. Principal woodland tree species on the Reservation include piñon, juniper, and Gambel oak.. Commercial woodlands are managed for forest products such as firewood, poles, posts, and piñon nuts. Trees important for religious ceremonies, such as cottonwoods, also are managed in woodland areas. Harvest of woodland products is typically carried out by individual Tribal members who have acquired a free-use permit. Products harvested may be for personal use or sold for profit. Non-Tribal entities may purchase permits for a fee and can use the wood products personally or for resale.

Parts of the Animas-La Plata, Morgan Canyon, Picnic Flats, Mesa Mountains, and Pine River management units have been identified as woodland management areas. The SUIT Forest Management Plan (SUIT, 1992) specifies that woodlands in the Animas-La Plata and Mesa Mountains management units be maintained as a mosaic of forest types and age classes. The Morgan Canyon and Picnic Flats management units are to be thinned or cleared of dense Gambel oak stands. Management in the Pine River Management Unit is directed at regenerating cottonwood stands that are currently experiencing no regeneration because of excessive cattle grazing and over-harvest for religious ceremonies. The Florida Mesa Management Unit is heavily used for agricultural and residential purposes, and there is no plan to manage forest resources in this unit.

The Tribe has recently initiated the 180-acre Black Ridge fuel break, which involves reducing the density of the woodlands by harvesting piñon and juniper. The objectives of this project are to create a fire fuels break zone, create wildlife habitat diversity, improve forage for wildlife and livestock, reduce sheet erosion and improve water quality, and provide a source of revenue for Tribal members. Other integrated resource projects similar to the Black Ridge fuel break are being planned for other woodland areas.

3.6.4.9 Tribal and Multi-use Lands

The only development that exists within Tribal and fee multi-use lands are associated with oil and gas development; however, much of these lands coincide with SUIT designated grazing units which, in select areas, include water supplies and fencing. Tribal and fee multi-use lands make up approximately 305,088 acres of the lands within the Study Area, of which 101,276 coincide with SUIT designated grazing units.

3.6.5 Future Land Uses

The future land use category includes general and specific planned land uses within the Study Area. Information from county and SUIT land use plans was used to determine general trends regarding future land use within the Study Area. The following discussion presents an overview of planned future land uses for each county within the Study Area, and a discussion of future land use on Tribal lands.

3.6.5.1 Archuleta and Montezuma Counties

Archuleta County is currently in the process of updating their master plan, which was originally completed in 1990. This original plan did not specify any future development plans within the Study Area. Within Montezuma County, there are approximately 5 square miles of land included in the Study Area, all of which are currently zoned for agricultural use. Currently, there is no plan for additional development in this area.

3.6.5.2 La Plata County

The majority of the Study Area is located in La Plata County, which is currently in the process of completing a land use plan to guide future development over the next 10 to 20 years. Portions of this plan were presented to and approved by the La Plata County Commission in October 1996. This plan divides the county into nine separate planning districts, three of which are within the Study Area: Ft. Lewis Mesa, Florida Mesa, and East La Plata. This plan does not apply to Tribal lands. The La Plata County Planning Department recently completed the land use plan for the Florida Mesa planning district and has started preparation of the Fort Lewis Mesa and East La Plata plans.

The Florida Mesa planning district was addressed first due to the existing density of development, and the county's desire to guide future growth in this area. The primary objective of the Florida Mesa land use plan is to preserve the existing agricultural and rural character of the land while accommodating growth. To accomplish this, the plan encourages future higher density growth in several "growth centers" in the district and preserving the remainder of the district for agriculture and rural residential development. Key planned land uses within the Study Area for the Florida Mesa planning district are discussed in the following text.

Residential

The majority of unsubdivided private lands within La Plata County have been classified as rural residential with densities of 1 unit per 10 to 20 acres. These low densities have been established in order to preserve agricultural lands and ensure development that maintains a rural character.

Commercial

In La Plata County, concentrations of commercial and mixed use development is planned near existing similar uses along Highway 160 through the Grandview area. Other areas of future commercial use are located in clusters near the towns of Oxford and Ignacio.

Office/Light Industrial

Light industrial growth will be encouraged near the La Plata County Airport, Animas Airpark, and the north one-third of Koshak Mesa (north of the entrance to the airpark).

Rural Residential

The majority of unsubdivided private lands within the district have been classified as rural residential. The rural residential designation is prescribed to preserve agricultural production and ensure development that maintains a rural character. This designation also indicates areas in which cluster development is encouraged, such as in areas of piñon-juniper stands, which provide visual screening of structures. Other recommended areas include mesa edges overlooking river corridors and areas adjacent to nonagricultural parcels.

In late 1999, La Plata County applied to the Colorado Department of Local Affairs for an Energy Impact Assistance grant to study natural resource extraction issues, particularly surface issues associated with methane development (Keller 2000). If funded, the county would hire consultants to perform the analysis. A decision on funding is expected from the state in the spring of 2000. The findings of this study, if completed, could affect county planning.

3.6.5.3 Tribal Lands

SUIT planners are currently in the process of updating the Tribe's comprehensive plan, which was developed in 1970, and updated in 1980. A natural resource plan for the Reservation was completed in 1990, and has provided guidance for natural resource management on the Reservation.

Future plans on Tribal lands include development of facilities between the Bear Dance Grounds and Ignacio City Park. The Tribe also is in the process of acquiring about 250 acres adjacent to Archuleta County Road 500 near the north shore of Navajo Reservoir. This road is being considered for improvement and promotion as a scenic route. This land may provide some commercial opportunities for the Tribe. There is potential for cabin or summer home sites as well as businesses catering to the fishing and boating public.

Related Projects within the Project Study Area

The Animas-La Plata Project is a water storage project that would divert flows of the Animas and San Juan Rivers for municipal and industrial uses. It also would provide for fish and wildlife preservation, recreation facilities, and a cultural resources program. The project would store water pumped from the Animas River in Ridges Basin Reservoir.

3.6.6 Utilities and Rights-of-Way

This land use category includes electric transmission lines (69 kV and higher), pipelines, fiber optic corridors, transportation corridors, and their corresponding rights-of-way. Within the Study Area there are numerous electrical transmission and distribution lines, as well as telephone lines and various natural gas, water, sewer, and petroleum product pipelines. The natural gas gathering and transmission pipelines and compressor stations are associated with oil and gas field development. Other utilities on the Reservation include dewatering facilities, and radio, television, and microwave towers. Utilities and rights-of-way in the Study Area are illustrated on Map 20.

3.7 TRAFFIC AND TRANSPORTATION

3.7.1 Transportation System

The main component of the transportation system within the Study Area is the roadway network. Rail transportation is not present within the Study Area and there is no general public transit system. Some senior center, educational, health-related, and limited public transit services are provided from Ignacio. Air service is available at the Durango-La Plata County Airport located near Ignacio.

The State (SH) and U.S. highways (US) that provide access to the Study Area are US 550, SH 140, SH 172, and SH 151 (Map 20). Outside the Study Area, to the north, these highways all connect to US 160, the major east-west highway in southern Colorado. US 550 is the major north-south route in southwestern Colorado, and connects Durango, Colorado to Farmington, New Mexico. US 550 provides the major access from these regional centers to the Study Area. SH 140 is the primary north-south route in the western portion of the Study Area and provides a connection between the communities of Redmesa, Kline, and Breen. SH 140 provides access to Farmington and, via US 160, also connects the Study Area to Durango. SH 172, a primarily north-south route, serves the Durango-La Plata County Airport and the town of Ignacio, which is southeast of Durango. SH 151 serves the eastern communities of Ignacio, Arboles, and Stollsteimer, and provides a connection from the eastern portion of the Study Area to US 160. These roadways are each maintained by the Colorado Department of Transportation.

Secondary public roads within the Study Area consist of two-lane paved, gravel, or dirt roads. Generally, these roads are county maintained (La Plata or Archuleta). Within the Study Area, there area several bridges with weight limits. These bridges are located on the following La Plata county roads (CRs): CR 105 and CR 122 over the La Plata River in the west, and two bridges on CR 334 over Allison Ditch in the east (map of La Plata County Bridge Weight Limits, November 1991).

A tertiary private roadway network consists of local Tribal roads and existing oil and gas roads. These roads are generally dirt or gravel and are maintained either by the Tribe or the respective oil and gas company. Volumes on these roads are minimal due to the low-density development patterns characteristic of rural southern Colorado.

3.7.2 Methodology

The following sections outline the baseline information related to traffic volumes, roadway capacity, bridge constraints, and accident history in the Study Area. The majority of the transportation-related baseline data were provided by the La Plata County Bridge and Highway Department and the remaining provided by the Colorado Department of Transportation. Where appropriate, the source of the data is presented.

Each of the proposed alternatives would generate varying levels of additional traffic in the Study Area. These traffic levels are estimated from the number of wells and compressors proposed by each alternative. This traffic is in addition to the baseline levels identified below. By definition, the baseline is constant across alternatives. The marginal effect on the baseline from each alternative was used to determine impacts which, along with impact methodology, are presented in Chapter 4.

3.7.3 Traffic Volumes and Roadway Capacities

Tables 3-19 and 3-20 show traffic volumes for La Plata county roads and Colorado state highways, respectively. In Table 3-20, only those county roads with an average daily traffic (ADT) count greater than 200 are shown. Based on ADT counts alone, the most traveled of the county roads are CR 141, CR 309, CR 310, CR 314, CR 318, and CR 517. Paved, two-way, two-lane roads have a daily design capacity of 4,800 vehicles. The most-traveled county roads have ADT counts of 1,300 to 2,600 vehicles per day, well below the design capacity. In general, this means that county roads are operating at or above acceptable levels.

Table 3-20 shows the respective traffic volumes for state highways within the Study Area. The highest traffic volumes on both SH 151 and SH 172 are found within the Ignacio city limits. The highest traffic volumes on SH 140 are found between the towns of Kline and Breen. The highest traffic volumes on US 550 are found between the Colorado-New Mexico state line and CR 213. Similar to the county roads, traffic volumes on state highways within the Study Area are well below the design capacities. This means that state highways are operating at or above

TABLE 3-19
Average Daily Traffic Volumes—La Plata County Roads

County Road	1994	1995	1996	County Road	1994	1995	1996
100 (West of 140)	257	--	169	310 (East of 550)	2,246	2,270	--
120 S (West of 140)	362	372	421	311 (South of 172)	884	500	--
134 (South of 140)	--	--	710	314 (West of 172)	1,032	2,227	--
141 (East of 140)	1,636	2,568	1,785	316 (North of 314)	415	552	--
213 (North of 550)	346	402	633	318 (West of 172)	1,802	1,911	--
214 (West of 550)	237	469	425	321 (South of 151)	591	473	--
215 (West of 550)	--	567	573	324 (South of 151)	--	212	--
216 (South of 215)	381	286	295	328 (South of 151)	412	318	--
218 (East of 550)	--	265	228	330 (South of 151)	600	147	--
301 (South of 220)	664	385	--	510 (West of 409)	601	616	--
302 (East of 550)	--	691	--	513 (North of 172)	258	324	--
307 (South of 172)	776	798	--	516 (East of 172)	352	368	--
309 (South of 172)	1,463	1,360	--	517 (East of 172)	1,838	2,303	--
309A (East of 309)	460	422	--	523 (East of 521)	260	492	--

Source: La Plata County Road and Bridge

acceptable levels during the majority of the day. The exception to this is SH 550 between the Colorado-New Mexico state line and CR 213. A separate study (URS Greiner, Inc. April 1997) indicates that existing peak hour levels of service for SH 550 south of CR 213 are at their lowest acceptable levels of service (LOS), at LOS D.

TABLE 3-20 1996 Average Daily Traffic Volumes—State Highways		
State Highway (Segment)	**Daily**	**LOS[1]**
140		
South of CR 134 (Kline)	2,000	B
CR 134 (Kline) to CR 141 (Breen)	1,700	B
151		
SH 172 to Shoshone Ave. (Ignacio)	2,700	C
Shoshone Ave. (Ignacio) to CR 80 (Arboles)	2,050-690	B-A
172		
CO/NM State Line to SH 151	590-8,200	A-E
Sh 151 to Browning Ave. (Ignacio)	6,550	D
North of SH 151 (Ignacio) to CR 220/221	5,050-6,100	D
550		
CO/NM State Line to CR 213	5,250	D
CR 213 to CR 220	4,750-6,250	C-D

Source: Colorado Department of Transportation, 1996 Traffic Volume Report.

Level-of-service rankings range from A-F. LOS A is characterized as minimal traffic volumes where there is no delay. LOS F is characterized by significant delay and when travel speeds are almost at a stop.

Planning-level roadway capacity for a rural two-lane highway is 2,800 passenger cars per hour.

[1] *Highway Capacity Manual, Third Edition*, Transportation Research Board, Washington D.C., 1994. Table 8-10, Rolling Terrain, various K-factors.

3.7.4 Traffic Accidents

Accident information for the county roads was available from the La Plata County Roads and Bridge Department. Data from the Roads and Bridge Department were provided for 1994, 1995, and 1996. More than half of the county lane-miles of road are within the Study Area, yet less than half of all accidents occurred in the Study Area. At a very coarse level, the accident rates are lower in the Study Area than in other parts of La Plata County. Table 3-21 shows the accident numbers for La Plata County as a whole, the Study Area, and for the three La Plata county roads with the most accidents over the three-year period. Approximately 10 percent of all accidents occur at the intersection of a county road with SH 550 or SH 172.

Over a three-year period from October 1, 1993 to September 30, 1996, 53 accidents occurred on SH 140 within the Study Area. Of those, approximately 40 percent involved injuries and an additional 4 percent involved fatalities. During the same period, there were 52 accidents on SH 151. Of the accidents on SH 151, 46 percent involved injuries, and 6 percent involved fatalities. SH 172 had 82 accidents; 44 percent involving injuries, and 2 percent involving fatalities. US

550 had 126 accidents over the three-year period; 47 percent involved injuries, and 1 percent involved fatalities.

TABLE 3-21
Accidents on La Plata County Roads

Location	1994	1995	1996
La Plata County	193	307	236
Study Area	61	109	75
CR 318	13	7	20
SH/CR 140	4	17	8
CR 141	2	8	12

Source: La Plata County Road and Bridge Department

The statewide average accident rates in 1994 and 1995 for rural, noninterstate highways were 1.43 and 1.45, respectively. All state highways in the Study Area currently exceed the statewide average benchmark accident rate with the exception of SH 172 (Table 3-22). Typically, accident rates higher than three to four accidents per million vehicle miles indicate the need for further analysis into the causes of the accidents and identification of problem areas. None of the state highways in the Study Area reach this threshold.

TABLE 3-22
Accidents on State Highways in the Study Area 10/1/93 - 9/30/96

State Highway	Property Damage	Injury	Fatal	Accident Rate[1]
140 (MP[2] 0.00 to 17.07)	30	21	2	2.19
151 (MP[2] 0.00 to 25.68)	25	24	3	2.00
172 (MP[2] 0.00 to 23.59)	44	36	2	1.23
550 (MP[2] 0.00 to 15.80)	66	59	1	1.80

Source: Colorado Department of Transportation
[1]Accident Rate = Total number of accidents per million vehicle miles traveled
[2]MP = Mile post

3.7.5 Oil and Gas Development Characteristics Related to Transportation

The development and operation of oil and natural gas wells generates a predictable number of trips per well per year based on historic oil and gas field experience. In addition to oil and gas

TABLE 3-23
Vehicle Type and Round Trip Frequency for Field Development and Operations

Facility/Activity	Vehicle	Trip Frequency
Well Drilling	Truck Mounted Rig	1/well
	Support Trucking	32/well
	Casing Tong Truck	1/well
	Water Truck	12/truck
	Mud Truck	3/well
	Fuel Truck	2/well
	Rig Crews/Pick-up	3/day
	Rig Machine/Truck	3/day
	Supervisor/Pick-up	2/day
	Mud Engineers Truck	1/day
	Casing Haul Truck	1/well
	Cementers, Pump Trucks	2/well
	Bull Truck	3/well
	Cementers/Pick-up	3/well
	Loggers/Logging Truck	1/well
	Loggers, Engineers Car	1/well
	Casing Crew Truck	1/well
	Miscellaneous Supplied/Pick-up	2/well
	Completion Unit/Rig	1/well
Well Completion and Testing	Completion Equipment Truck	1/well
	Completion, Crew Pick-up	12/well
	Completion Pusher	3/well
	Supervisor	2/well
	Tubing Trucks	1/well
	Service Tools	2/well
	Loggers/Truck	1/well
	Loggers/car	1/well
	Anchor Installation	1/well
	Frac Unit	1/well
	Sand Storage Bin	1/well
	Blender	1/well
	Chemical Truck	1/well
	Sand Truck	9/well
	Manifold Truck	1/well
	Manifold Trailer	1/well
	Instrument Van	2/well
	Miscellaneous Supplied/Pick-up	4/well
Wellsite Facilities Installation	Roustabout Crew Truck	2/well
	Welder Truck	5/well
	Water Truck	24/well

TABLE 3-23
Vehicle Type and Round Trip Frequency for Field Development and Operations

Facility/Activity	Vehicle	Trip Frequency
Pipeline Installation	Haul Truck for Dozer Haul Truck for Ditcher Haul Truck for Side Boom Haul Truck for Track Hoe Crew Pickups 10 Yard Dump Trucks for Padding	2/mile of flowline 3/mile of flowline 4/mile of flowline 2/mile of flowline 21/mile of flowline 11/mile of flowline
Well Workover	Service Unit Service Unit Equipment Truck Service Unit Crew Pick-up Pusher Truck Supervisor Pick-up	1/well 1/well 2/well 1/well 1/well
Operations	Pumper Pick-up	1/well/day
Compressor Site Installation	Tractor Truck Trailer Cement Truck Gang Truck 2 Welding Trucks Pick-up Pick-up Gang Truck Water Truck	8/site 4/site 4/site 30/site 30/site 100/site 2/day 1/week 2/month
Source: Tiffany EA, April 1996; adapted from Amoco, 1995(a).		

wells, compressor units generate their own unique trips. This section presents trip-making characteristics by well type and compressors.

Trips that would occur in the Study Area associated with wells and compressors include new facility installation trips and continuing service maintenance trips. Table 3-23 was adapted from the Tiffany EA (BLM 1996) and identifies typical vehicle trips by type and frequency for multiple stages of well development for ECBM wells. For the purposes of this document it is assumed that conventional wells will require the same number of trips for initial development.

The following categories are related to well and compressor installation:

- well drilling (336 round trips per site);
- well completion and testing (45 round trips per site);
- wellsite facilities installation (31 round trips per site);
- pipeline installation (75 round trips per site); and
- compressor installation (181 round trips per site).

The remaining two categories identified in the table (well workover and operations) are related to well maintenance and occur on a regular basis as long as the well is in production. Average annual maintenance trips per well is 371 for CBM wells and has been 373 for conventional wells. However, the average number of trips per conventional well is declining as operators attempt to lower operating costs on wells with declining production. Conventional wells occasionally have on-site storage of condensation liquids that are generated by the well and which require approximately two tanker trips per year to haul off site for disposal.
Compressor maintenance trips are generated at varying rates according to the size of the compressor. Some of the smaller compressors are in practice co-located with wells in which case one trip would be sufficient to service both facilities at each co-located site. However, due to the programmatic nature of this document, it is not possible to identify specific existing sites that will receive the additional compressors needed to implement the alternatives. For the purpose of determining visits, the facilities are treated as stand alone facilities as opposed to assigning them to existing facilities.[1] Table 3-24 identifies compressor maintenance trips by vehicle type and compressor size. For purposes of calculating annual trips per site, the average of the range in trips per day, week, or month is used.[2]

TABLE 3-24
Maintenance Trip Generation by Compressor Size

Compressor Size/ Vehicle Type	Pick-up Visits	Crew Cab Visits	Multi-Axle Visits
< 50 tons / year	0	5-7 visits per week	0.5 visits per year
50-100 tons / year	0	5-7 visits per week	1 visit per year
> 100 tons / year	2-5 visits per day	3-8 visits per month	2 visits per year
Source: Gilmore, 1998			

For purposes of this document, all trips, including both installation and maintenance, are assumed to be distributed randomly throughout the year. New well development is assumed to occur across the entire 20 years of the project with even development patterns in each year. Compressor site development is assumed to take place throughout the first 10 years of the project with even development patterns in each year. Due to the assumed even distribution of wells and compressors across the Study Area, it is further assumed that all trips, including both installation

[1] Facsimile memorandum from David Gilmore, SUIT, to D. Perkins-Smith, BRW, Inc. and L. Ellwood, Dames & Moore, Inc., dated January 16, 1998 (Gilmore, 1998).

[2] D. Gilmore facsimile memorandum, January 16, 1998.

and maintenance, will be evenly distributed throughout the Study Area and the existing public and private roadway network[3] (Gilmore, 1998).

Table 3-25 presents the baseline, or background, trips generated from current well operations in the Study Area. The Study Area contains three different well types: active, temporary and permanent shut-in, and plugged and abandoned. Active wells require daily maintenance trips (365 per year) and one annual workover (overhaul maintenance at a rate of six trips per workover) on average. Shut-in wells average approximately two trips per year for general inspection and maintenance. Plugged and abandoned wells do not require any maintenance or inspection trips. Daily service trips are computed as total annual trips divided by 365 days per year. To compute daily vehicle trips, daily service trips must be factored by the average number of well sites each service crew can visit in one day. For this study it is assumed that one service crew can visit eight well sites per day. For illustration, daily vehicle trips equal annual service trips divided by 365 days per year divided by 8 well sites per service crew (696,977/365/8 = 239 daily vehicle trips).

TABLE 3-25
Baseline Trip Generation by Well Type

	Number of Wells				
	Active	**Shut In**	**P and A**	**Total**	
West of Hogback	108	33	25	166	
East of Hogback	1,769	272	113	2,154	
Total	**1,877**	**305**	**138**	**2,320**	
Annual Trip Production				**Total Annual Trips**	**Daily Vehicle Trips**
West of Hogback	40,068	66	-	40,134	14
East of Hogback	656,299	544	-	656,843	225
Total	**696,367**	**610**	**-**	**696,977**	**239**

Active = Producing and Recompleted Wells
P and A = Plugged and Abandoned
Shut In = Permanent and Temporary
Daily Vehicle Trips=annual service trips /365/8

Source: K. Sitler, Dames & Moore, Inc., facsimile dated October 2, 1997 (number of wells only)

[3] Telephone conversation between D. Gilmore and D. Krutsinger, BRW, on January 27, 1998.

Table 3-26 presents baseline annual compressor maintenance trips. Generally, there are two compressors per site; however, because specific development sites are not known, each compressor will be treated as a separate unit with individual trip generating characteristics. The average number of trips per unit by vehicle type was used to calculate total service trips per unit and total annual trips by compressor size. Daily vehicle trips are computed by dividing annual trips by 365 days per year and again by 4 sites visited per vehicle per day for pick-up and crew cab visits. Annual multi-axle visits (workover trips) are assumed to be only one site visit per vehicle. Daily vehicle trips for these visits are computed as annual trips divided by 365. Using these assumptions, total Study Area baseline daily compressor vehicle trips are estimated to be 64 (94,082 annual trips/365 days per year/4 sites per vehicle). These trips are presented in Table 3-26.

TABLE 3-26
Compressor Maintenance Vehicle Trip Generation - Baseline

Compressor Size (tons NO produced per year)	Number of Units	Average Number of Trips Generated	Service Trips per Unit	Annual Trips	Daily Vehicle Trips[1]
< 50 tons	182	0 pick-up visits per week	-	-	-
		5-7 crew cab visit per week	312	56,784	39
		0.5 multi-axle visits per year	0.5	91	<1
50 - 100 tons	20	0 pick-up visits per week	-	-	-
		5-7 crew cab visit per week	312	6,240	4
		1 multi-axle visits per year	1	20	<1
> 100 tons	23	2-5 pick-up visits per day	1,278	29,394	20
		3-8 crew cab visit per month	66	1,518	1
		2 multi-axle visits per year	2	46	<1
Total Compressor Maintenance Trips Generated				**94,082**	**64**

Source: Leslie Ellwood at Dames & Moore, Inc. Facsimile dated October 27, 1997

[1]Daily Vehicle Trips = Annual Trips/365/4 sites per vehicle per day

The previous two tables presented average daily vehicle trips for both existing wells and compressors. Daily vehicle trips are equivalent to ADT and represent the average number of vehicles traveling within the Study Area each day for the purpose of servicing existing wells and compressors. In total, 304 (239 + 65) well and compressor service vehicles are in the Study Area, traveling both the public and private roadway networks on any given day. In terms of vehicles per square mile (vehicle density), this is roughly calculated to be 0.6 vehicles per square mile.

3.8 CULTURAL RESOURCES

3.8.1 Introduction

The cultural environment includes those aspects of the physical environment that relate to human culture and society, along with the social institutions that form and maintain communities and link them to their surroundings. For purposes of this EIS, the inventory of cultural resources focuses on: 1) historic preservation issues which relate primarily to protecting archaeological and historical properties within the Study Area, and 2) traditional cultural concerns.

Cultural resources within the Study Area have never been completely inventoried. However, numerous cultural resource surveys have been conducted on the Reservation for prior projects and these surveys provide information about the types of archaeological and historical resources that are present within the Study Area. Data regarding traditional cultural places and resources are far less abundant; however, the Southern Ute Tribal historian provided some information about traditional cultural concerns for the purposes of this study. Appendix K contains more detailed discussion of cultural resource inventory data and methods, cultural history of the SUIT and surrounding region, methods used to model cultural resource sensitivity and projection, and description of cultural resources sensitivity zones.

3.8.2 Regulatory Requirements

NEPA (Section 101[b][4]) establishes a federal policy of conserving the historic and cultural, as well as the natural aspects of our national heritage as federal agencies permit, fund, or plan and construct projects. The Council on Environmental Quality issued implementing regulations for *Protection of Environment* (40 CFR Part 1 1502.16[g]), stipulating that the consequences of federal undertakings on historic and cultural resources be analyzed. In accordance with these and other federal historic preservation regulations, cultural resources are considered in this EIS.

The Antiquities Act of 1906, the National Historic Preservation Act of 1966, as subsequently amended, and the Archaeological Resources Protection Act of 1979 are other federal laws that protect cultural resources. In addition, the American Indian Religious Freedom Act of 1978 requires that all federal agencies take into account the effects of their actions on traditional Native American religious and cultural values and practices. Also, the Native American Graves Protection and Repatriation Act of 1990 expressly provides for the protection of Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony, and gives affiliated Native American groups priority in the treatment of such human remains and artifacts.

Regulations for *Protection of Historic Properties* (36 CFR Part 800), which primarily implement Section 106 of the National Historic Preservation Act, define key regulatory requirements beyond those of NEPA. These regulations define a process for consulting with State Historic Preservation Officers, the Federal Advisory Council on Historic Preservation, and other interested parties to ensure that significant historic properties are duly considered as federal projects are planned and implemented.

Cultural resources include prehistoric, historic, and traditional cultural sites, buildings, structures, districts, and objects, as well as associated artifacts, records, and remains related to such properties. The significance of cultural resources is determined in consideration of the criteria for listing on the National Register of Historic Places. To be eligible for listing on the National Register, a property must be important in American history, architecture, archaeology, engineering, or culture and must possess integrity of location, design, setting, materials, workmanship, feeling, and association. In addition, properties must meet at least one of the following four criteria:

Criterion A: are associated with events that have made a significant contribution to the broad patterns of our history.

Criterion B: are associated with the lives of persons significant in our past.

Criterion C: embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent 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 (*National Register of Historic Places*, 36 CFR Part 60.4).

The eligibility of resources for listing on the National Register is seldom evaluated until they are threatened. Therefore, only a few of the cultural resources that have been inventoried within the Study Area have had an eligibility determination.

The Council on Environmental Quality regulations (§1502.25) encourage agencies to coordinate preparation of environmental assessments with other environmental review and consultation requirements, such as those of the National Historic Preservation Act. However, the proposed oil and gas development evaluated in this EIS is programmatic and specific impact zones are not identified at this time. Therefore, no formal Section 106 consultations have been undertaken at this time.

3.8.3 Archaeological and Historical Sites

Archaeological and historical properties are physical remnants of societies that have occupied the region. Since the 1950s, archaeologists have recorded almost 1,000 archaeological and historical sites within the Study Area (Table 3-27). The sites represent more than 1,000 site occupations because some sites were used during more than a single temporal component.

Although this is a large inventory, it represents only a small sample of the archaeological and historical sites that are present. Densities in excess of 25 sites per square mile are not uncommon in the area.

Human societies have lived in southwestern Colorado, as throughout much of North America, for at least 10,000 to 12,000 years. The earliest cultures, referred to as Paleo-Indians, were nomadic hunters of big game, including large Pleistocene species such as mammoth and giant bison that have since become extinct. Archaeological evidence of the Paleo-Indian era is rare, and no sites dating to this earliest period have yet been found on the Reservation. Most evidence of Paleo-Indians in the surrounding region consists of isolated finds of large, distinctive spear points.

The subsequent Archaic era, known locally as the Oshara Tradition, dates from about 8,000 to 2,000 years ago. Archaic peoples continued to hunt game and gather wild foods, but probably exploited a broader range of animals and plants than Paleo-Indians. Ground stone tools become more common throughout the Archaic era, indicating a growing reliance on native plant foods such as Indian rice grass and piñon nuts.

A series of chronological phases have been described for the Oshara Tradition, each reflecting technological changes, demographic shifts, and decreased mobility. Surveys have noted a particular concentration of Archaic sites in the Ridges Basin south of Durango, and limited excavations at some of these sites confirm they date to the late Archaic era. About 35 Archaic site components have been recorded within the Study Area, with most located in the La Plata River drainage on the west side of the Reservation. Most of these sites are scatters of chipped stone artifacts.

The adoption of agriculture marks the transition to the subsequent Formative era, represented regionally by the Anasazi Tradition. This widespread tradition commonly is divided into several temporal units: Basketmaker II (AD 1-400), Basketmaker III (AD 500 to 700), Pueblo I (AD 700 to 900), Pueblo II (AD 900 to 1100), Pueblo III (AD 1100 to 1300), and Pueblo IV (AD 1300 to 1700), which incorporates historically documented puebloan groups. More than half of the archaeological sites recorded within the Study Area represent the Anasazi Tradition (584 components).

Recognizing substantial geographical and temporal variation within the Anasazi Tradition, archaeologists have subdivided the region into subareas or "branches," and more precisely defined a series of temporal periods for each subarea. Two branches of the Anasazi Tradition are represented in the Study Area—Upper San Juan to the east and Mesa Verde to the west.

The San Juan branch began at about AD 1 and continued through about AD 1125. Peak occupation dates from about AD 700 to 950. Burned villages of pit houses dating from the end of this peak occupation suggest deteriorating social conditions. Subsequent occupation in the Upper San Juan branch focused on the Chimney Rock area. The Chaco Canyon cultural system constructed a "great house" at Chimney Rock in the eleventh century, and it was occupied until about AD 1125 when puebloan populations apparently abandoned the area. Chimney Rock is the most northeastern outlier of the Chaco Canyon system, which was centered in Chaco Canyon, New Mexico, about 90 miles to the southwest.

TABLE 3-27
Recorded Archaeological Site Components

Culture/Period		Drainage				Totals
		Piedra	**Pine**	**Animas-Florida**	**La Plata**	
Paleo-Indian		0	0	0	0	0
Archaic		0	1	6	28	35
Anasazi	Basketmaker II	3	11	14	6	34
Anasazi	Basketmaker III/ Pueblo I	67	52	120	118	357
Anasazi	Pueblo II/III	8	8	20	98	134
Anasazi	Pueblo IV	2	0	2	5	9
Anasazi	Unassigned	0	18	12	20	50
Anasazi	Subtotals	80	89	168	247	584
Navajo	Dinetah	0	0	2	0	2
Navajo	Gobernador	3	4	9	24	40
Navajo	Unassigned	1	2	25	8	36
Navajo	Subtotals	4	6	36	32	78
Ute		0	2	2	5	9
Euro-American		3	30	24	32	89
Unknown		15	29	65	136	245
Totals		102	157	201	480	1,040

Source: Colorado State Historic Society site database

The Mesa Verde branch began somewhat later than the San Juan branch, around AD 450, and survived somewhat longer, until around AD 1300, but followed a similar trajectory. In the aggregate, the Basketmaker and Pueblo I periods dominate the archaeological record on the Reservation. The large, impressive masonry pueblos and cliff dwellings that are the hallmark of the Pueblo III period are more common to the northwest of the Reservation at Mesa Verde National Park, and near Chimney Rock on the San Juan National Forest north of the Reservation.

The numbers of known Anasazi sites are densest in the western part of the Study Area and decline to the east.

When Euro-Americans first invaded the region, the native groups in the area included those who spoke Athapaskan languages, including the Navajos and Apaches, and those who spoke Shoshonean languages, including various bands of Utes. Language affiliations indicate that Athapaskan speakers migrated from northern Canada, but when and by what route remains a topic of research. Some Athapaskans certainly were in the region by 1500 and perhaps a century or two earlier. The Spanish were distinguishing the Navajos from the Apaches by about 1625, and eventually the Apaches diverged into several groups including the Western, Chiricahua, Mescalero, Kiowa, Lipan, and Jicarilla.

Archaeologists have defined two early phases of Navajo sites—Dinetah (dating about AD 1500 to 1700) and the Gobernador (about AD 1700 to 1780). A total of 78 Navajo site components have been recorded within the Study Area. Only two of these are assigned to the early Dinetah phase, 40 are identified as Gobernador, and the others cannot be assigned to a specific period on the basis of available information. Most of the recorded Navajo sites are in the Animas-Florida and La Plata drainages, with three-fourths of all the sites clustering in the Black Ridge-Long Mountain area that forms the divide between these drainages.

The Ute language is related to several others, including those of the Shoshones, Paiutes, Chemehuevis, Goshutes, and more distantly to the Hopi. Language affiliations suggest linkages to the Desert Culture of the Great Basin. The first definite Spanish reference to the Utes (the Capote band) dates from 1626, although they are likely to have been in the area at least a century or two earlier. Some researchers suggest the Utes were in west-central Colorado by AD 1150.

Several bands of Utes were documented by early historic records. These bands ranged over much of eastern Utah, western Colorado, and northern New Mexico. After the Utes acquired horses, they frequently ranged out onto the Great Plains. At times, the Utes allied with the Comanches against the Spanish, Pueblos, Apaches, and Navajos, and at other times they reversed their allegiances. Jicarilla Apache and Navajos, at times, were reported to be living among the Utes. During the era of Spanish and Mexican colonization, Hispano settlers expanded out of the Rio Grande Valley, into the Chama Valley, and then north into southern Colorado. During the early nineteenth century, some Utes culturally blended and intermarried with these Hispano ranchers.

Soon after the United States gained control of the region in the mid 1800s, the federal government sought to control and settle the Utes. An 1868 treaty granted the Utes the western third of Colorado as a Reservation, but the United States government soon began to whittle away the reserve to accommodate white mining and ranching interests. By 1881, the northern Ute bands were removed to a much smaller and remote Reservation in northeastern Utah. Efforts to move the three southern Ute bands—Capote, Mouache, and Weeminuche—to Utah never succeeded, and a Reservation was established for them in the southwestern corner of Colorado in 1895. The Capote and Mouache accepted the government's program to allot lands to individual

Indians in lieu of jointly held Tribal lands, but the Weeminuche band resisted. The Weeminuche relocated to the western part of the Reservation, which eventually was designated as the Ute Mountain Ute Reservation. After 371 allotments totaling 72,811 acres were made to the Capote and Mouache bands, the more than 0.5 million acres of remaining lands were opened to white homesteading in 1899. Lands that had not been homesteaded by the 1930s (mostly because they were undesirable) were returned to the Capote and Mouache, and the Reservation was established under the terms of the Indian Reorganization Act of 1934.

Archaeologists have found it difficult to recognize Ute sites. It is possible that some sites identified as Navajo are in fact Ute. Only nine Ute site components have been identified within the Study Area.

Historic non-Indian activities focused on homesteading. Within the Study Area, more than 2,800 homestead entries were made under the original 1862 Homestead Act, and the subsequent 1877 Desert Land and 1916 Stock Raising acts. Historic homestead and Indian allotment activities are presented in Map 21. Somewhat more than 1,000 of these entries, or less than 4 of every 10 attempts, were successfully patented. Almost another 450 land purchases were made as "cash entries" under the 1862 Act. Small farming communities such as Redmesa, Kline, Breen, and Bondad developed as service centers for ranchers, especially in the western part of the Study Area.

Other activities included development of irrigation systems on the La Plata, Animas, and Pine rivers. Transportation systems also were developed. The narrow gauge Denver and Rio Grande Railroad was completed in 1881, passing through the area to connect Alamosa, Chama, and Durango. A line later connected Durango and Farmington. Several communities developed along the railroad. Major wagon roads through the region included the Canyon Largo toll road, the Fort Lewis to Farmington road down the La Plata Valley, and roads connecting with Durango and Arboles. Many smaller roads were established to access isolated homesteads and grazing areas.

Some timbering was pursued, and sawmills were developed in forested uplands. Mining of placer gold occurred along the lower reaches of the Piedra River. Mineral exploration expanded in the 1920s, with oil and gas prospecting occurring across much of the western part of the Study Area. Coal was mined in several locations, but primarily in the vicinity of the Cinder Buttes southeast of Redmesa.

Historic locales identified on the basis of a review of historic documents are depicted on Map 22. A total of 89 Euro-American archaeological site components have been recorded throughout the Study Area. These reflect ranching, farming, transportation (including railroads), small coal mines, and pre-World War II oil and gas development.

Cultural resource inventory data are limited, but suggest that archaeological and historical sites could be found almost anywhere within the Study Area. The available inventory data were used to identify project sensitivities throughout the Study Area.

The projection of prehistoric and ethnohistoric resource sensitivities is based on estimates of varying densities of archaeological sites across the Study Area. High sensitivity zones (estimated to have more than 20 archaeological sites per square mile) are quite widespread. These zones include the valleys and many tributary drainages of the La Plata, Animas, and Pine rivers, as well as some piñon-juniper/sage upland areas such as the Mesa Mountains in the southwestern quadrant of the Study Area. Low sensitivity zones (projected to average nine or fewer sites per square mile) are limited to areas where archaeological sites have probably been destroyed by development around historic settlements, areas of badlands or cliffs, and pine/oak forests. The remaining areas are characterized as moderate sensitivity zones (estimated to have 10 to 19 sites per square mile).

The projection of sensitivities related to historic Euro-American and Reservation era occupation of the Study Area is depicted on Map 23. Because homesteading activities represent the dominant historic theme of non-Indian land use, the sensitivity projections are based primarily on an index score developed to reflect levels of homesteading and establishment of associated communities. The highest sensitivity areas are common along the Piedra, Pine, Animas, and La Plata rivers, the smaller tributaries in the upper reaches of the La Plata, Florida, and Pine rivers, and along the route of the Denver and Rio Grande Railroad. Homesteading activity was less intensive in areas with restricted surface water availability and in higher elevations. These areas include the southwest corner of the Reservation, most of the region between Springs Gulch (east of the La Plata River) and the Animas River, Mesa Mountain, and the Piedra Peak foothills. The centrally located area with available water between the upper Pine River and Ignacio Creek also appears to have been almost completely ignored by homesteaders.

In addition to homesteading and associated settlements, sensitivities are indicated by the distribution of Indian allotments, and other identified historic locales related to development of transportation corridors, irrigation systems, and historic oil and gas wells. Particularly sensitive resources such as cemeteries and grave sites also were considered.

3.8.4 Traditional Cultural Places and Resources

Many American Indian communities, including the Southern Ute, actively maintain aspects of their traditional lifeways. The Tribe has organized a Language and Cultural Preservation Committee within its Education Department, reflecting widespread Tribal concern for preserving aspects of traditional Southern Ute culture. The Tribe also has created a Tribal historian position, and has developed a Tribal museum. Traditional ceremonies, especially the Bear Dance, continue to be practiced by Tribal members.

A comprehensive inventory of traditional places and resources within the Study Area is not available. A recent study for the BOR Animas-La Plata Project identified a single trail as the only traditional cultural place within the boundaries of that project.

Consultations with the Southern Ute Tribal historian revealed that traditional territories of the Mouache and Capote Ute bands, who are the primary residents of the Reservation, were located largely to the east of the Reservation. Therefore, Tribal members do not have ancient ties to specific places within the Reservation. The Tribal historian indicated that traditional Ute cultural concerns regarding the proposed oil and gas leasing and development focus on protection of archaeological sites, and minimizing disturbance of natural vegetation. In historic times, the Utes relied on a variety of game animals and natural plant products. Some traditional Ute ceremonies may have required specific plant and animal products, but there are no practicing shamans among the Southern Ute today. Although many Tribal members continue to hunt game, plant products are no longer gathered as sources of staple foods. Some Tribal members may collect a few species of plants, such as wild onions, as condiments, and a variety of other plants continue to be used by some Tribal members as herbal medicines. There is no available documentation regarding the extent of this practice nor have the utilized species been inventoried.

Other nearby tribes, such as the Ute Mountain Ute, Navajo, Jicarilla Apache, Hopi, Acoma, Laguna, Zuni, and other puebloan groups in the northern Rio Grande drainage may claim affinity to some archaeological sites located on the Southern Ute Reservation. Some places may have traditional ties for descendants of Euro-American settlers in the Study Area, both Hispanic and non-Hispanic. Consultations with appropriate traditional cultural groups would be undertaken during post-EIS implementation of specific projects as warranted.

3.9 VISUAL RESOURCES

3.9.1 Introduction

The purpose of this section is to provide an overview of the visual environment of the Study Area. An assessment methodology was developed to identify visual impacts of the alternatives on the Study Area (see Section 4.9). The assessment included an inventory of viewer and setting characteristics, which are addressed in this chapter.

The character and setting of the visual environment are described in general and then categorized by landscape types for purposes of analysis. An evaluation and description of how current development has altered the natural setting is discussed in Section 3.9.3. Two other components of the visual environment, scenic quality and viewsheds from sensitive viewpoints (i.e., landscape visibility), are addressed in Sections 3.9.4 and 3.9.5, respectively. For these two components, the criteria for categorization and the results for the Study Area are presented.

3.9.2 Landscape Character, Scenic Quality, and Scenic Integrity

To define the landscape character and setting of the Study Area, landscape types were categorized by areas with similar patterns of landform, vegetation, water, land use, and unique features. Landscape character types and subtypes were developed by reviewing Physiographic Provinces of the United States (Fenneman 1931), interpreting aerial photographs, and conducting a field reconnaissance of the Study Area.

The San Juan Mountains are located north of the Study Area and provide a backdrop that dominates much of the visual setting within the Study Area. Topography in the Study Area is highly varied—from rolling to steep angular landforms, annual streams to large meandering rivers, and desert to lower montane vegetative associations. Major drainageways in the Study Area include the Animas, Pine, La Plata, and Florida rivers. River bottoms vary from the wide open, meandering valleys of the Animas and San Juan rivers, to the narrow steep canyons of Cherry Creek, a tributary to the La Plata River. While piñon-juniper is the major vegetative community represented within the Study Area, ponderosa pine and oakbrush are present in upper elevational zones, and grasslands and shrublands occupy the lower zones. Oakbrush and aspen provide a variety of color to the setting, especially in the fall.

Of the several major and minor riparian areas influencing the Study Area, the Animas and Pine rivers are the two major systems. The Animas River flows north to south near La Posta, Bondad, and the center of the Study Area, and the Pine River flows north to south through the eastern portion of the Study Area. Two other rivers—the Florida and La Plata—are subordinate to the Animas and Pine Rivers in volume, scale, and visual impact. These two smaller rivers also flow in a generally north to south direction through the Study Area. Three reservoirs provide important visual and recreational roles—the Navajo, which is located primarily outside and east of the Study Area; the Pastorious, which is located totally within the Study Area near the northwest corner; and the Mormon, located 1.5 miles northwest of Kline. The Navajo Reservoir is considerably larger than the other two reservoirs and is actively used as a recreation area by tourists, campers, and summer residents.

The northern and western portions of the Study Area are dominated by mesas, plateaus, and hogbacks, interspersed with drainageways of varying widths. The southern and eastern portions are dominated by high, uneven mesas and high ridges separated by wide to narrow drainageways, some with sheer rock walls. Rock forms and color also provide visual variety. The red sandstone cliffs are focal points along the lower Animas Valley, as are the gray volcanic cliffs and spires along the San Juan Valley.

The general landscape types within the Study Area have been defined physiographically based upon field observation and information available on contour maps and aerial photographs. The nine landscape types characterizing the Study Area consist of the following:

- ridges and narrow valleys;
- mountain areas;
- upland hills;
- rolling uplands;
- canyons;
- mesa tops;

- mesa rims and escarpments;
- river valleys; and
- reservoirs.

Ridges and Narrow Valleys

Ridges and narrow valleys comprise lands of intermediate elevation situated above the valley floor and below the mountains. Ridge and narrow valley landscapes are characterized by steeply sloping land that crests in sharply angular ridge lines and drops into steep-walled, narrow, v-shaped valleys. Large areas of outcroppings are present along many of the slopes.

Mountain Areas

Mountain areas in the region tend to be characterized by moderately to steeply sloping projections of land, which are typically very rugged and have extensive areas of rock outcroppings. High elevation ridges, broken talus slopes, and smoothly undulating slopes also are common to the mountain terrain. North-facing slopes tend to be densely forested with mixed alpine conifers and scattered groves of aspen, while south-facing slopes generally support a somewhat sparse cover of piñon-juniper and low shrubs.

Upland Hills

Landscapes that are more moderated and softly rounded than the rugged ridge and narrow valley landscapes are classified as upland hills. These areas are characterized by rounded, undulating uplands often flanked by long and linear elevated benches or terraces. Many small drainages and swales define the individual hillsides. The vegetative cover in these hilly areas ranges from extensive grasslands to low scrubby stands of piñon-juniper.

Rolling Uplands

Landscapes that are gentler than upland hills are classified as rolling uplands. These areas are characterized by gently rolling and sloping upland areas, which often are dissected by intermittent streams. The vegetative cover in these rolling upland areas includes sagebrush, piñon juniper, and grasslands. Much of the area classified as rolling uplands is dominated by agricultural features. Though there are numerous ranches and home sites in this landscape character type, these areas remain visually natural, and the scenic quality has not been affected adversely by this type of development.

Canyons

Several canyons are present within the Study Area. Canyon areas are characterized by nearly vertical walls, which often exhibit distinctively colored bands of sedimentary rock. Flowing or intermittently flowing streams generally bisect the canyon floors and are bounded by linear bands of riparian vegetation. Farther away from the drainage courses and along the side slopes, the vegetation in the canyon is composed primarily of coniferous species, which vary in density with the steepness of the canyon walls.

Mesa Tops and Rims and Escarpments

Broad extensive areas of relatively flat lands that are raised sharply above adjacent lands are classified as mesa tops. Various species of short grasses and extensive areas of sagebrush are common to these landscapes. The edge of the mesa tops are classified as mesa rims and escarpments.

River Valleys and Reservoirs

In the dry landscape of southwestern Colorado, a prominent reservoir, river, or stream is an important visual and recreational resource. It is felt that such a resource should be identified as a unit unto itself rather than as a component of a more extensive landscape type such as areas of hills. For this reason, land associated with a significant water feature was singled out and classified as either a river valley or a reservoir.

3.9.3 Visual Characteristics of Current Development

The degree to which existing development has an impact on the visual setting of the Study Area was identified by analyzing the individual components associated with CBM and conventional well development. Each of these components are described below and illustrated in Photographs 3-1 to 3-15. The locations of existing conventional and CBM wells within the Study Area are shown in Section 3.4 on Maps 11 and 12.

Some components associated with well development are relatively small and were determined to be prominent only within immediate foreground viewpoints such as residences, recreation facilities, and travel routes. These small well components are present throughout the Study Area and include well heads, separators, dehydrators, cathodic protection wells, and uncovered produced water pits. Typically, the visibility of these structures fades quickly into the landscape as the distance of the viewer is increased, particularly when the well components are backdropped by vegetation and local topography. The structures are subordinate to the characteristic landscape in foreground views (300 feet to 0.25 mile) and are unnoticeable to the casual observer in middleground (0.25 to 1 mile) and background (1 to 5 miles) views. Typically organic in shape, the facilities are constructed such that views through the structure are possible. The uncovered produced water pit is a solid cylindrical structure, which is typically fully buried and not obtrusive from distant views. Other solid geometric structures such as the meter house, pump jack, condensate tank, on-site water storage tank, and covered produced water pit also are prominent in immediate foreground views, but due to their solid mass they are still noticeable to the casual observer in foreground views. The visual characteristics of current well development are presented in Table 3-28.

Photograph 3-1 - Typical Well Head

Photograph 3-2 - Typical Separator

Photograph 3-3 - Typical Meter House

Photograph 3-4 - Typical Pump Jack (Associated with Fruitland/CBM Wells Only)

Photograph 3-5 - Typical Dehydrator (Typically Associated with Conventional Wells)

Photograph 3-6 - Typical Condensate Tank (Associated with Conventional Wells Only)

Photograph 3-7 - Typical Condensate Tank and Produced Water Pit (Associated with Conventional Wells Only)

Photograph 3-8 - Covered Produced Water Pit (Associated with Conventional Wells Only)

Photograph 3-9 - On-Site Water Storage Tank

Photograph 3-10 - Cathodic Protection Well

Photograph 3-11 - Water Injection Well Facilities (Associated with Fruitland/CBM Wells Only). Currently, there are 30 of these facilities on the Reservation.

Photograph 3-12 - Typical Fruitland Well Facilities - Immediate Foreground View (0 to 300 feet)

Photograph 3-13 - Typical Fruitland Well Facilities - Foreground View (300 feet to 0.25 mile)

Photograph 3-14 - Typical Conventional Well Facilities - Immediate Foreground View (0 to 300 feet)

Photograph 3-15 - Typical Conventional Well Facilities - Foreground View (300 feet to 0.25 mile)

Less common in occurrence, support facilities such as water injection wells and compressor stations are composed of solid geometric structures. However, they are much larger than the typical well facilities, with the largest element being approximately 25 feet tall by 15 feet wide. There are approximately 30 injection-well facilities located within the Study Area and several compressor stations. These facilities are prominent in both foreground and middleground views.

Cleared linear elements associated with well development include pipeline rights-of-way, well pads, and access roads. These are the most visible elements associated with well development. Transmission pipelines and well pads cleared within dense vegetation or on steep slopes are prominent in foreground, middleground, and background views. Well pads occupy approximately 1 to 2 acres and can be visible from long distances, especially when the pads are cleared in densely vegetated areas located in rolling landscapes. Rolling landscapes typically offer better vantage points from which to view the well pads than do flat landscapes where the observer is parallel with the clearing, and their views can easily be screened.

TABLE 3-28
Visual Characteristics of Current Well Development

Well Facility	Frequency of Occurrence	Immediate Foreground (0' to 300')	Foreground (300' to 0.25 mile)	Middleground (0.25 to 1 mile)	Background (1 to 5 miles)	Aerial
well head	common	P	S	U	U	U
separator	common	P	S	U	U	U
meter house	common	P	S	U	U	U
pump jack (CBM)	sporadic	P	S	U	U	U
dehydrator (typical with conventional)	moderate	P	S	U	U	U
condensate tank (conventional)	moderate	P	P	S	U	U
on site water storage tanks (CBM)	moderate	P	P	S	S	S
uncovered produced water pit (conventional)	moderate	P	S	U	U	U
covered produced water pit (conventional)	moderate	P	P	S	U	S
cathodic protection well (at edge of pad)	common	S	S	U	U	U
Support Facilities						
water injection well facilities (CBM)	sporadic	P	P	P	S	S
compressor station/ gas plant	sporadic	P	P	P	S	S

TABLE 3-28 Visual Characteristics of Current Well Development						
Well Facility	**Frequency of Occurrence**	**Immediate Foreground (0' to 300')**	**Foreground (300' to 0.25 mile)**	**Middleground (0.25 to 1 mile)**	**Background (1 to 5 miles)**	**Aerial**
Linear Elements						
access roads	common	P	P	P	S	S
gathering pipeline	common	P	P	P	S	S
transmission pipeline	common	P	P	P	P	S
well pad	common	P	P	P	P	P
Legend sporadic occurrence - very few structures moderate occurrence - found with only one well type, optional component of a well common occurrence - widespread, common distribution of wells U = unnoticed - does not attract attention S = subordinate - begins to attract attention P = prominent - dominates surrounding setting						

3.9.4 Scenic Quality

3.9.4.1 Scenic Quality Evaluation Criteria

The scenic quality rating is a relative indication of the visual quality of a landscape based on a systematic approach and analysis of the landscape elements. Factors considered to determine scenic quality include the physical scarcity or uniqueness of that particular landscape type within the region, the extent to which it has been altered by humans, the degree to which lands in adjacent landscape character units enhance overall visual quality, and diversity in landscape types. The greater the variety of form, line, color and texture, the greater the potential for high scenic quality. The following three categories are used to describe the scenic quality within the context of the physiographic region:

- **Distinctive scenic quality**—areas containing features such as landforms, vegetative patterns, water forms, and rock formations which are of an unusual or outstanding visual quality not common in the surrounding area;

- **Common scenic quality**— areas containing features with a variety of form, line, color, and texture or combinations thereof tending to be common throughout the surrounding area and not outstanding in visual quality; and

- **Minimal scenic quality**—areas generally characterized by little or no variety in form, line, color, texture or combination thereof.

Table 3-29 defines the individual landscape components that contribute to the overall scenic quality rating.

3.9.4.2 Scenic Quality Evaluation Results

Most landscapes within the Study Area are considered common in their scenic quality, with small areas of minimal scenic quality interspersed throughout. However, distinctive landscapes occur in narrow or broad river valleys with abundant ponderosa pine, spruce, fir, cottonwood, willow, and scrub oak trees. Distinctive landscapes also occur in areas of deeply eroded and colorful canyons. Areas classified as distinctive include the Animas, Florida, and Pine river valleys, as well as the Cherry Creek, Long Hollow, and Red Horse Gulch canyons. Map 24 illustrates the landscape character and scenic quality represented in the Study Area.

The Animas River is characterized by a wide valley that has been carved in the hills that bound it to the east and west. Dense stands of cottonwoods and willows inhabit the valley floor and river's edge, supporting a diverse wildlife community. Highway 550 and the Lower Animas Road flank both sides of the valley, and support significant development that might be considered visually distractive from the area. However, the adjacent steep slopes with colorful outcrops of horizontally banded rocks attract attention and add significantly to the scenic quality of the Animas River.

The Florida River valley is more narrow and canyon-like than the Animas River valley, and is situated between rolling uplands and steep ridges. The Florida River meanders through this valley and supports a diversity of vegetative types, including ponderosa pine, spruce, fir, cottonwoods, willows, and scrub oak. Though there are a number of ranches and homesites, the area remains visually natural, and the scenic quality has not been affected adversely.

TABLE 3-29
Scenic Quality Criteria Inventory and Evaluation Chart

	Distinctive	Common	Minimal
Landform	Prominent cliffs, spires, or massive rock outcrops. Highly eroded formations including major badlands or dune systems or dominant features that are exceptionally striking (such as glaciers).	Steep canyons, mesas, or buttes; interesting erosional patterns or landforms varied in size and shape; or detail features present and interesting, though not dominant or exceptional.	Low, rolling hills, foothills, or flat valley bottoms. Interesting, detail landscape features are few or lacking.
Vegetation	A variety of vegetative types as expressed in interesting forms, textures, and patterns.	Some variety of vegetation, but only one or two major types.	Little or no variety or contrast in vegetation.

TABLE 3-29
Scenic Quality Criteria Inventory and Evaluation Chart

	Distinctive	Common	Minimal
Water	Clear and clean appearing, still or cascading white water are dominant factors in the landscape.	Flowing or still, but not dominant in the landscape.	Absent or present, but not noticeable.
Color	Rich color combinations, variety or vivid color; or pleasing contrast in the soils, rock, vegetation, or water.	Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element.	Subtle color variations or contrast; generally muted tones.
Influence of adjacent scenery	Adjacent scenery greatly enhances visual quality.	Adjacent scenery moderately enhances overall visual quality.	Adjacent scenery has little or no influence on overall visual quality.
Scarcity	One of a kind, unusually memorable, or very rare within the region. Consistent chance for exceptional wildlife or wildflower viewing, etc.	Distinctive, though somewhat similar to others within the region.	Interesting within its setting, but fairly common within the region.
Cultural modifications	Free from aesthetically undesirable or discordant sights and influences; or modifications add favorably to visual variety.	Scenic quality is somewhat depreciated by inharmonious intrusions, but not so extensive that the scenic qualities are entirely negated or modifications add little or no visual variety to the area.	Modifications are so extensive that scenic qualities are for the most part nullified or substantially reduced.

The broad Pine River valley is 2 to 3 miles wide. It is adjoined on the east by abruptly rising mesa rims and escarpments generally oriented north to south. The Pine River braids a meandering course through the valley and is the most distinctive visual attraction, enhanced by the clearly visible, diverse contiguous vegetation that contrasts sharply against the adjacent agricultural-grazing lands. Even with a number of modifications to the natural landscape from agricultural and residential developments, this area retains an interesting visual quality.

Cherry Creek Canyon is a relatively wide canyon with a flat floor bounded by 400- to 500-feet-high walls. Large, blocky, banded sedimentary outcrops are frequent along the sideslopes. Cottonwood, oak brush and grasses follow the course of Cherry Creek as it meanders through the canyon. The steep canyon walls lend a sense of enclosure to the area and screen out most of the adjacent scenery.

3.9.5 Landscape Viewshed

3.9.5.1 Landscape Viewshed Evaluation Criteria

Landscape viewshed is the extent to which features are noticeable or apparent in the landscape. The two aspects considered in determining landscape viewshed for this evaluation were the distance of views and screening provided by topography. For purposes of this study, sensitive viewers were identified, and viewshed was modeled based on terrain data. This modeling process is referred to as viewshed modeling.

Viewsheds were created to determine the relationship of the observer from sensitive viewpoints to the setting and the proximity (distance zones) of these views. Sensitive viewpoints include major travel routes, recreation areas, rural/urban communities, and dispersed rural residences. Distance zones are used to indicate the relative detail that is perceived visually of natural and developed features on the landscape. The appearance of features in the landscape varies with viewing distance and project type. Distance zones are important frames of reference for discussing changes in the characteristic landscape. The greater the distance between the viewer and a development, the less noticeable are the details and, consequently, the less significant is the impact of the activity on the characteristic landscape.

3.9.5.2 Landscape Viewshed Evaluation Results

Sensitive viewpoints within the Study Area were identified through discussions with SUIT planners and BLM recreation resource planners. Identified viewpoints were located using aerial photography and topographic maps and verified through field investigations. Each viewpoint was digitized into an automated database with terrain and used to analyze viewsheds including immediate foreground, foreground, middleground, background, and seldom-seen areas. Sensitive viewpoints used to assess project visibility are listed in Table 3-30.

Sensitive viewpoints within the Study Area include the communities of Breen, Kline, Redmesa, La Posta, Ignacio, La Boca, Tiffany, Allison, and Arboles. Residential areas, including existing subdivisions and dispersed rural residences, also were considered as sensitive viewpoints. Travel routes identified as sensitive viewpoints include both major and secondary roads, as identified in Table 3-30. SH 140, SH 172, and US 550 were considered to be of primary importance. These roads provide regional connections through the study corridor and serve as major recreation destination roads. Recreation areas within the Study Area identified as sensitive viewpoints include the Navajo State Park and Wildlife Area and the Pastorious Reservoir Wildlife Area.

Volume, as it relates to view sensitivity, is a relative term denoting the number of users, visitors, or viewers at or along a given vantage point. Vantage points considered for their visual sensitivity include residences, recreation areas, and roadways. Comparatively, the number of users traveling on a road such as SR 550 is greater than that on Lower Animas River Road (CR 213) or Buck Highway (CR 321). Views from rural residences are considered to be of overall moderate “volume” due to the dispersed nature of such development.

TABLE 3-30
Sensitive Viewpoints in Study Area

Sensitive Viewpoints	Location	Traffic Volume
Travel Routes/Trails		
US 550	Connects US 160 and Bondad	High
SH 140	Connects Durango, Breen, Kline, and Redmesa	High
SH 151	Connects Ignacio and Arboles	High
SH 172	Connects US 160 and Ignacio	High
Lower Animas River Road (CR 213)	Connects US 160 and Bondad	Moderate
Buck Highway (CR 321)	Connects Ignacio and Bondad	Moderate
318/310	Connects Ignacio and Bondad	Moderate
CR 500 (Trujillo Road) Wahnita to Dulce	An old railroad grade that connects Navajo State Park and SH 151; proposed as a scenic byway	Moderate
Use Areas		
Navajo State Park	East of Arboles and Highway 151	High
Navajo Reservoir State Wildlife Area	Southwest of Arboles, adjacent to Navajo State Park	High
Pastorious Reservoir State Wildlife Area	0.5 mile south of the northern SUIT boundary between US 550 and SH 172	Moderate
Other		
Subdivisions	Throughout the Study Area	NA
Residences	Throughout the Study Area	NA
Breen	North of Kline on SH 140	Moderate
Kline	North of Redmesa on SH 140	Moderate
Redmesa	North of the SH 140 crossing of La Plata River	Moderate
La Posta	North from Bondad, east of the Animas River	Moderate
Ignacio	West of the Pine River, at the intersection of SH 151 and SH 172	High
La Boca (very small community)	South of Ignacio on SH 172	Moderate
Tiffany (very small community)	West of Arboles on SH 151	Moderate
Allison	East of Tiffany	Moderate
Arboles	West of the Navajo Reservoir on SH 151	Moderate

Immediate foreground views from sensitive viewpoints constitute approximately 4.7 percent of the Study Area, foreground views account for 17.5 percent, and middleground views account for 35.8 percent. These viewpoints are concentrated on private, subdivided, and residential lands and on primary travel routes such as SH 140, US 550, SH 151, and SH 172.

3.10 SOCIOECONOMICS

3.10.1 Introduction

For purposes of the socioeconomic analysis, the area of influence includes the five counties encompassing or bordering the Study Area, including Archuleta, La Plata, and Montezuma counties in Colorado, and Rio Arriba and San Juan counties in New Mexico. Baseline information for these counties as well as for the Reservation is provided, including demographics, housing, economic activity, public infrastructure and services, local government finances, and Tribal government finances.

The finances of the SUIT government are described at length because of the dominant role of energy development in maintaining the Tribe's fiscal health. However, the Tribe regards the details of its finances as proprietary, nonpublic information. For this reason, much of the material on Tribal finances is presented as percentages or averages rather than in absolute dollars.

3.10.2 Demographics

The following subsection summarizes population growth and trends, age distribution, and racial and ethnic characteristics of the population in the area of influence. Historic population and projections are presented in Table 3-31 for each of the five counties and the Reservation.

TABLE 3-31
Historic Population and Projections in the Area of Influence

State/County Area	Size (square miles)	1980	1990	1995*	2000*
Colorado	103,738	2,889,735	3,294,394	3,551,000	4,059,000
Reservation	1,070	N/A	7,804	9,134	9,968
La Plata	1,692	27,195	32,284	38,146	43,729
Montezuma	2,037	16,510	18,672	21,511	24,211
Archuleta	1,349	3,664	5,345	6,859	8,301
New Mexico	121,365	1,303,303	1,515,069	1,614,000	1,823,000

TABLE 3-31 Historic Population and Projections in the Area of Influence					
State/County Area	Size (square miles)	1980	1990	1995*	2000*
Rio Arriba	5,859	29,282	34,365	36,963	39,435
San Juan	5,515	81,433	91,605	101,108	110,159
*Estimates based on 1990 census Sources: U.S. Census, 1990; CACI Marketing Systems, no date; RAE Consultants, Inc., no date.					

The State of Colorado experienced a 14 percent increase in population between 1980 and 1990. During that time, Archuleta County grew by 46 percent, Montezuma County by 13 percent, and La Plata County by 19 percent. The State of New Mexico experienced a 16 percent increase in population during the 1980s. During that time, Rio Arriba County grew by 17 percent, and San Juan County grew by 12 percent. In general, population growth rates in the area peaked in the mid-1980s and then declined in the latter half of the decade. The total Reservation population experienced a 33 percent increase, with most of this growth occurring in the Southwest Census County Division (CCD). The Tribe's population grew from 900 in 1976 to 1,250 in 1992, representing an average annual growth rate of 2 percent (Keck 1994).

La Plata County has continued to grow in the 1990s. Although no census data are available to capture the growth in population directly, other measures can be used. For example, the number of nonvacant residential properties assessed in La Plata County grew from 12,769 in 1990 to 15,833 in 1996, an increase of 23 percent over 6 years. The assessed value of those non-vacant residential properties increased by nearly 50 percent, from $126.4 million to over $189.1 million. The number of residential electric utility customers in the county increased by 28 percent between year end 1990 and year end 1996 (La Plata County Electric Association 1997).

According to the Tribe's 1995 Annual Report, the Tribe's population was 1,305 in 1995, with 68.6 and 31.4 percent of the Tribe living on and off the Reservation, respectively. In 1997 the Tribe's population was still reported as 1,305 persons (SUIT 1998). Projections for the year 2000 indicate annual population increases ranging between 1 and 3 percent in the five counties. As shown in Table 3-31, growth projections for La Plata and Archuleta counties are higher than the state average for Colorado. In New Mexico, projections for both Rio Arriba and San Juan counties are substantially below the 12.9 percent growth projected for the state between 1995 and 2000.

Table 3-32 presents 1990 population totals for incorporated cities within the five-county area. The town of Ignacio is the largest community on the Reservation and serves as a shopping, medical, and service center. The Southern Ute Tribal government and most of its services are located in Ignacio, making it an employment and cultural center as well, especially for Tribal members. The primary municipalities serving the oil and gas industry in the area are Durango, Cortez, Ignacio, and Farmington. The service companies draw employees from throughout the five-county area.

According to the 1990 census, the median age was 32.5 in Colorado and 31.3 in New Mexico. In 1990, the median age was 35.4 in Archuleta County, 31.9 in La Plata County, 33.3 in Montezuma County, 29.9 in Rio Arriba County, and 28.1 in San Juan County. With a 1990 median age of 24.0, the population on the Reservation is younger than in the surrounding counties. The percentage of senior citizens living on the Reservation in 1990 was just below the state average of 10.0 percent. In 1990, the proportion of people under the age of 18 on the Reservation, 32.6 percent, was greater than the state average (RAE Consultants, no date).

TABLE 3-32
Population of Communities, 1990

State/Community	Population
Colorado	3,294,394
Bayfield	1,090
Durango	12,439
Pagosa Springs	1,207
Town of Ignacio	720
New Mexico	1,515,069
Farmington	33,997
Chama	1,048
Bloomfield	5,214
Aztec	5,480
Espanola (portion)	6,210

Sources: U.S. Census 1990

Table 3-33 summarizes 1990 census information on race and Hispanic origin by county and Reservation. Whites composed between 85 and 90 percent of the population in the Colorado counties and between 57 and 71 percent of the population in the New Mexico counties. The Native American population ranged between 2 and 37 percent of the population in the five counties, being most significant in Montezuma, Rio Arriba, and San Juan counties. According to the 1990 census, minority populations composed 18.5 percent of the Reservation, and Hispanics of any race composed 17.4 percent of the Reservation population. Native Americans represented 13.4 percent of the population living on the Reservation. Ninety-three percent of the Native American population lived in the Ignacio CCD. By comparison, approximately 2 percent lived in

TABLE 3-33
Race and Hispanic Origin by County, 1990

State or County	White		Black		Native American		Asian-Pacific		Other		White-Hispanic		Non-White Hispanic		Eskimo or Aleut Island	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Colorado																
Reservation	63,44	81%	16	<1%	1,044	13%	16	<1%	384	5%	NA	NA	NA	NA		
La Plata	29,022	90%	71	<1%	1,602	5%	179	1%	1,410	4%	1,925	54%	1,667	46%		
Ignacio Subdivision	2,574	69%	12	<1%	967	26%	7	<1%	164	4%	526	60%	353	40%		
Montezuma	15,943	85%	12	<1%	2,141	12%	46	<1%	530	3%	1,056	63%	610	37%		
Archuleta	4,664	87%	7	<1%	107	2%	29	1%	538	10%	710	57%	536	43%		
New Mexico																
Rio Arriba	24,323	71%	138	<1%	5,225	15%	58	<1%	4,621	13%	19925	80%	4,943	20%		
San Juan	51,806	57%	429	1%	33,64 6	37%	215	<1%	5,509	6%	5,948	4,990	6,069	51%		
Source: U.S. Census Data 1990																

the Southwest CCD and 5 percent lived in the Arboles CCD. The term "tri-ethnic community" has been used to describe Ignacio—within the Ignacio CCD, 55 percent of the residents are white, 24 percent are Hispanic, and 21 percent are Native American (Keck 1994).

3.10.3 Housing

Housing characteristics of the area of influence and the Reservation, including housing units and vacancy rates, are discussed in this section and summarized in Table 3-34. Vacancy rates in the Study Area range between 16 and 49 percent. In general, vacancy rates may appear high because of the strong vacation home market in the area. Affordable rental housing is in short supply in Durango and other areas of La Plata County due to high land and construction costs, county regulations, and subdivision covenants that keep the supply of affordable rental housing units low. On the demand side, the students of Fort Lewis College compete with employees of the tourism-based economy (relatively low service sector wages) for moderately priced rental units. In the oil and gas industry, hourly employees are more likely to rent accommodations while salaried employees are more likely to purchase homes (USFS and BLM 1992). As of 1995, 70 percent of oil and gas employees in La Plata County were homeowners (Aalund 1996).

In 1993, there was a shortage of affordable housing on the Reservation, and additional shortages were anticipated, in part resulting from the start-up of the casino. Tribal government recently established a Housing Task Force to inventory Tribal housing issues (Garner 1997).

TABLE 3-34
Housing Characteristics, 1990

Location	Housing Units	Vacant Units	Vacancy Rate (%)
Colorado			
Reservation	3,320	636	19
La Plata	15,412	3,436	22
Montezuma	8,050	1,288	16
Archuleta	3,951	1,941	49
New Mexico			
Rio Arriba	14,357	2,896	20
San Juan	34,248	5,508	16

Source: U.S. Census 1990

3.10.4 Economic Activity

This subsection summarizes economic activity within the area of influence, including employment, income sources, and fiscal characteristics. Table 3-35 presents 1990 data on the labor force and unemployment situation for the states, the five project region counties, and the Reservation. Table 3-36 presents similar data for 1997.

TABLE 3-35
Labor Force and Unemployment Information, 1990

State/County	Civilian Labor Force	Total Unemployment	Unemployment Rate (%)
Colorado	1,732,718	99,438	5.7
Reservation*	3,531	241	6.8
La Plata	16,611	1,010	6.1
Montezuma	8,340	653	7.8
Archuleta	2,425	215	8.9
New Mexico	684,160	54,888	8.0
Rio Arriba	14,398	1,703	11.8
San Juan	36,488	4,208	11.5

*Compiled from data for Southwest and Arboles CCDs
Source: U.S. Census 1990

TABLE 3-36
Labor Force and Unemployment Information, February 1997

State/County	Civilian Labor Force	Total Unemployment	Unemployment Rate (%)
Colorado	2,050,000	78,600	3.7
SUIT (1996)	NA	NA	9.0
La Plata	23,775	1,253	5.3
Montezuma	11,013	1,038	9.4
Archuleta	3,645	300	8.2
New Mexico	796,800	53,400	6.5
Rio Arriba	NA	NA	NA
San Juan	47,902	4,923	10.3

Source: Four Corners Business Journal, May 1 1997; Southern Ute Tribal Government 1997; Garner 1997

In the five-county area in 1990, unemployment was lowest in La Plata County and highest in Rio Arriba County (Table 3-35). In February 1997, unemployment was still lowest in La Plata County, despite a 30 percent growth in the workforce since 1990. Unemployment was highest in San Juan County, where the workforce has grown 24 percent since 1990.

By comparison, unemployment of both Tribal member and non-Tribal persons on the Reservation was 6.8 percent in 1990. Within the Reservation, unemployment was highest in the Ignacio subdivision at 9.7 percent. Recent estimates have not been made of unemployment on the Reservation as a whole.

According to the 1992 BIA Labor Force Report, unemployment among Tribal members on the Reservation was 25 percent, with 328 Tribal members employed and a civilian labor force of 435. Four years later, after significant growth in Tribal government and the establishment of the

Sky Ute Lodge and Casino, unemployment among Tribal members was estimated at 9 percent (Garner 1997).

Table 3-37 presents sectoral employment data for the states, the five project region counties, and the Reservation. Services and retail are dominant employment sectors in all five of the Study Area counties, reflecting the importance of tourism and recreation in the area. Popular tourist attractions include the Durango-Silverton Narrow Gauge Railroad, Mesa Verde National Monument, and Purgatory Ski Area. The services sector is strongest in Montezuma, Rio Arriba, and La Plata counties. Mining (including oil and gas production), transportation, communications, and public utilities are strong sectors in San Juan County, and public administration and construction are also relatively strong in Rio Arriba County.

The top five employers in La Plata County, by number of employees, are shown in Table 3-38. The federal government is also a significant employer, but neither the total number of employees nor total payroll for the federal government in La Plata County could be obtained. The SUIT is one of the top five employers in the county.

Oil and gas development is important to employment in the five-county area of interest. Most oil and gas production companies contract out nearly all field services for exploration and development activities, including trucking, equipment rental and repairs, site assessment and preparation, electrical service, and waste management, leading to the development of an enormous service industry. Farmington is generally regarded as the regional center for the oil and gas industry in the Four Corners area, but numerous industry contractors are located in Cortez, Ignacio, and Durango as well. Employees for both the production companies and the service companies are drawn from throughout the five counties of interest. According to the La Plata County Energy Association, approximately 200 oil and gas employees lived in La Plata County in 1990. San Juan County, which includes Farmington, had 3,000 persons employed in oil and gas extraction-related trades in 1993 (BEA 1995).

TABLE 3-37
Employment by Sector

	Colorado	La Plata	Ignacio	Montezuma	Archuleta	New Mexico	Rio Arriba	San Juan
Agriculture	46,010	755	164	546	150	20,485	502	747
Mining	20,438	231	23	299	9	15,559	137	3,653
Construction	94,849	1491	129	843	254	46,703	1,418	2,734
Manufacturing	207,423	716	64	380	148	53,164	611	1,389
TCPU	133,341	1069	106	499	114	41,037	800	3,547
Trade Wholesale	70,951	435	37	157	46	20,902	167	1,049

TABLE 3-37
Employment by Sector

	Colorado	La Plata	Ignacio	Montezuma	Archuleta	New Mexico	Rio Arriba	San Juan
Retail	286,630	3128	227	1,654	435	116,210	1,909	6,210
Fire	119,707	830	64	285	212	33,651	379	1,247
Service Business	93,754	591	33	441	59	29,445	552	1,447
Personal	60,624	1258	50	320	239	23,238	530	955
Entertainment	26,562	342	22	73	57	9,155	117	413
Professional	389,799	3864	346	1,653	363	170,481	4,078	7,249
Public Administration	83,193	798	189	537	124	49,242	1,495	1,640

Sources: U.S. Census Data 1990
Note: Oil and gas exploration and production are included in Mining.

TABLE 3-38
Major Employers in La Plata County

Employer	Annual Number Employees	Payroll (MM)
Fort Lewis College[1]	1,116	$18.3
Mercy Medical Center[2]	900	$26.4
Durango 9-R School District	750	$14.4
Southern Ute Indian Tribe[3]	713	NA
Purgatory Resort[4]	693	$4.8

[1] Fort Lewis employs 434 full-time staff and 682 part-time employees. No estimate of full-time equivalent positions is available.
[2] Mercy Medical Center estimates that their 900 employees are the equivalent of 730 full-time employees.
[3] Including Sky Ute Lodge and Casino
[4] Purgatory's workforce is highly seasonal. They have estimated their workforce is the annual equivalent of 220 full time employees.)

Sources: Brister 1997; Chase 1997; Kornelson 1997; Marshall 1977; Sheffield 1997.

Average wages in the oil and gas industry are substantially higher than countywide wages, and a higher percentage of the jobs are full time (Hammer, Siler, George Associates 1990). The average annual wage for oil and gas employees in La Plata County in 1990 was $30,000 to $47,000 (Aalund 1996). In 1995 La Plata County oil and gas workers earned a total of $7.54 million (Job Service Center 1997). Aggregate earnings in oil and gas extraction for San Juan

County in 1993 were $122.9 million (BEA 1995), or approximately $41,000 per employee. By comparison, per capita income in La Plata County was $15,932 in 1995 (Table 3-39).

The major employers in the oil and gas industry in La Plata County are the large producers, including Amoco Production Company and the SUIT's Red Willow Production Company; and the pipeline companies, including Red Cedar, in which the Tribe holds a majority interest, and Williams Field Services. Amoco currently employs approximately 80 people in its district offices (Burgess 1988). Red Cedar (Tsuru 1997) and Williams (Lucero 1998) each employ approximately 40. The Energy Department of the SUIT employs 29 people (Sheffield 1997). These companies employ primarily people with industry-specific technical skills, such as engineers, technicians, compressor mechanics, and office support staff. There are also many firms in La Plata County which provide water hauling and earth moving (drilling pad and access road construction) services. These firms employ primarily truck drivers and heavy equipment operators. They usually fill openings from the existing La Plata County labor force.

TABLE 3-39
Measures of Income

State/County	Per Capita Income ($)		Median Household Income ($)		Persons Below Poverty
	1990	1995	1990	1995	1990
Colorado	14,821	19,347	30,140	38,757	375,214
La Plata	12,163	15,932	25,759	34,137	4,804
Reservation	10,421*	n.a.	24,097*	n.a.	1,407*
Montezuma	10,176	14,477	22,491	30,745	3,735
Archuleta	10,913	23,083	22,894	29,794	903
New Mexico	11,246	12,095	24,087	25,851	285,855
Rio Arriba	7,859	8,935	18,373	20,718	9,372
San Juan	8,911	10,097	22,300	25,723	25,643

Source: CACI Marketing Systems, no date; U.S. Census 1990
*1989 data

The major economic sectors of the Reservation include government, energy development, casino gambling, and agriculture. As shown in Table 3-38, the Tribe is a major employer for La Plata County. Tribal government is the primary employer for Tribal members, directly employing 182 Tribal members and 14 spouses of Tribal members in 1997, as well as 44 other Native Americans and 113 non-Native Americans (Sheffield 1997). Tribal government will probably continue to grow in order to maintain and improve services to Tribal members, assuming that funding is available.

Energy development contributes more than 90 percent of Tribal revenues and provides substantial employment as well. Approximately 30 employees, including 12 Tribal members, currently work in the SUIT Energy Department (Sheffield 1997). Red Cedar Gathering

Company employs 46 people at present, of whom four are Tribal members (Tsuru 1997). Tribal members also are employed by industry service companies.

Tribal casino gaming was introduced on the Reservation in 1993. With an expansion in 1995, the Sky Ute Lodge and Casino now employs approximately 330 people, 16 percent of whom are Tribal members. Through prudent management and a careful development plan, the casino has become a steady source of revenue and employment for the Tribe although the magnitude of its revenues is dwarfed by the energy-related revenues.

According to 1990 BIA estimates, agriculture employs 60 Tribal families, and $1,000,000 worth of crops are produced on the Reservation annually. Moreover, agriculture is a high priority for expansion in Tribal development plans (Keck 1994). The Tribe's Agriculture Division provides subsidized agricultural services by providing machinery that is too expensive for individual Tribal members to afford, such as plowing, discing, and hay cutting, as well as extensive educational services and noxious weed control (Taylor 1997).

In the five-county Study Area, median household and per capita income levels were below the respective state averages in 1990. Within the Reservation, median household income ranged between $21,364 in the Ignacio CCD and $27,600 in the Southwest CCD. By comparison, median household income in the town of Ignacio was $12,847. Similarly, the proportion of the population below the poverty status was higher in the five counties than in the states as a whole. The percentages of persons below poverty status ranged from 15.7 percent in La Plata County to 28.3 percent in San Juan County. Measures of income data are summarized in Table 3-40.

3.10.5 Public Infrastructure and Services

Since the 1970s and the passage of the Indian Self-Determination and Education Assistance Act, the SUIT has greatly increased services provided by the Tribal government. The Tribe provides utilities, social services, health services, education, housing, and road construction. Sanitation services are provided by the Ignacio Sanitation District, and health services are provided by the Indian Health Service clinic in Ignacio. While the Tribe provides Headstart and Preschool programs, most Tribal students in grades K-12 attend the local Ignacio Public School System.

Critical public facility needs on the Reservation include housing, office space, municipal water supply, sewage treatment, health services, and educational facilities. The Tribe contracted the preparation of a comprehensive Overall Economic Development Plan in 1994 (*Walking With Our Vision*) that lays out the Tribe's vision, goals, and facility development requirements for the coming decade. At that time, capital costs were projected at more than $23 million (Keck 1994). The recommended projects and programs look at both remedying existing shortfalls in infrastructure adequacy and developing new capacity to attract investments to the Reservation.

Construction projects in 1997 included refurbishing the building that houses the Natural Resources and Energy departments and updating wastewater facilities on the Reservation. The

Tribe broke ground for a new Justice Center in November 1997 and is currently working on plans to build a new recreation center.

Public facilities and services that are most sensitive to population growth are roads and bridges, law enforcement, administrative services, social services, public education, and water and wastewater services. Of these, La Plata County provides non-Tribal services in unincorporated areas with the exception of education, water, and wastewater. Local school districts provide education services, and water and wastewater are provided by local water conservancy and sanitation districts.

3.10.6 Local Government and Tribal Finances

The sources and uses of local public sector and Tribal finances are described in this section. Revenues from oil and gas development, which flow from a number of sources, are of particular interest. The major oil and gas related revenue sources for state and local governments within the area of interest include the following:

- *Ad valorem* property taxes accruing to counties and school districts on facilities and production in each jurisdiction;

- Colorado severance taxes, a portion of which are returned to the counties and municipalities through energy impact assessment grants based on the residence of project-related employees;

- Federal mineral royalties, a portion of which is returned to the counties for schools and roads in the counties where they are earned; and

- Colorado sales and use taxes and local sales taxes accrued to counties and municipalities.

Revenues from *ad valorem* property and mineral severance taxes and royalties apply only to jurisdictions in Colorado since they relate to the location of development. Sales taxes apply to the entire area of influence since they accrue to the jurisdiction in which employees reside or purchases are made. Other state and local government revenue sources include the gross ton-mile, motor fuel, vehicle registration taxes, and miscellaneous fees paid by project-related contractors and vendors, and state corporate and personal income taxes.

The SUIT is nationally known as a prudently managed Indian tribe. Since 1980, the Tribe has implemented an aggressive program to manage its resources, particularly energy, in the manner most beneficial to its long-term financial goals. The Tribe employs nearly 30 people in its Energy Department, many of whom are professionals with substantial industry experience (Zahradnik 1997).

The SUIT government finances most of its activities (e.g., administration, maintenance of Tribal buildings and grounds, Tribal police and court, cultural programs, vocational training, and resource management programs) through the Tribe's General Fund. For the last five years, over 90 percent of revenues for the General Fund have come from oil and gas production. The largest revenue streams are natural gas royalties and production payments. Less significant oil and gas related revenue streams include various permit fees, penalties and interest, and fees for surface leasing and damage. The remaining 10 percent of the General Fund revenues comes primarily from Tribal services, non-oil and gas related leases and fees, and interest (confidential Tribal Budget Reports 1994-1996, Larry Beck, SUIT Controller).

In addition to the General Fund, the Tribe manages numerous other special purpose funds. The Tribe's severance tax revenues and revenues from sale of tax credits on unconventional gas production are collected in two separate funds and disbursed for specific purposes. Many other funds are associated with Tribal business enterprises such as the Sky Ute Lodge and Casino. The casino creates enough net income to contribute to funding other Tribal programs, but most of the other enterprises do not at present. Finally, the Tribe manages funds for specific benefit programs such as the Tribal Life Insurance Fund, which generally recognizes revenues only from interest and transfers from other funds.

3.10.6.1 Local Government Finances

The three Colorado counties included in the area of influence appear to have robust budgets, reflected in the fact that they are able not only to maintain strong levels of general government functions but also to support various capital spending projects and to meet debt service obligations. This conclusion is based on a review of their fiscal 1994 sources and uses of funds for general government activities, as published by the Colorado Department of Local Affairs, Division of Local Government. (BLM) Revenue sources are summarized in Table 3-40, and expenditures of the three counties for FY 1994 are summarized in Table 3-41.

Oil and gas development contributes to county, city, school and special district revenues primarily through the *ad valorem* property tax on oil and gas production and field equipment. These taxes are levied on the assessed value of gas and oil produced in the preceding year, the treatment and transmission facilities located within the county, and personal property tied to the production of gas.

TABLE 3-40
FY 1994 Revenue Sources
La Plata, Archuleta, and Montezuma Counties*

Revenue Source	La Plata (pop. 36,985)	Archuleta (pop. 6,501)	Montezuma (pop. 21,104)
Taxes	$11,639,680	$3,199,949	$3,519,631
Licenses and Permits	626,979	107,091	63,742
Intergovernmental Revenues	5,684,825	1,801,628	5,272,420
Charges for Services	1,905,258	385,272	1,412,654
Fines and Forfeits	88,734	6,166	14,154
Miscellaneous Other Revenues	1,289,207	325,641	421,787
Total Revenues	$21,234,683	$5,825,747	$10,704,388

Source: McGrane 1996
*County government only. School and other special districts are separately funded.

TABLE 3-41
FY 1994 Expenditures
La Plata, Archuleta, And Montezuma Counties*

Expenditure	La Plata (pop. 36,985)	Archuleta (pop. 6,501)	Montezuma (pop. 21,104)
General Government	$3,358,668	$1,302,564	$1,876,647
Judicial	364,815	55,821	243,971
Public Safety	3,343,903	875,175	1,419,714
Public Works	2,527,867	1,380,020	2,268,755
Health	312,632	102,874	76,149
Culture and Recreational	582,510	124,944	117,018
Social Services	2,925,768	666,864	2,629,976
Miscellaneous Other Expenditures	493,601	52,733	182,570
Total Operating Expenditures	13,909,764	4,560,995	9,514,800
Transfers to Other Governments	404,600	20,000	85,966
Capital Outlays	3,993,473	401,682	892,898
Debt Service (principle + interest)	698,401	361,313	8,000
Total Expenditures	$19,006,238	$5,343,990	$10,501,664

Source: McGrane 1996
*County government only. School and other special districts are separately funded.

Table 3-42 indicates 1995 assessed values of total real and personal property and of oil and gas property, and 1994 property tax collections in Archuleta, La Plata, and Montezuma counties. Oil and gas assessed value represents 1.2 percent of total assessed valuation in Archuleta County, 40 percent in La Plata County, and 28 percent in Montezuma County.

TABLE 3-42
Assessed Values And Property Taxes
Archuleta, La Plata, and Montezuma Counties

County	Total Assessed Value 1995	Oil and Gas Assessed Value 1995	General Property Taxes 1994*
Archuleta	$86,363,083	$1,036,392	$3,199,949
La Plata	$752,063,090	$302,840,090	$11,639,680
Montezuma	$160,333,862	$45,131,190	$3,519,631

*County governments only; school and other special districts separately funded.
Sources: DOLA 1996; Jelinek 1996; La Plata County Assessor's Office 1996; McGrane 1996; Newman 1996.

For the past four years, oil and gas related properties have made up over 30 percent of the taxable assessed property in La Plata County (Figure 3-4). Figure 3-5 shows that gas, primarily CBM production and equipment (personal property), contributes 99 percent of the assessed value each year whereas oil production is insignificant to property tax assessments (La Plata County 1985 to 1996). A similar breakdown of values for 1997 and 1998 was not available, although oil production still accounted for less than 1 percent of county oil and gas production in those years. Although the actual drilling of CBM wells peaked in 1990 because of the time limit on qualifying wells for tax credits, the assessed values of gas properties continued to grow into the late 1990s as production was established. Because of both high gas prices and high production volumes in 1997, the assessed value of gas property in La Plata County may peak in 1998.

In the past six years, school districts within La Plata County have received approximately 70 percent of total property taxes collected in the county (Figure 3-6). La Plata County retains for its own budget 10 percent to 15 percent of the property taxes it collects (La Plata County 1986 to 1996). Special districts, primarily fire protection and sewage districts, receive allotments from property tax collections based on their own mill levies and on assessments within each special district. However, most oil and gas production in La Plata County is located in unincorporated areas and does not contribute to any special taxing district (1996 Abstract of Assessments, La Plata County Assessor Craig Larson).

FIGURE 3-4
Assessed Values of Taxable and Exempt Property in La Plata County
8 ½ x 11

FIGURE 3-5
Assessed Values of Oil and Gas Property in La
Plata County
8 ½ x 11

FIGURE 3-6
Distribution of Property Tax Collected
8 ½ x 11

School districts throughout Colorado are buffered from swings in property tax collections by the Colorado School Finance Act. This legislation guarantees school districts a minimum budget per student each year through equalization payments from the state education budget, taking into account primarily property tax collections and the number of "at risk" students in each district. Equalization does not have a specific source of revenues; it is funded as part of each year's total state education budget (Pendley 1997).

Funding for the Durango 9-R school district, the largest school district in La Plata County, is shown on Figure 3-7. Property taxes contribute the greatest amount of school budget funds, approximately 70 percent. For 1997-98 school year, the Durango 9-R school district received equalization payments from the state of $6.284 million, or approximately $1,331 per student. For comparison, equalization payments range from less than $75 per student (Aspen, Vail) to nearly $10,000 per student (Silverton) (Pendley 1997).

Although La Plata County retains a relatively small portion of the property taxes it collects, those taxes are significant to the county budget. In the last six years, property taxes have made up 15 to 20 percent (La Plata County 1986 to 1996) of the county budget. State law prevents large increases in property tax collections by controlling mill levies, so the county has struggled to keep services in line with recent growth. Unlike the school districts, the county has no back up source for its budget funds. As shown on Figure 3-8, La Plata County has depended on gains in all its revenue stream except the highway users tax to support the 50 percent increase in budget between 1992 and 1997. As noted previously, La Plata County is projected to grow faster than the state as a whole in the next few years, so services will need to be added rather than decreased.

Severance taxes administered by the Colorado Department of Local Affairs are another source of state and local revenue. Severance taxes are assessed at 2 percent of gross income, but because producers are allowed to credit property tax payments against their severance tax obligations, revenues usually accrue only during periods of growth in production. Severance tax is not assessed on working interest owned by the SUIT, but is assessed on other properties within the exterior boundaries of the Reservation. Counties and municipalities receive 7.5 percent of severance tax revenues based on the number of employees involved in oil and gas production residing within their jurisdiction. A typical payment for oil and gas employees is $1,000 per employee. Local jurisdictions also may receive energy impact assistance grants that are partially funded by severance tax monies. In recent years, La Plata County has used severance tax distributions and grants for projects as diverse as new baseball fields, science technology projects, and upgrading of wastewater facilities.

Table 3-43 illustrates 1995 county and local receipts for severance tax distributions and energy impact assistance grants and payments based on employment.

FIGURE 3-7
Funding for Durango 9-r School District
8 ½ x 11

FIGURE 3-8
La Plata County Budget Revenue Sources
8 ½ x 11 Black & White

TABLE 3-43
Severance Tax And Energy Impact Assistance Grant Disbursements, 1995

Jurisdiction	Severance Tax Direct Distribution, 1995*	Energy Impact Assistance Grants, 1995**
La Plata County	$35,167	$407,474
Bayfield	$ 9,608	--
Durango	$16,133	--
Ignacio	$ 1,373	--
Montezuma County	$ 5,546	$100,000
Cortez	$19,455	--
Dolores	$ 1,373	--
Mancos	$ 2,324	--
Archuleta County	0.00	$97,500

Sources: Colby 1996
* Disbursements are based on employees and contractors declared by the producer for oil, gas, and coal development in each jurisdiction. Figures for Montezuma County include CO_2 production; figures for La Plata County include coal production.
** Totals for both county and local community projects.

The COGCC also receives funding for its administration from a conservation levy based on the value of production. This levy is currently 0.15 percent of total sales; an additional 0.02 percent assessment is made for the environmental response fund for remediation of abandoned wells (Tansey 1996).

Production from some CBM wells generates federal investment tax credits under the Crude Oil Windfall Profits Act of 1980 as codified in section 29 of the Internal Revenue Service Code of 1986 (26 U.S.C.), as amended. The exact amount of the credit is calculated using a statutory formula that considers the energy content of the product produced, a statutory tax credit, and an inflation adjustment factor. In 1998, the credit was $1.055 per million BTUs produced. The window for drilling new wells that qualify for the section 29 tax credit closed on December 31, 1992. The period in which section 29 credits may be taken on production will expire on December 31, 2002.

Among the federal sources, the Minerals Management Service (MMS) of the U.S. Department of Interior disburses portions of lease fees, bonuses, and royalties paid for production of minerals on public lands. According to MMS data, in fiscal year 1995, $72.09 million was collected for leases on federal lands in Colorado, of which $35.58 million was disbursed to state, county, and local governments and agencies (MMS 1996a). Disbursements to the Study Area county governments, school districts, and other agencies amounted to $30,943 to Archuleta County,

$845,542 to La Plata County, and $4,523,757 to Montezuma County (MMS 1996b). Montezuma County produces large amounts of carbon dioxide gas from leases on federal lands, which explains the large size of the royalty disbursement to that county. A large portion of the MMS disbursements go to local school districts.

The MMS also collects royalties from energy producers operating on Tribal lands. Tribes in Colorado are served by the MMS through the BIA, and in fiscal year 1995 a total of $15.89 million in royalties, rents, and other revenues on coal, gas, and other mineral production was collected from Tribal land leases (MMS 1996b). Data did not indicate how much of these Tribal land royalties was disbursed back among the various Colorado Tribes.

Separately, the MMS has "Cooperative Audit Agreements" with the Southern Ute and Ute Mountain Ute tribes that guide auditing of producers' royalty payment compliance. In fiscal year (FY) 1995, the SUIT received an additional $1.14 million in royalties due to the audits resolving discrepancies in royalty payments (MMS 1996a).

Sales tax revenues accrue to the state as well as to the county and municipal governments that assess local sales taxes. In Colorado, the state sales tax is 3 percent. A service fee, also known as vendor's fee, of 3-1/3 percent is allowed, and many counties and municipalities impose it as well. Table 3-44 shows the sales tax revenues generated by retail sales in FY 1994 in the Study Area Colorado counties.

TABLE 3-44
FY 1994 Retail Sales and Sales Tax Revenues
Archuleta, La Plata, and Montezuma Counties

	Archuleta	La Plata	Montezuma
Retail Sales ('000s)	$76,337	$640,261	$285,681
State Sales Tax Paid ('000s)	$1,491	$11,321	$4,622
Local Sales Tax Rate	$0.040	$0.020	$0.000

Source: McGrane 1996

In New Mexico the sales tax (called the Gross Receipts Tax) varies among counties and cities. In Farmington (San Juan County) it amounts to 5.8125 percent (it is slightly higher in Bloomfield and Aztec), while in the remainder of the county it is 5.625 percent (Clifford 1996). None of the Study Area counties have a local use tax, meaning that they do not receive revenues for purchases made outside the county.

3.10.6.2 Tribal Finances

Since 1980, the SUIT has implemented an aggressive program to manage its resources, primarily energy resources, in the manner most beneficial to the long-term financial goals of the Tribe. In recent years the Tribe's income, primarily from oil and gas related revenues, has financed a tripling of Tribal government programs, supported the start up of several new business enterprises, built a substantial Capital Reserve Fund, and still produced an annual budget surplus sufficient to make per capita payments to Tribal members. Grants and contracts, primarily funded through various agencies of the federal government, are decreasing in both absolute dollars and importance, although they remain substantial. The Tribal government manages its programs through funds administered by the Tribal Council. The General Fund is the source of funding for Tribal administration and for numerous benefit and cultural programs from Tribal police to home health care. A number of long-term benefit programs and all the business enterprises are managed through individual funds, such as the Elders Per Capita (pension) Fund and the Lake Capote (recreational enterprise) Fund. The Severance Tax Fund, Section 29 Tax Credits Fund, and Capital Reserve Fund are used to gather and distribute funds for qualifying new programs and for large capital expenditures.

In 1999, the SUIT is restructuring its financial plan to more clearly support the Tribe's Long Term Financial Plan. The SUIT recognizes that their current level of energy revenues based on production within the Reservation boundaries will inevitably decrease in the near future with depletion of the reservoirs. The Long Term Financial Plan aims at establishing a sound financial base for the Tribe in the future by managing spending and investing in a balance of conservative and growth oriented opportunities. The details of this plan have not been released to the public although the overall structure of the plan has been presented to the Tribal members.

General Fund

Most of the Tribal government's programs are budgeted through the General Fund. Table 3-45 shows the major categories of spending from the Tribe's General Fund (net of per capita payments) over the past five years and the approximate average spending in each category during that period. Tribal administration historically has taken the largest portion of the General Fund budget. Management of resources, including oil and gas, forests, air, water, and wildlife, has been the second largest budget group. Other programs funded involve health and welfare, justice and public safety, culture and education, and development of employment skills and opportunities. In the last five years, transfers from the General Fund to the Capital Reserve Fund have been made to capture funds for future capital replacement projects and for new capital expenditures such as buildings. Transfers from the General Fund also have been made to enterprises and to funds that provide specific benefits, such as the Scholarship Fund.

TABLE 3-45 SUIT Five-Year Average General Fund Budget	
	Percent of Five-Year Average
Transfer to Capital Reserve	22%
Administration	20%
Natural Resources	12%
New Ventures and Employment	11%
Construction and Maintenance	10%
Health and Welfare	6%
Energy Resources	6%
Justice and Safety	5%
Culture	4%
Education	4%
Total	100%
Source: SUIT Tribal Budget Reports 1993-1996	

General Fund Revenues

Figure 3-9 illustrates sources of revenues to the General Fund. Since 1992, over 90 percent of revenues for the SUIT General Fund have come from oil and gas production. The General Fund budget has more than doubled in magnitude since 1992 entirely due to increases in oil and gas related revenues. Interest revenue has also been growing because the Tribe has invested General Fund revenues against future needs. Services, sales, and use charges have almost tripled since 1992, but remain a small portion of General Fund revenues due to the overall growth of the General Fund. Other revenues have declined through time in both dollar and percentage terms. Table 3-46 illustrates the various revenue streams within the oil and gas revenue segment of the General Fund. In 1997 and 1998, royalties and production payments contributed over 90 percent of total oil and gas revenues allocated to the General Fund. Various fees, penalties, and interest made up the balance. Royalties and production revenues are directly related to volumes produced and to prices, so the amount of oil and gas revenue available to the Tribe each year is essentially controlled by volumes produced and prices. FY 1997 posted relatively high average prices as well as high volumes. FY 1998 posted record high volumes and moderate prices.

TABLE 3-46
Percent Contribution to the Oil and Gas Revenue Segment of the SUIT General Fund (FY 1997)

Sources	Contribution
Royalties + Production Payments	91.44%
Surface Lease Fees	2.79%
Severance Tax Administration Fee	1.99%
Sale of Tax Credits/Section 29 Revenues	0.74%
Interest - Red Willow Production Company	0.70%
Rights of Way Renewals	0.62%
Advance Rentals	0.50%
Pipeline Rights-of-way	0.50%
Disputed CBM Overrides	0.30%
Water Disposal Fees	0.22%
Surface Damages	0.10%
Royalty Penalties	0.05%
Lease Bonuses	0.02%
Administrative Fees	0.02%
Archeological Fees	<0.01%
Survey Fees	<0.01%
Total Energy Contribution	100.0%

Source: SUIT 1997

General Fund Expenditures

As previously mentioned, the Tribe provides services to Tribal members in critical areas such as utilities, law and order, education, health, social services, and construction. It provides complete funding for many cultural and recreational programs that are important to maintaining the cultural heritage and community spirit of the Tribe. In the past decade, Tribal government has been investing heavily in business enterprises, such as the Sky Ute Lodge and Casino, attempting to build and diversify the Reservation's economy.

FIGURE 3-9
SUIT General Fund Revenue Sources
8 ½ 11 B&W

The major categories of programs supported through the General Fund in the past six years are illustrated on Figure 3-10. During that time period, the Tribe's revenues from oil and gas increased dramatically, and the General Fund budget more than doubled. Numerous programs were added, and the dollars allocated to existing programs were generally increased each year. Administration and maintenance shrank as a portion of the budget. Programs that remained relatively constant as a percentage of the General Fund Budget, such as culture and education, actually enjoyed healthy increases in funding due to the overall growth of the budget. Transfers to the Capital Reserve Fund more than quadrupled, thus starting to build a significant resource for the Tribe's future fiscal health.

Figure 3-11 shows the relative magnitude of the major categories of expense types within the General Fund budget for the last five fiscal years. Personnel expenses historically have been the largest category although their percentage share of the total budget has decreased. The Tribe currently employs 353 persons, 226 of whom are Native Americans, in administration and programs funded through the General Fund (Sheffield 1997). Transfers of money to other Tribal funds have grown from being a relatively small portion of the General Fund to being the second largest category of expenditures because oil and gas revenues have outpaced annual operating expenses. Contractual work, which includes primarily on-going service providers such as contract labor, auditors, and archeologists, has decreased as a percentage of the General Fund. The supplies and maintenance category has increased with growth in spending on construction and maintenance. Travel expenses have risen in dollar terms proportionally to increases in total personnel but have decreased as a percent of the General Fund. Subsidies have declined in both dollar and percentage terms.

<u>Severance Tax Fund</u>

Severance Tax Fund Revenues

The SUIT levies a 6.5 percent severance tax, imposed in 1989 by Tribal Resolution, on production from Tribal interest lands. The tax is calculated on a revenue basis, so the Tribe's collections are directly proportional to gas prices and volumes produced. Volumes attributed to the royalty interest of the Tribe and volumes used on the lease for benefit of leased Tribal lands are exempt from the tax. Interest and civil penalties are imposed on delinquent payments.

Severance Tax Fund Spending

Revenues from the Tribal Severance Tax are held in a separate fund and spent on projects that qualify for Severance Tax Funds according the Tribe's 1989 Severance Tax Ordinance. The ordinance specifies " …the proceeds in the Oil and Gas Severance Tax Fund may be expended for the general welfare of the Tribe, including, but not limited to: the acquisition of or replacement of oil and gas reserves; funding of Tribal governmental operations made necessary by the depletion of existing oil and gas reserves and by declines in oil and gas revenue; the

FIGURE 3-10
General Fund Budgets as a Percent of the 1992 General Fund Budget
8 ½ x 11 B&W

FIGURE 3-11
SUIT General Fund: Budgeted Expenses
8 ½ x 11 B&W

creation of new Tribal governmental services; the improvement of governmental services beneficial to Tribal members and severance taxpayers; the promotion of economic development of the Tribe and its members; the mitigation of impacts from Reservation natural resource development; and the preservation of public health and safety;…."

Examples of projects that have been funded recently are the Tribal Life Insurance Fund, Scholarship Fund for college and graduate education of Tribal members, construction and building repair projects such as the new Justice Center and the wastewater treatment plant, a loan to the Red Cedar Gathering Company (in which the Tribe holds 51 percent interest), and the Tribal Elders Per Capita Fund (pension fund). The Severance Tax Ordinance also specifies "that in no event shall the monies collected pursuant to the severance tax be distributed per capita to members of the Tribe." (SUIT 1989)

Section 29 Tax Credits Fund

In 1995, the Tribe monetized a majority of its nonconventional fuel tax credits on royalty production volumes from wells that qualify under the 1980 Crude Oil Windfall Profits Tax Act as codified in Internal Revenue Code Section 29. The Tribe's revenues from the monetization of tax credits are based on royalty volumes and a unit value as defined in the act. A separate fund was established to manage these revenues.

Enterprise Funds

Revenues and expenses from Tribal enterprises, such as the Sky Ute Lodge and Casino, Lake Capote Park, and Red Willow Production Company, are managed via individual enterprise funds. The enterprises initially were capitalized by transfers from the Capital Reserve Fund, Severance Tax Fund, 1982 Southern Ute Water Rights Settlement Fund, or General Fund. Some are now self-sustaining. Net income from Red Willow Production Company is being reinvested to expand the company as designed in its business plan. The Sky Ute Lodge and Casino consistently makes enough net income to contribute significantly to funding other programs in Tribal government.

Tribal Benefit Funds

The Tribe has a small set of funds associated with specific Tribal benefit programs, such as the Elders Per Capita Fund and Scholarship Fund. These funds recognize little or no revenue other than interest and transfers from other funds, including the Severance Tax Fund. Expenditures from these funds must be associated with their specific benefit programs.

Grants and Contracts

In addition to revenues from Tribal businesses and programs, the SUIT currently manages funding from 61 contracts and numerous grants to support specific programs, primarily in health care, law enforcement and justice, construction, and environmental protection. The Tribe also manages contracts and grants for various community and cultural projects, such as Headstart and the Senior Citizens Center, through the Southern Ute Community Action Program. Most of the grants and contracts are funded by the federal government through agencies including Housing and Urban Development, the EPA, and the BIA. The BIA alone accounted for over $4 million of contracts for FY 1997. However, all recurring BIA contracts have shown decreases in funding since 1995, and the decreases are expected to continue with the progress of initiatives to balance the federal budget. Table 3-47 shows the distribution of 1997 federal contract funds by service category. The importance of grants and contracts to the Tribe has diminished in the last 10 years as increases in oil and gas revenues have allowed Tribal government to fund more programs on its own (Candelaria 1997).

TABLE 3-47
Federally Funded Contracts, 1997

Contract Service Area	Current Contract Funds
Education	1.6%
Health and Welfare	13.4%
Environmental	5.4%
Physical Infrastructure	2.4%
Jobs and Employment	53.8%
Justice and Law Enforcement	23.4%
Total	100.0%

Source: Candelaria 1997

3.11 NOISE

3.11.1 Introduction

Noise is generally defined as unwanted or annoying sound that is typically associated with human activity and that interferes with or disrupts normal activities. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principle human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, perceived importance of the noise and its appropriateness in the setting, time of day and type of activity during which the noise occurs, and sensitivity of the individual.

Decibels (dB) are the units of measure used to represent sound pressure levels, and dBA is the unit of measure of sound pressure levels using the A-weighting network. The A-weighting network was designed to simulate human hearing because the human ear does not perceive sounds at low frequencies in the same manner as those at higher frequencies. The A-weighting network de-emphasizes lower frequency sounds to simulate response of the human ear. Table 3-48 depicts the A-weighted values of sound levels for typical noise sources.

Although the A-weighted sound level may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a conglomeration of noise from distant sources that create a relatively steady background noise in which no particular source is identifiable. A single descriptor called the equivalent sound level (L_{eq}) is used and is the 'equivalent' constant sound level that would have to be produced by a given source to equal the fluctuating level measured. Furthermore, the day-night sound level (Ldn) is a logarithmic average of daytime and nighttime sound levels and represents a weighted 24-hour average sound level. Due to the increased sensitivity to noise during the quiet nighttime hours (10:00 p.m. - 7 a.m.), a 10 dB penalty is applied to the nighttime sound levels to calculate the Ldn.

3.11.2 Existing Noise Environment

The background noise level depends on population density and proximity to existing industrial and agricultural/ranching activities. Land uses within the Study Area vary from sparsely populated rural areas to small Tribal communities and towns. Commercial, recreational, and agricultural land uses are present within the Study Area. Baseline noise levels in the Study Area are expected to range from those found in quiet rural settings to those normally associated with noisy urban environments (approximately 50 to 70 dBA). The average Ldn in downtown Ignacio was found to be approximately 62 dBA, based on noise monitoring.

Oil and gas development already has occurred in many locations within the Study Area. Major noise sources associated with oil and gas development are well drilling and compressor station operation. Based on noise monitoring conducted for the San Juan Basin Coal Degas Project, the Ldn within 500 feet of oil and gas activities was found to range from approximately 50 to 70 dBA. Sound levels from gas compressor facility operation may be as high as 89 dBA at 50 feet from the source.

TABLE 3-48
Sound Levels* of Typical Noise Sources and Noise Environments
(A-weighted Sound Levels)

Noise Source (at a Given Distance)	**Scale of A-Weighted Sound Level (dBA)**	**Noise Environment**	**Human Judgment of Noise Loudness (relative to a reference loudness of 70 dB*)**
Military jet take-off with after-burner (50 feet) Civil defense siren (100 feet)	140 130	Carrier flight deck	
Commercial jet take-off (200 feet)	120		Threshold of Pain *32 times as loud
Pile driver (50 feet)	110	Rock music concert	*16 times as loud
Ambulance siren (100 feet) Newspaper press (5 feet) Power lawn mower (3 feet)	100		Very Loud *8 times as loud
Motorcycle (25 ft) Propeller plane flyover (1,000 feet) Diesel truck, 40 mph (50 feet)	90	Boiler room Printing press plant	*4 times as loud
Garbage disposal (3 feet)	80	High urban ambient sound	*2 times as loud
Passenger car, 65 mph (25 feet) Living room stereo (15 feet) Vacuum cleaner (3 feet) Electronic typewriter (10 feet)	70		**Moderately Loud** ***70 decibels** **(Reference loudness)**
Normal conversation (5 feet) Air conditioning unit (100 feet)	60	Data processing center Department store	*1/2 as loud
Light traffic (100 feet)	50	Private business office	*1/4 as loud
Bird calls (distant)	40	Lower limit of urban ambient sound	Quiet *1/8 as loud
Soft whisper (5 feet)	30	Quiet bedroom	
	20	Recording studio	Just Audible
	10 0		Threshold of Hearing

*These values are logarithmic measurements (i.e., every 10-dBA increase is perceived by the human ear as approximately twice the previous noise level; therefore, the pile driver is twice as loud as the ambulence siren).
Source: Compiled from various sources.

The ambient noise contribution from the existing oil and gas development is site-specific, and intervening topography, vegetation, and meteorological conditions affect the actual noise contribution from a given site. Sound levels of unenclosed equipment and operations generally would be expected to attenuate at a rate of approximately 6 dBA per doubling distance from the source (Engineering Dynamics 1998).

On private lands within the Study Area, noise monitoring conducted by the COGCC in 1997 indicates that noise levels above 50 dBA have been experienced in the vicinity of several compressor stations (COGCC, 1998). Mitigation procedures to reduce these noise levels to 50 dBA (during night time hours) are being implemented. In cases where the noise source is located on Tribal lands, implementation of the mitigation process is the responsibility of the SUIT.

3.11.3 Applicable Criteria

There are no Tribal, BLM, or BIA noise guidelines or standards. In the absence of standards, the Tribe and federal government have assessed noise impacts on a case-by-case basis. When a concern with noise has been identified on the Reservation, the Tribe reviews the situation and determines the need for mitigation measures. To date, this approach and the use of mitigation have resolved noise issues satisfactorily.

For activities occurring on private lands within the Reservation, noise compatibility guidelines have been developed for various land uses by the State of Colorado. The COGCC utilizes the State of Colorado noise guidelines for monitoring oil and gas programs. According to COGCC noise monitoring procedures, sound levels radiating from an oil and gas related noise source should not exceed the appropriate noise levels for the predominant land use in a zone (as identified in Table 3-49) at a location either 25 feet beyond the property line or at a residential home.

TABLE 3-49
State of Colorado Noise Guidelines

Zone	Noise Level (dBA)	
	7:00 a.m. to 7:00 p.m.	7:00 p.m. to 7:00 a.m.
Residential	55	50
Commercial	60	55
Light Industrial	70	65
Industrial	80	75

Exceptions to these guidelines include temporary oil and gas operations, such as well drilling, completion, stimulation, and workover, as well as pipeline and road installation and maintenance. These oil and gas operations are subject to the maximum permissible noise levels for industrial zones.

3.12 HEALTH AND SAFETY

3.12.1 Introduction

Health and safety issues pertaining to the development of oil and gas resources within the Study Area are related to the following:

- worker-related occupational risks and safety associated with oil and gas industry construction and operation practices and processes;
- public health and safety associated with oil and gas industry construction and operation practices and processes;
- generation, handling, storage, and disposal of both nonhazardous and hazardous wastes and materials;
- spills of wastes, chemicals, or associated condensate;
- potential of pipeline rupture;
- seeps of methane gas and associated hydrogen sulfide gas; and
- coal outcrop fires.

3.12.2 Worker-Related Risks

During 1992, 12,100 work days were lost in the oil and gas extraction industry (U.S. Department of Labor 1994). Of this total 2,600 days were lost in the area of crude petroleum and natural gas production; the remaining 9,500 lost workdays occurred in the oil and gas field services area. Occupational risks associated with the oil and gas production industry are typically limited to oil and gas company employees and subcontractors and do not affect the public, except where wells, production equipment, or pipelines are in proximity to populated areas.

3.12.3 Public Health Risks

Risks to the public associated with the construction and production of oil and gas extraction wells and associated facilities include wildfire; increased traffic on public roads; natural gas flow line leakage, rupture, and fire and explosion; spills of condensate or produced water; and potential air emission exposure. Potential exposure and safeguards to these risks are discussed below; however, air emissions are discussed in Section 3.2.

3.12.4 Hazardous and Non-hazardous Materials and Wastes

Most wastes generated at oil and gas production facilities are exempt from regulation under the Resource Conservation and Recovery Act (RCRA) under the exploration and production exemption (Table 3-50). Exploration and production wastes include produced water, oilfield production fluids (including drilling muds and frac flowback), crude oil and condensate, and contaminated soils. Produced water, drilling muds, and frac fluids are generally authorized for disposal by underground injection in Class II Underground Injection Control wells under regulations of the EPA. Small uneconomical quantities of crude oil and/or condensate, when wasted, are typically collected and sold to a waste oil recycler. Soils contaminated with exploration and production wastes can be disposed in a Subtitle D (nonhazardous) landfill or may be treated onsite with the approval of the appropriate regulatory authority and surface lessee.

Appendix P provides a description of potentially hazardous materials that could be used or produced during the project. They may come from drilling materials, casing and plugging materials, fracturing materials, production products, fuels, geophysical survey materials, pipeline materials emissions, and miscellaneous materials. Where possible, the quantities of these products or materials have been estimated on a per-well basis.

TABLE 3-50
Oil and Gas Wastes

RCRA Exempt Wastes	RCRA Nonexempt Wastes
Produced water	Constituents removed from produced water before it is injected or otherwise disposed
Drilling fluids	Liquid hydrocarbons removed from production stream but not from oil refining
Drill cuttings	Gases from the production stream (such as hydrogen sulfide, carbon dioxide, and volatilized hydrocarbons)
Rig wash	Materials ejected from producing well during blowdown
Well completion, treatment and stimulation fluids	Waste crude oil from primary field operations and production
Basic sediment, water, and other tank bottoms from storage facilities that hold product and exempt waste	Light organic fractions volatilized from exempt wastes in reserve pits, impoundments, or production equipment
Hydrocarbons, solids, sand, and emulsion accumulated from production separators, fluid treating vessels, and production impoundments	Oil and gas service company wastes (such as empty drums, drum rinsate, vacuum truck rinsate, sandblast media, painting waste, spent solvents, spilled chemicals, and waste acids)
Pit sludges and contaminated bottoms from storage or disposal of exempt wastes	Gas plant cooling tower cleaning wastes
Workover wastes	Painting wastes

TABLE 3-50
Oil and Gas Wastes

RCRA Exempt Wastes	RCRA Nonexempt Wastes
Gas plant dehydration wastes	Unused fracturing fluids or acids
Gas plant sweetening wastes for sulfur removal	Rinsate from vacuum trucks and drums transporting or containing nonexempt waste
Cooling tower blowdown	Refinery wastes
Spent filters, filter media and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream)	Liquid and solid wastes generated by crude oil and tank bottom reclaimers
Packing fluids	Used equipment lubrication oils
Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation	Waste compressor oil, filters, and blowdowns
Hydrocarbon bearing soils	Waste solvents
Pigging wastes from gathering lines	Waste in transportation pipeline-related pits
Wastes from subsurface gas storage and retrieval	Caustic or acid cleaners
	Laboratory wastes
	Sanitary wastes
	Pesticide wastes
	Radioactive tracer waste
	Drums, insulation, and miscellaneous solids
	Any waste not otherwise exempted

Wastes generated from the wellhead through the production stream to and through the gas plant are exempt from regulation as a hazardous waste under RCRA. The exemption does not apply to natural gas as it leaves the gas plant for transportation to market. The disposal of exempt waste is subject to the applicable solid waste laws. As the SUIT does not have a delegated program, the EPA has primacy over solid waste.

Several materials associated with well construction and production activities are classified as hazardous. EPA has jurisdiction of all nonexempt hazardous wastes generated, treated, stored, or disposed on the Reservation. None of the commonly used materials listed in Table 3-51 are classified as acutely hazardous, which would entail more stringent controls.

TABLE 3-51
Hazardous Materials Associated with Oil and Gas Development

Material	General Use	Project Phase Used in		
		Construction	Production	Abandonment
Gasoline	Vehicle fuel	X	X	X
Diesel fuel	Vehicle and equipment fuel	X	X	X
Motor oil	Vehicle lubricant	X	X	X
Greases/lubricants	Vehicle or equipment lubricant	X	X	X
Solvents	Equipment cleaning/degreasing	X	X	
Heat transfer fluids (glycols)	Residual water removal		X	
Flocculants	Filtration control	X		
Lost circulation material	Controlling drilling circulation	X		
Sodium hydroxide	pH control of drilling mud	X	X	
Buffers	pH control during completion	X	X	
Acids	Well stimulation	X	X	
Surfactants	Gas processing (CO_2 removal)		X	
Paint	Equipment painting	X	X	
Cement additives (accelerators and weight modification)	Cement casings and reworking within the well bore and abandonment	X	X	X
Sand	Fracture propulant in hydrofracing	X	X	
Inert gas	Well stimulation	X	X	
Welding and cutting material	Equipment welding and cutting	X	X	X
Fertilizers	Reclamation	X	X	X
Herbicides	Reclamation weed control	X	X	X
Refrigerant/cooling media (chlorodifluoromethane/R-22)	Nitrogen generation during ECBM		X	

The transportation of hazardous materials is regulated by the Department of Transportation (DOT) under CFR Parts 171-180. These regulations pertain to the packing, container handling, labeling, vehicle placarding, and other safety aspects.

Notifying governmental agencies when significant amounts of chemicals are stored onsite is a requirement of the Emergency Planning and Community Right-to-Know Act of 1986 known as Title III of the Superfund Amendments and Reauthorization Action (SARA) under 40 CFR Parts 355, 370, and 372. One of the key requirements is the reporting of information pertaining to the chemicals stored in threshold amounts associated with a facility and/or operation. For most chemicals, anything in excess of 10,000 pounds must be reported. For those chemicals listed as extremely hazardous substances or acutely hazardous, the threshold varies by chemical. Some of the chemicals or materials listed in Table 3-52 are categorized as extremely hazardous substances (e.g. sulfuric and nitric acids, hydrogen fluoride). The industry is required to comply with hazard communications requirements for employee training and labeling of containers.

RCRA requires the identification and tracking of hazardous waste from the point of generation to the point of disposal. The EPA has jurisdiction over the RCRA implementation within the Reservation. Facilities that report generation, storage, transportation, treatment, and disposal of hazardous waste are identified as large or small quantity generators. Large quantity generators of hazardous waste are those generating more than 1,000 kilograms (kg) per month of non-acutely hazardous waste (or 1 kg per month of acutely hazardous waste). Small quantity generators generate between 100 and 1,000 kg per month of hazardous waste. The identification of a facility as a generator does not necessarily indicate environmental contamination, but a risk factor exists due to the presence of hazardous waste. Five permitted RCRA small quantity generation facilities were identified within the Study Area, but none generated acutely hazardous waste[4]. All five facilities are in Ignacio, Colorado and are summarized below:

- SUIT Maintenance Yard;
- Tiffany Compressor Station;
- Bondad Compressor Station;
- Williams Field Services; and
- Arkansas Loop Plant.

The EPA also maintains a list of corrective action reports identifying hazardous waste operations undergoing RCRA corrective action. No sites were identified[5] within the Study Area.

The Toxic Substances Control Act administered by the EPA regulates the manufacture, use, and, in some instances, the disposal of chemical substances. The chemical substances of concern for gas development, processing, and distribution is Aroclor or polychlorinated biphenyls (PCBs). PCBs have been detected in the nation's natural gas facilities associated with air system equipment and valve grease. Specific authorization of PCB uses are listed in 40 CFR 761.30, and one of the uses is in compressors and in liquid of natural gas pipelines [40 CFR 761.30(I)]. PCBs may be used indefinitely in the compressors and natural gas pipeline liquids at concentrations of less than 50 ppm, provided the items are marked in accordance with 40 CFR 761.45.

Section 101 of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires reporting any releases from a facility that are outside the boundary of the facility. There are federally allowable releases in Section 101(10) of CERCLA that include natural gas, natural gas liquids, liquefied natural gas, and petroleum including fractions like

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[4] A review of selected federal, state, and local environmental regulatory agency database records was conducted for the Study Area. It is not possible to verify the accuracy or completeness of the database information. However, the use of, and reliance upon, this information is a generally accepted practice in environmental industry investigations.

waste oil. Spills of exploration and production wastes or produced fluids exceeding five barrels must be reported to the BLM, BIA, and SUIT if on Tribal surface leases and to the COGCC if on non-Tribal surface leases. The EPA Emergency Response Branch requires that a discharge of any petroleum product released into the waters of the United States, which causes a sheen, sludge, or discoloration or otherwise violates applicable water quality standards, be immediately reported to the National Response Center. County fire departments also have reporting requirements.

Initial notifications of continuous hazardous substance releases and new releases are required to be made in accordance with Section 103 of CERCLA and the implementing regulations (40 CFR 302). The list of hazardous substances and extremely hazardous substances and the reportable quantities are included in 40 CFR Table 302.4. Releases of hazardous substances (40 CFR 302) and extremely hazardous substances that exceed the reportable quantities are required to be reported to the National Response Center and state and local response agencies. CERCLA hazardous substances reportable under the Clean Water Act are listed in 40 CFR 117.21. Liability under CERCLA for facilities where waste has been improperly disposed and becomes subject to an investigation and/or remediation under CERCLA is a concern for generators. Any generator shipping waste offsite for treatment, recycling, or disposal can be held liable for the waste if it is not managed in accordance with federal waste disposal laws.

One historical Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) site was identified[5] within the Study Area, and is related to oil and gas industry activities. A removal action for soils containing PCB-contaminated lubricating oil was completed in 1988 at the Ignacio Gas Plant, a natural gas compressor station located near the Durango Airport. Cleanup was completed within one month by December 3, 1988. Records indicate no further remedial action is planned. Based upon the reported cleanup activities at the gas plant, the documented incident is not likely to create an environmental concern for the Study Area.

3.12.5 Spills of Wastes or Chemicals

Spill prevention control and countermeasures (SPCC), which are designed to reduce the impacts of oil spills on surface waters, must be prepared by the operators in accordance with the oil pollution prevention regulations (40 CFR 112) for sites that could impact navigable waters and for all oil storage facilities. EPA enforces the SPCC requirements for oil tanks over 1,320 gallons combined or 660 gallons for any one tank. In 1995, EPA began citing operators for lack of secondary containment around separators as a technical violation per the SPCC requirements of 40 CFR 112. Secondary containment around heater treaters should be carefully designed to minimize the risk of fire.

All oil and gas related spills within the Reservation, regardless of quantity, are reported to the Tribe's Energy Resources Division, the BIA, the BLM (NTL 3A), the EPA, and the Coast Guard if navigable waters are involved. The Tribe's database indicates that 148 spills or releases have been reported to the SUIT since October 1990 (initial date of electronic tracking of reports). Of the reported spills, most were releases of produced water (113) or a mixture of condensate or glycol with produced water (7). The other 28 reports were releases of glycol (9), gas (3), or liquid hydrocarbon (16). The maximum reported volume of water spilled was 1,500 barrels (bbl) and the maximum volume of oil/condensate spilled was 300 bbl. The average size of reported water releases is 120 bbl.

The Emergency Response Notification Systems (ERNS) database was designed to track spills greater than the established reportable quantities of the approximately 700 listed CERCLA and the 366 listed SARA 302 extremely hazardous substances. Those substances that do not meet the CERCLA and SARA criteria, such as petroleum products, need not be reported. In general, facilities that are responsible for reporting spills also are responsible for spill clean-up. Thirty-four oil and gas industry-related incidents are identified in the ERNS database (1990 through July 1995). Water produced during the CBM extraction process comprises 23 of the oil and gas production-related releases. Other material releases identified in the report included natural gas emissions, waste oils, ethylene glycol, mercury, gasoline, miscellaneous chemicals, and triethylene glycol.

Stormwater runoff at oil and gas production facilities is not regulated unless a spill of a hazardous substance under the Clean Water Act occurs in excess of its reportable quantity that could contact stormwater.

3.12.6 Pipeline Safety

Natural gas pipeline interconnections and all pipeline facilities within production facilities are to be designed, constructed, operated, and maintained in accordance with the DOT Subchapter D as prescribed in Title 49 CFR, Parts 190 and 192. DOT's 49 CFR 192 governs the design, construction, and operation of gas transmission lines. Its purpose is to ensure adequate protection of the public from natural gas pipeline accidents. Any incidents involving DOT-regulated gas pipelines must be reported to authorities as required by 49 CFR 191.

The DOT standard 49 CFR 192 has several provisions. It prescribes minimum safety requirements for pipeline facilities and gas transportation including material selection, minimum design requirements, and protection required from internal, external, and atmospheric corrosion. All pipelines are required to be designed, constructed, inspected, operated, and maintained in accordance with these requirements.

Class locations for pipeline routes are also defined in 49 CFR 192 (Table 3-52). The class location unit is the area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipe. These classes determine pipeline design and safety measures, such as thickness of the pipe wall, design pressure, valve spacing, and depth of cover. Area classifications are based on population density in the vicinity of the pipeline, with more densely populated areas requiring more rigorous safety measures.

TABLE 3-52
DOT's Pipeline Classification, Construction, Testing, and Inspection Standards (49 CFR 192)

Class	Applicable Locations (based on number of buildings intended for human occupancy within 220 feet of the pipeline centerline)	Burial Depth [1]	Non-destructive Welding Testing Require-ments[2,3]	Test Pressure per MAOP[4] (psi)	Test Fluid	Maximum Distance Between Block Valves (miles)	Frequency of Surface Inspections	
							At Highway and RR Crossings	All Other Places
1	10 or fewer	Minimum of 30 inches in normal soil and 18 inches in consolidated rock	10 %	1.1[5]	Water, air, or gas	20	7.5 months but at least 2/year	15 months but at least 1/year
2	More than 10 but fewer than 46	36 inches in normal soil or 24 inches in consolidated rock	15 %	1.25	Water, air, or gas	7.5	7.5 months but at least 2/year	15 months but at least 1/year
3	46 or more or pipeline within 100 yards of area occupied by 20 or more people during normal use	36 inches in normal soil or 24 inches in consolidated rock	100 %	1.5	Water	4	4.5 months but at least 4/year	7.5 months but at least 2/year
4	Buildings with four or more stories above ground	36 inches in normal soil or 24 inches in consolidated rock	100 %	1.5	Water	2.5	4.5 months but at least 4/year	4.5 months but at least 4/year

1Burial at 36 inches in normal soils or 24 inches in consolidated rock is required for all drainage ditches of public roads or RR crossing. Burial depth should be deep enough so that tillage activities in agricultural areas would not pose a threat to pipeline integrity.
2100 percent[3] testing at crossings of all major or navigable rivers; within railroad or public highway rights-of-way including tunnels, bridges, and overhead road crossings.
3If 100 percent testing is impracticable, then at least 90 percent of welds must be tested.
4MAOP - proposed maximum allowable operating pressure
51.25 X MAOP if pipeline is within 300 feet of building

Part 192 prescribes the minimum standards for operating and maintaining gas pipeline facilities, including the requirement to establish a written plan governing the above activities. Under section 192.615, "Emergency Plans," each gas pipeline operator also must establish an emergency plan that provides written procedures to minimize the hazards from a gas pipeline emergency. Key elements of the emergency plan include procedures for the following:

- receiving, identifying, and classifying notices of emergency events, such as gas leaks, fires, explosions, and natural disasters;
- establishing and maintaining communications with local fire, police, and public officials, and coordinating emergency response;
- making personnel, equipment, tools, and materials available at the scene of an emergency;
- protecting people and property from actual or potential hazards;
- notifying appropriate fire, police, and other public officials of emergencies and coordinating with them both planned and actual responses during an emergency;
- providing for the emergency shutdown of the system and its safe return to service; and
- beginning investigation of failures as soon as possible after the end of the emergency.

Each pipeline operator also must maintain a liaison with fire, police, and public officials; know the resources and responsibilities of each organization that may respond to a gas pipeline emergency; and coordinate mutual assistance in responding to emergencies. The operator also must establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a gas pipeline emergency and report it to appropriate public officials.

49 CFR Part 192 applies to all gas pipeline facilities and the transportation of gas within the Study Area with the exception of the gathering of gas outside the limits of any incorporated or unincorporated city, town, or village or any designated residential or commercial area. DOT-regulated pipelines within the Study Area fall mostly within Class 1, though Classes 2 and 3 exist in the towns and communities within the Study Area. However, most of the pipelines (flowlines and gathering lines) installed as part of the proposed alternatives would not be regulated by these DOT standards. However, these standards incorporate by reference all the applicable standards documents published by the American National Standards Institute, American Petroleum Institute (API), the American Society of Mechanical Engineers (ASME), American Society for Testing Materials, Manufacturers Standardization Society, National Fire Protection Association, and other recognized national standards in each of the pertinent engineering and technical disciplines. Design, materials, construction, operations, maintenance, and abandonment practices for flow and gathering lines shall be in accordance with safe and proven engineering practices and shall meet or exceed standard construction specifications recommended by ASME-31.8 and API Standard 1004.

These standards and the DOT standards (49 CFR 192) provide guidelines for land use considerations and provide adequate safeguards against encroachments, thereby increasing long-term public safety and protection of the pipeline integrity.

Adherence to these standards during construction and testing reduces the potential for leaks or pipeline failure to a minimal probability. Frequent signing of gas pipeline right-of-way and placement of colored warning tape above the pipeline in the trench reduces the risk of accidental ruptures from excavating equipment. Block valves are installed to shut-off flow of produced gas in the event of a sudden drop in pipeline pressure. A combination of both manual and automated block valves are used. The block valve is located to allow access for maintenance and for actuating the manually operated valve.

Pipelines are coated and wrapped to prevent external corrosion. For additional protection from external corrosion, cathodic surveys that evaluate physical conditions in and around the pipeline after installation are normally conducted to determine the potential for corrosion. If the potential for corrosion is identified, anodes are installed to protect the pipeline.

3.12.7 Natural Gas Seeps

Seeps of natural gas have been observed within the Study Area for many decades, especially associated with the Fruitland coal seams along the Hogback. In the late 1800s, settlers in the area noted gas seeps in rivers, and between the discovery of the natural gas seeps and the development of gas fields in the 1950s, methane gas was encountered occasionally when shallow boreholes and groundwater wells were drilled.

Although methane (the principal component of natural gas) is tasteless, odorless, colorless, and non-toxic to humans, its presence when confined in water can create an anoxic environment that may lead to geochemical reactions and foster bacterial growth that adversely affect the taste, odor, and appearance of the pumped water. When water containing entrained natural gas is exposed to the air, gas is released from solution and can dissipate rapidly with adequate ventilation. However, in confined or poorly ventilated spaces, natural gas may rise (methane is less dense than air) and accumulate, creating a fire or explosion hazard. Because methane has no taste, odor, or color, the presence of hazardous accumulations can be difficult to detect (Robson and Wright 1995). Accumulated methane also poses an asphyxiation hazard due to displacement of oxygen and lack of warning properties. Additional discussion of natural gas seeps and natural gas within groundwater can be found in Sections 3.4 and 3.5. Hydrogen sulfide gas has been measured in the soil near some of the gas seeps in the Fruitland Formation outcrop. Measurements recorded to date show no hydrogen sulfide gas levels in excess of permissible standards.

3.12.8 Coal Outcrop Fires

Coal seams of the Fruitland Formation appear to be on fire in the subsurface within the Fruitland outcrop at three places in the southwestern part of the Study Area, as discussed in Section 3.4.2.1.

Underground coal fires present hazards to persons in the immediate area of them due to potential for noxious gases, excessive heat, explosion, and collapse of the ground surface into a void created by burning of the coal. Also, there is a small potential for igniting a fire at the surface. At present, these three fires do not pose a significant threat to public health and safety because they are relatively small, completely underground, and located in an uninhabited area of Tribal land. Access to the area is controlled by the SUIT and can be restricted with physical measures, such as locked gates, if necessary, so no unauthorized, unprepared persons should be in the area of the fires. The SUIT spent $865,000 in 2000 in an attempt to mitigate one of the fires by injecting 4400 cubic yards of foamy cement, a recognized mitigation measure for underground coal fires. Unfortunately, this attempt did not extinguish the fire in question. The SUIT continues to monitor the fires and the surrounding area, and to consider other options for mitigating the fires. County emergency response personnel also have been notified of the locations of the fires.

CHAPTER 4—ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter describes the predicted effects that would result from the construction, operation and maintenance, and abandonment activities associated with Alternatives 1 through 3. The process of identifying impacts and conducting a systematic impact analysis is in accordance with the Council of Environmental Quality guidelines, which establishes procedures for implementing NEPA. Both direct and indirect impacts (adverse and beneficial) are described for each environmental resource. The duration of the impacts is analyzed and described as either short-term (up to 5 years) or long-term (the life of the project and beyond). Cumulative impacts, which consider the alternatives in conjunction with other significant future developments in and near the Study Area, including oil and gas development projects, are summarized for each environmental resource. Mitigation and environmental protection measures that are not already included as part of the Agency's and Tribe's Preferred Alternative or alternatives are described and evaluated, and the residual impacts are determined. Unavoidable adverse impacts are then summarized.

4.1.1 Resource Analysis

In order to determine the vulnerability of resources to impacts, resources were evaluated in terms of the following general criteria:

- **Resource Significance**—a measure of formal concern expressed for a resource through legal protection or by designation of special status.
- **Resource Sensitivity**—the probable response of a particular resource to project-related activities.
- **Resource Quality**—a measure of rarity, intrinsic worth, or distinctiveness, including the local value and importance of a resource.
- **Resource Quantity**—a measure of resource abundance and the amount of the resource potentially affected.

4.1.2 Significance Criteria

Each environmental resource was assigned anticipated impact levels of significance or insignificance (adverse and/or beneficial), or no identifiable impacts. The critical determination for each resource was the definition of significant impact thresholds. In accordance with CEQ NEPA regulations (CFR 40, part 1508.27), in determining whether an impact would be significant or insignificant, several factors related to the intensity and severity of impacts are considered. These include:

- impacts that may be both beneficial and adverse;
- the degree to which the proposed action affects public health/safety;
- unique characteristics of the geographic area such as proximity to historic or cultural resources, parklands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas;
- the degree to which the effects on the quality of the human environment are likely to be highly controversial,
- the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks;
- the degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration,
- whether the action is related to other actions with individually insignificant but cumulatively significant impacts;
- the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in, or eligible for listing in, the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historical resources, and
- whether the action threatens a violation of Federal, State, or local law or requirements imposed for protection of the environment.

4.1.3 Analysis of Surface Disturbance Impacts

The inherent difficulty of a programmatic EIS is to describe potential project impacts before the exact locations of project sites are known. To be able to evaluate impacts consistently on surface resources, an impact assessment methodology was developed through GIS (ArcInfo) and was based on known gas-well spacing units in the Study Area. This section provides summarizes the methodology; a more detailed description is in Appendix D. Figure 4-1 is a schematic of the impact analysis process.

FIGURE 4-1
Impact Assessment/Alternative Comparison Process
11 x 17

4.1.3.1 Conventional Gas Wells

The number of conventional gas wells (269 wells) for all alternatives was projected from recent drilling trends and knowledge of the extent of reservoir characteristics. New conventional wells generally could be drilled anywhere in the Study Area where the subsurface is owned by the tribe.

Each conventional gas reservoir has unique and irregular patterns of current development and of future potential. In addition, the future development would be complicated by the perceptions and opportunities of the lessees. Therefore, the pattern or spacing of future conventional gas well development cannot be predicted. The extent of impacts of future development of conventional gas on a surface resource was considered to be proportional to the area of the resource within the Study Area.

Specifically, the percentage of a resource within the Study Area was calculated by dividing the resource acreage by the total acreage of the Study Area. The resulting percentage was then multiplied by the total number of projected conventional wells (269) to determine the number of conventional wells that could impact that resource. To obtain the area of surface disturbance, the number of wells was then multiplied by the appropriate Construction Disturbance Factor (e.g., 3.06 acres for a new well pad or 1 acre for existing well pads). The disturbance factor for new well pads includes a 0.25-mile access road (which also contains flow lines). The Operation Disturbance Factor assumed that some interim reclamation of disturbed sites would occur following construction. Therefore, the Operation Disturbance Factor for new well pad sites was 2.06 acres (after reclamation of 1 acre) and 1 acre for sites developed on existing well pads, which usually must be enlarged to accommodate an additional well.

4.1.3.2 Surface-Disturbance Impacts from CBM and Enhanced-Recovery Injection Wells

Analysis of surface-disturbance impacts of CBM wells involved the identification of "development windows" throughout the Study Area. The concept of this method was that a given development window could receive one CBM well, and therefore be assessed a disturbance factor, if there were currently no CBM wells within that development window. If a development window currently contained a CBM well, then no additional CBM wells would be assigned to that development window, and no surface disturbance impacts would be assessed. Since it is not possible in this programmatic EIS to determine which development windows actually would receive wells, it was assumed that 100 percent of the available development window would receive wells, although only 80 percent are predicted to be developed.

Analysis of impacts for surface resources was obtained by counting all development windows that contained 2 acres or more of a given resource and multiplying that total by the appropriate disturbance factor (Construction or Operation Disturbance Factor). In other words, if a development window on tribal land contained a particular resource, then that development window was assigned a CBM well and was assigned a disturbance factor similar to the conventional gas wells. If a given resource constituted less than 2 acres within a development window, then the resource was not evaluated for surface impacts within that particular development window. This decision was based on the assessment that any resource present within a development window in less than 2 acres could reasonably avoid project impacts through relocation of the installation.

The locations of existing well pads were identified through the GIS system and were overlaid on the resource maps. Using existing well pads, rather than constructing new pads, reduces the extent of surface disturbance. The number of existing well pads for each resource was tallied. The Construction Disturbance Factor for existing well pads was 1 acre, as opposed to 3.06 acres for new well pads.

It is important to note that evaluating surface-disturbance impacts on a particular resource through this development-window concept does not mean that impacts on that resource would necessarily occur; rather, it is an estimate of the potential for those impacts to occur on a particular resource. The actual area of surface disturbance (well pad and access road) would depend on the location determined by the site visit, as required by the APD, and the site location, which can be adjusted to avoid sensitive features (e.g., residences, wetlands, agricultural land, etc.). A proposed drill pad (or other surface disturbance) can be moved to avoid impacts on sensitive resources.

It is also important to note that this analysis method is conservative in terms of estimating surface disturbances of resources. Every development window was evaluated if it overlapped a resource. If two resources were present in one development window, both resources were counted as impacted by that development window. Consequently, a given development window could register impacts on several resources (Example: coniferous forest = 3.06 acres, grassland = 3.06 acres) even though the actual construction would impact only a total of 3.06 acres. This situation is referred to as "impact loading." Obviously, surface impacts are not intended to be additive between different resource types with this model.

Disturbances were not considered for CDPs (compressor facilities) and treatment facilities, because future expansion of these facilities is anticipated to occur almost entirely within the existing disturbance areas.

4.1.4 Cumulative-Impact Analysis

"Cumulative impacts" are effects on the environment that result from the incremental impact of the alternatives when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person is undertaking them.

For the purposes of this EIS, it was decided that the cumulative analysis would emphasize impacts from oil and gas industry-related projects within the project Study Area and appropriate adjacent areas, depending on the resource being analyzed. The cumulative analysis also considers impacts from the largest of the foreseeable non-oil-and-gas-industry developments: community expansion, highway development, gravel mining, and the Animas-La Plata water project. Due to the programmatic nature of this EIS and the large area of study (421,300 acres), it was not practicable or economically feasible to describe all projects, actions, and developments that potentially might occur in the future within the Study Area and adjacent area. Cumulative impacts are evaluated in detail in Section 4.13.

4.1.5 Mitigation Planning

After initial impacts were identified, mitigation measures were designed and examined to determine their effectiveness in reducing either the magnitude or duration of impacts. General and specific mitigation measures were identified for the Agency's and Tribe's Preferred Alternative and alternatives. General mitigation consists of measures or techniques included on a project-wide basis as part of the Agency's and Tribe's Preferred Alternative or alternatives. Specific mitigation includes measures that pertain to a particular resource and these are described within the resource sections. A number of standard environmental protection measures currently exist that have been developed by SUIT, BIA, and BLM. These standard agency environmental protection measures are provided in Appendix E. In addition, resource specialists develop mitigation measures for specific resources and projects, as needed and where appropriate. The impacts remaining after applying mitigation and environmental protection measures are considered residual, unavoidable impacts of the Agency's and Tribe's Preferred Alternative or alternatives.

Mitigation measures are implemented by BIA, BLM, and tribal personnel as appropriate depending on their jurisdictions. The BLM is responsible for mitigating downhole and surface operations directly related to downhole operations. The BIA is primarily responsible for surface impacts, including pipeline rights-of-way, and works with the BLM in monitoring and mitigating surface impacts due to downhole operations. The presence of tribal personnel from many disciplines on the Reservation makes them an important part of the mitigation efforts. Tribal specialists work with federal employees to monitor activities and to mitigate potential impacts on the Reservation.

4.2 AIR QUALITY AND CLIMATE

No significant, adverse impacts on climate are anticipated from implementation of the Proposed Action or Alternatives. Potential impacts on air quality were analyzed as described below.

4.2.1 Issues, Impact Types, and Criteria

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (i.e., well operations, injection well and pipeline compressor engines, etc.), are potential causes of unacceptable decreases in air quality. These issues are more likely to generate public concern where natural gas development activities occur near residential areas. The USDI National Park Service and the USDA Forest Service have also expressed concerns regarding potential visibility and atmospheric-deposition (acid rain) impacts in distant downwind mandatory Federal PSD Class I areas under their administration (Mesa Verde National Park and the Weminuche Wilderness Area).

Potential air quality impacts from potential CBM development were analyzed and reported in Section 4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery and in Section 4.2.7 Cumulative Impacts. This analysis was prepared under the requirements of NEPA, in order to assess and disclose "reasonably foreseeable" impacts on both the public and the Bureau decision maker before a Record of Decision is issued. Due to the nature of the programmatic NEPA analysis, it should be considered a "reasonable, but conservative" upper estimate of predicted impacts. Actual impacts at the time of development (subject to air pollutant emission source permitting) are likely to be less.

The air quality impact assessment was based on the best available engineering data and assumptions, meteorology data, and EPA dispersion modeling procedures, as well as professional and scientific judgement. Where specific data or procedures were not available, however, "reasonable, but conservative" assumptions were incorporated. For example, the Alternative 3 air quality impact assessment assumed that all injection wells and natural gas wells would go into production (no dry holes), then operate at full production levels (no shut ins) throughout the 20-year life of the project (LOP).

Potential direct, indirect, and cumulative air quality impacts were analyzed in order to predict maximum near-field ambient air pollutant concentrations and Alternative 3 (Proposed Action) hazardous air pollutant (HAP) impacts, as well as to determine maximum far-field ambient air pollutant concentrations, visibility and atmospheric deposition (acid rain) impacts.

Air pollution impacts are limited by state, tribal, and Federal regulations; standards; and implementation plans established under the Clean Air Act and administered by the applicable air quality regulatory agency (including the SUIT, the CDPHE-APCD, and the EPA). Although not applicable to the Proposed Action or Alternatives, the New Mexico Environment Department, Air Quality Bureau (NMED-AQB) has similar jurisdiction over potential air pollutant emission sources in New Mexico, which can have a cumulative impact with tribal and CDPHE-APCD approved sources.

Air quality regulations require that proposed new, or modified existing, air pollutant emission sources (including nitrogen injectors and gas compression facilities) undergo a permitting review before their construction can begin. Therefore, the applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees and control devices, prior to construction and/or operation. In addition, the U.S. Congress (through the Clean Air Act, Section 116) authorized local, state, and tribal air quality regulatory agencies to establish air pollution control requirements more stringent than

Federal requirements (but not less). Additional site-specific air quality analysis would be performed, and additional emission control measures (including a BACT analysis and determination) may be required by the applicable air quality regulatory agencies, to ensure protection of air quality resources.

In addition, under the Federal Land Policy and Management Act (FLPMA) and the Clean Air Act, BLM cannot authorize any activity which does not conform to all applicable local, state, tribal and Federal air quality laws, statues, regulations, standards, and implementation plans. An extensive, two volume air quality impact assessment technical support document was prepared to analyze potential impacts from the Proposed Action and alternatives, as well as other reasonably foreseeable emission sources, and is available for review (Dames and Moore, 2000; and Earth Tech, 2000).

The significance criteria for potential air quality impacts include state, tribal, and federally enforced legal requirements to ensure air pollutant concentrations will remain within specific allowable levels. These requirements include the Colorado and National Ambient Air Quality Standards which set maximum limits for several air pollutants, and PSD increments which limit the incremental increase of certain air pollutants (including NO_2, PM_{10}, SO_2) above legally defined baseline concentration levels. These legal limits are presented in Table 3-2 (Applicable Ambient Air Quality Standards and PSD Increments).

Where legal limits have not been established, the BLM uses the best available scientific information to identify thresholds of significant adverse impacts. Thresholds have been identified for HAP exposure, incremental cancer risks, a "just noticeable change" in potential visibility impacts, and potential atmospheric deposition impacts on sensitive lake water chemistry. Specific threshold levels are described in Section 4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery and in Section 4.2.7 Cumulative Impacts.

4.2.2 Impacts Common to All Alternatives

Air quality impacts would occur during construction (due to surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, and drilling rig and vehicle engine exhaust) and production (including well production equipment, nitrogen injection and pipeline compression engine exhausts). The amount of air pollutant emissions during construction would be controlled by watering or applying chemical surfactants to disturbed soils, and by air pollutant emission limitations imposed by applicable air quality regulatory agencies. Actual air quality impacts depend on the amount, duration, location, and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.).

4.2.3 Alternative 1 - Continuation of Present Management

Significant air quality impacts would not occur under this Alternative. Potential air quality impacts would be less than those described in Section 4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery below.

4.2.4 Alternative 2 - Coalbed Methane Infill Development

Significant air quality impacts would not occur under this Alternative. Potential air quality impacts would be less than those described in Section 4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery below.

4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery

Significant air quality impacts would not occur under this Alternative. No violations of applicable state, tribal, or Federal air quality regulations or standards are expected to occur as a result of direct, indirect, or cumulative CBM development-related air pollutant emissions (including construction and operation).

The EPA ISCST3 dispersion model was used with meteorological data generated by the MM4 (mesoscale model) and CALMET models including hourly regional surface observations and twice-daily upper air soundings throughout calendar year 1990 (Earth Tech, 2000). These generated data were used to predict maximum potential concentrations in the vicinity of assumed well and compressor engine emission sources for comparison with applicable air quality standards and PSD Class II increments (Dames and Moore, 2000).

Air pollutant dispersion modeling was performed to quantify potential "reasonable, but conservative" PM_{10} and SO_2 impacts during construction based on the individual pollutant's period of maximum potential emissions. The maximum predicted "near-field" air pollutant concentrations occur close to and between well locations, and would occur so close to each well location that adding additional wells throughout the field would not increase the overall maximum concentration.

Construction emissions would occur during road and well pad construction (3 days), well drilling (8 days), and well completion testing (25 days). During well completion testing, natural gas would be burned (flared) for up to 7 days. Since the burned natural gas is "sweet" (does not contain sulfur compounds), no objectionable odors are likely to occur. In addition, since orientation of the road and well pad is unknown, several preliminary PM_{10} and SO_2 modeling analyses were performed to identify and apply the physical geometry for maximum potential impacts in the final analysis.

Maximum potential near-field particulate matter emissions from traffic on unpaved roads and during well pad construction were used to predict the maximum 24-hour and annual average PM_{10} concentrations. Maximum air pollutant emissions from each well would be temporary (i.e., occurring during a 36-day construction period) and would occur in isolation, without significantly interacting with adjacent well locations. Particulate matter emissions from well pad and resource road construction would be minimized by application of water and/or chemical dust suppressants. The control efficiency of these dust suppressants was computed at 50 percent during construction.

The maximum potential particulate matter concentrations at least 650 feet (200 m) from road and 0.5 miles (805 m) from well emission sources (including representative background values) would be nearly 128 $\mu g/m^3$ (24-hour PM_{10}), well below the 24-hour PM_{10} NAAQS of 150 $\mu g/m^3$. In addition, predicted particulate matter concentrations would decrease rapidly beyond 200 m from the emission source. Since these PM_{10} construction emissions are temporary, PSD increments are not applicable.

The predicted maximum 24-hour concentrations overestimate actual expected PM_{10} concentrations because the maximum modeled concentrations from the proposed activities are assumed to coincide with the first maximum measured background concentrations. However, the meteorological conditions which lead to both situations would be very different, and are not likely to occur at the same location and the same time.

The maximum short-term (3- and 24-hour) SO_2 emissions would be generated by drilling rigs and other diesel engines used during rig-up, drilling, and completion operations (sulfur is a trace element in diesel fuel). These SO_2 emissions would be temporary, occurring only during the limited 36-day construction period at each well location. The maximum modeled concentrations (including representative background values of 57 and 23 $\mu g/m^3$, respectively) would be nearly 702 $\mu g/m^3$ (3-hour) and 133 $\mu g/m^3$ (24-hour).

Therefore, predicted short-term SO_2 concentrations would be slightly above the restrictive Colorado SO_2 Ambient Air Quality Standards of 695 $\mu g/m^3$ (3-hour) and well below 365 $\mu g/m^3$ (24-hour). The 3-hour SO_2 National Ambient Air Quality Standard (1,300 $\mu g/m^3$) is less stringent. Given the conservative assumptions used in the 3-hour modeling analysis, and the limited spatial applicability of the Colorado standard, significant impacts are unlikely to occur, even when compared to the more restrictive standard. Since these SO_2 construction emissions are temporary, PSD increments are not applicable.

Air pollutant dispersion modeling was also performed to quantify potential “reasonable, but conservative” CO, NO_2 and HAP impacts during operation, based on the period of maximum potential emissions and other emission sources located in the vicinity of the Reservation (including tribal, Colorado and New Mexico sources). Operation emissions (primarily CO and NO_x) would occur due to increased compression requirements, including nitrogen injection wells and pipeline compressor stations. It is anticipated additional field-wide compression would be about 118,000 hp (at more than 40 new compressor station locations). Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct volatile organic compound (VOC) emissions would occur due to well operations, although well heaters would emit small amounts of CO and NO_x.

The maximum direct CO impacts during operation were predicted to be nearly 159 $\mu g/m^3$ (1-hour) and 110 $\mu g/m^3$ (8-hour). When these values are added to the assumed background concentration of 2,300 $\mu g/m^3$, they become nearly 2,459 $\mu g/m^3$ (1-hour) and 2,410 $\mu g/m^3$ (8-hour), demonstrating compliance with the applicable CO NAAQS of 40,000 $\mu g/m^3$ (1-hour) and 10,000 $\mu g/m^3$ (8-hour), respectively.

Maximum direct NO_2 impacts during operations were predicted based on assumed NO_x emissions from reasonably foreseeable CBM recovery wells, injector well and pipeline compressor engines. However, given the uncertain and preliminary nature of potential development, three different NO_x emissions rates were used: 1.0 grams per horsepower-hour (g/hp-hr; which reflects currently available, clean burning equipment), 1.5 g/hp-hr (which reflects recently permitted equipment), and 2.0 g/hp-hr (which reflects historically permitted equipment). The highest emission rate represents compression engines using proven technology which would ensure this level of control could be continuously achieved. The lowest emission rate represents compression engines using emerging technology which would be more difficult to guarantee throughout the life of the project (LOP). The maximum potential near-field NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with standard EPA methodology (40 CFR 51, Appendix W, Section 6.2.3).

Assuming injector well and pipeline compressor engine NO_x emission rates of 1.0 g/hp-hr, the maximum predicted direct annual NO_2 impact was 4.5 $\mu g/m^3$, which is nearly 18 percent of the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration (15 $\mu g/m^3$), the resulting predicted maximum total impact of 20 $\mu g/m^3$ is also well below the applicable NO_2 NAAQS of 100 $\mu g/m^3$ (annual).

Assuming injector well and pipeline compressor engine NO_x emission rates of 1.5 g/hp-hr, the maximum predicted direct annual NO_2 impact was 6.8 $\mu g/m^3$, which is nearly 27 percent of the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration (15 $\mu g/m^3$), the resulting predicted maximum total impact of 22 $\mu g/m^3$ is also well below the applicable NO_2 NAAQS of 100 $\mu g/m^3$ (annual).

Assuming injector well and pipeline compressor engine NO_x emission rates of 2.0 g/hp-hr, the maximum predicted direct annual NO_2 impact was 9.1 $\mu g/m^3$, which is nearly 36 percent of the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration (15 $\mu g/m^3$), the resulting predicted maximum total impact of 24 $\mu g/m^3$ is also below the applicable NO_2 NAAQS of 100 $\mu g/m^3$ (annual).

As stated previously, all NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis.

Maximum HAP (formaldehyde) impacts were predicted for all Alternative 3 (Proposed Action) potential injection and pipeline compressor engines. Since neither the CDPHE-APCD nor EPA have established HAP standards, predicted 8-hour HAP concentrations were compared to a range of 8-hour state maximum Acceptable Ambient Concentration Levels (AACL; EPA 1997a). The maximum predicted cumulative 8-hour formaldehyde impact was 10.5 $\mu g/m^3$, which is within the range of states' AACLs of 4.5 $\mu g/m^3$ (Pinnellas County Air Pollution Control Board, Florida) to 71 $\mu g/m^3$ (State of Nevada, Division of Environmental Protection, Air Quality Control). The maximum formaldehyde concentration was predicted to occur at 320 m (less then 1/4 mile) adjacent to a compressor station; as the distance from the emission source increases, the predicted concentrations decrease rapidly.

Long-term (70-year) exposures from suspected carcinogenic emissions (e.g., formaldehyde) were used to estimate the incremental cancer risk at the maximum predicted concentration location and in eight communities (Breen, Bondad, Ignacio, Kline, La Boca, La Posta, Redmesa and Trinity) . These were calculated from EPA (1997b) unit risk factors for carcinogenic constituents. Two estimates of cancer risk were made; one that corresponds to a most likely exposure (MLE) condition, and one reflective of the maximally exposed individual (MEI). The estimated cancer risks were adjusted to account for duration of exposure and time spent at home.

Under the MLE scenario, the estimated incremental cancer risk associated with long-term exposure to formaldehyde (from the largest compressor engine operation) would be 0.9×10^{-6}. Under the MEI analysis, the maximum individual cancer risk for formaldehyde would be 2.8×10^{-6}. In addition, the MEI analysis for the town of Bondad indicated a individual cancer risk of 1.1×10^{-6}. Therefore, the predicted incremental cancer risks for the inhalation pathway all fall below or at the lower end of the 1×10^{-6} to 100×10^{-6} threshold range. Given the conservative nature of these analyses, the predicted exposures are likely to overstate actual exposures, and the potential incremental cancer risks would not be significant.

When reviewing the predicted near-field (Proposed Action) impacts, it is important to understand the "reasonable, but conservative" assumptions made regarding potential resource development. In developing this analysis, there is uncertainty regarding ultimate development (i.e., number of wells, equipment to be used, specific locations). The analysis was also based on a reasonably foreseeable development scenario, including several conservative assumptions:

- Maximum measured background criteria air pollutant concentrations were assumed to occur at all locations in the region throughout the LOP. In addition, the maximum predicted air quality impacts would occur only in the vicinity of the anticipated emission sources. Actual impacts would be less further away from the predicted points of maximum.

- All emission sources were assumed to operate at their reasonably foreseeable maximum emission rates simultaneously throughout the LOP. Given the number of sources included in this analysis, the co-probability of such a scenario actually occurring over an entire year (or even 24-hours) is small. While this assumption is typically used in modeling analyses, the resulting predicted impacts will be overstated.

- All proposed natural gas wells were assumed to be fully operational (no dry holes), and remain operating (no shut ins) throughout the LOP.

- The total proposed injector well and pipeline compression engines (nearly 118,000 hp) were assumed to operate at their rated capacities continuously throughout the LOP (no phased increases or reductions). In reality, compression equipment would be added or removed incrementally as required by the well field operation, compressor engines would operate below full horsepower ratings, and it is unlikely all compressor stations would operate at maximum levels simultaneously.

- Total predicted short-term air pollutant impact concentrations were assumed to be the sum of the first maximum background concentration, plus the maximum cumulative modeled concentrations, which actually occur under very different meteorological conditions and are not likely to coincide.

- Preliminary PM_{10} and SO_2 modeling analyses were performed in order to identify and apply the physical geometry for maximum potential impacts in the final analyses.

- The HAP analyses assumed all equipment would operate simultaneously at the maximum emission levels continuously throughout the LOP.

Given these numerous "reasonable, but conservative" analysis assumptions, which may actually compound one another, the predicted impacts represent an upper estimate of potential air quality impacts which are unlikely to actually be reached. However, even applying these "reasonable, but conservative" analysis assumptions, most predicted impacts are below applicable regulatory limits, and the scientific evidence is not compelling that reasonably foreseeable significant adverse impacts would occur.

It is important to note that before actual development could occur, the applicable air quality regulatory agencies (including the state, tribe or EPA) would review specific air pollutant emissions preconstruction permit applications which examine potential project-wide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impacts analyses or mitigation measures. Thus, before development occurs, additional site-specific air quality analyses would be performed to ensure protection of air quality.

4.2.6 Impacts Summary

No significant, adverse, direct or indirect impacts on air quality are anticipated from implementation of the Proposed Action or Alternatives. Based on a separate assessment predicting potential near-field (direct, indirect and cumulative) air quality impacts (Dames & Moore 2000), localized short-term increases in CO, NO_2, PM_{10}, and SO_2 concentrations would occur, but maximum concentrations would be well below applicable state and National Ambient Air Quality Standards. Similarly, at the maximum assumed Alternative 3 (Proposed Action) emission rates, predicted HAP concentrations would be between various 8-hour maximum states' AACLs, and the related incremental cancer risks would also be below applicable significance levels.

4.2.7 Cumulative Impacts

Based on a separate assessment predicting potential far-field (cumulative) air quality impacts (Earth Tech, 2000), the EPA CALMET/CALPUFF dispersion model was used to predict maximum potential air quality impacts at downwind mandatory Federal PSD Class I areas to: 1) determine if the PSD Class I NO_2 increment might be exceeded; 2) calculate potential nitrate and sulfate atmospheric deposition (and their related impacts) in sensitive lakes; and 3) predict potential impacts on visibility (regional haze).

Meteorological information was assembled to characterize atmospheric transport and dispersion from several 1990 data sources, including: 1) 80 km gridded MM4 (mesoscale model) values with continuous four-dimensional data assimilation; 2) hourly surface observations (wind speed, wind direction, temperature, cloud cover, ceiling height, surface pressure, relative humidity, and precipitation) measured at Grand Junction, Colorado, and Gallup, New Mexico; 3) twice-daily upper air vertical profiles (wind speed, wind direction, temperature and pressure) measured at Grand Junction, Colorado, and Albuquerque, New Mexico; and 4) PRISM adjusted hourly precipitation measurements.

Potential "reasonable, but conservative" air pollutant emissions from Alternative 3 (Proposed Action) sources were combined with other reasonably foreseeable facilities to determine the total potential cumulative air quality impacts. These other "reasonably foreseeable" facilities included development associated with: 1) about 50 emission sources permitted by the NMED-AQB; 2) about 25 emission sources permitted by the CDPHE-APCD; and 3) approximately 40 emission sources located within the exterior boundary of the Reservation, which do not require CDPHE-APCD operating permits.

TABLE 4-1
Predicted Mandatory Federal PSD Class I Area Cumulative Impacts (in $\mu g/m^3$)
Alternative 3 (Proposed Action)

Pollutant/Averaging Period/Emission Scenario	Class I Area	Maximum Modeled Concentration	Class I Increment
Nitrogen dioxide - Annual 1.0 g/hp-hr emission rate	Mesa Verde NP Weminuche Wilderness	0.18 0.07	2.5 2.5
Nitrogen dioxide - Annual 1.5 g/hp-hr emission rate	Mesa Verde NP Weminuche Wilderness	0.21 0.09	2.5 2.5

Nitrogen dioxide - Annual 2.0 g/hp-hr emission rate	Mesa Verde NP Weminuche Wilderness	0.25 0.10	2.5 2.5
Sulfur dioxide - Annual	Mesa Verde NP Weminuche Wilderness	<0.01 <0.01	2 2
Sulfur dioxide - 24-hour	Mesa Verde NP Weminuche Wilderness	<0.01 <0.01	5 5
Sulfur dioxide - 3-hour	Mesa Verde NP Weminuche Wilderness	0.04 <0.01	25 25

As described in Section 4.2.5 Alternative 3 - Enhanced Coalbed Methane Recovery, given the uncertain and preliminary nature of potential development, three different NO_x emissions rates from reasonably foreseeable nitrogen injection wells and the compressor stations were used: 1.0 g/hp-hr (which reflects currently available, clean burning equipment), 1.5 g/hp-hr (which reflects recently permitted equipment), and 2.0 g/hp-hr (which reflects historically permitted equipment). Table 4-1 demonstrates that potential direct cumulative NO_2 and SO_2 impacts would be at or below applicable PSD Class I increments, regardless of assumed NO_x emissions rate.

It should be noted that this comparison is not a complete PSD Increment Consumption Analysis, but an assessment indicating that the increment would not be exceeded by the cumulative emission sources. Many of the potential air pollutant emission sources were analyzed at their maximum permitted levels; actual emissions and their related air quality impacts are typically less. At the time of a preconstruction air quality permit application, the applicable air quality regulatory agencies may require a much more detailed PSD Increment Consumption Analysis.

Four lakes were identified by the USDA-Forest Service as being sensitive to atmospheric deposition and for which the most recent and complete data have been collected. No sensitive lakes were identified by the USDI National Park Service in Mesa Verde National Park. The USDA Forest Service, Region 2 (Blett 1999), has also identified the following "Limit of Acceptable Change" regarding potential changes in lake chemistry for the mandatory Federal PSD Class I Weminuche Wilderness Area: no more than a 10 percent change in acid neutralizing capacity (ANC) for those water bodies where the existing ANC is at or above 25 microequivalents per liter (μeq/l) and no more than a 1 μeq/l change for those extremely sensitive water bodies where the existing ANC is below 25 μeq/l. Using USDA-Forest Service recommended procedures (Fox, *et al* 1989), Table 4-2 demonstrates that potential impacts on sensitive lakes would be well below applicable significance thresholds from the Alternative 3 (Proposed Action) total cumulative sources combined. Potential impacts underAlternatives 1 and 2 would be even less. This analysis procedure was recently published as the *"Screening Methodology for Calculating ANC Change to High Elevation Lakes*," published by the USDA Forest Service, Rocky Mountain Region, January 2000.

Since the Alternative 3 (Proposed Action) and cumulative emission sources constitute many small sources uniformly spread out over a very large area, discrete visible plumes are not likely to impact the mandatory Federal PSD Class I areas, but the potential for cumulative visibility impacts (increased regional haze) is a concern. Regional haze degradation is caused by fine particles and gases scattering and absorbing light. Potential changes to regional haze are calculated in terms of a perceptible "just noticeable change" (1.0 deciview) in visibility when compared to background conditions.

TABLE 4-2
Predicted Change in Acid Neutralizing Capacity in the Weminuche Wilderness
PSD Class I Area Sensitive Lakes (percent change)
Alternative 3 (Proposed Action)

NO_x Emission Rate	Sensitive Lake	Minimum Background ANC (μeq/l)	Total Cumulative Sources	Thresholds
1.0 g/hp-hr	Big Eldorado Lake	17.9	0.9	5.6 a/
	Lower Sunight Lake	62.8	0.3	10
	Upper Grizzly Lake	8.0	2.6	12.5 a/
	Upper Sunlight Lake	16.4	1.2	6.1 a/
1.5 g/hp-hr	Big Eldorado Lake	17.9	1.0	5.6 a/
	Lower Sunight Lake	62.8	0.4	10
	Upper Grizzly Lake	8.0	3.1	12.5 a/
	Upper Sunlight Lake	16.4	1.5	6.1 a/
2.0 g/hp-hr	Big Eldorado Lake	17.9	1.2	5.6 a/
	Lower Sunight Lake	62.8	0.4	10
	Upper Grizzly Lake	8.0	3.6	12.5 a/
	Upper Sunlight Lake	16.4	1.7	6.1 a/

a/ For sensitive lakes with minimum background ANC values less than 25 μeq/l, the threshold of concern is less than a 1 μeq/l reduction below the minimum background ANC value (e.g.; for Big Eldorado Lake, 0.056 x 17.9 μeq/l equals 1 μeq/l).

A 1.0 deciview change is considered potentially significant as described in the EPA Regional Haze Regulations (40 CFR 51.300 *et seq*), and originally presented in Pitchford and Malm (1994). A 1.0 deciview change is defined as about a 10 percent change in the extinction coefficient (corresponding to a 2 to 5 percent change in contrast, for a "black target" against a clear sky, at the most optically sensitive distance from an observer), which is a small but noticeable change in haziness under most circumstances when viewing scenes in mandatory Federal Class I areas.

It should be noted that a 1.0 deciview change is not a "just noticeable change" in all cases for all scenes. Visibility changes less than 1.0 deciview are likely to be perceptible in some cases, especially where the scene being viewed is highly sensitive to small amounts of pollution. Under other view-specific conditions, such as where the sight path to a scenic feature is less than the maximum visual range, a change greater than 1.0 deciview might be required to be a "just noticeable change."

However, this NEPA analysis is not designed to predict specific visibility impacts for specific views in specific mandatory Federal PSD Class I areas based on specific project designs, but to characterize reasonably foreseeable visibility conditions that are representative of a fairly broad geographic region, based on "reasonable, but conservative" emission source assumptions. This approach is consistent with both the nature of regional haze and the requirements of NEPA. At the time of a preconstruction air quality permit application, the applicable air quality regulatory agency may require a much more detailed visibility impact analysis. Factors such as the magnitude of deciview change, frequency, time of the year, and the meteorological conditions during times when predicted visibility impacts are above the 1.0 deciview threshold (as well as inherent conservatism in the modeling analyses) should all be considered when assessing the significance of predicted impacts.

After the DEIS air quality impact assessment was completed, the USDA-Forest Service, USDI-National Park Service, and the USDI-U.S. Fish and Wildlife Service, published their "Final FLAG Phase I Report" (Federal Register, Vol. 66 No. 2, dated January 3, 2001), providing "a consistent and predictable process for assessing the impacts of new and existing sources on AQRVs" including visibility. For example, the FLAG report states "A cumulative effects analysis of new growth (defined as all PSD increment-consuming sources) on visibility impairment should be performed," and further, "If the visibility impairment from the proposed action, in combination with cumulative new source growth, is less than a change in extinction of 10% [1.0 deciview] for all time periods, the FLMs will not likely object to the proposed action."

Although the FLAG procedures were primarily designed to provide analysis guidance to Clean Air Act PSD permit applicants, the following revised Table 4-3 uses the "Final FLAG Phase I Report" procedures for this NEPA analysis.

TABLE 4-3
Predicted Visibility Impacts in Mandatory Federal PSD Class I Areas
(Number of Days Predicted to Equal or Exceed a 1.0 Deciview "Just Noticeable Change")

NO_x Emission Rate Scenario	Mandatory Federal PSD Class I Sensitive Area	Alt. 1 No Action	Alt. 2 CBM Infill	Alt. 3 (Proposed Action)
1.0 g/hp-hr	Mesa Verde Nat'l Park Weminuche Wilderness	0 0	0 0	0 0
1.5 g/hp-hr	Mesa Verde Nat'l Park Weminuche Wilderness	0 0	0 0	0 0
2.0 g/hp-hr	Mesa Verde Nat'l Park Weminuche Wilderness	0 0	0 0	0 1

Based on multiple iterations of the nonsteady-state CALPUFF dispersion modeling system, including the CALMET meteorological model, for three different development alternatives, each with three different assumed compressor engines NO_x emission scenarios, no day was predicted to equal or exceed the 1.0 deciview "just noticeable change" level at Mesa Verde National Park Mandatory Federal PSD Class I area, and only a single day (based on January 19, 1990 meteorology conditions) was predicted to reach the 1.0 deciview "just noticeable change" level at the Weminuche Wilderness Mandatory Federal PSD Class I area (at a predicted level of 1.083 deciview). Given the numerous "reasonable, but conservative" assumptions applied throughout this analysis (which may actually compound one another), these projected impacts represent an upper estimate of potential air quality impacts that are unlikely to actually occur. These assumptions include:

- All emission sources were assumed to operate at their reasonably foreseeable maximum emission rates simultaneously throughout the LOP. Given the number of sources included in this analysis, the co-probability of such a scenario actually occurring over an entire year (or even 24-hours) is small. While this assumption is typically used in modeling analyses, the resulting predicted impacts will be overstated.

- All proposed natural gas wells were assumed to be fully operational (no dry holes), and remain operating (no shut ins) throughout the LOP.

- The total proposed injector well and pipeline compression engines (nearly 118,000 hp) were assumed to operate at their rated capacities continuously throughout the LOP (no phased increases or reductions). In reality, compression equipment would be added or removed incrementally as required by the well field operation, compressor engines would operate below full horsepower ratings, and it is unlikely all compressor stations would operate at maximum levels simultaneously.

- The atmospheric deposition impact analysis assumed no other ecosystem components would affect lake chemistry for a full year (assuming no chemical buffering due to interaction with vegetation or soil materials).

- The visibility impact analysis assumed daily "natural background" optical conditions would occur simultaneously throughout each mandatory Federal PSD Class I area, and that a 1.0 deciview "just noticeable change" would be a reasonably foreseeable significant adverse impact, although there is no applicable state, tribal or Federal regulatory visibility standards.

Given these numerous "reasonable, but conservative" analysis assumptions, which may actually compound one another, the projected impacts represent an upper estimate of potential air quality impacts which are unlikely to actually be reached, although potential air quality impacts are more likely at the 2.0 g/hp-hr injector well and pipeline compressor engine NO_x emission rate, than under lower NO_x emission rate scenarios.

Even applying these "reasonable, but conservative" analysis assumptions, however, most predicted impacts are below assumed threshold limits, and scientific evidence is not compelling that reasonably foreseeable significant adverse impacts would occur.

It is important to note that before actual development could occur, the applicable air quality regulatory agencies (including the state, tribe, or EPA) would review specific air pollutant emissions preconstruction permit applications that examine potential projectwide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impacts analyses or mitigation measures. Thus, before development occurs, additional site-specific air quality analyses would be performed, to ensure protection of air quality.

4.2.8 Mitigation Summary

Mitigation

- Roads would be surfaced or dust inhibitors would be used (i.e., 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 *(mitigation from SUIT EIS and based on existing policy or regulation).*

- Speed limits would be enforced to the extent practicable on roads in and adjacent to the project area, further to reduce fugitive dust *(mitigation from SUIT EIS).*

In developing the emission inventory for the air quality impact assessment, it was assumed that compressor engines would have an average potential NO_x emission rate of 1.0 g/hp-hr, 1.5 g/hp-hr, or 2.0 g/hp-hr of operation. This reflects a range of emission levels anticipated from currently available, clean burning equipment to historically permitted equipment. The highest emission rate represents compression engines using proven technology which would ensure this level of control could be continuously achieved. The lowest emission rate represents compression engines using emerging technology which would be more difficult to guarantee throughout the LOP. A variety of potential emission reduction measures (BLM 1999) are available to limit NO_x and other pollutant emissions. The evaluation was not intended to rank or identify a required emission reduction measure; the appropriate level of control would be determined and required by the applicable air quality regulatory agencies during the preconstruction permit process.

- Reduce Compression Requirements. Reducing the need for LOP compression by limiting the need for injection compressors.

- Nonselective Catalytic Reduction. This control technology is applicable to relatively new engines and requires the installation of catalysts in the engine exhaust. The catalyst removes between 80 and 90 percent of the uncontrolled NO_x emissions, for an operating emission rate of 1.0 to 5.0 g/hp-hr. The cost effectiveness of this control technology applied to a 2,500 to 4,000 hp rich-burn engine ranges from $315 to $395 per ton of NO_x removed.

- Lean Combustion. This technology involves the increase of the air-to-fuel ratio to lower the peak combustion temperature, thus reducing the formation of NO_x (new engines and retrofit applications). The controls are between 80 and 90 percent efficient, for an operating emission rate of 1.5 to 4.0 g/hp-hr. The cost effectiveness of this control technology applied to a 2,500 to 4,000 hp rich-burn engine ranges from $480 to $500 per ton of NO_x removed.

- Selective Catalytic Reduction. This is a post-combustion control technology that is applicable only to exhaust streams with significant oxygen content (a lean burn engine). The controls are between 80 and 90 percent efficient, for an operating emission rate of 1.0 to 2.5 g/hp-hr. The cost effectiveness of this control technology applied to a 2,500 to 4,000 hp rich-burn engine ranges from $700 to $890 per ton of NO_x removed.

- Electric Compression (including solar power). Using electric-powered compressor motors in place of the typical natural gas-fired compressor engines could eliminate direct NO_x emissions from compressor station locations. Increased NO_x emissions are likely to occur at the point of electrical generation, however, often burning dirtier fuels and emitting more air pollutants (such as from coal-fired power plants). Using current industrial electrical rates and assuming 100 percent control due to elimination of 2.0 g/hp-hr NO_x emissions at the compressor site, the cost effectiveness of electric compression is roughly $26,000 per ton of NO_x removed. Photovoltaic (solar) electrical systems cannot provide the needed power requirements for proposed injector well and pipeline compression engines (nearly 118,000 hp).

- Fuel Cell Technology. It is not feasible to connect enough fuel cells together to generate the necessary compression horsepower. About 75 fuel cells (at a capital cost of nearly $30 million) would be required to provide 20,000 hp of compression. In addition, current technology allows only two fuel cells to be connected in a series, and, as of January 1998, there were only 160 of these units operating worldwide. The cost effectiveness of this control technology ranges from $20,000 to $40,000 per ton of NO_x removed.

- Natural Gas-Powered Drilling Rigs. The theoretical use of natural gas-fired engines to power drilling rigs, mud pumps, and associated equipment, rather than diesel-powered equipment, is technically feasible to reduce PM_{10} and SO_2 emissions. However, such equipment is not commercially available.

The following "mitigation measures" are outside the jurisdiction of the Bureau's management authority.

- Suspend Future Development Until Air Quality Issues Are Resolved. Previous NEPA document comments have suggested the Bureau "reconsider future development after more information is gathered," such as a regulatory PSD Increment Consumption Analysis. The Bureau can deny an individual "Application for Permit to Drill" only under very specific legal conditions. However, the applicable air quality regulatory agencies would review potential air pollutant emission sources and issue any applicable emission permits prior to construction and operation. Without this regulatory approval, the natural gas leases cannot be developed.

- Withdraw or Prohibit Future Leasing. Previous NEPA document comments have suggested the Bureau "withdraw or don't offer leases," apparently to eliminate natural gas development and the related air pollutant emissions. However, once the Department of the Interior Secretary has issued a valid mineral lease, it may be conditioned, but not revoked. Similarly, under current Federal mineral law, future leasing can be prohibited only in specific legal circumstances. The U.S. Congress could revise these laws, but the prospect of securing passage of such legislation and appropriation of funds for that specific purpose is extremely remote. In addition, elimination of natural gas leasing is inconsistent with Congressional direction (through the Clean Air Act) for development and promotion of alternative clean fuels needed to improve air quality nationally.

- NO_x Emissions "Cap and Trade". Previous NEPA document comments have suggested the Bureau consider NO_x emissions trading, therefore limiting NO_x emissions at current levels. Existing NO_x emission facilities could then either keep, trade or sell their emission allocations (essentially a property right to pollute) to other groups seeking to increase their NO_x emissions. When coupled with "banking" (holding, but not using credits) and "discounting" (reduced emission credit values with each "trade"), overall NO_x emissions would decrease. Under the Clean Air Act, the U.S. Congress has already established an "allowance program" for certain SO_2 emitting facilities, and Congress could establish a similar NO_x trading program to be implemented by the applicable air quality regulatory agencies.

- Phased (Staged) Development. Previous NEPA document comments have suggested the Bureau reduce the intensity of natural gas development, such as limiting the "...number of wells or...amount of emissions until reach[ing] 0.5 deciview..." The Bureau does not have the authority to require that development of existing leases be limited when specified emissions levels are reached. However, an overall air pollutant emissions "level of concern" could be established at a point where reevaluation would occur, providing timely management review and ensuring compliance with the Federal land managers' mandate to protect AQRVs through participation in the applicable air quality regulatory agencies preconstruction permitting.

Monitoring

The Bureau could continue to cooperate with existing visibility and atmospheric deposition impact monitoring programs. The need for, and the design of, additional monitoring could include the involvement of the EPA Region VIII Federal Leadership Forum and applicable air quality regulatory agencies. Based upon future recommendations, operators could be required to cooperate in the implementation of a coordinated air quality monitoring program. Oil and gas lease terms (Section 6) require the lessee, within the lease rights granted, to take measures deemed necessary by the lessor for the conduct of operations in a manner that minimizes adverse impacts on air quality, as well as other resources.

4.2.9 Unavoidable Adverse Impacts

Some increase in air pollutant emissions would occur as a result of the Proposed Action and Alternatives; however, based on the "reasonable, but conservative" modeling assumptions, these impacts are predicted to be below applicable significance thresholds.

4.3 BIOLOGICAL RESOURCES

The purpose of this section is to describe and analyze impacts that have the potential to affect biological resources within the Study Area and its vicinity, as a result of the proposed alternatives. Biological resources include vegetation; wetlands; noxious weeds; cultural plant species; wildlife; fisheries; and Threatened, Endangered, and Sensitive (TES) species. Mitigation measures for the avoidance or minimization of project impacts that are specific to biological resources are also discussed in this section.

4.3.1 Vegetation and Wetlands

4.3.1.1 Issues, Impact Types, and Criteria

Potential project impacts on vegetation resources focus on responding to issues that were identified during the scoping process for this project. Direct, indirect, short-term, and long-term impacts have been identified for vegetation resources, which include vegetation, wetlands, cultural plant species, and weeds.

Direct impacts on vegetation consist of ground-disturbance-related activities that immediately affect vegetation resources. Indirect impacts are those effects that may result from the implementation of the project, but are removed in time or place from project activities. Short-term impacts occur only during the period of construction or those that are mitigated (i.e., revegetation of disturbed areas) within several growing seasons following construction. Long-term impacts would occur throughout or beyond the life of the project.

Impacts on wooded riparian vegetation are of concern because: (1) it is relatively rare within the Study Area (1.94 percent of the Study Area), (2) it contains wetland areas, and (3) it contains several culturally important vegetation species (e.g., cottonwood, willows). Because of the relatively greater importance of wetlands and riparian biological resources, relatively more effort is made to protect those areas from potential impacts during project development. Individual project areas, i.e. well pads, would be identified and preferentially located away from wetlands and riparian environments. The impacts shown in the following evaluation are thus maximum impacts that potentially could occur due to full development under each alternative, with the actual impacts under any of the alternatives expected to be lower because of the mitigative strategy of avoidance of these habitats.

Impacts on vegetation and wetland resources would be considered significant if the Agency's and Tribe's Preferred Alternative were to seriously affect a resource in the long term. Examples include the following:

- disturbance or contamination of vegetation such that suitable vegetation species could not be reestablished through reclamation;
- high-quality riparian habitat (e.g., multistructured willow or mature cottonwood) is affected to a degree that the function of the habitat is compromised;
- direct or indirect impacts on wetlands that would require mitigation actions through a 404 permit with the U.S. Army Corps of Engineers;
- losses of cultural plant species occur to the extent that they are no longer available for cultural activities; and/or
- widespread, uncontrolled new infestations of noxious weeds occur.

4.3.1.2 Impact Assessment Methods

Impacts on vegetation resources were based on estimates of surface disturbance for each of the alternatives. The amount of surface disturbance for each resource was calculated using GIS resource delineations on a map base that included likely well pad locations. Vegetation categories included grassland/shrubland, Gambel oak scrub, low density piñon-juniper woodland, medium-to-high density piñon-juniper woodland, ponderosa pine forest, and wooded riparian shrub (Map 6).

For mapping purposes, wetlands were represented by the wooded riparian vegetation category (Map 6), although it is recognized that not all wooded riparian vegetation is synonymous with wetland vegetation. Isolated wetlands outside the wooded riparian areas were generally too small (less than 114 acres) to be identified on maps and were not included in the GIS maps. Impacts resulting from the spread of noxious weeds were estimated based on the overall surface disturbances predictions.

For construction-related disturbances, each well pad was assigned a disturbance area of 3.06 acres. The area of surface disturbance for each new well is expected to be 3.06 acres, of which 2 acres would be cleared for the well pad and the remaining 1.06 acres would be cleared for the right-of-way (0.25 mile by 35 feet). The right-of-way would include both roadway and pipeline. With the exception of this new 0.25-mile right-of-way to each to new well pad, it is anticipated that no additional roadways or pipelines would need to be constructed. For production-related disturbances, each well pad was assigned a disturbance area of 2.06 acres, which is based on the assumption that 1 acre of each well pad would be revegetated during production. Existing compressors would be used to the extent possible, and new compressors would be constructed adjacent to existing compressor sites and would therefore not result in additional surface disturbances.

4.3.1.3 Impacts Common to All Alternatives

Impacts on vegetation resources primarily result from the removal of vegetation as a consequence of ground-disturbing activities, although additional impacts could occur from soil compaction, methane seeps, coal fires, and accidental contamination from petroleum or produced (saline) water. Impacts on vegetation are likely to be of greater duration in areas with steep slopes (greater than 30 percent) or erodible soils where reclamation and revegetation activities would be less successful or would require a more substantial effort. The duration of impacts from seeps and coal fires cannot be accurately assessed at this time.

Construction Phase

Vegetation - Direct impacts on vegetation resources (vegetation, wetlands, cultural plant species, noxious weeds) would primarily result from well pads, pipelines, roads, and other support facilities construction during the construction phase of the project . In all cases, surface disturbance would be held to a minimum required to construct and operate the facility, to reduce the area of impact on vegetation resources. Impacts on vegetation from geophysical surveys generally are expected to be localized and short term.

Wetlands - Direct impacts on wetlands from implementation of any of the alternatives would likely result from filling, excavating, clearing, and grading, although, to mitigate such impacts, project planning at initial stages would provide for the avoidance and minimization of impacts on wetland areas wherever possible. Impacts primarily would occur from the construction of linear facilities such as roads and pipelines, which are more difficult to relocate so as to avoid potential impacts on wetlands than are isolated well pads. Impacts would be more severe in areas where roads/pipelines are constructed parallel to riparian systems and longitudinally through riparian vegetation rather than crossing the riparian system at a perpendicular angle, which would decrease the area of disturbance.

Cultural Plant Species - Since cultural plant species are generally distributed throughout the Reservation, avoidance of these species by project activities would be difficult, although minimizing surface disturbances through application of the standard environmental protection criteria and best management practices would reduce potential impacts on these species. The greatest potential threat to cultural plant species is estimated to occur through disturbances to wooded riparian vegetation, which contain known collection sites of several species, including cottonwood, cattails, and willows, that are used for ceremonial purposes. Such impacts would be minimized by providing for the avoidance and minimization of impacts on wetland areas wherever possible.

Noxious Weeds - The spread of noxious weeds can result from ground-disturbing phases of the project. Soil disturbances allow weed seeds that are already present in the soil to germinate and grow without competition from native species. The greatest threat and spread of noxious weeds would come from vehicle use of unsurfaced roads during wet conditions. Weed seeds can be moved from one location to another when mud-containing weed seeds are transported on vehicles. However, for environmental protection purposes the BIA, BLM and SUIT require operators to control noxious weeds in disturbed areas.and during site reclamation, to use seed that is certified free of noxious weed seed.

Production Phase

During the production phase, 1 acre of previously cleared land at each new well pad would be reclaimed and revegetated, thereby reducing the disturbed area at each well pad to 1 acre of cleared land. Rights-of-way containing roads and pipelines would remain during this phase of the project and would not be fully reclaimed until completion of the project.

Vegetation - Areas of surface disturbances incurred during the construction phase will revegetate relatively quickly (i.e., several growing seasons) for certain vegetation types such as grassland/shrubland. Surface disturbances of vegetation types that revegetate slower (i.e., 50 years), such as ponderosa pine forest, Gambel oak scrub, and piñon-juniper woodland, would be replaced initially by grasses and shrubs and would not be expected to return to the pre-disturbance vegetation condition during the production phase.

With implementation of any of the alternatives, indirect impacts on vegetation include the increased potential for vegetation die-off as a result of methane seeps in locations where the Fruitland Formation approaches the surface, i.e., the Hogback in the near outcrop zone. Plant die-off currently occurs in this region in discrete patches associated with relatively high methane seepage. Dewatering at the outcrop is accelerated by increasing the density of wells near the outcrop. A higher density of wells will, eventually, intercept some methane that would have migrated to the surface with a lower density of wells. However, with the minimal number of wells planned in this area and the application of selected mitigation and monitoring activities as described in Section 4.5.1.8, it is anticipated that overall impacts on biological resources from methane in this area would be minimized.

Coal fires in the subsurface at the Fruitland outcrop also have been hypothetically linked to CBM production (see Section 3.4). Vegetation losses near existing coal fires on the Reservation have been confined to the area immediately adjacent to a vent leading to an underground fire. These losses are apparently caused by the heat and toxic fumes from the fires, which may damage either the roots or the subsurface portions of vegetation. However, there is some possibility that a coal fire could start a forest or brush fire on the surface, which could potentially result in much more widespread vegetation loss, although there is no evidence of such an occurrence on the Reservation to date.

Impacts from saline water may occur from accidental leaks during surface handling and transportation of produced water. Most plant species are affected by saline water with electrical conductivities greater than 14 micromhos percentimeter (total dissolved solids [TDS] = 8,260 milligrams per liter [mg/L]) (Richards 1951). Produced water from the Fruitland Formation can be as high as 20,000 mg/L (Ayers et al. 1988), but most is below 8,260 mg/L.

Wetlands - During the production phase, wetlands may be affected indirectly as a result of alterations in the quantity or quality of surface waters, although these indirect impacts are difficult to quantify. Changes to drainage systems could alter the water supply to a wetland or riparian system; likewise, increased sedimentation and salinity from discharges of produced water could adversely affect a wetland system. Wetlands located directly at the outcrop will be affected by a lowering of the water table. Monitoring wells at the outcrop have shown a drop in the water table. Other potential wetland impacts include contamination of water sources from uncontrolled releases of petroleum products and produced water. However, with application of the standard environmental protection measures used during the construction and operation of wells and associated facilities (Page 2-74), as well as specific mitigation measures provided subsequently in this section as well as in the surface water section, these potential impacts would be minimized or prevented, and overall wetland impacts minimized. Disturbed areas of wetland grasses and sedges would be expected to revegetate relatively quickly (i.e., several growing seasons), while shrub wetland species would require a longer time period of at least 10 years.

Cultural Plant Species - Impacts on cultural species during the production phase primarily include the potential for accidental contamination from petroleum or produced water spills, although standard industry operation procedures are designed to minimize these occurrences. Again, a drop in the Fruitland water table could change drainage patterns and affect vegetation, although this has not been studied or quantified.

Noxious Weeds - Infestations of noxious weeds have the potential to increase during the production phase as a result of relatively large amounts of cleared land that have not been reclaimed plus vehicle use during wet conditions, which would spread weed seeds. However, with the application of the specific mitigation measures described in Section 4.3.1. 8, such as weed spraying to reduce production of viable seed, impacts would be significantly lowered.

Abandonment Phase

During the abandonment phase, all well pad sites will be reclaimed and revegetated. Reclamation would involve removal of structures and gravel at well pad sites. Well pads will be recontoured to previous topography as much as feasible and would be reseeded with appropriate native species. No new surface disturbances are anticipated during this phase.

Vegetation - Areas of surface disturbances of vegetation types such as grasslands/shrublands would revegetate relatively quickly (i.e., several growing seasons). Surface disturbances of vegetation types which grow slower, such as ponderosa pine, Gambel oak scrub, and piñon-juniper woodland, would first be replaced by grasses and shrubs and not be expected to return to the pre-disturbance vegetation community for about 50 years.

Wetlands - Wetland mitigation plans will be developed and incorporated to enhance or replace any wetland areas impacted during the abandonment phase. Disturbed areas of wetland grasses and sedges will generally revegetate quickly (i.e., several growing seasons), and woody wetland species would require a longer time period of at least 10 years. If impacts are due to a change in drainage, then replacement of the wetlands in a different location would be considered as a mitigation approach.

Cultural Plant Species - Reclamation and revegetation of disturbed sites will allow for the return of native plant communities, although it is unlikely that some of the more unique culturally important plant species (e.g., Knowlton's cactus, peppermint) would return naturally. The more unique species may require special revegetation techniques for their re-establishment.

Noxious Weeds - A comprehensive weed monitoring and management program is essential for a successful revegetation operation. The spread of weedy species may occur as a result of reclamation activities and the potential use of contaminated hay, mulch, gravel, or straw in the reclamation procedures. Infestations of noxious weeds will be reduced through minimization of surface disturbances and through application of standard environmental protection criteria and best management practices described in Section 4.3.1.8.

4.3.1.4 Alternative 1 - Continuation of Present Management (No Action)

About 269 conventional and 81 CBM production wells would be drilled on tribal land in the Study Area during the 20-year life of the project under the current spacing requirements. This total of 350 new wells would result in a maximum disturbance area of 1,071 acres during the construction phase.

Vegetation - Based on estimates of likely locations of wells (Map 3, and Section 4.1.3.1 for CBM wells and the assumed distribution described in Section 4.1.3.1 for conventional gas wells) and right-of-way construction, potential direct impacts from surface disturbances on all vegetation types of the Study Area for Alternative 1 were calculated and are provided in Table 4-5. Vegetation types that would likely sustain the largest losses on a percentage basis include Gambel oak scrub (1.05 percent, 113 acres), low-density piñon-juniper (0.92 percent, 135 acres), and ponderosa pine forest (1.09 percent, 184 acres). Wooded riparian vegetation, which is one of the more unique vegetation types within the Study Area, would sustain impacts on 46 acres (0.56 percent).

Through the use of existing well pads, impacts on these resources (Gambel oak scrub, low-density piñon-juniper, and ponderosa pine forest) can be reduced to 103 acres (0.96 percent), 116 acres (0.79 percent), and 161 acres (0.95 percent), respectively. Impact on riparian vegetation can be reduced to 42 acres (0.51 percent).

A total of six wells are projected to be developed in the near outcrop zone for Alternative 1. It is difficult to quantify if six new wells would exacerbate the vegetation die off or coal fires. The connection between coal fires and CBM production remains hypothetical. Mitigation that is being tested by the SUIT is the placement of shallow, densely spaced interceptor wells that would capture the methane before it seeps out at the surface.

Wetlands - As shown in Table 4-5, a maximum of 46 acres (0.56 percent of the resource within the Study Area) of wooded riparian vegetation could be potentially impacted by Alternative 1. Wetlands are a subset of wooded riparian sites and wetlands mitigation would involve avoidance of these sites. Another wetland impact is loss of source water due to potential surface water depletions or potential changes in drainage patterns. At a programmatic level, we cannot predict how or where drainage patterns would be altered, but changes in drainage patterns would be minmized and mitigated to the maximum extent possible during individual project layout and design.

It is estimated that Alternative 1 would require a total of up to 18 acre-feet/year for well construction and stimulation. The majority of this water would be produced water that otherwise would be disposed of directly. Fresh water needed for cementing and fracturing at designated extraction points would be acquired from irrigation volumes or from municipal water systems. Additionally, producing CBM wells would intercept about 37 acre-feet/year of Fruitland Formation water that would normally discharge in to the Animas River. This process of interception should not affect wetlands.

Cultural Plant Species - Sites containing culturally important plant species are not specifically mapped at this programmatic level, although they are generally related to specific vegetation types upon which the study area is stratified (Map 6). Because a number of these species are known to occur in wetland areas, impacts on wooded riparian areas are used for comparison purposes; a total of 46 acres (0.56 percent of the resource within the Study Area) of wooded riparian area could be impacted by Alternative 1, as shown in Table 4-5. Potential impacts on cultural species would be mitigated by avoidance of this vegetation type as the first line of mitigation, and by conducting site surveys during project on-site reviews and siting well pads away from important species where practical.

Noxious Weeds - Increased surface disturbance area would be the primary stimulus for noxious weed infestation. Alternative 1 would result in a maximum disturbance area of 1,071 acres during construction. The use of existing well pads has the potential to reduce the total area of surface disturbance to 714 acres. All areas of disturbance would be treated for noxious weeds to destroy infestations and prevent the spread of weeds.

4.3.1.5 Alternative 2 - Coalbed Methane Infill Development

Although of greater magnitude, impacts from Alternative 2 on vegetation resources would be of similar nature to those described for Alternative 1. Alternative 2 involves the construction of a total of 636 new wells and would result in a maximum disturbance of 1,946 acres.

Vegetation - Based on estimates of likely locations of wells (Map 4, and Section 4.1.3.1 for CBM wells and the assumed distribution described in Section 4.1.3.1 for conventional gas wells) and right-of-way construction, maximum direct impacts from surface disturbances on vegetation types of the Study Area for Alternative 2 were calculated and are provided in Table 4-6. Vegetation types that would likely sustain the largest impact on a percentage basis include Gambel oak scrub (2.65 percent, 285 acres), low-density piñon-juniper (3.91 percent, 572 acres), and ponderosa pine forest (3.16 percent, 534 acres). Wooded riparian vegetation, which is one of the more unique vegetation types within the Study Area, could sustain a maximum impact of 168 acres (2.06 percent) if not avoided (see Section 4.3.1.1).

Through the use of existing well pads, impacts on these resources (Gambel oak scrub, low-density piñon-juniper, and ponderosa pine forest) can be reduced to 272 acres (2.53 percent), 518 acres (3.55 percent), and 509 acres (3.01 percent), respectively. Impacts on riparian vegetation would be reduced to 164 acres (2.01 percent), and avoidance of riparian habitats during project planning would further reduce the extent of potential riparian impact.

A total of 37 wells are projected to be developed in the near outcrop zone for Alternative 2. It is difficult to quantify if 37 new wells would exacerbate the vegetation die off or coal fires. The connection between coal fires and CBM production remains hypothetical. Mitigation that is being tested by the SUIT is the placement of shallow, densely spaced interceptor wells that would capture the methane before it seeps out at the surface.

Wetlands - As shown in Table 4-6, a maximum of 168 acres (2.06 percent of the resource within the Study Area) of wooded riparian vegetation could be potentially impacted by Alternative 2. Wetlands are a subset of wooded riparian sites and wetlands mitigation would involve avoidance of these sites. Another wetland impact is loss of source water due to potential surface water depletions or potential changes in drainage patterns At a programmatic level, we cannot predict how or where drainage patterns would be altered, but changes in drainage patterns would be minmized and mitigated to the maximum extent possible during individual project layout and design.

It is estimated Alternative 2 would require a total of up to 25 acre-feet/year for well construction and stimulation. The majority of this water would be produced water that otherwise would be disposed of directly. Fresh water needed for cementing and fracturing at designated extraction points would be acquired from irrigation volumes or from municipal water systems. Additionally, producing CBM wells would intercept about 37 acre-feet/year of Fruitland Formation water that would normally discharge in to the Animas River. This process of interception should not affect wetlands.

Table 4-5
Anticipated Surface Disturbance Impacts on Vegetation Resources
from Alternative 1 - Continuation of Present Management (No Action)

Table 4-6
Anticipated Surface Disturbance Impacts on Vegetation Resources from Alternative 2 - Coalbed Methane Infill Development
11 x 8 ½
1 page
Landscape

Cultural Plant Species - Sites containing culturally important plant species are not specifically mapped at this programmatic level, although they are generally related to specific vegetation types upon which the Study Area is stratified (Map 6). Because a number of these species are known to occur in wetland areas, impacts on wooded riparian areas are used for comparison purposes; a total of 46 acres (0.56 percent of the resource within the Study Area) of wooded riparian area could be impacted by Alternative 2, as shown in Table 4-6. Potential impacts on cultural species would be mitigated by avoidance of this vegetation type as the first line of mitigation, and, secondly, by conducting site surveys during project on-site reviews and siting well pads away from important species where practical.

Noxious Weeds -. Increased surface disturbance area would be the primary stimulus for noxious weed infestation. Alternative 2 would result in a maximum disturbance area of 1,946 acres. The use of existing well pads has the potential to reduce the total area of surface disturbance to 1,306 acres. All areas of disturbance would be treated for noxious weeds to destroy infestations and prevent the spread of weeds.

4.3.1.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

Although of slightly greater magnitude, impacts from Alternative 3 on vegetation resources would be similar to those described for Alternative 2. Alternative 3 involves the construction of a total of 706 new wells on tribal land and would result in a maximum disturbance of 2,160 acres.

Vegetation - Based on estimates of likely locations of wells (Map 4, and Section 4.1.3.1 for CBM wells and the assumed distribution described in Section 4.1.3.1 for conventional gas wells) and right-of-way construction, direct impacts from surface disturbances on vegetation types of the Study Area for Alternative 3 were calculated and are provided in Table 4-7. Vegetation types that would likely sustain the largest impact on a percentage basis include Gambel oak scrub (2.71 percent, 291 acres), low-density piñon-juniper woodland (4.00 percent, 585 acres), and ponderosa pine forest (3.24 percent, 548 acres). Wooded riparian vegetation, which is one of the more unique vegetation types within the Study Area, would sustain a maximum potential impact of 171 acres (2.10 percent) but would be preferentially avoided during project layout (see Section 4.3.1.1) to reduce these impacts. Through the use of existing well pads, maximum impacts on Gambel oak scrub, low-density piñon-juniper woodland, and ponderosa pine forest can be reduced to 276 acres (2.57 percent), 525 acres (3.59 percent), and 515 acres (3.05 percent), respectively. Potential reduction in disturbances for other vegetation resources from the use of existing well pads also are provided in Table 4-7.

Although potential impacts from increased methane seepage and coal fires in the near outcrop zone are difficult to estimate, it is assumed that an increased number of wells in the near outcrop zone has the potential to increase the methane seep or coal fire impacts. A total of 37 wells are projected to be developed in the near outcrop zone for Alternative 3.

Table 4-7
Anticipated Surface Disturbance Impacts on Vegetation Resources from Alternative 3 - Enhanced Coalbed Methand Recovery (Proposed Action)
11 x 8 ½
1 page
Landscape

Wetlands - As shown in Table 4-7, a maximum of 171 acres (2.10 percent of the resource within the Study Area) of wooded riparian vegetation could be potentially impacted by Alternative 3. Wetlands are a subset of wooded riparian sites and wetlands mitigation would involve avoidance of these sites wherever possible. Another wetland impact is loss of source water due to potential surface water depletions or changes in drainage patterns. At a programmatic level, we cannot predict how or where drainage patterns would be altered, but changes in drainage patterns would be mitigated to the maximum extent possible during individual project layout and design.

It is estimated Alternative 3 would require a total of up to 27 acre-feet/year for well construction and stimulation. The majority of this water would be produced water that otherwise would be disposed of directly. Fresh water needed for cementing and fracturing at designated extraction points would be acquired from irrigation volumes or from municipal water systems. Additionally, producing CBM wells would intercept about 37 acre-feet/year of Fruitland Formation water that would normally discharge in to the Animas River. This process of interception should not affect wetlands.

Cultural Plant Species - Sites containing culturally important plant species are not specifically mapped at this programmatic level, although they are generally related to specific vegetation types upon which the Study Area is stratified (Map 6). Because a number of these species are known to occur in wetland areas, impacts on wooded riparian areas are used for comparison purposes; a total of 171 acres (2.10 percent of the resource within the Study Area) of wooded riparian area could be impacted by Alternative 13, as shown in Table 4-7. Potential impacts on cultural species would be mitigated by avoidance of this vegetation type as the first line of mitigation, and, secondly, by conducting site surveys during project on-site reviews and siting well pads away from important species where practical.

Noxious Weeds - The principal potential impact that would affect the spread of noxious weeds is the increased area of surface disturbance. Alternative 3 would result in a maximum disturbance area of 2,160 acres. The use of existing well pads has the potential to reduce the total area of surface disturbance to 1,410 acres. All areas of disturbance would be treated for noxious weeds to destroy infestations and prevent the spread of weeds.

4.3.1.7 Impacts Summary

Surface disturbance such as well pad and road construction would have the greatest impact on vegetation resources (vegetation, wetlands, cultural plant species, and noxious weeds). Vegetation types that would sustain proportionally the largest area of disturbance include Gambel oak scrub, low- density piñon-juniper woodland, and ponderosa pine forests; maximum areas of disturbance (Alternative 3) for these vegetation types are 291 acres (2.71 percent), 585 acres (4.00 percent), and 548 acres (3.24 percent), respectively. However, use of existing well pads, where available, would reduce the area of surface disturbance in the case for all alternatives. The maximum impact on wooded riparian vegetation could be 171 acres (2.10 percent) under Alternative 3, but is expected to be lower because wooded riparian vegetation tends to grow in relatively small areas that would be preferentially avoided to the extent possible when locations for individual projects are determined.

The 3M Reservoir Model predicts that methane seepage at the outcrop will increase over the levels seen today. The model results indicate that methane seepage rates may actually decrease if wells are on a 160-acre spacing instead of 320-acre spacing. For Alternative 1, six wells are projected to be developed in the near outcrop zone, and 37 wells are projected to be developed in the near outcrop zone for both Alternatives 2 and 3.

Potential impacts of wetland losses from surface water depletions are difficult to quantify. Extended over the 20-year period covered by this EIS, the expected annual maximum water use requirement for well construction and stimulation associated with Alternative 2 is 25 acre-feet/year (Table 4-23). The expected annual maximum water use requirement for Alternative 3 is 27 acre-feet/year. The water use requirement for Alternative 1 would be less, about 18 acre-feet/year. Because water for drilling and stimulation would be acquired from existing irrigation sources, although it is possible that some water may be acquired from local streams, ponds and formations, significant well construction related water depletion impacts are not anticipated.

Additionally, the 3M Study estimates that CBM gas production within the Study Area will intercept about 37 acre-feet of Fruitland Formation water that would normally discharge into the Animas River. This amount of water is not presently measurable in-stream and is not anticipated to significantly impact fish habitat or agricultural use.

For comparison purposes, the average annual runoff in the Animas River near Cedar Hill, New Mexico (2.5 miles upstream from the Colorado-New Mexico state line) for period 1934 to 1996 was 671,700 acre-feet (USGS 1996). The 3M (Monitoring, Mapping, and Mitigation) project will continue to monitor the situation and report to the participating agencies, the public, and the Fish and Wildlife Service any changes, particularly increases, in the calculated depletion.

Future depletions will occur as the regional pressure in the Fruitland Formation drops below the water level in the Anima River where it crosses the Fruitland /Pictured Cliffs. The BLM and Groundwater Protection Research Foundation are studying the magnitude of future depletions.

Additional surface water depletions appear to be associated with the dropping of the water table at the outcrop. While there is no clear cause and effect relationship, Soda Springs went dry simultaneously with CBM development. Other springs, seeps, and wetlands are likely to dry up with continued CBM development. Each alternative will have a similar impact, but denser well spacing and more rapid development will accelerate the onset of these impacts.

Potential impacts on cultural plant species also are difficult to estimate at a programmatic scale; mitigation measures are applied during project planning and involve avoidance of entire habitats, such as wetlands, and avoidance of individual plants and species through careful siting of facilities. Because a number of cultural plant species are known to occur in wetland areas, surface disturbance impacts on wooded riparian areas are used for comparison purposes.

Maximum impacts on wooded riparian vegetation from Alternatives 1, 2, and 3 include 46 acres, 168 acres, and 171 acres, respectively, but would be expected to be lower under each alternative because individual projects could selectively avoid wetlands and wooded riparian areas. Like wetlands, some cultural species could be impacted by reductions in surface water or changes in drainage patterns due to production of water from the Fruitland Formation. The 3M study showed that wetlands and springs on the outcrop may dry up. Within the Basin, it is highly unlikely that any surface water sources will be affected by CBM water withdrawals.

Project impacts that would affect the spread of noxious weeds generally are correlated to the area of surface disturbance and continued vehicle use of unsurfaced roads and well pads during wet weather. Alternatives 1, 2, and 3 would result in a maximum disturbance of 1,071 acres, 1,946 acres, and 2,160 acres, respectively. The use of existing well pads, as compared to constructing new well pads, has the potential to reduce the surface disturbance area to about 714 acres, 1,306 acres, and 1,410 acres, respectively. Aggressive noxious-weed control immediately following site disturbance, and continuous control thereafter, should prevent widespread weed infestations.

4.3.1.8 Mitigation Summary

The Tribe, BIA, and BLM have developed additional standard environmental protection measures that apply to well site development and right-of-way construction (see Appendix E). The following text describes mitigation and environmental protection measures that are specific to vegetation, wetlands, cultural plant species, and noxious weeds.

<u>Vegetation</u>

- Avoid areas containing sensitive vegetation types, such as wooded riparian vegetation or known sites with culturally important plants, to the fullest extent possible. *(Mitigation developed from SUIT EIS.)*

- Reclaim and revegetate all disturbed areas of soil with approved, certified weed free seed mixes, fertilizer, and/or mulch. *(Based on Existing Policy or Regulation.)*

- Separate topsoil and set aside for reclamation purposes. *(Based on existing policy or regulation.)*

- Limit construction activities to dry conditions to reduce soil compaction and rutting, as appropriate. *(Based on existing policy or regulation.)*

- Use spark arresters on chainsaws and mufflers on vehicles to prevent wildland fires. Burning brush, trash, scrap materials, etc. is restricted by state agency or Reservation rules. *(Based on existing policy or regulation.)*

- Apply herbicide only under the supervision of a licensed pesticide applicator, and ensure that application, storage, and disposal procedures meet state and federal requirements. *(Based on existing policy or regulation.)*

- Clean up spills of petroleum products or produced water in an appropriate manner as soon as possible to minimize damage to plant materials. *(Based on existing policy or regulation.)*

- Control erosion and sedimentation with best management practices. *(Based on existing policy or regulation.)*

Wetlands (see **Surface Water** Section also)

- Avoid construction in wetlands to the fullest extent possible. *(Mitigation developed from SUIT EIS.)*

- 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. *(Mitigation developed from SUIT EIS.)*

- 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 best management practices at any temporary stream crossings, and rehabilitate wetlands as soon as possible. *(Mitigation developed from SUIT EIS.)*

- Protect water quality within, and downstream of, the Study Area from soil erosion and sedimentation by best management practices 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. *(Mitigation developed from SUIT EIS.)*

- Conduct equipment fueling, maintenance, and storage operations at least 100 yards from any wetland or stream system. *(Mitigation developed from SUIT EIS.)*

Cultural Species

- Avoid disturbing areas containing culturally significant plant species (e.g., cottonwood trees along the Pine River). *(Mitigation developed from SUIT EIS.)*

Noxious Weeds

- Monitor invasive species populations. *(Mitigation developed from SUIT EIS) and (Based on existing policy or regulation.)*

- Use Best Management Practices to minimize the introduction of invasive species. *(Mitigation developed from SUIT EIS and (Based on existing policy or regulation.)*

- Require operators to control noxious weeds in disturbed areas. *(Based on Existing Policy or Regulation)*

- For site reclamation, use seed that is certified free of noxious weed seed. *(Based on Existing Policy or Regulation)*

4.3.1.9 Unavoidable Adverse Impacts

Unavoidable adverse vegetation impacts include those that would remain for the life of the project (about 20 years), such as well pads, new roads, and new pipelines. Lost wooded riparian vegetation areas are of the greatest concern due to their rarity within the Study Area and value as wildlife habitat, and because they are a source of materials for cultural activities.

4.3.2 Wildlife and Fisheries

4.3.2.1 Issues, Impact Types, and Criteria

Under all of the alternatives, it is anticipated that wildlife would be impacted through a variety of disturbance regimes. These would include direct habitat loss through surface disturbance resulting from the development of roads, pipelines and well pads, loss of security through increased human presence within the associated habitats, a reduction in water quality from development related activities, as well as potential changes in the quantity and timing of water movement through the project area drainage systems.

The Study Area provides a broad range of habitat opportunities for a variety of wildlife species. The potential impacts on these individual species will vary significantly based on the ecology of the species, availability of suitable habitats within the Study Area, and species sensitivity to project related disturbance regimes. For example deer and elk would be lose foraging habitat resulting from road and well pad construction, as well as a loss of security resulting from the increased human presence within their habitats during the construction and production/maintenance phases. This latter disturbance, for many species, may result in an overall loss of viable habitat much higher than that represented by the surface disturbance alone. Other species, such as the reptile group, which have more local site fidelity and less sensitivity to human presence, may be most affected by the direct loss of suitable habitat through project related surface disturbance.

Based on criteria developed by SUIT, impacts on wildlife would be considered significant if 60 percent of any critical wildlife range would be affected, either through removal of vegetation or disturbance from noise and activity, provided that the project would involve minimal road construction. If it is anticipated that the project would require more substantial road construction, then the significance level would be more stringent and impacts on wildlife would be considered significant if 40 percent of any critical wildlife range would be affected, either through the removal of vegetation or disturbance from noise and activity (Stroh, 1997, pers. comm.).

4.3.2.2 Impact Assessment Methods

Three analysis approaches were used in the examination of potential wildlife effects that could be expected through the implementation of the proposed project alternatives. A Biological Assessment was conducted to determine the potential project effects to USFWS's listed threatened and endangered species. A Biological Evaluation was performed to determine potential impacts on BLM, tribal and State sensitive species. Additionally, an analysis of indicator species was conducted to characterize the potential project effects to the large number of "non-sensitive" wildlife species that use the various habitats types found within the proposed project area.

Potential habitat losses for terrestrial species would occur through direct habitat loss from surface disturbance and, for many species, a reduction in usation of adjacent intact habitats resulting from the disturbances associated with increased human presence during the construction and production phases. As discussed in Section 4.3.1.2 each new well site would represent an estimated surface disturbance of 4.06 acres for well pads, access roads and associated pipelines during the construction phase. Approximately 1 acre at each well pad would be reclaimed during the production phase. This may allow for some usation of previously disturbed acres by some wildlife species during the production phase, especially in grassland/shrubland vegetative type. However, for many species the structural characteristics necessary for viable habitat would not be functionally restored in these reclaimed areas during the life of the project.

Effects to aquatic species could occur through changes in the timing and volume of water moving through the analysis area drainage systems. Aquatic species could also be affected by decreases in water quality resulting from increased sedimentation, as well as increased risks of pollution associated with gas development activities. The removal of water from the Fruitland Formation could affect some terrestrial wildlife, as well, particularly if wooded riparian areas are impacted.

The area of disturbance for wildlife indicator species differs from deer and elk and is a function of each species sensitivity to human disturbance. The disturbance factors for each indicator species is discussed in Section 4.3.2.7.

4.3.2.3 Impacts Common to All Alternatives

Construction Phase

Wildlife would be impacted directly by loss of habitat, through the removal of vegetation for well pads, roads, pipelines, and other facilities. In addition to habitat directly removed by construction, larger habitat areas would be impacted due to human intrusion and noise resulting in the disturbance and displacement of individual animals. The extent of effects on wildlife would depend on the animal species, the type and quantity of vegetation removed, and the period of disturbance. Habitat changes due to loss of remoteness or security are difficult to estimate for all species because species differ in their tolerance to intrusion.

Wildlife - Vegetation losses would affect elk and mule deer populations by changes in forage availability and a reduction in thermal and hiding cover, and are of greater concern in unique and important areas, such as calving, fawning, and winter habitats. However, the most serious impact from increased well densities within wildlife habitats is likely to be the greater disturbance levels associated with increased construction activity, human intrusion, and additional roads and traffic. Elk have been known to be disturbed by human activities within 0.5 mile, although topography and vegetation can act as buffers and may affect this distance (Hayden-Wing Associates 1990). Deer acclimate reasonably well to disturbances such as low levels of vehicular traffic and appear to avoid areas within 660 feet of roads (Rost and Bailey 1979). Linear facilities such as roads and pipelines have the potential to cause a greater impacts on wildlife habitat than well sites since a more extensive area would be affected.

Disturbances associated with energy extraction activities are known to produce altered patterns of range use and movement by large ungulates (Kluck et al. 1985). Responses of elk to installation of oil wells suggest that elk compensate for disturbances through shifts in use of range and activity centers, rather than abandonment of range, provided that the activity occupies a relatively small portion of total range of the population (Van Dyke and Klein 1996). Physiological responses to disturbances can include elevated heart and respiration rates, increased disease frequency (Ward and Cupal 1979), reduced reproduction rates and smaller body size (Douglas 1971). Therefore, level of disturbance plays a critical role in over-winter survival for elk and deer. Since elk and deer cannot consume enough calories in the winter to meet their daily minimum requirements, they depend on stored fat reserves for their metabolic needs. Even minimally disruptive actions and disturbances associated with project activities can adversely affect elk and deer populations. Any affect on deer or elk populations would also have an indirect impact on recreational aspects of those populations (e.g., hunting, photographic opportunities).

Habitat loss and disturbance from construction impacts other wildlife species (see Section 4.3.2.7). Impacts on wooded riparian vegetation likely would affect a large number of species, including small mammals, birds, reptiles, and amphibians that use this habitat for feeding, breeding, and resting. Within other more common habitat types, such as piñon-juniper, most individuals displaced by construction probably would find new habitat in adjacent areas. Direct mortality may occur on the roads and during the construction phase, particularly among species that inhabit burrows or take refuge in burrows if alarmed. Losses of locally important resources, such as maternity dens or concentrated feeding areas, may result in local population declines of some species.

Unless a nest is directly removed by construction, impacts on raptors would result primarily from noise disturbances, human intrusion and vehicle activity. Raptors are sensitive to disturbance in nesting areas during the breeding season and may abandon eggs or young as a consequence of nearby activity (Section 4.3.2.7).

Fisheries - Fish populations in the Study Area, as well as downstream of the Study Area, could be affected by any reduction in the quantity and quality of the surface waters of the Study Area. Both the well drilling and stimulation processes use water, although water requirements should be met by appropriated agricultural sources and therefore should not impact fisheries through stream depletions. Fish populations could be affected adversely by contamination of surface waters from accidental spills or leakage of petroleum products from vehicles. Indirect impacts on aquatic systems could occur from erosion, and subsequent sedimentation, resulting from increased surface disturbances in the Study Area. Fish could be impacted directly from sedimentation of gravel spawning beds, as well as indirectly impacted by depletion of food sources such as mayflies, caddisflies, and stoneflies that inhabit the interstitial spaces of stream beds.

<u>Production Phase</u>

Wildlife - No additional surface disturbance impacts (e.g., habitat losses) generally are expected to occur to wildlife resources during the production phase. During this phase, 1 acre of land at each new well site would be reclaimed and revegetated with grass species, leaving about 2 acres of well pad remaining. Revegetated areas are expected to provide forage for elk and deer within several growing seasons. Surface disturbances of vegetation types which would revegetate slower (i.e., 35 to 50 years), such as ponderosa pine forest and piñon-juniper woodland, would not be expected to return to the pre-disturbance vegetation community during the production phase.

Direct impacts on wildlife ranges during this phase include the increased potential for disturbance of habitats as a result of project operation and maintenance activities. The zone of disturbance for elk and deer can be expected to extend for a 0.25-mile radius from a well site, road, or compressor station. Zones of disturbance for indicator species are presented in Section 4.3.2.7. During this phase, disturbances would occur from production and maintenance activities at well sites and compressor stations and from traffic to and from those sites. Maintenance visits at compressor stations typically are frequent and can be as often as two to five vehicle visits per day for some of the larger compressors, although the majority of the compressors each require five to seven visits per week.

Other concerns for wildlife during this phase are the increased potential for the presence of methane and hydrogen sulfide gas in soils, and coal fires in the near outcrop zone. Plant die-off currently occurs in some localized areas of the near outcrop zone, possibly as a result of methane or other gases in the soil depriving the plants' roots of oxygen. Although gas seeps appear to be localized, it is possible, though not proven, that ground-burrowing mammals that are present in the vicinity of the seeps have been killed through contact with the methane and hydrogen sulfide.

Fisheries - Potential impacts on aquatic species are similar to those described in the construction phase, with the addition of accidental leakage of produced (saline) water into local streams during this phase of the project. Produced water from the Fruitland Formation may have a TDS as high as 20,000 mg/L, but are generally less than 8,000 mg/L. Lakes with dissolved solids in excess of 15,000 mg/L generally are considered unsuitable for most freshwater fishes (Rawson and Moore 1944). Depletion of surface water would also occur as a result of CBM gas wells intercepting groundwater that would normally discharge in to the Animas River. Aquatic populations also could be affected adversely by contamination of surface waters from accidental petroleum product spills. Fluids containing PAHs, which are known carcinogens, would be limited to fuels and some lubricants, and are not contained in the methane. A study conducted in the New Mexico portion of the San Juan Basin concluded that oil and gas development activities do not contribute to PAH contamination of the San Juan River drainage. Therefore, there is little potential for PAH contamination of fisheries within and downstream of the Study Area.

Abandonment Phase

Wildlife - No additional surface disturbances of wildlife habitats are anticipated during this phase. Surface disturbances of grasslands/shrublands would be revegetated relatively quickly (i.e., several growing seasons). Surface disturbances of vegetation types that would grow slower, such as ponderosa pine and piñon-juniper, would be first replaced by grasses and shrubs, but would not be expected to return to the pre-disturbance vegetation community for about 35 to 50 years. Disturbance effects associated with abandonment and reclamation activities would cause short-term disturbance impacts on nearby wildlife.

Fisheries - Except for the possibilities for erosion and sedimentation resulting from grading and reclamation activities, no new impacts are expected to occur to aquatic species during the abandonment phase.

4.3.2.4 Game Species

Deer and elk - Under Alternative 1, 269 conventional and 81 CBM production wells would be drilled under the present management program. Therefore, a total of 350 wells could be drilled, which would result in a maximum disturbance area of 1,071 acres. Direct impacts from surface disturbances (vegetation removal) on deer and elk ranges of the Study Area for Alternative 1 were based on estimates of likely locations of wells and right-of-way construction (Table 4-8). Ranges that would likely sustain the largest losses on a percentage basis include elk summer range (0.50 percent, 367 acres) and elk winter concentration areas (0.27 percent, 138 acres). The ranges that generally are considered to be the most sensitive to disturbance include elk and deer winter concentration areas (Maps 7 and 8). Within the deer winter concentration area, 135 acres (0.19 percent) would be disturbed. Compared to regional values for wildlife ranges, direct impacts on elk winter concentration areas from vegetation removal would impact 0.27 percent of the regional range. Regional values for elk summer range were not available.

Surface disturbance impacts have the potential to be reduced by constructing new wells on existing well pads. Using this method, elk summer range surface impacts can be reduced to 246 acres (0.34 percent), elk winter concentration areas to 84 acres (0.17 percent), deer winter concentration areas to 96 acres (0.13 percent) (Table 4-8), and wooded riparian habitats to 42 acres (0.51 percent) (Table 4-5).

During construction, short-term disturbance impacts are expected to result from noise and activity associated with drilling and construction operations and are considered to extend 0.5 mile from an activity at a well pad or road. Therefore, deer and elk ranges that would experience some of the larger construction/drilling disturbance impacts in a given year include elk summer range (4.11 percent) and elk winter concentration areas (2.22 percent) (Table 4-9). During production, long-term disturbance impacts are expected to result from operations and maintenance activities and are considered to extend 0.25 mile from an activity at a well site or road. Therefore deer and elk ranges that would experience some of the larger operation/maintenance disturbance impacts, assuming full buildout, include elk summer range (20.45 percent) and elk winter concentration areas (11.04 percent) (Table 4-9). Noise disturbances are estimated to occur in 23.0 percent (1,875 acres) of the wooded riparian habitat.

The combined effects from construction/drilling/maintenance/operation in a given year indicate that elk summer range (24.56 percent) and elk winter concentration areas (12.90 percent) would probably experience the largest disturbances on a percentage basis. Regional values for elk and deer summer ranges were not available.

Indirect impacts could occur from increased non-project-related traffic on well-site access roads, or from coal fires and methane seeps. Because well access roads are likely to be short, dead end roads, they should not contribute to substantially increased non-gas-industry traffic. Although potential indirect impacts from increased methane seepage in the near outcrop zone are difficult to estimate, an increased number of wells in the near outcrop zone may increase localized methane seep impacts. Six wells are projected to be developed in the near outcrop zone under Alternative 1. It is difficult to estimate if six additional wells will increase vegetation die off.

Although of greater magnitude, impacts from Alternative 2 on deer and elk and fisheries resources would be similar to those described for Alternative 1. Alternative 2 involves the construction of a total of 636 new wells and would result in a maximum disturbance of 1,946 acres. Project construction generally would occur throughout the central and eastern regions of the Study Area, which contains elk winter range, elk severe winter range, and elk winter concentration areas (Map 7), as well as some deer winter and severe winter ranges (Map 8). The primary area in which development would occur avoids deer and elk migration routes as well as the majority of deer winter concentration areas.

Direct impacts on deer and elk ranges of the Study Area for Alternative 2 were based on estimates of likely locations of CBM wells (Map 3), conventional wells (Section 4.1.3.1) and right-of-way construction (Table 4-10). Ranges that would likely sustain the largest losses on a percentage basis include elk summer range (1.2 percent, 881 acres) and elk winter concentration areas (0.63 percent, 321 acres). Wildlife ranges that are generally considered to be the most sensitive to disturbance include elk and deer winter concentration areas (Maps 7 and 8). Within the deer winter concentration area, 147 acres (0.20 percent) would be disturbed.

Compared to regional values for wildlife ranges, a total of 0.63 percent of the regional range would be directly impacted by vegetation removal. (Table 4-10). Regional values for elk summer range were not available.

Surface disturbance impacts have the potential to be reduced by constructing new wells on existing well pads. This mitigation approach will be used wherever practical. As such, elk summer range surface impacts can be reduced to 590 acres (0.80 percent), elk winter concentration areas to 245 acres (0.48 percent), and deer winter concentration areas to 118 acres.

Ranges that are expected to experience some of the larger construction/drilling disturbance impacts in a given year as a result of Alternative 2 include elk summer range (9.87 percent) and elk winter concentration areas (5.18 percent) (Table 4-11). During production, wildlife ranges that are anticipated to experience some of the larger operation/maintenance disturbance, assuming full buildout, include elk summer range (49.07 percent), elk winter concentration areas (25.75 percent), and deer summer range (19.03 percent) (Table 4-11). Noise disturbances are estimated to occur in 100 percent of the wooded riparian habitat.

The combined effects of construction/drilling and maintenance/operation shown in Table 4-11 indicate that elk summer range and elk winter concentration areas would experience the largest disturbances on a percentage basis. The combined disturbance for elk winter concentration areas (58.94 percent) would more than likely approach but not exceed the 60 percent threshold level without mitigation. As shown in Table 4-11, compared to regional wildlife ranges, combined impacts on elk winter concentration areas would total 14.0 percent of the regional range. Regional values for elk and deer summer ranges were not available.

The 3M Reservoir Model predicts that methane seepage at the outcrop will increase over the levels seen today. The model results indicate that methane seepage rates may actually decrease if wells are on a 160-acre spacing instead of 320-acre spacing. A total of 37 wells are projected to be developed in the near outcrop zone for Alternative 2.

Impacts of Alternative 3 on deer and elk and fisheries resources are estimated to be similar to and only of slightly greater magnitude than those described for Alternative 2.

Table 4-8
Anticipated Impacts from Surface Disturbance (Vegetation Removal) on Wildlife Resources from Alternative 1 - Continuation of Present Management (No Action)
11 x 8 ½
1 page
Landscape

Table 4-9
Anticipated Disturbance Impacts from Construction and Operation Activities on Wildlife Resources
from Alternative 1 - Continuation of Present Management (No Action)
11 x 8 ½
1 page
Landscape

Table 4-10
Anticipated Impacts from Surface Disturbance (Vegetation Removal) on Wildlife Resources from Alternative 2 - Coalbed Methane Infill Development

Table 4-11
Anticipated Noise/Human Activity Disturbance Impacts from Construction and Operation Activities on Wildlife Resources from Alternative 2 - Coalbed Methane Infill Development
11 x 8 ½
1 page
Landscape

Alternative 3 involves the construction of a total of 706 new wells and would result in a maximum disturbance of 2,160 acres. Project construction generally would occur throughout the central and eastern regions of the Study Area, which contains winter range, severe winter range, and winter concentration areas for elk (Map 7), as well as some winter and severe winter ranges for deer (Map 8). The primary development areas generally would avoid deer and elk migration routes as well as the majority of deer winter concentration areas (Maps 7 and 8).

Direct impacts of surface disturbances (vegetation removal) on wildlife ranges of the Study Area for Alternative 3 were based on estimates of likely locations of CBM wells (Map 3), conventional wells (Section 4.1.3.1), and right-of-way construction (Table 4-12). Ranges that would likely sustain the largest losses on a percentage basis include elk summer range (1.30 percent, 958 acres) and elk winter concentration areas (0.68 percent, 346 acres). Wildlife ranges that are the most unique to the Study Area and generally considered to be the most sensitive to disturbance include elk and deer winter concentration areas (Maps 7 and 8). Within the deer winter concentration area, 150 acres (0.21 percent) would be disturbed. Compared to regional values for wildlife ranges, direct impacts on elk winter concentration areas from vegetation removal would impact 0.31 percent of the regional range (Table 4-12). Regional values for elk and deer summer ranges were not available.

Surface disturbance impacts have the potential to be reduced by constructing new wells on existing well pads, which will be done wherever practical. Using this method, elk summer range surface impacts can be reduced to 624 acres (0.85 percent), elk winter concentration areas to 257 acres (0.50 percent), and deer winter concentration areas to 117 acres (0.16 percent) (Table 4-12).

During construction, wildlife ranges that would experience some of the larger construction/drilling disturbance impacts in a given year include elk summer range (10.73 percent) and elk winter concentration areas (5.58 percent) (Table 4-13). During production, ranges that would experience some of the larger operation/maintenance disturbance impacts in a given year, assuming full buildout include elk summer range (53.33 percent), elk winter concentration areas (27.70 percent) (Table 4-13).

The combined effects from construction/drilling and maintenance/operations indicate that elk summer range and elk winter concentration areas are anticipated to experience the largest disturbances on a percentage basis (Table 4-13). The combined disturbances for elk summer range (64.06 percent) is anticipated to exceed the 60 percent threshold level if no mitigation is implemented. Compared to regional wildlife ranges, combined impacts on elk winter concentration areas would equal 15.06 percent of the regional range (Table 4-13). Regional values for elk and deer summer ranges were not available.

The 3M Reservoir Model predicts that methane seepage at the outcrop will increase over the levels seen today. The model results indicate that methane seepage rates may actually decrease if wells are on a 160-acre spacing instead of 320-acre spacing. For Alternative 3, 37 wells are projected to be developed in the near outcrop zone.

Aquatic species - Fish populations in the Study Area, as well as downstream of the Study Area, could be affected by any reductions in the quantity and quality of the surface waters of the Study Area.

Produced water from the Fruitland Formation may have a TDS as high as 20,000 mg/L, but is typically less than 8,000 mg/L. Lakes with dissolved solids in excess of 15,000 mg/L generally are considered unsuitable for most freshwater fishes (Rawson and Moore 1944). Fish populations also could be affected adversely by contamination of surface waters from accidental petroleum product spills. Fluids containing PAHs, which are known carcinogens, would be limited to fuels and some lubricants, and are not contained in the methane. A study conducted in the New Mexico portion of the San Juan Basin concluded that oil and gas development activities do not contribute to PAH contamination of the San Juan River drainage. Therefore, there is little potential for PAH contamination of fisheries within and downstream of the Study Area.

Indirect impacts on aquatic systems could occur from erosion, and subsequent sedimentation, resulting from increased surface disturbances in the Study Area. Fish could be impacted directly from sedimentation of gravel spawning beds, as well as indirectly impacted by depletion of food sources such as mayflies, caddisflies, and stoneflies that inhabit the interstitial spaces of streambeds. Indirect impacts may occur from erosion and sedimentation as a result of surface disturbances. However, for the three alternatives, mitigation and environmental protection measures outlined in sections 4.3.1.8, 4.4.2.8 and Appendix E should minimize erosion by providing for aggressive revegetation of disturbed soils and using best management practices designed to check erosion before entering water courses. The BLM is engaged in formal consultation with the USFWS on effects to endangered fish species in the San Juan River.

Both the well drilling and stimulation processes use water. Extended over the 20-year period covered by this EIS, the expected annual maximum water use requirement for well construction and stimulation associated with Alternative 2 is 25 acre-feet/year (Table 4-23). The expected annual maximum water use requirement for Alternative 3 is 27 acre-feet/year. The water use requirement for Alternative 1 would be less, about 18 acre-feet/year. Because water for drilling and stimulation would be acquired from existing irrigation sources, although it is possible that some water may be acquired from local streams, ponds and formations, significant well construction related water depletion impacts are not anticipated.

Additionally, the 3M Study estimates that CBM gas production within the Study Area will intercept about 37 acre-feet of Fruitland Formation water that would normally discharge into the Animas River. This amount of water is not presently measurable in-stream and is not anticipated to significantly impact fish habitat or agricultural use.

For comparison purposes, the average annual runoff in the Animas River near Cedar Hill, New Mexico (2.5 miles upstream from the Colorado-New Mexico state line), for the period 1934 to 1996, was 671,700 acre-feet (USGS 1996). The 3M (Monitoring, Mapping, and Mitigation) project will continue to monitor the situation and report to the participating agencies, the public, and the Fish and Wildlife Service any changes, particularly increases, in the calculated depletion.

Table 4-12
Anticipated Impacts from Surface Disturbance (Vegetation Removal) on Wildlife Resources from Alternative 3 - Enhanced Coalbed Methane Recovery (Proposed Action)
11 x 8 ½
1 page
Landscape

Table 4-13
Anticipated Noise/Human Activity Disturbance Impacts from Construction and Operation Activities on Wildlife Resources From Alternative 3 - Enhanced Coalbed Methane Recovery (Proposed Action)
11 x 8 ½
1 page
Landscape

4.3.2.5 OTHER GAME SPECIES

Black Bear: Although the black bear may be conditioned to lose their fear of humans, they are basically intolerant of human disturbance, particularly during the early stages of cub rearing. This species uses mainly forested habitats where adequate cover is available for concealment and escapement. However, during the late summer and fall they may use a variety of other habitats to supplement their diet prior to hibernation. The Gambel oak type is especially important for mast and late season berries.

Black bear would lose some foraging habitat as a direct result of surface disturbance. However, the increased disturbance represented by human intrusion, noise and traffic is likely to be much more of an impact on this species. The proposed well sites would be well-distributed within suitable habitat, particularly under Alternatives 2 and 3. This may result in a significant loss in suitable habitat due to general avoidance and to fragmentation. The overall effects to the black bear would be directly related to well density.

Turkey: This species lives primarily in the ponderosa pine cover type, but also uses Gambel oak and piñon/juniper for foraging and roosting when adequate roost trees area are available. Adequate roost sites can be a limiting factor for turkeys. Sites are usually characterized by groups of mature trees, particularly ponderosa pine. Removal of suitable roosting sites can result in a decrease in habitat quality. Turkeys are sensitive to human disturbance, especially during the nesting season and the pre-flight period for poults. Surface disturbance would result in some loss of foraging habitat and may result in the loss of suitable roosting trees. However, it is likely that the impacts associated with increased human intrusion would have a greater effect to this species. The level of overall potential impacts on turkey would increase with increasing well density in and adjacent to suitable habitat. Although populations may decline, it is unlikely that any of the alternatives would result in a significant loss of population viability within the Study Area.

Mountain Lion: This species has a very large cruising radius and occasionally uses all of the vegetative cover types found within the Study Area. Within these habitats, mountain lions tend to prefer rocky cliffs, ledges, vegetated ridgetops, or other areas that provide cover for undetected surveillance of prey. Stream courses and ridgetops are frequently used as travel corridors and hunting routes. Riparian vegetation along streams provides cover for mountain lions when traveling through open areas. In the western United States, mule deer are the major prey species of the mountain lion and seasonal movements tend to be associated with the migratory patterns of this prey species.

Mountain lions are generally intolerant of human presence and avoid areas of human activity when possible. Mountain lions also tend to avoid roaded areas. However, road-killed mountain lions comprise the largest number of accidental deaths.

The mountain lion is likely to be adversely affected by gas development in a variety of ways. Due to their intolerance of human presence the increased level of human activity associated with the construction and production/maintenance phases of the project would probably result in a decrease in the usation of affected areas. The increase in human activity in previously remote areas would likely result in habitat fragmentation. Development in an adjacent to the narrow riparian corridors and woodland riparian habitats, which are used for movement in open areas between larger tracts of cover, would also add to fragmentation effects. The increased presence of roads may result in a general avoidance of these areas, but could also result in direct mortality to individuals. The increased presence of roads may also result in increased non-energy related human activity and in increased pressure from unauthorized hunting. Potential impacts on deer herds would have a direct effect on the primary prey base to the mountain lion (See discussion on elk and deer, above). These effects, taken collectively, may adversely affect the mountain lion population within the Study area. These impacts would increase with increasing well density. Therefore, Alternative 1 would have the least potential impact on mountain lion and Alternatives 2 and 3 would have a significantly greater potential impact on the mountain lion.

4.3.2.6 NON-GAME SPECIES

As described in Section 3.3.3, a wide variety of wildlife species occur within the Study Area. These species vary greatly in their sensitivities to habitat alteration and other human-related disturbance regimes within their individual territories. The potential for impacts on wildlife species, as a whole, would generally increase as the well densities increase.

Songbirds: The Study Area provides habitat to a large number of resident and migratory songbirds. Gas development activities could potentially impact this species group in a number of ways. Surface disturbance would result in a direct loss of nesting, roosting and foraging habitat. Due to the proportionally small area of total surface disturbance, even under the highest level of well development, it is unlikely that this would result in a serious loss to any of the songbird species inhabiting the area. A significantly larger area, especially for breeding habitat, may be impacted by operational disturbances such as noise, traffic and general human activity at the well sites. For example, under Alternative 3 in an analysis of indicator species, it was estimated that the gray flycatcher, which is associated with low-density piñon-juniper, would lose 5.2% of suitable breeding habitat to surface disturbance but may lose up to 31.4% of breeding habitat when considering all disturbance factors. Additional impacts on songbird habitat could occur from habitat fragmentation where roads and well pads isolate otherwise suitable habitat from larger functioning blocks of habitat. Many songbird species are susceptible to nest parasitism by the brown-headed cowbird. Studies have shown that cowbird densities and parasitism increases with increased edge at the interface between vegetative cover and openings. Therefore, it is likely that surface disturbance in dense forest and woodland communities would result in an increase in brown-headed cowbird parasitism to susceptible species. All potential adverse impacts on songbirds would be expected to increase with increasing well densities. It is unknown if any of the songbird species would experience a loss in population viability as a result of these impacts. It should be mentioned that some bird species, such as western bluebird, might actually benefit from the creation of openings in areas where the tree or woodland cover is continuous.

Waterfowl: A variety of waterfowl use the Study Area for breeding and migratory habitat including geese, numerous varieties of ducks, kingfishers, herons, pipers and other shorebirds. Habitats used include riverine corridors, ponds, lakes, marshes, and irrigation channels. Waterfowl species depend on these habitats for breeding, foraging and roosting activities. Suitable habitat for waterfowl within the Study Area is not well distributed and comprises a very small percentage of the total area potentially affected by project activities. However, due to their relatively scarcity, they often support an abundance of species and serve as concentration areas, both intra-specifically and inter-specifically.

Potential impacts from gas development activities include direct habitat alteration through surface disturbance, alterations in hydrologic flow patterns, sedimentation, pollution, and general disturbance associated with human intrusion into to previously undisturbed areas (See Section 4.3.1. for a discussion of potential impacts on wetland and riparian vegetation). It is not anticipated that surface disturbance would result in a significant loss of suitable habitat. Wet areas tend to be problematic operationally and would be avoided where possible. Since much of the water used for the construction and production phases would be obtained from adjudicated irrigation water, a significant alteration in hydrologic processes is also not anticipated. However, impacts on water tables through well drilling are difficult to predict and some effects to wetlands that are fed by subsurface recharge could occur. Sedimentation, deriving from vegetation removal and soil disturbance during the construction phases, is likely to increase into these systems. Although sedimentation may not have a direct impact on waterfowl, it could affect their forage base by impacting the fish, amphibians, aquatic invertebrates and plants populations on which they depend. Pollution, resulting from accidental chemical or petroleum spills could have a direct impact on waterfowl coming into contact with these pollutants, and through impacts on their food base. Pollution-associated impacts are difficult to predict but overall risks would be reduced by proposed mitigation to contend with accidental spills. The greatest potential impact on waterfowl would come from disturbance associated with human intrusion such as noise, traffic and general human activity along roads and well pads. Most waterfowl species are sensitive to human activity within their habitats. Individuals may temporarily or permanently abandon nesting sites as a result of such disturbances. Additionally, foraging birds or birds in migration may completely avoid suitable habitat in proximity to continuous or periodic disturbance regimes.

Amphibians: Several amphibious species are found within the Study Area including the tiger salamander, New Mexico spadefoot, Woodhouse's toad, striped chorus frog, and the northern leopard frog. These species spend at least a portion of their seasonal activities in and in proximity to aqueous habitats and are dependent on these areas for breeding. These habitats are similar to those discussed above for waterfowl and potential impacts are similar, as well. It is not likely that impacts related to surface disturbance would result in significant losses of suitable habitat. Amphibious species would be more sensitive to changes in hydrology due to limitations in the distance that they could migrate to locate other suitable habitat. Additionally, eggs and juvenile stages of development are wholly dependent on adequate water levels for survival. These species tend to be highly sensitive to pollution due to permeable skin membranes. Additionally, the aquatic plant and animal matter on which they feed could also be negatively affected by extraneous substances. Sedimentation could also affect these species by affecting their food base, as well as by filling habitable water pockets. These species tend to be relatively tolerant to human presence and general disturbance such as noise, traffic and human intrusion are not likely to have a significant effect on suitable habitat. However, since many of these species move a considerable distance from water during non-breeding periods they are susceptible to direct mortality from traffic on roads within proximity to breeding areas.

Reptiles: A number of reptile species inhabit the Study Area including a variety of lizards and snakes and one species of turtle (painted turtle). The snakes and lizards use a wide range of habitat types, while the painted turtle is generally confined to aqueous sites (ponds). Due to the relative small size of individual territories for most reptile species, and a relatively lower level of sensitivity to disturbance factors when compared to birds and mammals, the direct area of surface disturbance would probably be a good indicator of the total potential habitat loss for this wildlife group. However, habitat fragmentation resulting from roads and well pads may result in additional losses to some species. Reptiles are cold-blooded and often move to open areas, including roads and man-made openings, to regulate their body temperatures. This makes individuals vulnerable to direct mortality from road traffic. The level of impact from all disturbance factors to reptile species would be directly related to the density of wells within suitable habitats. However, although individuals would be affected by these disturbances, it is unlikely that any species would suffer a significant loss in population viability as a result of any of the alternatives examined in this analysis.

Small mammals: A large variety of small mammals are found within the Study Area. These include, but are not limited to, porcupine, ground and rock squirrel, Abert's squirrel, red squirrel, red-backed vole, a variety of mice species, jackrabbit, cottontail, skunk, beaver and prairie dog. Small mammals play a number of roles in maintaining ecosystem health. They are the primary food base for larger mammalian carnivores and raptor species. Due to the constant threat of predation, most of this species have developed sensitivities to activities that occur within their habitats. Therefore, it is likely that for many of these species the actual total habitat lost through human activity, noise and traffic would be significantly greater than the area represented by surface disturbance alone. For example, in an analysis of indicator species, it was estimated that the Abert's squirrel, which is dependent on the ponderosa pine cover type, would lose about 4.2% of its habitat within the Study Area to surface disturbance under Alternative 3, but up to 43.8% of its habitat may be impacted when all disturbance regimes are considered. It is likely that individuals of many of these species would habituate, to some degree, to activities within their habitats. Additional impacts on small mammals may occur through habitat fragmentation, which could restrict the movement of individuals within suitable habitats. Individuals of these species would also be vulnerable to direct mortality from traffic on the access roads to the well sites. As with other species groups the level of potential impacts on small mammals would increase with increasing well and road densities. It is difficult to predict whether development under any of the alternatives would result in a level of habitat loss that would significantly affect overall population viability within the Study Area for any of the small mammal species.

Mammalian Carnivores: Several mammalian carnivores are known to inhabit the Study Area. These include mountain lion (discussed above under game species), coyote, red and gray fox, bobcat, badger and weasel. These species tend to have large territories, which are necessary to supply an adequate prey base. These large territories often encompass a variety of vegetative cover types. These species tend to avoid areas of significant human activity although their large ranges occasionally bring them into contact with humans. They are particularly sensitive to human activity within their denning territories and some are known to abandon dens as a result of disturbance. Considering their general large home ranges and denning territories and the general intolerance to human activity within their territories, potential losses in habitat to these species would be considerably larger than the area represented by surface disturbance alone. The relative uniformity of well spacing, especially under Alternatives 2 and 3, could result in significant impacts on suitable habitats and especially to denning territories. Habitat fragmentation could also result from road and well pad construction. These facilities could restrict movements between denning and hunting territories during the breeding season and generally affect movement in hunting territories during other times of year. These predators depend primarily on small mammals as a significant portion of their prey base. Activities that have a negative affect on the abundance of that prey base, as discussed above, would also have a negative effect on these predator species. The level of impacts on these species would increase with increasing well and road densities.

Raptors: The raptor species occurring within the Study Area are described in Section 3.3.3.5. These species tend to use a wide variety of habitats for breeding and foraging activities. They typically have large hunting and nesting territories. Although they are tolerant, to varying degrees, to human activity within their foraging areas, they are generally highly intolerant of disturbance within their nesting territories. Disturbance during nesting can result in nest abandonment for many of these species. The zone of disturbance sensitivity can extend from ¼ to ½-mile from the nest site. Considering this sensitivity the potential loss of breeding habitat to raptors would be much greater than the area represent solely by surface disturbance in suitable habitat. For example, in an analysis of indicator species, the golden eagle would potentially lose 1.2% of suitable habitat within the Study Area to surface disturbance under Alternative 3, but could lose up to 48.8% of breeding habitat when all disturbance regimes are considered (based on a ¼-mile distance from nest to disturbance source). Additional impacts on raptor species could occur through project-related reductions in prey base, which generally consist of birds and small mammals. The potential adverse impacts to raptors would increase with increasing well densities. Considering the high potential losses in breeding habitat, some species could experience a loss in population viability, particularly under Alternatives 2 and 3.

4.3.2.7 WILDLIFE INDICATOR SPECIES

The Southern Ute Gas Development Study Area is comprised of six primary vegetative cover types (3.3.2.1). These cover types, individually and collectively, provide habitat for over 300 species of wildlife and fish (Appendix F) including deer and elk which are addressed in Section 4.3.2.4. While it is not practical to address the potential impacts represented by the proposed alternatives to each of these species individually, potential effects can be inferred through the analysis of a select group of species (indicator species) that depend on specific project area cover types for their primary biological requirements. It is recognized that few species would confine all of their activities to any one cover type, but for many species, one specific cover type plays a critical biological role in the maintenance of species population viability.

The analysis of potential project effects to these indicator species is intended to provide a qualitative and quantitative comparison of the project alternatives as they relate to these species and, through inference, to project potential effects to other wildlife species that may depend on similar habitats.

Indicator species were generally selected on the basis of the specificity of their dependence on basic habitat characteristics as represented by the individual vegetative cover types found in the Study Area. A general description of the species' distribution, biology and management sensitivities was used to predict how a particular species may respond to the disturbance regimes expected to occur under the proposed alternatives. For each species the total "zone of disturbance" for each well facility was calculated by adding the total area of surface disturbance to the additional area of anticipated disturbance that would result from human activities such as noise, traffic and general human presence in proximity to the wells and roads. This additional disturbance would persist during the construction and production/maintenance phases of the project. During the abandonment phase the zone of disturbance would be limited to the area of physical surface disturbance, since human activity at the well sites would be significantly diminished.

For most of the species in this analysis, the expanded zone of disturbance was based on research observations regarding typical breeding territory size. It was assumed that species would establish the center of breeding activity one territory away from adjacent disturbance regimes. If research information was available that provided recommended buffer distances based on specific species sensitivities, as was the case for golden eagle, deer, and elk, then that distance was used to define the expanded disturbance zone.

Finally, it was assumed in this analysis, unless other information was available, that there is a direct correlation between territory size and sensitivity to human disturbance, which may not be the case for all species.

The effects of habitat fragmentation are very difficult to estimate and could have significant implications to some species from a population viability standpoint. Habitat fragmentation could not be quantified. However, where fragmentation is a concern it was addressed in the discussion of effects.

This analysis assumes that the entire cover type is suitable habitat for the species being analyzed, which is generally not the case and may result in an overestimation of the total acres of habitat loss. However, the percentage of suitable habitat potentially lost would be more indicative of the relative effect to the species. Since wells and roads would be moderately well distributed across the vegetative cover type, especially for Alternatives 2 and 3, the varying number of new well sites proposed with each alternative would reflect the probability that these wells would occur in proximity to suitable habitat.

The past, present and future disturbances acres used in the calculation for cumulative percentages of potential habitat loss were derived from Section 4.13.3.2. Estimated project-related disturbance acres added to this reflect total potential loss of habitat during the life of the project. These figures include only existing or anticipated future disturbances within the Study Area. They do not reflect conditions outside of the area.

GRASSLAND/SHRUBLAND HABITAT

The grassland/shrubland vegetation type represents about 39.9% of the Study Area. This vegetative cover type occurs at elevations below 6,000 feet where annual precipitation averages less than 12 inches. It includes areas of annual and perennial grasses (including out-of-production agricultural fields) occurring in association with varying proportions of the Great Basin shrubs including sagebrush, saltbush, snakeweed, rabbitbrush, bitterbrush and yucca.

Brewer's Sparrow (Grassland/Shrubland) (*Spizella breweri*)

Factors Of Concern And Management Implications: Brewer's sparrow habitat loss occurs primarily through the removal of sagebrush and other shrub. Removal of shrubs over large areas causes individuals to abandon the treated area (Schroeder and Sturges 1975). Prescribed burns that remove no more than 50% of the sagebrush may result in a decline in local Brewer's Sparrow populations for 1-2 years, but populations should rebound after that (Petersen and Best 1987).

Associated Species: Other bird species that may use habitat in a similar way and/or respond similarly to management, activities include sage grouse, sage thrasher, green-tailed towhee, and sage sparrow. (CPIF)

Assumptions Made in the Analysis of the Brewer's Sparrow: Based on previous research (Reynolds 1981) it was assumed that the average breeding territory for this species is 1.2 acres. It was also assumed that a buffer of ½ the diameter of that territory (129 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Based on this assumption, each new facility would represent about 15.9 acres of potential lost breeding habitat during the construction and production/maintenance phases of the project. During the abandonment phase lost habitat would equal the areas of surface disturbance represented by each alternative.

SUMMARY OF POTENTIAL HABITAT LOSS TO BREWER'S SPARROW
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1[1]	2671	1.6	8.4	2671	1.6	8.4	672	0.3	7.1
Alt. 2[2]	7425	4.4	11.2	7425	4.4	11.2	1868	1.1	7.9
Alt. 3[3]	7791	4.6	11.4	7791	4.6	11.4	1960	1.2	8.0

[1] Based on 168 new wells in the 168,018 acres of the grassland/shrubland cover type

[2] Based on 467 new wells in the grassland/shrubland cover type

[3] Based on 490 new wells in the grassland/shrubland cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (6.8%).

Direct and Indirect Effects: When compared to the total acreage of the grassland/ shrubland cover type within the Study Area, the level of surface disturbance would be relatively low for all alternatives. The removal of shrubby vegetation would negatively affect both breeding and foraging areas for the life of the project and would continue to represent a loss beyond the life of the project until the original vegetative structural characteristics are re-established. It is likely that this would span a period of at least 25 years after the abandonment phase, considering the arid conditions associated with this plant community. An additional loss of suitable habitat would result from non-physical disturbances (e.g. noise, traffic, human presence) immediately adjacent to production facilities. This disturbance would be greatest during the construction phase and would persist, at some level, throughout the production phase of the project. Overall, potential project related habitat losses are relatively low for this species, with 1.6, 4.4, and 4.6 percent of suitable breeding habitat impacted during the life of the project under Alternatives 1, 2 and 3, respectively. Brewer's sparrow is sensitive to fragmentation of suitable habitats and tends to avoid isolated stands of shrub less than five acres in size. Fragmentation can also increase the occurrence of nest parasitism by brown-headed cowbirds. The potential for and degree of habitat fragmentation would increase with increasing well densities. The overall effects of fragmentation are difficult to assess but should be recognized as a factor that may increase total habitat loss beyond that reflected by the losses and impacts on individual territories.

Cumulative Effects: The effects table for Brewer's sparrow indicates that the cumulative potential habitat loss to Brewer's sparrow within the Study Area would total 8.4, 11.2, 11.4 percent for

Alternatives 1, 2, and 3, respectively. It is unlikely that this level of habitat loss would significantly affect overall population viability within the Study Area.

Past, present and anticipated habitat disruptions in the areas surrounding the Study Area also impact this species. Northern New Mexico, which features a relative abundance of the grass-land/shrub cover type, may be particularly important to regional populations of Brewer's sparrow. This area has been the focus of significant past gas development and is currently proposed for significant future development. These cumulative habitat losses may represent a higher level of concern for this species on a regional basis. Significant impacts on Brewer's sparrow habitat outside the Study Area would increase the relative value of suitable habitat within area.

GOLDEN EAGLE (GRASSLAND/SHRUBLAND)

(*Aquila chrysaetos*)

Factors of Concern and Management Implications: Direct and indirect human-caused mortality, disturbance, and the elimination of prey by habitat alteration are the main factors limiting golden eagle populations (Wassink 1991). Golden eagles are sensitive to human disturbance and are likely to abandon their nests during the incubation period if disturbed (Dunstan 1989, Palmer 1988). Other losses occur through shooting, poisoning, trapping, electrocution and collision with power lines, and pesticide contamination. In addition to breeding disruptions, human activities may disturb wintering and migration activities, which may reduce populations (Dunstan 1989).

Habitat management for the golden eagle primarily consists of protecting areas used for nesting, resting, and foraging, and protecting habitat used by the prey base (Dunstan 1989). Some researchers suggest placing 0.25 to 2-mile buffer zones around nest sites in areas undergoing energy development or increased recreational use (Richardson and Miller 1997). Nest-site protection is only advantageous if the prey base remains adequate following development. If nesting sites and important prey concentrations such as ground squirrel colonies are avoided, golden eagles should be able to coexist with oil and gas development (Suter and Jones 1982).

Associated Species: Species that use similar habitats or species that may respond similarly to management activities would include the Swanson's hawk, red-tailed hawk, northern harrier, peregrine falcon and prairie falcon.

Assumptions Made in the Analysis: Based on previous research (Richardson and Miller) a minimum ¼-mile (1320 feet) buffer was assumed necessary to maintain viable nesting habitat for the golden eagle. This results in each well pad potentially affecting 164 acres of potential habitat.

SUMMARY OF POTENTIAL HABITAT LOSS TO GOLDEN EAGLE
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production. Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1[1]	28,123	16.7	23.5	28,123	16.7	23.5	672	0.3	7.1
Alt. 2[2]	78,176	46.5	53.3	78,176	46.5	53.3	1,868	1.1	7.9
Alt. 33	82,026	48.8	55.6	82,026	48.8	55.6	1,960	1.2	8.0

[1] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (6.8%).

[2] Based on 168 new wells in the 168,018 acres of the grassland/shrubland cover type

[3] Based on 467 new wells in the grassland/shrubland cover type

[4] Based on 490 new wells in the grassland/shrubland cover type

Direct and Indirect Effects: The surface disturbance from well development would probably result in a minor loss of foraging habitat for the golden eagle. Overall surface disturbance would be relatively low when compared to the total acreage of this cover type within the Study Area. However, other disturbance regimes associated with human activity in and in proximity to the production sites would likely result in impacts relating to disturbances to nesting sites. Research has shown that human disturbance is a primary cause of nest abandonment for this species. Disturbances to potential nesting habitat during the construction and production phases would be 23.5, 53.3 and 55.6 percent for Alternatives 1, 2 and 3, respectively. During the abandonment phase the surface disturbance represented by the well sites and roads may have a slight negative effect on foraging habitat but would probably not represent a significant impact on the overall quality of breeding habitat.

Cumulative Effects: The effects table for golden eagle indicates that the cumulative potential habitat impact on this species within the Study Area would total 23.5, 53.3 and 55.6 for Alternatives 1, 2, and 3, respectively. Past, present and anticipated future habitat disruptions in the areas surrounding the Study Area could have additional implications to this species. Proposed gas development in areas directly north and south of Study Area could extend the potential impacts on golden eagle habitat over a much larger area and could result in compounding factors to the maintenance of population viability within and adjacent to the Study Area.

Gambel Oak Habitat

This cover type comprises about 2.6% of the Study Area. Gambel oak vegetation occurs at elevations of about 4,500 to 8,500 feet, often in association with piñon-juniper woodlands, ponderosa pine timberlands, or in previously burned areas. Associated understory shrubs include snowberry (*Symphoricarpos* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.).

VIRGINIA'S WARBLER (GAMBEL OAK)
(*Vermivora virginiae)*

Factors of Concern and Management Implications: Virginia's warblers have a small breeding range, and in many places within their range their habitat has been severely altered. Activities such as mining, road construction, hiking trails, fire, development of rural areas, and range improvement for livestock can result in habitat fragmentation and degrade nesting, resting, and foraging habitat for this species. Virginia's Warbler is vulnerable to brown-headed cowbird parasitism and the rate of parasitism may be increasing (Kingery 1998). Due to their narrow breeding range, Colorado plays an important role in protecting the habitat of this species. (CPIF)

Associated Species: Other bird species that may use similar habitats in a similar way and/or respond similarly to management activities include common poorwill, broad-tailed hummingbird, house wren, blue-gray gnatcatcher, green-tailed towhee, spotted towhee and black-headed grosbeak. (CPIF)

Assumptions Made in Analysis: Based on previous research (Hoover and Wills 1984) it was assumed that the average breeding territory for Virginia's warbler is 1.0 acre. It was also assumed that a buffer of ½ the diameter of that territory (118 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Therefore, each new facility would represent about 15.0 acres of potentially impacted breeding habitat during the construction and production/maintenance phases of the project. During the abandonment phase impacted habitat would be equal to the areas of surface disturbance represented by each alternative.

Direct and Indirect Effects: Impacts on Virginia's warbler would occur from direct habitat loss through surface disturbance that would remove the shrub component on which this species depends for foraging and breeding habitat. Additionally, breeding birds could be adversely affected by other disturbance regimes such as noise, traffic and other human activities in proximity to these facilities. This disturbance would be greatest during the construction phase and would continue at a reduced level through the production/maintenance phase of the project. However, during the abandonment phase, due to the absence of significant human activity, the amount of disturbance would be limited to the surface area disturbance alone. It is estimated that it would take 30-40 years after abandonment for the shrub component in affected areas to regain the structural characteristics required for viable breeding habitat for this species.

SUMMARY OF POTENTIAL HABITAT LOSS TO VIRGINIA'S WARBLER

BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production. Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1 [1]	555	5.2	10.9	555	5.2	10.9	148	1.4	7.1
Alt. 2 [2]	1395	13.0	18.7	1395	13.0	18.7	372	3.5	9.2
Alt. 3 [3]	1425	13.3	19.0	1425	13.3	19.0	380	3.5	9.2

[1] Based on 37 new wells in the 10,751 acres of Gambel oak cover type

[2] Based on 93 new wells in the Gambel oak cover type

[3] Based on 95 new wells in the Gambel oak cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance, past, current and anticipated future disturbances within the cover type (5.7%).

The level of overall disturbances to Virginia's warbler habitat, through all phases of the project, would be directly related to the well densities represented by each of the proposed alternatives. Potential habitat losses within the Study Area due to project-related activities are estimated to be 5.2, 13.0 and 13.3 percent for Alternatives 1, 2 and 3, respectively. This level of habitat loss, alone, is unlikely represent a serious threat to population viability within the Study Area, even at the highest level of well development (Alternative 3). Under Alternative 3 roughly 87% of existing habitat would remain relatively unaffected by project-related disturbances.

Virginia's warbler is sensitive to habitat fragmentation. The potential for habitat fragmentation would increase with increasing well densities. The overall effects of fragmentation are difficult to assess but should be recognized as a factor that may increase total habitat loss beyond that reflected by the losses and impacts on individual territories.

Virginia's warbler is susceptible to brood parasitism by the brown-headed cowbird. Research has shown that cowbird populations increase when openings are created in closed woodland and forest canopies, thus increasing amount of forest edge (Hejl 1992, Robinson 1993). It is likely that cowbird parasitism on this species would increase with an increasing level of surface disturbance in and adjacent to suitable habitat.

Cumulative Effects: The above table indicates that the cumulative potential habitat loss to Virginia's warbler within the Study Area would total 10.9, 18.7 and 19.0 percent for Alternatives 1, 2, and 3, respectively. This probably does not represent a critical level of habitat loss as it relates to overall population viability within the Study Area. However, other past, present and anticipated habitat disruptions in areas outside of, but adjacent to Study Area could have somewhat more significant implications. Proposed gas development directly north and south of Study Area could potentially result in compounding factors for this species. Additionally, other disturbance regimes, such as residential development would result in additional losses of suitable habitat. The breeding range for the Virginia's warbler is restricted to the shrub dominated vegetative communities of the Four Corners states. This restricted breeding range increases the overall value of existing suitable habitat on both a local and regional basis.

PIÑON-JUNIPER HABITAT

Piñon-juniper woodlands dominate much of the Study Area uplands. This cover type occurs between elevations of about 6,000 and 8,400 feet within the area. Canopy cover is quite variable, ranging from less than 5 to 70 percent crown cover. Low-density piñon-juniper areas have a crown cover of 10 to 30 percent. The low-density piñon- juniper cover type comprises about 3.5% of the Study Area and the medium to high density piñon -juniper, about 32.4%. Associated grasses include muttongrass, Indian ricegrass, western wheatgrass, needle-and-thread, blue grama, sideoats grama, and galleta grass. Typical shrubs consist of sagebrushes, bitterbrush, and mountain mahogany. Scattered to dominant stands of big sagebrush occur in deteriorated range areas along valley bottoms and in upland parks. The black-throated gray warbler was selected to represent the medium-high density Piñon -juniper and the gray flycatcher was selected to represent the low-density pinion-juniper.

Black-throated grey warbler (Med.-High Density PJ)

(*Dendroica nigrescens*)

Factors of Concern and Management Implications: This species appears to tolerate some level of alteration in its habitat. However, there have been no detailed studies of responses to habitat alteration, such as changes in densities, breeding success, and habitat use (Guzy and Lowther 1997). Land management practices that remove overstory trees from piñon-juniper woodlands, may adversely affect habitat use by BTGW (Sedgwick 1987). Continued alteration and loss of habitat may have cumulative effects unidentified to date. For example, land management practices that increase contact between Black-throated Gray Warblers and brown-headed cowbirds may have a substantial impact on breeding success.

Associated Species: Other bird species that may use habitat in a similar way and/or respond similarly to management, activities include mourning dove, scrub jay, stellar jay, black-billed magpie, western tanager, black-headed grosbeak and dark-eyed junco.

Assumptions Made in the Analysis: Based on previous research (Stahlecker 1989, Hoover and Woulds 1984) it was assumed that the average breeding territory for this species is 2.5 acres. It was also assumed that a buffer of ½ the diameter of that territory (186 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Assuming a 3-acre average well pad and an access road averaging ¼ -mile in length and 35 feet in width, each new facility would represent a loss of 24.9 acres of viable breeding habitat.

SUMMARY OF POTENTIAL HABITAT LOSS TO BLACK-THROATED GRAY WARBLER
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1 [1]	4,756	3.5	8.6	4,756	3.5	8.6	764	0.5	5.6
Alt. 2 [2]	11,977	8.8	13.9	11,977	8.8	13.9	1,924	1.4	6.5
Alt. 3 [3]	12,774	9.4	14.5	12,774	9.4	14.5	2,052	1.5	6.6

[1] Based on 191 new wells in the 136,483 acres of the medium-high density pinion-juniper cover type

[2] Based on 481 new wells in the grassland/shrubland cover type

[3] Based on 513 new wells in the grassland/shrubland cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (5.1%).

Direct and Indirect Effects: affects to the BTGW would result from surface disturbance, which would remove piñon-juniper woodland cover, reducing available breeding and foraging areas for the life of the project. However, the overall level of project-related surface disturbance would be relatively low when compared with the total acreage of this cover type within the Study Area.

Additional impacts on suitable habitat would result from non-physical disturbances (e.g. noise, traffic, human presence) immediately adjacent to production facilities. This disturbance would be greatest during the construction phase and would persist, at some level, throughout the production/ maintenance phase of the project. Surface disturbances would continue to represent a loss beyond the life of the project until the original vegetative structural characteristics are re-established. Considering the arid conditions associated with this plant community disturbed areas may not regain that structure for 80 years after abandonment.

Overall potential project related habitat losses appear to be relatively low for this species, with 3.5, 8.8, and 9.4 percent of suitable breeding habitat potentially lost during the life of the project under Alternatives 1, 2 and 3, respectively. This indicates that even under the highest level of well development (Alternative 3) roughly 90% of suitable habitat would remain relatively unaffected by project-related disturbances.

BTGW is susceptible to brood parasitism by the brown-headed cowbird. Research has shown that cowbird populations increase when openings are created in closed woodland and forest canopies, thus increasing amount of forest edge (Hejl 1992, Robinson et al. 1993). It is likely that cowbird parasitism on this species would increase with an increasing level of surface disturbance in and adjacent to suitable habitat.

Research seems to indicate that this species can tolerate some levels of habitat fragmentation. It is unclear if the level of disturbance represented by the any of the alternatives would reach a level in which fragmentation would affect the usability of suitable habitat within the Study Area.

Cumulative Effects: The cumulative potential habitat loss to BTGW within the Study Area for Alternatives 1, 2, and 3 would total 8.6, 13.9, and 14.5 percent, respectively. It is unlikely that this represents a critical level of habitat loss as it relates to overall population viability within the Study Area. However, other past, present and anticipated future habitat disruptions in areas outside of, but adjacent to Study Area could have somewhat more significant implications. Proposed gas development directly north and south of Study Area could potentially result in habitat loss on a larger scale, compounding impacts on this species. Other disturbance regimes, such as residential development would also result in additional loss of suitable habitat.

Gray flycatcher (Low Density PJ)

(Empidonax wrightii)

Factors of Concern and Management Implications: Gray Flycatchers appear to be relatively tolerant to disturbance and partial fragmentation within their habitats. They will occur in small stands of less than 2.5 ac, but will not use these smaller stands if they are isolated from larger stands by more than roughly a half-mile (CPIF). This species is sensitive to loss of the shrub component within their habitats. Activities such as heavy annual grazing and significant reductions in shrub cover within nesting habitat may also increase the risks of nest parasitism by brown-headed cowbirds (CPIF, Robinson et al. 1993).

Associated species: Other bird species that may use similar habitat and/or respond similarly to threats, management, and conservation activities include ash-throated flycatcher, gray vireo, pinyon jay, juniper titmouse, and Bewick's wren. (CPIF)

Assumptions Made in the Analysis: Based on previous research (Stahlecker 1989, Hoover and Wills 1984) it was assumed that the minimum breeding territory for this species is 3.0 acres. It was also assumed that a buffer of ½ the diameter of that territory (208 feet) would represent the distance form from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Assuming a 3-acre average well pad and an access road averaging ¼ -mile in length and 35 feet in width, each new facility would represent an impact on 24.0 acres of viable breeding habitat during the construction and production and maintenance phases.

SUMMARY OF POTENTIAL HABITAT LOSS TO GRAY FLYCATCHER BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production. Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1 [1]	1,056	7.2	18.3	1,056	7.2	18.3	176	1.2	12.3
Alt. 2 [2]	4,488	30.7	41.8	4,488	30.7	41.8	748	5.1	16.2
Alt. 3 [3]	4,584	31.4	42.5	4,584	31.4	42.5	764	5.2	16.3

[1] Based on 44 new wells in the 14,617 acres of the low density pinion-juniper cover type

[2] Based on 187 new wells in the low density pinion-juniper cover type

[3] Based on 191 new wells in the low density pinion-juniper cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (11.1%).

Direct and Indirect Effects: Surface disturbance could directly affect gray flycatcher habitat through the removal pinion-juniper woodland cover, reducing available breeding and foraging areas for the life of the project. Additional impacts on suitable habitat would result from non-physical disturbances (e.g. noise, traffic, human presence) immediately adjacent to production facilities. This disturbance would be greatest during the construction phase and would persist, at some level, throughout the production/ maintenance phase of the project. Surface disturbances would continue to represent a loss beyond the life of the project until the original vegetative structural characteristics are re-established. Considering the arid conditions associated with this plant community disturbed areas may not regain that structure for 80 years after abandonment. Overall potential project-related losses of habitat appear to be relatively low for Alternative 1 (7.2%) but are relatively high for Alternative 2 (30.7%) and Alternative 3 (31.4%). This indicates under the higher levels of well development (Alternative2 & 3) roughly 69% of suitable breeding habitat would remain relatively unaffected by project effects. It is unknown if this level of habitat loss would affect overall population level within the Study Area.

The gray flycatcher is susceptible to brood parasitism by the brown-headed cowbird. Research has shown that cowbird populations increase when openings are created in closed woodland and forest canopies, thus increasing amount of forest edge (Hejl 1992, Robinson et al. 1993). Even though the gray flycatcher seems to prefer more open piñon-juniper stands it is likely that cowbird parasitism on this species would increase, to some degree, with an increasing level of surface disturbance in and adjacent to suitable habitat.

Research seems to indicate that this species can tolerate some levels of habitat fragmentation. It is unclear if the level of disturbance represented by the alternatives would reach a level in which fragmentation would affect the usability of suitable habitats or overall population dynamics within the Study Area.

Cumulative Effects: The above table indicates that the cumulative potential habitat loss to the gray flycatcher within the Study Area would total 18.3, 41.8, and 42.5 for Alternatives 1, 2, and 3, respectively. This may represent a significant level of habitat loss as it relates to overall population viability within the Study Area during the life of the project. Additionally, other past, present and anticipated habitat disruptions in areas outside of, but adjacent to Study Area could result in increased concerns for habitat viability over a larger area. Proposed gas development directly north and south of Study Area could potentially result in compounding impacts for this species. Additionally, other disturbance regimes, such as future residential development, would result in further losses of suitable habitat in areas adjacent to the Study Area.

Ponderosa Pine Habitat

This plant community occurs at elevations between 6,500 and 8,800 feet within the Study Area where annual precipitation generally equals or exceeds 16 inches. This cover type comprises about 4.0% of entire Study Area. The dominant vegetation type is ponderosa pine timberlands, with an understory of mountain muhly, pine dropseed , needle-and-thread, muttongrass, and slender wheatgrass. Associated shrubs include Gambel oak, serviceberry, mountain mahogany, and mountain juniper.

ABERT'S SQUIRREL (PONDEROSA PINE)

(Sciurus aberti)

Factors of Concern and Management Implications: Significant reductions in stocking in well-stocked ponderosa pine stands through timber harvesting or other activities can have a detrimental effect on this species. Habitat fragmentation through clearing or road building would also reduce habitat quality. Individuals often suffer mortality near well-traveled roads. Hoover and Wills (1984) consider that it would take about 30 individuals to provide a minimum viable population, which would require 429 acres of optimal habitat.

Associated Species: Other species that may use habitat in a similar way and/or respond similarly to management, activities include flammulated owl, grace's warbler, Merriam's turkey, pygmy nuthatch, porcupine, and western tanager.

Assumptions Incorporated into Species Analysis of Effects: For this analysis it was assumed that the minimum size of a viable breeding territory for Abert's squirrel is 10.0 acres. It was also assumed that a buffer of ½ the diameter of that territory (372 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Assuming a 3-acre average well pad and an access road averaging ¼-mile in length and 35 feet in width, each new facility would impact 41 acres of viable breeding habitat.

Direct and Indirect Effects: Actual project-related surface disturbance within suitable habitat for the Abert's squirrel would be relatively low for all alternatives. Even at the highest level of well development about 96% of potentially suitable habitat would remain physically intact. However, when taking into account other disturbance regimes such as noise, traffic and human movement at and in proximity to well facilities, a significantly larger impact on habitat may be indicated. This is especially true for Alternatives 2 and 3, which would potentially impact up to about 44% of the Species habitat. This disturbance is likely to be most disruptive during the construction phases of the project but would continue, at a reduced level, throughout the production/ maintenance phase.

SUMMARY OF POTENTIAL HABITAT LOSS TO ABERT'S SQUIRREL
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production. Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1 [1]	2484	14.7	21.0	2484	14.7	21.0	240	1.4	7.7
Alt. 2 [2]	7245	42.8	49.1	7245	42.8	49.1	700	4.1	10.4
Alt. 3 [3]	7411	43.8	50.1	7411	43.8	50.1	716	4.2	10.5

[1] Based on 60 new wells in the 16,904 acres of the ponderosa pine cover type

[2] Based on 175 new wells in the ponderosa pine cover type

[3] Based on 179 new wells in the ponderosa pine cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (6.3%).

The territory size, used in this estimate, may exaggerate actual effects to Abert's squirrel habitat. Since territory overlap within the species is known to occur this may indicate some level of tolerance to disturbance, especially at the periphery of the territory. Additionally, many species, including the Abert's squirrel may habituate, to some degree, to human disturbance in proximity to and within their territories. The level of disturbance for all alternatives would decrease substantially during the abandonment phase. Due to this species requirements for relatively mature forest cover, areas of surface disturbance may require 80-100 years after abandonment to regain the structural characteristics associated with suitable habitat.

Research indicates that this species is sensitive to habitat fragmentation. The potential for fragmentation within Study Area would increase with increasing well densities within suitable habitat. Both well pads and access roads may contribute to this effect.

Cumulative Effects: Cumulative potential habitat impact on the Abert's squirrel within the Study Area would total 20, 49, and 50 percent for Alternatives 1, 2, and 3, respectively. Although it is not reflected in summary acres of past, present and anticipated future impacts (6.3%) much of the suitable habitat for Abert's squirrel may have been affected by past forest management activities that reduced stocking levels below that required or preferred by this species. It is unknown what percentage of the ponderosa pine type within the Study Area may currently provide the structural characteristics for suitable habitat. Past, present, and anticipated habitat disruptions in areas outside, but adjacent to, the Study Area are unlikely to affect populations within the Study Area, due to a general lack of continuity of the cover type between these areas.

Grace's warbler (Ponderosa Pine)

(Dendroica graciae)

Factors of Concern and Management Implications: There appears to be a relative paucity of information regarding the ecology of this species. Any activities that significantly affect the integrity of the pine habitats, such as significantly reducing stand densities, would probably have an effect on breeding and foraging success.

Associated Species: Other species that may use similar habitat and/or respond similarly to threats, management, and conservation activities include flammulated owl, olive-sided flycatcher, violet-green swallow, pygmy nuthatch, and western tanager. (CPIF)

Assumptions Incorporated into Species Analysis of Effects: For this analysis it was assumed that the size of a viable breeding territory for Grace's warbler is 1.1 acres. It was also assumed that a buffer of ½ the diameter of that territory (124 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Assuming a 3-acre average well pad and an access road averaging ¼-mile in length and 35 feet in width, each new facility would represent a loss of 15.7 acres of viable breeding habitat.

SUMMARY OF POTENTIAL HABITAT LOSS TO GRACE'S WARBLER
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	**Construction Phase (Ac.) of Potential Lost Habitat**	**%**[4]		**Production. Phase (Ac.) of Potential Lost Habitat**	**%**		**Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat**	**%**	
		Project	**Cumul.**		**Project**	**Cumul.**		**Project**	**Cumul.**
Alt. 1 [1]	942	5.6	11.9	942	5.6	11.9	240	1.4	7.7
Alt. 2 [2]	2748	16.3	22.6	2748	16.3	22.6	700	4.1	10.4
Alt. 3 [3]	2810	16.6	22.9	2810	16.6	22.9	716	4.2	10.5

[1] Based on 60 new wells in the 16,904 acres of the ponderosa pine cover type

[2] Based on 175 new wells in the ponderosa pine cover type

[3] Based on 179 new wells in the ponderosa pine cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (6.3%).

Direct and Indirect Effects: Surface disturbance would result in losses to Grace's warbler through the removal of ponderosa pine cover, reducing available breeding and foraging habitat for the life of the project. Additional impacts on suitable habitat would result from non-physical disturbances (e.g. noise, traffic, human presence) immediately adjacent to production facilities. This disturbance would be greatest during the construction phase and would persist, at some level, throughout the production/ maintenance phase of the project. Surface disturbances would continue to represent a loss beyond the life of the project until the original vegetative structural characteristics are re-established. Considering the Grace's warbler's need for at least semi-mature ponderosa pine, forested areas subjected to surface disturbance would not regain that structure for 60-80 years after abandonment.

Overall potential project related habitat impacts appear to be low to moderate for this species, with 5.6, 16.3, and 16.6 percent of suitable breeding habitat potentially impacted during the life of the project under Alternatives 1, 2 and 3, respectively. This indicates that even under the highest level of well development (Alternative 3) roughly 84% of suitable habitat would remain relatively unaffected by project-related disturbances.

Grace's warbler is a rare host to the brown-headed cowbird. Research has shown that cowbird populations increase when openings are created in closed woodland and forest canopies, thus increasing amount of forest edge (Hejl 1992, Robinson et al. 1993). Although cowbird populations could increase as a result of disturbance it is unlikely that cowbird parasitism on this species would increase substantially.

It is unknown how Grace's warbler would respond to possible habitat fragmentation resulting from project-related activities. It is likely that the species has some level of sensitivity to fragmentation but it is unclear if the level of disturbance represented by any of the alternatives would reach a level fragmentation that would affect population viability within the Study Area.

Cumulative Effects: Cumulative potential habitat impacts on the Grace's Warbler within the Study Area would total 11, 22, and 23 percent for Alternatives 1, 2, and 3, respectively. Although it is not reflected in summary acres of past, present and anticipated future impacts (6.3%) much of the suitable habitat for Grace's warbler may have been affected by past forest management activities within the Study Area. It is unknown what percentage of the ponderosa pine type may currently provide the structural characteristics necessary for suitable habitat. If substantial past habitat alterations have occurred in suitable Grace's warbler habitat, then additional impacts would have significant implications for this species in terms of population viability within the Study Area. Past, present and anticipated habitat disruptions in areas outside of, but adjacent to Study

Area are unlikely to have an affect on populations within the Study Area due to a lack of continuity of the cover type between these areas.

Riparian Woodland Habitat

Narrow bands of wooded riparian areas occur within the Study Area along perennial and intermittent stream courses. Characteristic tree species primarily consist of cottonwoods (*Populus* spp.) associated with shrubs including alder, ash, hawthorn and willow (*Salix exigua, Salix* spp.). Further discussion of wetland systems is provided in the section below on wetlands. The vegetative cover type comprises about 1.9% of the total Study Area acres.

YELLOW WARBLER
(*Dendroica petechia*)

Factors of Concern and Management Implications: Activities that alter the structure of riparian woodland habitat through tree or shrub removal could have an impact on the breeding and foraging success of this species. Fragmentation of contiguous tree and shrub canopies may increase parasitism by brown-headed cowbird.

Associated Species: Other species that may use similar habitats and/or respond similarly to management, activities include bald eagle, Bullock's oriole, yellow-breasted chat, blue grosbeak, willow flycatcher and Lewis woodpecker.

Assumptions Incorporated into Species Analysis: The yellow warbler primarily inhabits woodland riparian habitats but is occasionally found in other habitats, as discussed above. This analysis emphasizes the impacts resulting from activities in the woodland riparian type since these areas are most favored and probably most critical for this species. Based on previous research (Hoover and Wills 1984) it was assumed that the breeding territory for this species is 1.0 acre. It was also assumed that a buffer of one-half the diameter of that territory (117 feet) would represent the distance from the edge of surface disturbance to the edge of viable breeding territory surrounding the well pad and roads. Assuming a 3-acre average well pad and an access road averaging 1/8-mile in length and 35 feet in width, each new facility would represent a loss of 11.0 acres of viable breeding habitat during the construction and production and maintenance phases. (1/8-mile was used to determine road disturbance since, considering the typical narrowness of woodland riparian habitats, it was unlikely that the entire ¼-mile road would be constructed within the cover type.)

SUMMARY OF POTENTIAL HABITAT LOSS TO YELLOW WARBLER
BY ALTERNATIVE AND PHASE OF PROJECT

Alternative	Construction Phase (Ac.) of Potential Lost Habitat	%[4]		Production. Phase (Ac.) of Potential Lost Habitat	%		Surface Disturbance & Abandonment. Phase (Ac.) of Potential Lost Habitat	%	
		Project	Cumul.		Project	Cumul.		Project	Cumul.
Alt. 1 [1]	165	2.0	8.0	165	2.0	8.0	60	0.7	6.7
Alt. 2 [2]	605	7.4	13.4	605	7.4	13.4	220	2.7	8.7
Alt. 3 [3]	616	7.6	13.6	616	7.6	13.6	224	2.7	8.7

[1] Based on 15 new wells in the 8,156 acres of the riparian woodland cover type

[2] Based on 55 new wells in the riparian woodland cover type

[3] Based on 56 new wells in the riparian woodland cover type

[4] Percentage cover type affected from project related activities and cumulative percentage including project related disturbance and past disturbances and anticipated future disturbances within the cover type (6.0 %).

Direct and Indirect Effects: Surface disturbance would result in losses to the yellow warbler through the removal of riparian shrub and tree cover, reducing available breeding and foraging habitat for the life of the project. Additional impacts on suitable habitat would result from non-physical disturbances (e.g. noise, traffic, human presence) immediately adjacent to production facilities. This disturbance would be greatest during the construction phase and would persist, at a reduced level, throughout the production/ maintenance phase of the project. Surface disturbances would continue to represent a loss beyond the life of the project until the shrub and tree layers are adequately re-established. Areas subjected to surface disturbance would probably not regain that structure for at least 20 years after abandonment.

Overall potential project related impacts on viable habitat appear to be relatively low for this species, with 2, 7, and 8 percent of suitable breeding habitat potentially lost during the life of the project under Alternatives 1, 2 and 3, respectively. This indicates that even under the highest level of well development (Alternative 3), roughly 92% of suitable habitat would remain relatively unaffected by project-related disturbances.

The yellow warbler is a frequent host to the brown-headed cowbird. Even though the yellow warbler has developed unique methods for contending with this, nest parasitism still reduces overall nesting productivity. Research has shown that cowbird populations increase when openings are created in closed woodland and forest canopies, thus increasing amount of forest edge (Hejl

1992, Robinson et al. 1993). Cowbird parasitism could increase as a result of project-related disturbance in and adjacent to suitable habitats.

Habitat fragmentation could result in reduction in habitat quality for the yellow warbler. It is unclear if the level of disturbance represented by any of the alternatives would result in a level fragmentation that would significantly affect population dynamics within the Study Area. The potential for and the degree of habitat fragmentation would increase with increasing well densities.

Cumulative Effects: The above table indicates that the cumulative potential habitat loss to the yellow warbler within the Study Area would total 8.0, 13.4 and 13.6 percent for Alternatives 1, 2, and 3, respectively. This probably does not represent a critical level of habitat loss as it relates to overall population viability within the Study Area. Additional losses of suitable habitat have, and will continue to in areas outside of, but adjacent to Study Area. Proposed gas development directly north and south of Study Area could potentially result in the same types and level of impacts anticipated for this species within the Study Area. Additionally, other disturbance regimes, such as residential development would result in additional future losses of suitable habitat.

Wetland/Marsh Habitat

The wetland/marsh cover type comprises less than 1% of the Study Area. It is occurs along perennial streams, irrigation and wastewater ditches, water impoundments, as well in small areas isolated areas of high groundwater in flat valley bottoms. These areas are found dispersed within the previously discussed vegetative cover types. Since wetlands typically occur in low-lying areas they can be affected by activities that occur at quite a distance from the site. Reductions in surface and ground water flow can adversely affect these systems. These changes can result in commensurate effects to wildlife habitat found in these areas. Sections 4.5.1 and 4.5.2 provides a comprehensive discussion of potential effects to groundwater and surface water resulting from proposed project-related activities.

STRIPED CHORUS FROG

(Pseudacris triseriata)

Factors of Concern and Management Implications: The chorus frog is sensitive to changes in the hydrologic processes that would affect availability of breeding habitat. This species appears to be quite tolerant of human activities, considering its presence in agricultural and suburban areas. However, contaminants in runoff can concentrate in breeding ponds, making eggs and larvae susceptible to detrimental effects (Harding 1997).

The permeable skin of the western chorus frog also makes it susceptible to contaminants and other external stimuli. Changes in morphology or ecology of this species might indicate high levels of pollution or other activity detrimental to their well-being.

Associated Species: Species that use similar habitats or species that would be affected in similar ways from management activities include the tiger salamander, northern leopard frog, Woodhouse toad, New Mexico spadefoot toad, and painted turtle.

Direct and Indirect Effects: Due to wetland protection issues and the general difficulty in construction in wet areas, it is anticipated that very few wetland/marsh areas would be directly affected by surface disturbance during well development. Roads crossings in wetland areas may occur when no alternative access route is possible. The greatest threat to the chorus frog would be through significant changes in hydrology that might dewater breeding sites. Any action that lowers the water table or reduces water flows into wetland/marsh systems could potentially reduce the availability or suitability of breeding habitat. Most of the water required for project operations would be obtained from existing irrigation sources but may be occasionally taken from streams and ponds. It is not expected that drilling activities would significantly affect groundwater. For a discussion on potential project effects to hydrology see 4.5.1 and 4.5.2.

An additional source of concern would be the degradation of water quality in existing habitat. This could occur through accidental spills of chemicals, saline water or petroleum at the well site or on the access roads through occurrences such as traffic accidents. Degradation can also occur through significant sedimentation entering the wetland complex, which can alter the overall functioning of these systems. Both new roads and well pads would be a source of sedimentation, particularly during and shortly after the construction phase. Individuals would also be at risk to direct mortality from vehicular activity on roads in or adjacent to suitable breeding areas.

It is not anticipated that the overall effects to the chorus frog would be significant under any of the proposed alternatives. However, the potential for adverse effects would increase with increasing well density.

Cumulative Effects: It is unknown whether the total amount of breeding habitat has decreased from past activities within the Study Area. Some areas have undoubtedly been lost to a variety of development and agricultural activities. However, new habitat has also been created from seeps along irrigation channels, pond development, beaver dams, and other changes in hydrologic systems. Future development, both inside and outside the Study Area, could result in additional cumulative impacts but these would be difficult to predict.

Multiple Habitats : A number of wildlife species found within the Study Area are classed as "habitat generalist". These species do not depend on any one vegetative cover type to meet their biological requirements and no specific type attributed to the maintenance its population viability. Most of the larger mammals that use the Study Area, including deer, elk, mountain lion, black bear, coyote and bobcat fall into this group. Some of the larger raptors, such as the red-tailed and the great-horned owl would also be considered habitat generalist. Generally, these species typically have large territories and may move considerable distances on a seasonal or annual basis. Elk and deer were given special attention in Sections 4.3.2.4 through 4.3.2.6 due to the critical role that tribal land plays in the maintenance of populations of these species both within and outside of the Study Area. Unlike most of the other species addressed in this analysis, existing deer and elk habitat and usage patterns have been well defined and quantified by tribal and CDOW wildlife specialists.

4.3.2.8 Impacts Summary

Impacts on wildlife resources would result from habitat loss (i.e., surface disturbances) as well as from disturbances from noise and human activity. The differences in impacts among the alternatives is related to the number of wells that are constructed and the resulting disturbances. Alternative 1 involves the construction of 350 wells while Alternatives 2 and 3 involve the construction of 636 and 706 wells, respectively. Wildlife ranges that would sustain the largest percentages of habitat loss include elk summer range (1.3 percent, 958 acres for Alternative 3) and elk winter concentration areas (0.68 percent, 346 acres for Alternative 3). Wooded riparian areas (Map 6) provide important habitat for a variety of wildlife species and therefore are considered to be an important habitat type in this analysis. Alternative 3 could result in a maximum loss of 171 acres (2.10 percent) of wooded riparian habitat. Mitigation, such as the use of existing well pads, where available, would reduce the area of surface disturbance and of individual resource disturbances. Additionally, during project design and layout wooded riparian areas would be avoided where possible. Because of the small percentages affected, direct impacts from habitat loss (surface disturbance) are not considered to be significant.

However, impacts from noise and activity disturbances are expected to result in significant impacts on elk habitat because this habitat characterizes a large proportion of the Study Area (Map 7) and because it is unlikely that project activities can avoid this habitat due to its widespread occurrence. Similarly, upwards of 50 percent of golden eagle, Abert’s squirrel and grey flycatcher habitat would be impacted by noise and activity disturbance. Furthermore, elk habitat is expected to receive year-round disturbances from production and maintenance activities. Unless mitigation measures are implemented, significant impacts are expected to occur from construction and production activities for Alternative 3 on elk summer range. Additionally, significant impacts are expected to occur on wildlife from construction activities from all of the alternatives as a result of impacts on wooded riparian habitats (23.0 percent for Alternative 1, 100 percent for Alternatives 2 and 3) since all these values are over the 20 percent disturbance level established by the Tribe. The environmental protection measures described in Appendix E would reduce impacts on wooded riparian areas.

Aquatic Species- Potential impacts on aquatic species include degradation of water quality from increased sedimentation, and contamination of habitat from accidental spills or leakage of petroleum products and produced (saline) water. Produced water may have a TDS as high as 20,000 mg/L, which would be toxic to aquatic systems and organisms, although impacts would localized. There is little potential for PAH contamination of fisheries within, and downstream of, the Study Area. Mitigation and environmental protection measures described in Sections 4.3.1.8, 4.4.2.8 and Appendix E should minimize erosion by providing for aggressive revegetation of disturbed soils and using best management practices designed to check erosion before entering water courses. Accidental spill and leakage should be minimized by standard industry practice and the requirements presented in Section 2.9.2 that are attached to gas development and production as operations procedures.

Potential impacts on fisheries also include water depletions for well drilling and stimulation. Extended over the 20-year period covered by this EIS, the expected annual maximum water use requirement for well construction and stimulation associated with Alternative 2 is 25 acre-feet/year (Table 4-23). The expected annual maximum water use requirement for Alternative 3 is 27 acre-feet/year. The water use requirement for Alternative 1 would be less, about 18 acre-feet/year. Because water for drilling and stimulation would be acquired from existing irrigation sources, although it is possible that some water may be acquired from local streams, ponds and formations, significant well construction related water depletion impacts are not anticipated.

Additionally, the 3M Study estimates that CBM gas production within the Study Area will intercept about 37 acre-feet of Fruitland Formation water that would normally discharge into the Animas River. This amount of water is not presently measurable in-stream and is not anticipated to significantly impact fish habitat or agricultural use.

For comparison purposes, the average annual runoff in the Animas River near Cedar Hill, New Mexico (2.5 miles upstream from the Colorado-New Mexico state line) for period 1934 to 1996 was 671,700 acre-feet (USGS 1996). The 3M (Monitoring, Mapping, and Mitigation) project will continue to monitor the situation and report to the participating agencies, the public, and the Fish and Wildlife Service any changes, particularly increases, in the calculated depletion.

4.3.2.9 Mitigation Summary

The BIA's 1990 EA describes standard mitigation measures for well site development and pipeline rights-of-way construction. The Tribe, BIA, and BLM have also written standard conditions of approval for oil and gas development (Appendix E) and can amend those conditions for individual projects as appropriate. The following text provides additional mitigation measures that would be implemented and that are specific to wildlife and fisheries resources.

Wildlife

- Minimize surface disturbance by accessing new wells via spur roads off existing roadways rather than through construction of new primary roads. *(Mitigation Developed from SUIT EIS)*

- Use existing rights-of-ways to the extent possible for new roads and pipelines. *(Mitigation Developed from SUIT EIS)*

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- Minimize or avoid development in areas of critically important wildlife habitat, such as elk or deer winter concentration areas and wooded riparian vegetation. *(Mitigation Developed from SUIT EIS)*

- Conduct on-site inspections of potential development locations to ensure avoidance of wooded riparian areas to the greatest extent possible. *(Based on Existing Policy or Regulation) and (Mitigation Developed from SUIT EIS)*

- Survey areas to be developed (rights-of-way and wells) for nesting activity or winter roost sites (e.g., eagles) prior to construction. *(Mitigation Developed from SUIT EIS)*

- Restrict new well locations and rights-of-way to at least 0.25 mile from a raptor nest or winter roost. *(Mitigation Developed from SUIT EIS)*

- Prohibit construction or other intrusive activities within 0.5 mile of an active raptor nest during the nesting season. *(Mitigation Developed from SUIT EIS)*

- Tribal wildlife 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. This data would be used to evaluate the effectiveness of mitigation measures for wooded riparian habitat and develop additional mitigation criteria as necessary. *(Mitigation Developed from SUIT EIS)*

- Limit construction activities in elk and deer wintering habitats to appropriate times (e.g., summer months) or to any applicable seasonal restrictions, in order to reduce disturbance-related impacts on these species. *(Mitigation Developed from SUIT EIS)*

- 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. *(Mitigation Developed from SUIT EIS)*

- Minimize the number of well monitoring trips by coordinating well visits to limit traffic, or installing automated monitoring systems. *(Mitigation Developed from SUIT EIS)*

- Where development in unique habitats cannot be avoided, mitigation, such as habitat enhancement and restoration, would be considered. *(Mitigation Developed from SUIT EIS)*

- Install fencing that reduces wildlife mortality (e.g., a 38-inch-high top strand with a 12-inch kickspace permits easier wildlife movements). *(Mitigation Developed from SUIT EIS)*

- Revegetate disturbed areas as soon as possible. Monitor the success of revegetation efforts, and re-seed as needed to develop established stands of vegetation. *(Based on Existing Policy or Regulation)*

Fisheries

- Protect surface waters from oil- and gas-related sedimentation and contaminant releases. *(Based on Existing Policy or Regulation)*

- Minimize the number of stream crossings by roadways and pipelines. Where feasible, cross streams and riparian corridors at right angles to protect additional habitat and minimize erosion. *(Mitigation Developed from SUIT EIS)*

- Maintain riparian vegetation during construction projects, along stream channels to the fullest extent possible. *(Based on Existing Policy or Regulation)*

4.3.2.10 Unavoidable Adverse Impacts

Habitat losses that would occur for the life of the project (about 20 years), such as well pads and new roads, are an irretrievable commitment of resources. Of these losses, elk winter concentration areas and severe winter areas are of the greatest concern. Disturbance to elk in winter concentration areas and to wooded riparian areas from noises and activities associated with construction and production is considered to be a significant impact. However, the environmental protection measures provided in Appendix E, including, but not limited to, the measures described above should reduce impacts to an acceptable level.

4.3.3 Threatened, Endangered, And Sensitive Species

4.3.3.1 Issues, Impact Types, and Criteria

Threatened, Endangered, and Sensitive (TES) species include federally and state-listed threatened, endangered, proposed, and candidate species, SUIT sensitive species, and Colorado Natural Heritage Program (CNHP) species of concern as described in Chapter 3, Section 3.3.5. The purpose of this section is to describe and analyze impacts that have the potential to affect TES species and their habitats within the Study Area and its vicinity as a result of the implementation of the proposed action and alternatives.

The Endangered Species Act (ESA) of 1973, as amended, provides protection to threatened and endangered species and their critical habitats. Section 7 (a) of the ESA directs federal departments and agencies to ensure that actions of a federal agency are "not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of (its) habitat." Section 7 (a) of the ESA also requires consultation with the U.S. Fish and Wildlife Service (USFWS) when a federal action may affect a federally listed endangered or threatened species. Through discussions with the USFWS, it was determined that formal consultation is required for this project although it is a programmatic EIS (USFWS, personal communication). In addition, formal consultation would be required for site-specific oil and gas projects that would be developed under this EIS if a federally-listed threatened or endangered species may be affected. Colorado State Statutes 33-2-105 Article 2 provide protection to state threatened or endangered species but does not provide protection to habitat for such species.

SUIT sensitive species have been identified as species of concern by the SUIT Wildlife Department. Although no specific protection is provided for these species, SUIT sensitive species do receive special management attention from the Tribe, ultimately for the purpose of avoiding the need for federal protection in the future. Similarly, CNHP species of concern may receive special attention from the Tribe but no specific protection is required by tribal or state regulatory agencies.

A Biological Assessment (BA) was prepared to determine whether any impacts on TES species could result from implementing the alternatives. Where the BA determined that any TES species could be affected adversely, appropriate measures were identified to prevent impacts, as required under the ESA. A copy of the BA is provided in Appendix G of this EIS. The BA was sent to USFWS with a request for a Biological Opinion (BO).

Impacts on TES species would be considered to be significant if there would be a loss of any individual plant or animal of a federally- or state-listed species, or loss of critical habitat of such species, or would be considered significant if there is any potential for take under ESA. Significant impacts as they pertain to individual threatened or endangered species are described in the BA (Appendix G). Impacts on sensitive species or species of concern would be considered significant if there would be a loss of population viability of a SUIT sensitive species. Federal and regional lists of protected species are periodically subject to change. The list of TES species addressed in this EIS will be updated through coordination with the USFWS or the BIA prior to the initiation of a site-specific oil or gas development project.

4.3.3.2 Impact Assessment Methods

Based on estimates of likely locations of wells, direct impacts on TES species in the Study Area were calculated from surface disturbances (vegetation removal). Mapping was available for bald eagle winter range and bald eagle winter concentration areas (Map 9). Although habitats for the peregrine falcon and southwestern willow flycatcher are not currently mapped, impacts on areas of wooded riparian vegetation were used to approximate potential impacts for these species (Maps 6 and 9). Potential impacts on the Colorado pikeminnow and razorback sucker, for which critical habitat is designated in sections of the San Juan River downstream of the Study Area, were described based on the project's potential to affect water quality and quantity. Potential impacts on the Knowlton's cactus were estimated based on surface disturbances to piñon-juniper communities for the purposes of providing a comparison between the alternatives, although site-specific field surveys would be required prior to site disturbance in order to avoid direct impacts on individuals.

4.3.3.3 Impacts Common to All Alternatives

Construction Phase

Impacts on TES animal and plant species during the construction phase primarily would occur from surface disturbances and the removal of vegetation for well pads, roads, pipelines, and other facilities. In addition to habitat directly removed by construction, larger areas would be lost as viable habitat for TES animal species that are vulnerable to human intrusion, noise, and habitat isolation.

During construction, aquatic populations (fish and river otter) in and downstream of the Study Area could be affected potentially by any reduction in the quantity and/or quality of the surface waters of the Study Area. Both the well drilling and stimulation processes use water, although water requirements should be met by appropriated agricultural sources and therefore should not impact fisheries through stream depletions. Additionally, all alternatives will intercept the groundwater that would normally discharge from the Fruitland Formation to the Animas River. Fish populations could also be adversely affected by contamination of surface waters from accidental spills or leakage of petroleum products from vehicles. Indirect impacts on aquatic systems could occur from erosion and subsequent sedimentation as a result of increased surface disturbances in the Study Area.

Production Phase

During the production phase, no additional habitat losses would occur. However, long-term, year-round noise and human-related activity disturbance impacts would result from production and maintenance activities at well sites and compressor stations, and from truck hauling of produced water. Maintenance visits at compressor stations are typically frequent and can be as often as two to five truck visits per day for some of the larger compressors, although the majority of the compressors each require five to seven visits per week.

Potential impacts on aquatic populations during the production phase are similar to those described in the construction phase with the exception of the potential for accidental leakage of produced (saline) water into local streams. Produced water from the Fruitland Formation may have a TDS as high as 20,000 mg/L, although it is typically less than 8,000 mg/L. Lakes with dissolved solids in excess of 15,000 mg/L are generally considered unsuitable for most freshwater fishes (Rawson and Moore 1944). Fish populations also could be affected adversely by contamination of surface waters from accidental spills. Fluids containing PAHs, which are known carcinogens, would be limited to fuels and some lubricants and are not contained in the methane. There is little potential for PAH contamination of fisheries within, and downstream of, the Study Area.

Data on the Reservation suggests that production of water with CBM has caused a drop in the Fruitland Formation water table near the Fruitland outcrop and has affected preexisting springs and ephemeral flows. Each alternative will have a similar impact, but denser well spacing and more rapid development would accelerate the onset of these impacts.

Abandonment Phase

During the abandonment phase, all well pad sites would be reclaimed and revegetated. No new surface disturbances or habitat losses are anticipated during this phase, although short-term noise disturbances would result from abandonment activities.

4.3.3.4 Potential Impacts Specific to TES Species

The following text provides a discussion of impacts that could occur on TES species that have the potential to occur in, or downstream of, the Study Area. Impacts anticipated for the federally-listed species are described in greater detail in the BA, (Appendix G).

Federally-Listed Threatened and Endangered Species

Federally-listed species that have the potential to be affected by the proposed alternatives include bald eagle, peregrine falcon, southwestern willow flycatcher, Colorado pikeminnow, razorback sucker, Mancos milkvetch and Knowlton's cactus. However, most impacts should be prevented through appropriate use of avoidance measures. Potential impacts on federal TES species are as follows:

- Bald eagles may be affected through noise and human-related activity disturbances to nesting and wintering sites. They may also be by the removal of vegetation, especially large cottonwood trees, within the known bald eagle winter range and bald eagle winter concentration areas.

- Colorado pikeminnow and razorback sucker in the San Juan River may be affected by upstream depletions in the Study Area. It is likely that all fresh water required for well drilling and stimulation would be acquired from appropriated agricultural sources. Instream depletions are estimated to be below the 3,000-acre-foot/year threshold established by the USFWS. Potential depletions due to the long term production of water from the Fruitland Formation have not been determined at this time, but they are possible.

- Colorado pikeminnow and razorback sucker may be affected by degradation of water quality from accidental spills of petroleum products, produced (saline) water, and from sedimentation from erosion of disturbed surfaces. BLM analysis of 1995 and 1996 data indicates that the oil and gas program is not contributing PAHs to the pikeminnow and razorback sucker habitat via surface runoff (BLM 1997).

- Knowlton's cactus may be affected by surface disturbances from clearing for well pads and roads. In addition, increased roadway development may provide easier access for illegal collections of these plants. Two populations of the Knowlton's cactus are known to occur in the Study Area and additional populations may be present.

- Mancos milkvetch may be affected by surface disturbing activities that could affect individual plants through there removal or habitat destruction.

- No critical nesting habitat is designated for the Mexican spotted owl within the Study Area, and field surveys have not identified any Mexican spotted owls or nesting habitat within the Study Area. If present, however, the Mexican spotted owl could be affected by removal of mature stands of conifers and by noise and human-related disturbances from project activities.

State-Listed Threatened and Endangered Species and Species of Concern

State-listed species that have the potential to be affected by the proposed alternatives include the bald eagle, peregrine falcon, and North American river otter. Potential impacts on the bald eagle and peregrine falcon were described in the previous section. River otters, which are present in the Piedra and Pine rivers, could be impacted as follows:

- Den sites and resting areas could be impacted by removal and disturbance of wooded riparian habitats. Aquatic habitats and food sources could be affected by in-stream depletions and degradation of water quality through accidental spills of petroleum products and produced (saline) water as well as sedimentation from erosion of disturbed surfaces.

- Construction activities requiring stream crossings and/or work within riparian corridors would be minimized or avoided where suitable river otter habitat is present and where known dens (e.g., bank dens) are present. Disturbance-free buffer zones based on the quality and quantity of suitable habitat would be established and BIA and SUIT experts should be consulted wherever habitat impacts are suspected to occur. Also, USFWS, BIA, and BLM construction standards regarding well placement would be followed, and wastewater pits would be lined accordingly to avoid hydrocarbon contamination of streams.

- Peregrine falcons may be affected by noise and human-related disturbances of nest sites (cliffs) and from alteration of foraging habitats (e.g., wooded riparian areas).

SUIT Sensitive Species

The SUIT sensitive species that may be affected by the proposed alternative is the roundtail chub, for which potential impacts are as follows:

- Roundtail chubs may be affected by disturbance and/or destruction of stream habitats, especially where stream crossings or work in riparian corridors may alter stream characteristics (e.g., depth, velocity, cover). Additionally, roundtail chub may be affected by instream depletions in the Study Area, although it is likely that all water required for well drilling and stimulation would be acquired from appropriated agricultural sources. Potential depletions due to the long-term production of water from the Fruitland Formation are small, totaling an estimated 37 acre-feet/year.

- Roundtail chubs also may be affected by degradation of water quality from accidental spills of petroleum products and produced (saline) water and by sedimentation from erosion of disturbed surfaces.

CNHP Species of Concern

Plant species of concern include Aztec milkvetch, Arboles milkvetch, compact gilia, Abajo penstemon, little penstemon, showy collomia, and wood lily. These plant species could be affected by clearing of surface areas for well pad and right-of-way during the construction phase. Additional impacts are not anticipated during the production and abandonment phase.

Animal species of concern include the flannelmouth sucker, ferruginous hawk, Mexican vole, Yuma myotis, and southern plateau lizard. Potential impacts on the flannelmouth sucker would be similar to those described for the roundtail chub and include disturbance and/or destruction of stream habitats, instream depletions in the Study Area, although it is likely that all water required for well drilling and stimulation would be acquired from appropriated agricultural sources, as well as degradation of water quality from accidental spills of petroleum products and produced (saline) water and by sedimentation from erosion of disturbed surfaces. Potential depletions due to the long-term production of water from the Fruitland Formation would be small. Potential impacts on terrestrial species of concern include removal of surface vegetation during construction and disturbance of individual animals in the vicinity of well pads and roads from noise and activity associated with production and maintenance operations. The actual degree of disturbance would depend on the individual species type, time of year, and other factors specific to each animal and location.

4.3.3.5 Threatened or Endangered Species Impacts

Species: **Bald eagle** *(Haliaeetus leucocephalus)*

Status: Federally Threatened

Distribution/Habitat: Bald eagles occur in Colorado primarily in the winter and are typically present from October to March. Bald eagles are considered to be uncommon to locally uncommon winter residents of the western valleys of Colorado. Wintering areas may include semideserts and grasslands, especially near prairie dog towns (Andrews and Righter 1992). Winter roost sites generally occur in sheltered areas with large trees for perching, a nearby food source, and minimal human disturbance. Bald eagles feed primarily on fish, prairie dogs, rabbits, and waterfowl. Bald eagles are considered to be a rare summer resident in restricted localities of Colorado. Although some nesting occurs in Colorado, most bald eagles migrate to northern breeding grounds and return to lower latitudes in winter. Populations have been severely impacted by shooting, habitat destruction, and pesticides.

Potential to Occur in Study Area: Bald eagles are known to both nest and winter in various locations throughout the Study Area. Winter range, including habitat designated as winter concentration areas by the CDOW, occurs along all the major drainages in the Study Area, as well as between the Florida and Pine rivers along northern boundary of the Reservation (see EIS Map 9 which is included in this BA). As many as 10 bald eagles may be present along the Pine River in winter (Diswood 1996). Three known active bald eagle nests occur within the Study Area, one is located near the Town of Allison west of the Navajo Reservoir and two are located on the Pine River north and south of the Town of Ignacio, respectively. All nests have been documented in large, mature cottonwood trees (Stroh 1998). Historic bald eagle nest sites also occur along the Animas and Pine rivers within the Study Area; these sites may be used by bald eagles again in the future.

Analysis of Effects: Bald eagles could be impacted both by the removal of wooded riparian vegetation as well as disturbances caused by gas development. Removal of wooded riparian vegetation primarily would occur during the construction phase (e.g., roads, drill pads, pipelines, and other facilities), rather than the operation and abandonment phases. While the removal of riparian vegetation would be minimized through avoidance as described above, nevertheless some minor fragmentation and degradation of this habitat type could occur.

Based on estimates of likely locations of wells, rights-of-way, and other facilities, direct impacts from surface disturbances to TES habitats were calculated. A maximum of 422 acres of bald eagle winter habitat would be directly impacted by construction of the Agency's and Tribe's Preferred Alternative without mitigation. These values represent 0.72 percent of the resource in the Study Area. By constructing on existing well pads, the area of disturbance can be reduced to 346 acres (0.59 percent). Furthermore, as prescribed as a first line of mitigation, this impact would be further reduced by siting well pads such that sensitive areas are avoided as much as possible.

Within the bald eagle winter concentration areas, a maximum of 77 acres would be directly impacted by the Agency's and Tribe's Preferred Alternative. These values represent 0.48 percent of the resource. By constructing on existing well pads, the area of disturbance can be reduced to 67 acres (0.42 percent). However, by following the prescribed mitigation it is possible to greatly reduce this direct impact by siting well pads such that sensitive areas are avoided as much as possible.

Disturbance-related impacts could be expected to occur throughout the year, especially during the production phase. Disturbance-related impacts from construction are expected to be short-term, although more severe than the operation phase. During winter months (November 15 through March 15), project activities within or directly adjacent to bald eagle winter ranges and winter concentration areas could result in the abandonment of some of these areas and may force individuals to use less optimal habitats. However, to reduce such impacts, construction would be restricted from 15 November to 15 March in bald eagle winter range and concentration areas.

Three active bald eagle nests are known to occur within the Study Area. Disturbance-related impacts that occur during summer months within or directly adjacent to bald eagle nesting sites could cause the disruption or abandonment of nesting activities. No activity would occur within 0.25 mile of an active nest. Seasonal restrictions during the eagle's reproductive period would be imposed within a 0.5 mile area to protect nesting birds.

Oil and gas activities could impact the eagle's prey base, including both fisheries and small mammal populations. Degradation of the water quality and quantity of local streams and rivers, and subsequently the degradation of fisheries, could adversely impact both summer and winter residents. Potential impacts on water quality could occur as a result of erosion and sedimentation, as well as from contamination from accidental spills and leaks associated with machinery fuels, lubricants, and drilling fluids. However, erosion and sedimentation would be minimized as described above by implementing best management practices, required spill prevention and remediation procedures, and containing fluids typically in small, lined and bermed areas or pits. Production water, which is highly saline, would be reinjected into formations below the Fruitland Formation and should not affect water quality or quantity, unless accidental spills occur.

Cumulative Effects: Based on the estimates of surface disturbances from existing oil and gas development within the Study Area, the cumulative effect of the Agency's and Tribe's Preferred Alternative combined with existing well pad development could maximally result in a total surface disturbance of 2,989 acres (5.1 percent of the resource) of bald eagle winter range and 719 acres (4.5 percent of the resource) of bald eagle winter concentration areas. Again, these impacts would be reduced by using existing well pads where feasible and practical and by avoiding wooded riparian areas. Other cumulative effects, though difficult to quantify, could result from residential and other forms of development within wooded riparian habitats within the Study Area as well as from additional oil and gas and other development outside the Study Area.

We project that an additional 375 CBM wells would be constructed in the northern San Juan Basin, north of the Southern Ute EIS Study Area. This additional development is currently under study by the US Forest Service and BLM. Development of a lesser number of wells (95 wells) in the northern Basin was studied in the 1992 Forest Service/ BLM HD Mountain Gas Development EIS. The HD's EIS Study Area included bald eagle winter range along the Piedra and Pine rivers. The 1992 Biological Assessment for the HD's EIS concluded that 62 acres of eagle winter range would be impacted. The BA further concluded that there would be no-effect on the bald eagle. Mitigation measures approved in the HD's EIS Record of Decision are similar to those presented in this BA. The greater level of development now projected in the northern San Juan Basin has the potential to increase the density of wells in bald eagle winter range and thus to affect the species in ways similar to that described in this BA. Total avoidance of eagle winter range would not be possible if development were to proceed according to gas industry plans. The northern Basin CBM development EIS is still in scoping.

Species: **Southwestern willow flycatcher** (*Empidonax traillii extimus*)

Status: Federally Endangered

Distribution/Habitat: The USFWS listed the southwestern willow flycatcher as endangered in February 1995. The southwestern willow flycatcher is a subspecies of one of the ten North American flycatchers in the genus Empidonax. Willow flycatchers are Neotropical migrants. The southwestern willow flycatcher arrives on breeding grounds as early as mid-May and may be present through mid-August. Migration routes and winter ranges are not well known.

The southwestern willow flycatcher breeds in riparian habitats along rivers, streams or other wetlands, where dense growths of willows (*Salix* spp.), seepwillow (*Baccharis* spp.), arrowweed (*Pulchea* spp.), buttonbrush (*Cephalanthus* spp.), or other shrubs and medium-sized trees are present, often with a scattered overstory of cottonwood (*Populus* spp.) (Tibbitts et al. 1994). Thickets or shrubs are about 13-23 feet in height, with dense foliage from about 13 feet above ground, and often a high canopy cover percentage. Nest site vegetation may be even or uneven-aged, but is usually dense and structurally homogenous (USDI 1995a). Surface water or saturated soil is virtually always present in or adjacent to nesting thickets. The nest-site community may be even-aged, or consist of diverse age classes of various plant taxa. Stream gradient may be also an important determinant in habitat suitability.

The distribution of the southwestern willow flycatchers within the state of Colorado includes areas below 8,500 feet elevation within the southwestern corner of the state extending north to Rifle, Garfield County, and east to Fort Garland, Costilla County (USFWS 1996).

Potential to Occur in Study Area: No comprehensive surveys have been done for the southwestern willow flycatcher within the Study Area, although surveys have been completed in support of individual well projects. Suitable habitat has been identified and has been mapped for the EIS. The ability to identify suitable nesting habitat for the willow flycatcher was difficult with the available vegetation data. Wooded riparian habitat has been used as a proxy and likely significantly over-represents what is actually available for nesting habitat (see EIS Map 6 which is included in this BA). Additionally, large willow stands associated with irrigation canals may provide additional suitable nesting habitat.

It is considered possible that the southwestern willow flycatcher breeds in the Study Area, although none have been identified. In 1995, willow flycatchers were identified near Pastorius Reservoir, which is located in the north-central region of the Study Area; however, these individuals were considered migratory and were not observed in the Study Area during the breeding season (T. Ireland, USFWS, personal communication, 1997). Other individuals have been located near Bayfield and south of the Study Area in New Mexico (Chris Schultz, pers. comm. 2001).

Analysis of Effects: Although suitable breeding southwestern willow flycatcher habitat does exist in the Study Area, no southwestern willow flycatchers have been identified and no critical habitat has been designated in the Study Area. Areas of suitable habitat would be surveyed in the future and a site-specific BA conducted prior to the initiation of any site-specific oil and gas development projects.

The majority of the potential direct impacts on the southwestern willow flycatcher would occur from the removal of vegetation that would result from the construction phase (e.g., roads, drill pads, pipelines, and other facilities), rather than during the production and abandonment phases. Breaking up the riparian habitat would cause fragmentation and degradation of possible nesting habitat. Within the southwestern willow flycatcher's possible habitat (wooded riparian habitat), a maximum of 171 acres would be potentially impacted. This values represent 2.10 percent of the resource. By constructing on existing well pads, the area of maximum disturbance can be reduced to 165 acres (2.02 percent). However, it is the intent to greatly reduce this potential direct impact by siting well pads during project design such that sensitive areas are avoided as much as possible. The impacts on riparian vegetation would be minimized during site-specific project design.

Cumulative Effects: Based on the estimates of surface disturbance from existing oil and gas development within the Study Area, the cumulative effect of the Agency's and Tribe's Preferred Alternative, combined with the existing well pad development, would result in potential total surface disturbance of 484 acres (5.9 percent of the resource) of wooded riparian habitat. However, this potential impact would be minimized by siting wells and roads away from flycatcher habitat during individual project design. In addition, this may be an overestimate of total acres disturbed since wooded riparian vegetation was used as a proxy for nesting habitat. Other cumulative effects, though difficult to quantify, could result from residential and other forms of development within riparian habitats within the Study Area, as well as from additional oil and gas and other development outside the Study Area.

In the northern San Juan Basin, there are similar habitat patterns as described for the Southern Ute Study Area. Suitable riparian areas are scattered throughout the analysis area. Suitable habitat will be mapped for the Northern Basin EIS and similar mitigation as described here, including avoidance and timing limitations on activities, would apply.

Species: **Mexican spotted owl** (*Strix occidentalis lucida*)

Status: Federally Threatened

Distribution/Habitat: The FWS listed the Mexican spotted owl as threatened in April 1993. This spotted owl is geographically isolated from the Northern and California subspecies. It is distributed discontinuously throughout its range, with its distribution largely restricted to montane forests and canyons. It occurs in disjunct localities that correspond to isolated mountain systems and canyons.

Mixed conifer forests are commonly used throughout most of the owl's range. These forests are dominated by Douglas-fir and/or white fir, with codominant species including southwestern white pine, limber pine and ponderosa pine. The understory often contains these species as well as broad-leaved species such as Gambel oak, maples, boxelder and New Mexico locust (USDI 1995b). Mexican spotted owls typically nest and roost in closed-canopy forests or deep shady canyons; both situations provide cool micro-sites. They breed sporadically and do not nest every year. Eggs are laid in late March or, more typically, early April. The eggs usually hatch in early May (USDI 1995b).

Spotted owls appear to occupy two disparate canyon habitat types. The first is sheer, slick-rock canyons containing widely scattered patches (up to 1 ha in size) of mature Douglas-fir in or near canyon bottoms or high on the canyon walls in short, hanging canyons. The second consists of steep canyons containing exposed bedrock cliffs either close to the canyon floor or, more typically, several tiers of exposed rock at various heights on the canyon walls. Mature Douglas-fir, white fir, and ponderosa pine dominate canyon bottoms and both north- and east-facing slopes. Ponderosa pine grows on the more xeric south- and west-facing slopes, with piñon-juniper growing on the mesa tops.

The owls nest and roost primarily in closed-canopy forests or rocky canyons. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure. These forests are typically uneven-aged, multi-storied, and have a high canopy closure. Nest trees are typically large in size, where as the owls typically roost in both large and small trees. Douglas-fir is the most common species of nest tree.

In general, owls forage more in unlogged forests than in selectively logged forests. Both high-use roosting and high-use foraging sites had more big logs, higher canopy closure, and greater densities and basal areas of both trees and snags than random sites. Owls used a wider variety of forest conditions for foraging than they used for roosting (USDI 1995b).

Potential to Occur in Study Area: Spotted owl surveys were conducted in areas of suitable habitat within the Study Area. These surveys occurred prior to development of the EIS. No spotted owls were located. The Study Area is dominated by piñon-juniper which is not suitable for nesting (T. Stroh, SUIT, personal communication 1997).

Analysis of Effects: No Mexican spotted owls are presently known to occur within the Study Area. If this owl is identified within the Study Area, management sites known as Protected Activity Centers (PACs) would be delineated by the SUIT biologists and USFWS around the nest site or roost site and typically would include an area of no less than 600 acres (USFWS 1994). Development activities generally would be restricted within a PAC, although they would be evaluated on a project-specific basis (USFWS 1995).

The removal of forest vegetation for construction would have a direct effect on spotted owl habitat. Clearing for rights-of-way would degrade habitat through fragmentation and create more edge. No suitable nesting habitat for the Mexican spotted owl would be affected under the Preferred Alternative since no nesting habitat is located within the Study Area. There is about 1,021 acres (6%) of suitable foraging habitat which would be affected by the surface disturbance.

Cumulative Effects: Based on the estimates of surface disturbances from existing oil and gas development within the Study Area, the cumulative effect of the Agency's and Tribe's Preferred Alternative, combined with the existing well pad development, is anticipated to result in a total surface disturbance of 1,021 acres (6 percent of the resource) of ponderosa pine vegetation, which is considered to be foraging habitat for the Mexican spotted owl. No nesting habitat is present within the Study Area, although it may be present in areas of densely, wooded coniferous forest in the vicinity of the Study Area. Foraging habitat has been identified within the Study Area. Other cumulative effects, though difficult to quantify, could result from timber harvest of coniferous forests within ponderosa forests in the Study Area as well as from additional oil and gas and other development outside the Reservation.

In the northern San Juan Basin EIS Study Area, areas of foraging habitat are present in the HD Mountains. Mexican spotted owl surveys were completed in the HD mountain area in the Ignacio Creek, Bull Creek, Turkey Creek, and Fosset Gulch drainages in 1990, 1991, 1996 and 1998. An owl was heard calling in the Fosset Gulch drainage in 1996 but no activity center was located, nor was the owl located again (Chris Schultz pers. comm 2001). No other owls were identified during the surveys.

Species: **Colorado pikeminnow** (*Ptychocheilus lucius*)
Razorback sucker (*Xyrauchen texanus*)

Status: Federally Endangered

Potential to Occur in Study Area: The razorback sucker and Colorado pikeminnow are listed as endangered by the FWS. They will be analyzed together for purposes of this analysis. Neither species is known to occur within the Study Area. Critical habitat has been designated downstream in the San Juan River for both species.

There is a small reproducing population of Colorado pikeminnow in the San Juan River, downstream from Shiprock, New Mexico. During 1991 surveys, nine pikeminnow were captured 5 miles upstream from Shiprock.

The razorback sucker occurred historically in the lower Animas River. During a 1987 - 1990 study, suckers were observed within the San Juan River Basin in the vicinity of Lake Powell.

Analysis of Effects: Impacts on the Colorado pikeminnow and the razorback sucker have the potential to occur through water depletion and contamination of the San Juan River. As described in the Intra-Service Section 7 Consultation for Minor Water Depletions of 100 Acre-feet or Less From the San Juan River Basin (1999), the FWS concluded that "water depletions reduce the ability of the river system to provide the required water quantity and hydrologic regime necessary for recovery of the fishes". Water depletions can restrict the ability of the San Juan River to produce flow conditions necessary for the life stages of these fish.

Coalbed methane drilling and completion, as proposed, would require, in total, about 27 to 29 acre-feet per year of water that would typically be taken from irrigation ditches connected to the Animas, Pine, and Florida Rivers. This drilling and completion water would be recycled to a certain extent, but for the purposes of this analysis it is assumed that it would be lost from the system. In addition, existing coalbed methane wells in the Indian Creek area will continue to produce 37 acre-feet per year of water that would normally discharge to the Animas River or Basin Creek, but instead is pumped into deep formations or evaporation ponds. Therefore, a maximum total of about 66 acre-feet per year would be depleted from the San Juan River system as a result of the proposed action. Please see the appendix in the Biological Assessment (Appendix G) for a water depletion summary (Janowiak 2001).

Surface and ground water quality have become a significant concern in the Animas, La Plata, Mancos, and San Juan drainages (USFWS 1994). Increased loading of the San Juan River and its tributaries with soil salts, elemental contaminants, and pesticides from irrigation return flows could potentially degrade water quality and harm fish within the system (USFWS 1994). Contamination to ground and surface water is unlikely as a result of this proposed action. Petroleum spills may occur but safety precautions are in place to keep these types of accidents to a minimum. In the event of a spill, procedures would be implemented to contain hazardous materials and decrease the likelihood that contaminated materials reach ground and surface water.

Potential impacts also include contamination by polynuclear (or polycyclic) aromatic hydrocarbons (PAH), which are a class of organic chemicals that are present in the environment from natural and anthropogenic sources. Relatively few (less than 50) are known to be toxic, mutagenic, teratogenic, or carcinogenic (Odell 1997). Sources of PAH production include: forest fires, agricultural burning, combustion engines, coal-fired energy generation, municipal and industrial waste discharge, stormwater run-off from streets and roads, and spills of both crude and refined petroleum and hydrocarbon products (Odell 1997). Polynuclear aromatic hydrocarbons have low water solubility and there is a low potential for mobilization via dissolution in surface or ground water. PAHs are found in sediments, aquatic biota, and the water column. PAHs in sediment are often found in concentrations 1000 or more times than in the water column (Abell 1994). They can be ingested by fish through their food or by ingesting the sediment itself. Concentrations of PAH have been found in fish but studies have been unable to draw direct correlations to anthropogenic sources (Joel Lusk, U.S. Fish and Wildlife Service, Albuquerque Field Office, pers. comm). Although no studies have unequivocally linked PAH contamination to fish disease, high incidences of tumors and other abnormalities have been documented in areas of PAH contamination (Abell 1994).

Species: **Knowlton's cactus** (*Pediocactus knowltonii*)

Status: Federally Endangered

Potential to Occur in Study Area: The Knowlton's cactus occurs in piñon-juniper woodland with black sage (*Seriphidium novum*) in association with rocky alluvial soils at about 6,300 feet elevation. This species is one of the rarest of the genus and one of the rarest plants in the United States with collecting by hobbyists one of the factors contributing to its decline (Ecosphere 1995). The main population occurs near the New Mexico border, and other small populations are present on the Reservation. Because of possible collecting losses, specific locations of these populations are not provided in order to protect the species.

Analysis of Effects: Surface disturbing activities from gas and oil development would directly affect individual plants or populations. Within the pinon-juniper vegetation type, about 1,570 acres (1.15%) would be impacted through well pad and right of way development under the Preferred Alternative. Using existing well pads would reduce the disturbance to 1,318 acres (0.97%).

Cumulative Effects: Based on the estimates of surface disturbances from existing oil and gas development within the Study Area, the cumulative effect of the Tribal and Agency Preferred Alternative combined with the existing well pad development is anticipated to result in a total surface disturbance of 6,543 acres (4.8 percent of the resource) of piñon-juniper (medium to high density) habitat. Other cumulative effects, though difficult to quantify, could result from residential and other forms of development within piñon-juniper habitat within the Study Area, as well as from additional oil and gas and other development outside the Study Area.

Species: **Mancos milkvetch** (*Astragalus humillimus*)

Status: Federally Endangered

Potential to Occur in Study Area: Mancos milkvetch is found on ledges and mesa tops in slick-rock communities of the Mesa Verde Group in the Four Corners area. This species has been observed in Montezuma County, Colorado and San Juan County, New Mexico. Mancos milkvetch has not been observed in the Study Area, although Mesa Verde Group outcrops are present.

Analysis of Effects: Surface disturbing activities could directly affect individual plants and populations through their removal or habitat destruction. Cumulatively, residential development may occur within the Study Area. However, ledges and mesa tops are relatively inaccessible and the likelihood of impacts is quite low. There should be little or no cumulative effects to the Mancos milkvetch.

Table 4-14
Anticipated Surface Disturbance Impacts on Threatened, Endangered, and Sensitive Species Habitats from Alternative 1 - Continuation of Present Management (No Action)
11 x 8 ½
1 page
Landscape

Table 4-15
Anticipated Surface Disturbance Impacts on Threatened, Endangered, and Sensitive Species Habitats from Alternative 2 - Coalbed Methane Infill Development
11 x 8 ½
1 page
Landscape

Table 4-16
Anticipated Surface Disturbance Impacts on Threatened, Endangered, and Sensitive Species Habitats from Alternative 3 - Enhanced Coalbed Methane Recovery (Proposed Action)
11 x 8 ½
1 page

4.3.3.8 Impacts Summary

Federally listed TES species that have the potential to occur in, or downstream of, the Study Area include the bald eagle, peregrine falcon, southwestern willow flycatcher, Colorado pikeminnow, razorback sucker, Mancos milkvetch and Knowlton's cactus. State endangered species and SUIT sensitive species that may occur in the Study Area include the roundtail chub and North American river otter, respectively. Several plant and animal species of concern also are present within the Study Area (see Section 3.3.4.1, TES Plant Species, and Section 3.3.4.2, TES Wildlife and Fish Species).

Potential impact types that could affect TES species include surface disturbances from construction of well pads and rights-of-way (access roads and pipelines), which could affect species and/or habitat, as well as noise and activity disturbances from project operations, which could affect TES wildlife species. Additionally, potential impacts on aquatic TES species (i.e., fish, river otter) include possible stream depletions from well drilling, hydro-fracture operations, and production of water from the Fruitland Formation; and water quality degradation from accidental spills of petroleum products and produced (saline) water.

The actual locations of construction and disturbances would be sited to avoid sensitive areas as much as possible. This should effectively reduce the chance for significant impacts to occur. Some habitats, such as wooded riparian vegetation, are difficult to avoid altogether because of their linear and continuous nature, although impacts can be minimized by crossing riparian areas at right angles and by avoiding areas of higher quality riparian habitat. Impacts can also be avoided or reduced by scheduling construction to occur during less sensitive times of each year. Potential impacts on aquatic species can be reduced greatly by using appropriated agricultural water and committing to best management practices during construction and operation. Prior to initiation of site-specific projects, consultation with USFWS, BIA, and SUIT experts would be required regarding actual project locations and the potential for significant impacts to occur.

4.3.3.9 Mitigation Summary

Current BIA and tribal standard stipulations and conditions of approval are designed to protect federal threatened and endangered species by not allowing actions that would result in a "jeopardy opinion" under Section 7 of the Endangered Species Act, or actions that could result in destruction or adverse modification of their habitat. All site-specific environmental documents that are subsequent to this EIS will address protection for all known habitats of Federally-listed threatened or endangered species on the Reservation. The Tribe also is committed to avoiding or minimizing impacts on state-listed species and SUIT and CNHP species of concern, where possible.

<u>Federally Listed Species</u>

Bald eagle

- Conduct surveys of bald eagle nesting and roosting areas during appropriate seasons each year prior to initiation of site-specific project activities to determine if nesting or roosting areas are active. *(Mitigation Developed from SUIT EIS)*

- Construct well pads and rights of way at least 0.25 miles away from active bald eagle nests or winter roosts. *(Mitigation Developed from SUIT EIS)*

- Restrict activities within bald eagle winter range or winter concentration areas from November 15 to March 15. *(Mitigation Developed from SUIT EIS)*

- Restrict activities that could disturb nesting bald eagles within 0.5 miles of active bald eagle nests from January 1 to July 1. *(Mitigation Developed from SUIT EIS)*

- Do not remove large cottonwood or other large trees within areas designated as bald eagle winter range or winter concentration areas, and areas that may provide nesting habitat. *(Mitigation Developed from SUIT EIS)*

- If development activities are required within bald eagle winter range or winter concentration areas, they would be restricted to working from 10:00 am to 2:00 pm (Craig 1995). *(Mitigation Developed from SUIT EIS)*

Southwestern willow flycatcher

- Conduct Southwestern willow flycatcher surveys within suitable habitat prior to any construction activities to determine presence or absence of willow flycatchers. *(Mitigation Developed from SUIT EIS)*

- If Southwestern willow flycatchers are located during survey efforts, no surface disturbing activities would be conducted from May 1 through August 15. *(Mitigation Developed from SUIT EIS)*

- Minimize construction activities in wooded riparian habitat, or any other potential Southwestern willow flycatcher nesting habitat. *(Mitigation Developed from SUIT EIS)*

Mexican spotted owl

- If Mexican spotted owls are located within the Study Area, Protected Activity Centers (PAC) wouldbe delineated around the nest or roost site by SUIT biologists and the U.S. Fish and Wildlife Service (USFWS). *(Mitigation Developed from SUIT EIS)*

- Development activities within a PAC wouldbe restricted, although they wouldbe evaluated on a project-specific basis (USFWS 1995). *(Mitigation Developed from SUIT EIS)*

Colorado pikeminnow and razorback sucker

- Use Best Management Practices to avoid contamination of local streams and rivers to protect the razorback sucker and Colorado pikeminnow. *(Mitigation Developed from SUIT EIS)*

Knowlton's cactus

- Conduct field surveys for Knowlton's cactus prior to all construction activities. *(Mitigation Developed from SUIT EIS)*

- Avoid individuals or populations of Knowlton's cactus which may be impacted by activities. *(Mitigation Developed from SUIT EIS)*

- Use existing rights of way when possible. *(Mitigation Developed from SUIT EIS)*

Mancos milkvetch

- Conduct surveys for Mancos milkvetch prior to well pad and rights-of-way construction activities, unless previously surveyed by the USFWS. *(Mitigation Developed from SUIT EIS)*

- Avoid individuals or populations of Mancos milkvetch located during surveys. *(Mitigation Developed from SUIT EIS)*

<u>State-Listed Threatened and Endangered Species</u>

- Construction activities requiring stream crossings and/or work within riparian corridors should be minimized or avoided where suitable North American River Otter habitat is present and where known dens (e.g., bank dens) are present. Disturbance-free buffer zones based on the quality and quantity of suitable habitat should be established and BIA and SUIT experts should be consulted wherever habitat impacts are suspected to occur. Also, USFWS, BIA, and BLM construction standards regarding well placement should be followed, and wastewater pits should be lined accordingly to avoid hydrocarbon contamination of streams. *(Mitigation Developed from SUIT EIS)*

CNHP Species of Concern

- Section 4.3.3.4 details current CNHP and SUIT species of concern. Environmental protection measures for species of concern include avoidance of known populations, where possible, as well as a minimization of project disturbances and impacts. In general, field surveys would not be required for species of concern. *(Mitigation Developed from SUIT EIS)*

4.3.3.10 Unavoidable Adverse Impacts

Potential impacts on Federally-listed threatened and endangered species could be avoided through appropriate siting of project facilities and careful operations during the construction and production phase, including limited access to sites during some parts of the year and some parts of the day which are deemed vulnerable periods to certain species. However, if a potential impact on a Federally-listed TES species appears unavoidable, formal consultation would be required with the USFWS in coordination with the SUIT and BIA.

Potential impacts on State- and tribe-listed species could also be, for the most part, avoided through appropriate siting of project facilities and careful operations. Impacts due to instream depletions may be the hardest to recognize and avoid.

4.4 GEOLOGY, MINERALS, AND SOILS

4.4.1 Geology and Minerals

4.4.1.1 Issues, Impact Types, and Criteria

Impacts on geological and mineral resources would be considered significant if activities and restrictions associated with the project prohibited a reasonable opportunity to explore for or to produce resources, such as solid coal, which otherwise would be economically recoverable. With regard to all three alternatives, the recovery of natural gas and oil is the only significant consequence to geological and mineral resources. It is significant because it represents an irretrievable commitment of the resources, since they no longer would be available for future exploitation. Under current oil and gas exploration, and development practices and guidelines, no geological or mineral resource should be unintentionally damaged or otherwise adversely impacted by development of oil and gas.

Methane seeps and coal fires in the Fruitland outcrop are potential issues. Both situations can occur naturally in association with coal outcrops. In La Plata County, occurrences of methane seeps and coal fires have been hypothetically linked to CBM production. Both phenomena represent a loss of potentially economic resources as well as potentially significant health-and-safety issues. Within the Study Area, the 3M Model predicts an 8-fold methane seepage rate increase over current rates occurring around the year 2015. These increases were predicted for both 320-acre well spacing and 160-acre infill well spacing scenarios. It should be noted that the model predicts lower seepage rates after the year 2015 with infill wells. The model predictions are confirmed by the vapor tube data collected by the BLM along the Fruitland outcrop. These data show a statistical increase in methane concentrations along the outcrop within the Study Area and north of the Study Area. Coal fire occurrence and frequency cannot be predicted, nor has a link been confirmed between increased coal fire frequency and CBM development.

4.4.1.2 Impact Assessment Methods

Impacts on mineral resources were assessed by first identifying existing impacts from development that has occurred to date in the Study Area and then by projecting the potential impacts additional development would have. Oil and gas development impacts that have occurred in other basins were also considered. All potential impacts were assessed in consultation with BLM and SUIT fluid mineral managers and compared to industry practices, and rules and regulations. The primary impact on mineral resources is the irretrievable commitment of the methane gas resource through production. As such, the predictive modeling results of production quantities reported in the project description were used to quantify impacts on the methane gas resource. The irretrievable commitment of conventional resources would be the same under any of the three alternatives. The anticipated future production under each alternative is shown in Table 4-17.

TABLE 4-17
Anticipated Future Cumulative Gas Production During the Project Period by Alternative

Alternative	Production Type	Total Proposed Additional Production Wells	Total Gas Production (bcf)
1 - Continuation of Present Management (No Action)	Conventional	269	135[1]
	CBM	81	920
2 - CBM Infill Development	Conventional	269	135[1]
	CBM	367	1,182

TABLE 4-17 Anticipated Future Cumulative Gas Production During the Project Period by Alternative			
Alternative	**Production Type**	**Total Proposed Additional Production Wells**	**Total Gas Production (bcf)**
3 - Enhanced CBM Recovery (Agency's and Tribe's Preferred Alternative)	Conventional	269	135[1]
	CBM	367	1,304
[1]Cawley, Gillespie, and Associates 1998			

Note: the 3M Reservoir Model predicts significantly greater incremental recovery between alternatives #1 and #2. However, the 3M Reservoir Model was not used to predict incremental recovery for Enhanced CBM.

4.4.1.3 Impacts Common to All Alternatives

The production of methane gas, either conventional or CBM, or oil under all alternatives is an irretrievable commitment of the resource. The produced gas or oil would no longer be available for future use. However, intentional production of the resource provides economic and social benefits to the Tribe which ultimately makes business decisions regarding the rate at which to develop its resources. In addition, production from one formation does not affect the recovery of gas or oil from other geologic formations.

The production of CBM, other gas, or oil resources would not negatively impact the potential future mining of the solid coal resources. Removal of methane gas is a safety measure required in conjunction with solid coal mining. Steel casing that would be left cemented in the ground when wells are abandoned can be safely and economically removed as mining of solid coal occurs, especially if the locations of the abandoned wells are known accurately (Ginn 1999).

The potential for the proposed project to affect natural seismic activity in the area during any phase of the project's alternatives is minimal, as is the potential for seismic activity to affect the project. Maps of seismic risk for the United States indicate the location of the Study Area to be at the lowest seismic hazard risk (USGS 1994a). A discussion of potential impacts common to all of the evaluated alternatives by project phase follows.

<u>Construction Phase</u>

No specific construction-related impacts on geologic or mineral resources within the Study Area were identified. Potential impacts on health and safety, such as high formation pressure and hydrogen sulfide, can be predicted or evaluated based on knowledge of geological formations that are to be encountered during drilling. These impacts are discussed in Section 4.12, Health and Safety.

Production Phase

The amount of gas produced by alternative would vary depending on the number of wells drilled in the field and the ability to recover the gas. According to the future production scenarios presented in Section 2.6, the cumulative gas production from all existing Fruitland wells in the Study Area (tribal and non-Tribal) expected by the end of 1999 is about 1,480 bcf, with an estimated total recovery in excess of 3.1 tcf. Fruitland CBM production from tribal land alone is predicted to total about 1,075 bcf by the end of 1999. Table 4-17 presents the anticipated future natural gas production on tribal land in each alternative for the project life of 20 years (about January 1, 2000 to January 1, 2020). These production figures do not include production from wells drilled within fee land within the Study Area or existing wells.

Formation water also is produced with the oil and/or natural gas and is called produced water. Produced water within the Study Area is not used for domestic or stock water supplies due to its high TDS content. Conventional wells do not produce large quantities of water, though water quantities do commonly increase over the life of the well. Disposal of conventional well water can be through collection with on-site evaporation or with trucking to a permitted underground injection control (UIC) facility (disposal well). CBM wells typically produce more water than conventional wells. In some cases, this happens throughout the life of a well. Water quantities are typically large enough to justify constructing produced water pipelines to the disposal well, though some water is trucked.

New water disposal wells are usually drilled for disposal purposes. However, dry holes or depleted conventional wells have also been converted for produced water disposal. The SUIT Energy Resources Division, BIA, and BLM have expressed concern that injecting produced water into depleted formations may cause water to migrate to surrounding producing wells in the same formation and cause a “watering out” or decrease natural gas production in these wells. Except in unusual cases, the SUIT Energy Department has requested that EPA not permit disposal wells with a disposal or target formation the same as surrounding production wells within the exterior boundaries of the Reservation.

Subsidence occurs where there are huge volumes of water pumped (i.e., thousands of acre-feet/year.) from huge unconsolidated aquifers (Central Valley of California), or where very large gas reservoirs are depleted over an area that is already subsiding due to tectonics (i.e., Sacramento- San Joaquin delta of California). Although subsidence has occurred as a result of water production in some areas of the country, subsidence in the Study Area from groundwater withdrawal associated with this project is unlikely. The production zone occurs at a significant depth and the geologic units are relatively incompressible. No evidence has been found to date of subsidence associated with production from Ignacio Blanco Field.

The coal resources occur too deep in most portions of the Study Area to be a mineable resource at this time (see Section 3.4.2.2). Where the coal is found closer to the surface in the near outcrop zone, the degassing and dewatering of the coal from CBM operations would be a beneficial impact on coal mineability by reducing the gases that could potentially hinder safe mining operations. Methane encountered in coal mines can be hazardous requiring expensive mitigation. Studies indicate that CBM production significantly reduces the amount of methane encountered during mining (Dixon 1987). Studies conducted outside the Study Area involving the stimulation and production of methane gas from coal seams that were later mined indicate that hydrofracturing does not cause roof falls or adverse mining conditions (Diamond 1987; Dixon 1987). Steel casing and cement that is left in the ground when well bores are abandoned can be easily cut during mining (Ginn 1999).

Just as dewatering the coal releases the methane and allows the gas to move within the reservoir to the production well, dewatering the coals near the outcrop could also release methane. Shallow coal dewatering can occur naturally due to dropping water tables during periods of drought or from nearby production CBM wells. Dewatering of the shallow coal, whether natural or not, could cause a loss of the methane gas resource at the outcrop rather than being captured by a well. Degassing at the outcrop also could produce a safety hazard due to the explosive character of the gas. The released gas is not toxic since it contains only minor amounts of hydrogen sulfide if any at all. However, gas collecting in soils could produce an oxygen-depleted environment which could impact vegetation, or provide nutrients for bacteria causing the reduction of sulfur-containing minerals into hydrogen sulfide gas, which is toxic in large quantities or high concentrations.

Currently, CBM production appears to increase natural gas seepage at the Fruitland outcrop. It is well documented that methane gas leaks naturally from coal outcrops, and hydrogen sulfide may be produced by microbial action on seeping methane. In 1992 the SUIT began monitoring the western Hogback for methane and hydrogen sulfide leaks, anticipating that Fruitland coal dewatering could affect methane gas leakage at the Fruitland outcrop. Only low levels of methane and hydrogen sulfide were detected in the area at that time. In April 1995, the methane gas seeps appeared to be increasing in intensity at Valencia Canyon Gap, an area of the western Hogback which, according to anecdotal evidence, has had historical gas seeps. Also, new gas seeps were noted in the Fruitland Formation outcrop along strike. In response to the increased seep activity, the SUIT restricted access to the Valencia Canyon Gap, expanded monitoring, and began a mitigation program (Section 4.4.1.8). The expanded monitoring includes new monitoring wells, added soil vapor tubes, and water level monitoring in existing wells.

The mechanics and effects of the seeps are not yet completely understood, but the gas seeps themselves may cause an irretrievable loss of the methane resource. At this time it is not known whether the seeping gas could be economically captured by either existing wells or by some other means. An increase in water production in downdip coal could elevate the potential for resource loss at the outcrop. Seep mitigation eventually may include alternative technology, other than using existing wells, to capture coalbed methane before it reaches the outcrop. Impacts of the seeps on biological resources, and human health and safety are discussed in Sections 4.3 and 4.12, respectively.

An increase in the number or severity of coal fires in the Fruitland Formation, near the outcrop, could have a significant impact on tribal coal resources, as well as indirect impact on other resources. In 1998 and 1999, three subsurface coal fires were discovered in the Fruitland Formation on the western side of the Reservation. Because the fires are located in an area where the coal burned long before any CBM production was started, it is not clear if CBM production in the basin has had any impact on the existence or size of the coal fires. The fires are burning shallowly buried coal, and at this time no estimates have been made of the extent of the fires. Coal is a valuable resource to the Tribe because it would be physically possible to mine coal in the Hogback area using current technology. The Tribe worked with a consultant to attempt to put out the fires, as described in Chapter 3, Section 3.4.2.1., but these efforts were unsuccessful.

The history, magnitude, and severity of underground coal fires is under investigation. Two of these fires are adjacent to areas where coal burned in situ long before CBM production began. All three are located in remote, seldom accessed parts of the Reservation. Key questions include:

- Have these fires been smoldering unnoticed for decades or have they been newly ignited, or has renewed conflagration been facilitated by CBM water extraction;
- How extensive and active are the fires;
- Has potential water withdrawal or methane seepage in the area affected the fires; and
- Are there other subterranean fires which have not yet been discovered.

Many of the measures being taken to understand the methane seeps are also expected to aid in gaining an understanding of coal fire causes and effects (see Section 4.4.1.8). The Tribe is using infrared photography in an attempt to identify any other fires.

Potential indirect impacts on other resources from subsurface coal fires include degradation of vegetation and wildlife habitat, release of potentially toxic and caustic gases, forest or brush fires, explosions, or collapse of the surface soil layer into a burned-out underground cavern. These potential impacts are discussed in other appropriate sections of this document. The Tribe hopes to extinguish all the fires, which would limit the potential impacts.

Abandonment Phase

In general, plugging and abandoning production wells is not predicted to result in any impacts on geological or mineral resources, but in fact would re-establish permanent vertical zonal isolation. One potentially small impact would be the possibility of the cased hole within a coal seam to damage coal mining equipment (i.e., continuous miners and longwalls) if the area is subsequently mined for coal resources. As most of the coal is deeper than is presently economically feasible to mine, the impact on mineability of the coal is only predicted to be present in the near outcrop zone. A complete survey and/or inventory of development records for the proposed development area would be conducted prior to mining so that well casings could be removed and damage to equipment avoided.

4.4.1.4 Alternative 1 - Continuation of Present Management (No Action)

Construction Phase

No specific construction-related impacts on geologic or mineral resources within the Study Area were identified for this alternative, which would include construction of 269 conventional wells and 81 CBM wells on tribal land, other than those impacts identified in Section 4.4.1.3.

Production Phase

Development of the proposed number of wells under the Alternative 1 would result in the projected estimated incremental production of 135 bcf and 920 bcf for conventional and CBM wells, respectively, over the life of the project (Table 4-17).

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative, other than those impacts identified in Section 4.4.1.3.

4.4.1.5 Alternative 2 - Coalbed Methane Infill Development

Construction Phase

Construction of the proposed 269 conventional wells on tribal land and 367 CBM wells is not predicted to result in specific impacts on geologic or mineral resources in the Study Area, other than those identified in Section 4.4.1.3.

Production Phase

Development of the proposed number of wells under Alternative 2 is projected to add about 135 bcf and 1,182 bcf of incremental production for conventional and CBM wells, respectively, for the life of the project (Table 4-17). Compared to the no-action alternative, development of an increased number of wells in the Study Area under Alternative 2 would result in an increased removal of the methane gas resource, an incremental increase of 262 bcf.

Initial results of reservoir and hydrologic modeling within the framework of the 3M Project indicate that field wide infill drilling would not exacerbate methane seepage at the Fruitland Formation outcrop beyond that which already exists. The reservoir model predicts that the incremental recovery of gas created by infill drilling and production should diminish the volume and rate of gas seepage at the outcrop after a period of twenty years.

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative, other than those identified in Section 4.4.1.3.

4.4.1.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

Construction Phase

Construction of the proposed 269 convention wells on tribal land and 367 CBM wells, plus the projected 70 injection wells, is not predicted to result in impacts on geological or mineral resources in the Study Area, other than those identified in Section 4.4.1.3.

Production Phase

Development of the proposed wells under the Agency's and Tribe's Preferred Alternative is projected to result in incremental production of about 135 bcf and 1,304 bcf from conventional and CBM wells on tribal land, respectively, for the life of the project (Table 4-17). The Agency's and Tribe's Preferred Alternative would result in an incremental increase of 384 bcf and 122 bcf of produced natural gas over Alternatives 1 and 2, respectively, from wells on tribal land. Impacts within the near outcrop zone, that is, potential increases in gas seeps, occurrence of hydrogen sulfide, and coal fires, are expected to be similar to those identified in Section 4.4.1.3 and 4.4.1.5.

Predicting the effects of ECBM on the Fruitland Formation Outcrop is not currently part of the scope of the 3M project.

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative, other than those identified in Section 4.4.1.3.

4.4.1.7 Impacts Summary

With the exception of the commitment and development of the oil and gas, no significant adverse impacts on geologic or mineral resources are expected from implementation of any of the alternatives within the main or fairway portions of the Study Area. The potential exists for CBM production, including ECBM, to exacerbate natural gas seeps and or coal fires along the outcrop. The natural gas seeps may also be related to hydrogen sulfide in the soil in and near the outcrop. The seeps and fires could remove or destroy previously valuable resources, as describe in Section 4.4.1.3.

4.4.1.8 Mitigation Summary

BLM regulations, including Onshore Oil and Gas Orders and Notices to Lessees (Section 2.9.2), ensure orderly and efficient gas production while protecting the environment. Due to the increased natural gas seepage apparently linked to coalbed methane production downdip, there is a possibility that additional stipulations on development activities would be imposed in the future. At the present time, the SUIT Energy Department and BLM are continuing the following safety, monitoring, and environmental protection programs:

- restricting access to specific areas of the Fruitland outcrop. *(Based on Existing Policy or Regulation)*
- requiring individuals accessing specific areas of the Fruitland outcrop to attend a safety training class and to use gas monitors when in the field. *(Based on Existing Policy or Regulation)*
- monitoring natural gas and hydrogen sulfide gas seeps on the Fruitland outcrop. *(Based on Existing Policy or Regulation)*
- monitoring water at natural and manmade springs along the Fruitland outcrop. *(Based on Existing Policy or Regulation)*

- monitoring soil vapor concentrations at more than 150 locations along the Fruitland outcrop. *(Based on Existing Policy or Regulation)*

- periodically monitoring vegetative stress using infrared aerial photography. *(Based on Existing Policy or Regulation)*

- collecting records of daily flow volume data and periodic gas analysis data from Valencia Canyon Gap gas collection system. *(Based on Existing Policy or Regulation)*

- collecting pressure data from 22 monitoring locations across the Fruitland outcrop. *(Based on Existing Policy or Regulation)*

- measuring gas flow rates from “slant” wells drilled into the Fruitland outcrop at Valencia Canyon Gap. *(Based on Existing Policy or Regulation)*

- additional reservoir modeling may be conducted on areas near the Fruitland outcrop to predict potential for future gas seepage. *(Mitigation Developed from SUIT EIS)*

- Applications for Permits to Drill (APDs) for new wells to be located near the Fruitland outcrop may include Conditions of Approval designed to aid the outcrop monitoring or mitigation efforts. *(Based on Existing Policy or Regulation)*

4.4.1.9 Unavoidable Adverse Impacts

The primary unavoidable significant consequence on geologic and mineral resources is the consumptive loss of the oil and gas resource within the Fruitland and conventional gas formations, which is also the main purpose of the Agency’s and Tribe’s Preferred Alternative. Seepage and coal fires at the outcrop may be unavoidable adverse impacts. Programs are in place to assess these potential impacts, and mitigation measures would be taken to minimize any significant adverse impacts. No other unavoidable significant consequences were identified for geologic or mineral resources in this evaluation.

4.4.2 Soils

4.4.2.1 Issues, Impact Types, and Criteria

Impacts on soils may result from various activities during construction or installation, operation, and abandonment of the oil and gas wells. The primary concerns include increased soil erosion, loss of topsoil, loss of prime farmland, impacts on floodplains, mixing of soil horizons, compaction, and contamination of soils from various pollutants. These impacts may result in a loss of either soil resources or soil productivity.

In general, most impacts on soils would occur during the construction phase of the project, including the construction of well pads; establishment of new access roads; installation of flow lines, produced water lines, and satellite compressors at the central delivery point; and the establishment and use of construction staging areas. Short-term impacts would occur typically during the construction phase of the project, including reclamation of construction site. Impacts continuing beyond construction are long term. Permanent impacts can be minimized by proper construction, operation, abandonment, and reclamation procedures.

For the purposes of this evaluation, impacts would be considered significant if the following conditions occur:

- accelerated soil erosion is uncontrolled or soil productivity is not restored to approximate preconstruction conditions in an area within five years of construction
- greater than 5 percent of the total prime farmland acreage of the Study Area is a long-term loss or is permanently removed from agricultural production
- accelerated erosion rates in soils increase to the extent that manmade facilities are damaged resulting in possible safety hazards
- accelerated erosion rates in soils with high to severe erosion hazards remain uncontrolled, thereby increasing sedimentation to the extent that local water quality in streams is adversely affected and water quality standards are exceeded

4.4.2.2 Impact Assessment Methods

Impacts on soils and prime farmland were evaluated based on maximum potential surface disturbance and approximated locations of well pads, roads, and pipelines. Because this is a programmatic EIS, it is not possible to know the exact location of specific construction projects. These predicted locations were determined as part of the baseline for the project and were included in the GIS analysis. Inventory information on soils, erosion hazard potential, and prime farmland suitability also was included in the GIS analysis to complete the assessment. Potential impacts were determined in consultation with Natural Resources Conservation Service (NRCS), SUIT, and BIA soils or rangeland resource specialists.

4.4.2.3 Impacts Common to All Alternatives

Impacts on soils within the Study Area may occur from various activities during the construction and production of the oil and gas wells developed for the project and may result in a loss of either soil resources or soil productivity. Due to the size of the construction well pad and the post-construction reclamation activities, impacts during the construction phase are predicted to be of greater extent but of shorter term than the production phase impacts.

Construction and Production Phases

Accelerated soil erosion may occur when vegetation is removed or damaged by compaction during construction activities or in areas where the earth's surface is disturbed by heavy equipment. Accelerated soil erosion also may occur during the production phase in high traffic areas of the well pad or along access roads or in portions of the well pad that have not been properly graded. In areas where soils have high to severe erosion potential (Map 14) and are unstabilized, disturbance could result in accelerated erosion to the extent that damage to facilities and roadways may occur. The soils with high to severe erosion potential (Map 14) generally occur in broad portions of the south-central to southwestern regions as well as the eastern third of the Study Area. Slope instability or mass wasting could damage facilities and possibly cause hazardous situations. No specific areas of slope instability or failure have been identified in the Study Area; however, the potential for instability typically exists where slopes are greater than 30 percent. Such steep slopes do occur in the Study Area, typically encompassing the area of the near outcrop zone and within two miles west of the near outcrop zone. Project activities should have minimal effect on slope stability because surface disturbance on slopes in excess of 30 percent would be avoided where possible. Where such disturbances cannot be avoided, mitigative measures required by SUIT, BIA, and BLM through the APD authorization process would be implemented to reduce erosion and protect watershed resources.

Indirect impacts from accelerated soil erosion include increased sedimentation in streams from runoff following rainfall or snowmelt. Increased sedimentation may affect aquatic habitats, fisheries, and domestic drinking water supplies; clog irrigation systems; and degrade the aesthetic attraction of the stream itself.

Increased wind or water erosion of unstabilized, disturbed soils often results in the loss of topsoil, reduces soil productivity, and affects the revegetation potential of those soils. Areas of prime farmland may be impacted by the conversion of agricultural production acreage to well pads, roads, pipelines, and other project facilities. Prime farmland occurs generally in the northeastern quarter of the Study Area (Map 14). Some acreage also occurs in the southeastern portion in the vicinity of the town of Tiffany (Map 14). Loss of prime farmland may affect local economic conditions for the Tribe. Compaction of soils can inhibit natural revegetation of disturbed areas. Loss of topsoil and a decrease in soil productivity from soil layer mixing and compaction impacts the natural vegetation supported in the area, which in turn may affect forage and habitat for wildlife.

Soils are at risk of being contaminated from uncontrolled or accidental releases of petroleum products and other hazardous materials. Wells that produce large quantities of liquids (produced water, condensate, or oil) have a greater potential for releases than dry gas wells. See Section 4.12 for a discussion of the potential for oil and gas industry releases.

Tables 4-18 and 4-19 present predicted impacts for highly erosive soils and prime farmland by alternative. The impacts are presented as the maximum potential surface disturbance from the alternative as well as the reduced impact if all existing available well pads are used to reduce surface disturbance.

TABLE 4-18
Impact Evaluation for Areas with Soils That Have High to Severe Erosive Potential

	Alternative 1 - Continuation of Present Management (No Action)	**Alternative 2 - Coalbed Methane In-fill Development**	**Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)**
Highly erosive soils Acreage within the Study Area (Percent of the Study Area)	85,141 acres (20.21%)		
Maximum Number of Proposed Wells Potentially Impacting the Highly Erosive Soils	130	426	447
Construction			
Maximum Acres Disturbed (Percentage of Highly Erosive Soils)	398 (0.47)	1,304 (1.53)	1,368 (1.61)
Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Highly Erosive Soils)	303 (0.36)	1,124 (1.32)	1,157 (1.36)

TABLE 4-18 Impact Evaluation for Areas with Soils That Have High to Severe Erosive Potential			
	Alternative 1 - Continuation of Present Management (No Action)	**Alternative 2 - Coalbed Methane In-fill Development**	**Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)**
Production			
Maximum Acres Disturbed (Percentage of Highly Erosive Soils)	268 (0.31)	878 (1.03)	921 (1.08)
Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Highly Erosive Soils)	219 (0.26)	785 (0.92)	813 (0.95)

TABLE 4-19 Impact Evaluation for Prime Farmland			
	Alternative 1 - Continuation of Present Management (No Action)	**Alternative 2 - Coalbed Methane In-fill Development**	**Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)**
Prime Farmland Acreage Within the Study Area (Percent of the Study Area)	20,768 acres (4.93%)		
Maximum Number of Proposed Wells Potentially Impacting the Prime Farmland	14	29	30
Construction			

TABLE 4-19
Impact Evaluation for Prime Farmland

	Alternative 1 - Continuation of Present Management (No Action)	Alternative 2 - Coalbed Methane In-fill Development	Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)
Maximum Acres of Prime Farmland Disturbed (Percentage of Resource)	43 (0.21)	89 (0.43)	92 (0.44)
Acres of Prime Farmland Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	37 (0.18)	83 (0.40)	86 (0.41)
Production			
Maximum Acres of Prime Farmland Disturbed (Percentage of Resource)	29 (0.14)	60 (0.29)	62 (0.30)
Acres of Prime Farmland Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	26 (0.13)	57 (0.27)	59 (0.28)

Abandonment Phase

Once abandoned, a well is marked by a pipe monument unless waived by the BLM Authorized Officer. If waived, the casing is typically cut off and capped below ground level. In irrigated fields such as prime farmland, the casing is cut off and capped below plow depth (usually 18 to 24 inches). Therefore, upon reclamation the acreage can be returned to its previous land use. Reclamation of non-agricultural acreage includes revegetation with native species to reduce erosion and return the ecosystem to its original integrity.

4.4.2.4 Alternative 1 - Continuation of Present Management (No Action)

Construction Phase

Approximately 269 conventional and 81 CBM production wells are predicted under Alternative 1. Therefore, the total of 350 wells could result in a maximum disturbance of 1,071 acres of soil in the Study Area. Approximately 130 wells may be located in areas where soils are rated with a high to severe erosion potential, resulting in a maximum disturbance of 398 acres (0.47 percent of Study Area) (Table 4-18). If all existing well pads within the Study Area were used in order to reduce the amount of surface disturbance, the impact on soils with high to severe erosive potential would be reduced, resulting in a disturbance of 303 acres (0.36 percent). Due to the severe soil erosion potential, predicted impacts on these areas may occur, and reclamation actions would be required during and following construction.

An estimated 14 wells could be established in prime farmland areas (Table 4-19), resulting in a maximum loss of about 43 acres (0.21 percent of resource in Study Area) of prime farmland from agricultural production during the construction phase. Impacts on prime farmland can be reduced by using available existing well pads, resulting in a loss of about 37 acres (0.18 percent) of prime farmland from agricultural production.

Production Phase

A maximum of 268 acres of soils with high to severe erosive potential would continue to be subject to impacts during production (Table 4-18). The impact in areas with high to severe erosive soils during production can be reduced to 219 acres (0.26 percent) if all available existing pads were used. This acreage may require more extensive reclamation and routine maintenance during production to reduce potential adverse impacts caused by increased soil erosion. Adherence to recommended mitigation actions is expected to result in minimal impacts.

During production, a maximum of 29 acres (0.14 percent) of prime farmland would remain out of agricultural production, resulting in a long-term impact (Table 4-19). If all available well pads were used, up to 26 acres (0.13 percent) would continue to be impacted.

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative. Since the area would be reclaimed as prescribed by an approved reclamation plan. Revegetation would reduce soil erosion. Impact types are identified in Section 4.4.2.3 and indicate that most impacts are anticipated to occur during construction and production phases.

4.4.2.5 Alternative 2 - Coalbed Methane Infill Development

Construction Phase

With this alternative, 636 wells would disturb about 1,946 acres of soil in the Study Area. Up to 426 wells may be located in areas where soils have a high to severe erosion potential, resulting in a maximum disturbance of 1,304 acres (1.53 percent of highly erosive soils) (Table 4-18). Impacts can be reduced by using all available existing well pads, resulting in a disturbance of 1,124 acres (1.32 percent) of soils with high to severe erosion potential. These areas would require more extensive reclamation during and following construction. Impacts may be further reduced by siting new wells off of these high to severe erosion soils where possible.

Under Alternative 2, about 29 wells could be established in prime farmland areas (Table 4-19), resulting in a loss of 89 acres (0.43 percent) of prime farmland from agricultural production during the construction phase. Impacts on prime farmland can be reduced by using all available existing well pads, resulting in a loss of about 83 acres (0.40 percent) of prime farmland from agricultural production. Impacts on prime farmland might be reduced further through careful consideration of possible alternate locations for individual projects.

Production Phase

A maximum of 878 acres (1.03 percent) of soil with high to severe erosive potential would continue to be subject to impact during production (Table 4-18). Impacts on soil erosion can be reduced by using all available existing well pads, resulting in a loss of about 785 acres (0.92 percent) of prime farmland from agricultural production. This acreage may require more extensive reclamation and routine maintenance during production to reduce potential adverse impacts caused by increased soil erosion.

During production, a total of 60 acres (0.29 percent) of prime farmland would remain out of agricultural production (Table 4-19). Impacts on prime farmland can be reduced by using all available existing well pads, resulting in a loss of about 57 acres (0.27 percent) of prime farmland from agricultural production.

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative, other than those impacts identified in Section 4.4.2.3. The area would be reclaimed as prescribed by an approved reclamation plan including revegetation to reduce soil erosion.

4.4.2.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

Construction Phase

The Agency's and Tribe's Preferred Alternative encompasses development of the same number of conventional and CBM wells as proposed in Alternative 2, with the addition of up to 70 injection wells on tribal land for ECBM recovery. Under this alternative, about 706 production and injection wells could be drilled, disturbing about 2,160 acres within the Study Area. A total of 447 wells may be located in areas where soils have a high to severe erosion potential, resulting in a maximum disturbance of 1,368 acres (1.61 percent) of soils with severe erosion potential (Table 4-18). Impacts can be reduced by using all available existing well pads, resulting in disturbance of 1,157 acres (1.36 percent) of soils with high to severe erosion potential. These areas would require more extensive reclamation following construction. Impacts may be further reduced by siting wells off of these high to severe erosion soils where possible.

Under the Agency's and Tribe's Preferred Alternative, a total of 30 wells could be drilled in prime farmland areas, resulting in a maximum loss of 92 acres (0.44 percent) of prime farmland from agricultural production during the construction phase (Table 4-19). Impacts on prime farmland can be reduced by using available existing well pads, resulting in a loss of about 86 acres (0.41 percent) of prime farmland from agricultural production. Impacts might be further reduced through careful consideration of locations for individual projects.

Production Phase

A maximum of 921 acres (1.08 percent) of soil with high to severe erosion potential would continue to be subject to impact during production (Table 4-18). Through the use of existing well pads, the area of disturbance can be reduced if all available existing pads are used, resulting in disturbance of 813 acres (0.95 percent) of soils with high to severe erosion potential. This acreage may require more extensive reclamation and routine maintenance during production to reduce potential adverse impacts caused by increased soil erosion.

During production a total of 62 acres (0.30 percent) of prime farmland would remain out of agricultural production (Table 4-19). Again, impacts on prime farmland would be reduced by using available existing well pads, resulting in a loss of about 59 acres (0.28 percent) of prime farmland from agricultural production.

Abandonment Phase

No significant impacts from abandonment of production wells are predicted for this alternative, other than those identified in Section 4.4.2.3. The area would be reclaimed as prescribed by an approved reclamation plan which includes revegetation to reduce soil erosion.

4.4.2.7 Impacts Summary

The principal impacts on soils and prime farmland are directly related to the amount of soil disturbance, which varies by the amount of development proposed under each analyzed alternative. The soils with high to severe erosion potential are subject to measurable increases in erosion rates when disturbed by construction and production activities for oil and gas development. However, with adherence to mitigative measures to revegetate and reclaim these disturbed areas in an expeditious manner, no significant long-term impacts as a result of soil erosion are predicted. More intensive and stringent application of mitigative measures would be required in those areas that are more sensitive to disturbance than in those areas where the soils have only slight or moderate erosion potential.

Some prime farmland taken out of production during construction may be returned to agricultural production during the production phase. Prime farmland acres taken out of agricultural production during the project's production phase would be long-term losses of the resource. In comparing the three alternatives (Tables 4-18 and 4-19), Alternative 1 has the least amount of impact on high to severe erosive soils and prime farmland. Alternative 2 and Alternative 3 are similar in the amount of acreage disturbed and the percentage of resource impacted. These impacts are predicted to be minimal based on total acreage disturbed and implementation of mitigative measures.

4.4.2.8 Mitigation Summary

Federal legislation that addresses the protection of soils and prime farmland includes the Farmland Protection Policy Act of 1984, Clean Water Act of 1972, and Soil and Water Resources Conservation Act of 1977. Executive Order 11988 (May 24, 1977) provides guidance for floodplain management.

On tribal land, the BLM and BIA are the authorizing agencies relative to oil and gas regulations and reclamation. Standard conditions of approval and stipulations from the BIA and SUIT for reclamation on Southern Ute Indian land are in Appendix E. Adherence to the applicable environmental protection measure included in Appendix E would generally minimize impacts on soils, floodplains and prime farmland in the Study Area. These environmental protection measures include limiting disturbance, avoiding floodplains, salvage and protection of topsoil, and revegetation guidelines, as well as safe handling and storage of fuels, lubricants, and other materials to prevent spills and subsequent soil contamination. Required compliance checks by BLM, the SUIT Energy Resources Division, and/or BIA realty personnel are expected to ensure adherence to these mitigative measures. Additional stipulations and conditions of approval would be made as necessary, by the SUIT or BIA, at the site-specific project stage.

4.4.2.9 Unavoidable Adverse Impacts

Unavoidable adverse impacts include short-term increases in soil erosion rates, particularly in those areas where oil and gas development occurs in soils with high to severe erosion potential. These impacts are expected generally to be minimal and short term because of adherence to recommended mitigative measures.

The amount of prime farmland acreage taken out of production by any of the alternatives is substantially less than the significance criteria of 5 percent of the total prime farmland acreage within the Study Area. Therefore, although the loss is unavoidable and long term, the overall impact is predicted to be below significance level. The significance criteria of 5 percent was based on studies of predicted losses of prime farmland acreage due to urban development in other portions of Colorado.

4.5 WATER RESOURCES

4.5.1 Groundwater

4.5.1.1 Issues, Impact Types, and Criteria

Impacts on groundwater resources may result from withdrawing large quantities of water from the Fruitland Formation and injecting this produced water into deeper formations. Impacts on existing water resources may occur as a result of the water requirements of oil and gas drilling. Potential impacts on domestic groundwater quality during the project activities also may occur and are identified and assessed.

Protection of groundwater resources would be achieved through compliance with federal, state, and local BLM regulations and Notices To Lessees (NTLs) (section 2.9.2). The standard drilling, completion, production, and abandonment practices are governed by 43 CFR 3160, NTLs, Onshore Oil and Gas Orders, and general and special requirements of each APD. These practices provide safeguards, monitoring, and mitigation to ensure that the groundwater resources are protected during the life of any new conventional, CBM, or ECBM injection well.

Impacts on groundwater resources would be considered significant if the following conditions occur:

- aquifers are altered enough to affect established water uses
- water quality within any given zone is degraded by the introduction of foreign substances, cross flow of methane gas, or by communication with a zone containing water of lesser quality

- quantity of usable groundwater is diminished by the effects of pumping water from wells during production

4.5.1.2 Impact Assessment Methods

For the impact analysis groundwater is assumed to be present everywhere in the Study Area in quantities and qualities for at least some stock or domestic uses. Therefore, every proposed well is assumed to penetrate a usable groundwater source and to have the potential to impact groundwater. As the locations of the proposed production, injection, and disposal (UIC) wells are expected to be distributed throughout the Study Area, impacts were assessed to the resource rather than to individual users. The circumstance under which groundwater would be impacted is highly complex and rely on many different and unrelated conditions to occur together and thus are not inevitable. Impacts on groundwater resources were assessed qualitatively by evaluating (1) known impacts in the Study Area potentially from existing wells or (2) potential impacts based on well (production, injection, and disposal) completion and operation practices and chemical properties of the produced fluids (natural gas and produced water). All potential impacts were assessed in consultation with BLM, BIA, and SUIT and analyzed relative to industry practices, rules, and regulations.

4.5.1.3 Impacts Common to All Alternatives

The impacts associated with the construction, production, and abandonment phases of the project are described below. In general, the impacts identified and evaluated for each alternative are the same but vary only in degree of impact.

<u>Construction Phase</u>

All alternatives would require water for well drilling and development; construction of roads, pipelines, and well pads; and dust suppression. The potential for impacts on groundwater quality would be limited to drilling, well development, and well testing activities.

The shallow groundwater aquifers that supply domestic and stock water needs within the Reservation typically produce water at rates less than 15 gpm and would, therefore, not provide sufficient quantities of water for the project. Other formations that may have higher rates are not of usable quality for many construction phase uses. Usable water is typically less than 3,500 ppm TDS within the Study Area. Surface waters are typically the source for most of the water used in oil and gas industry activities (Section 4.5.2).

Water produced with CBM from the Fruitland Formation is sometimes used in the drilling and completion of new Fruitland wells. Many Fruitland wells produce large quantities of water. This water can be used to make up drilling fluids (drilling mud) or in the cavitation of a Fruitland zone (Section 2.8.4.4). However, produced water from Fruitland wells on the Reservation is generally too saline for use in cementing and fracture completion of wells on the Reservation.

When drilling through sections of high permeability rock, losses of drilling fluids may occur in the formation (these are called lost circulation zones). When drilling through shale, losses of such drilling fluids are typically minimal. Drilling fluid, which often is referred to as “mud,” is a mixture of water, bentonite clay, and polymers. Drilling mud also may contain chemical additives such as caustic soda or barite to adjust the characteristic of the mud. Additives to drilling mud are controlled and are further diluted by the formation waters. Some minor loss of cement in the formation may also occur during the drilling process as lost circulation zones are plugged or during the cementing of the casings. Impacts on groundwater quality associated with drilling muds or cementing activities are restricted to the immediate vicinity of the well bore (within a few feet) and are not considered to be substantial because of the very small volume of groundwater that could be affected.

A majority of conventional wells and some CBM wells are stimulated by a process, hydrofracturing, that hydraulically fractures the targeted or producing formation near the well bore. Hydrofracturing is conducted to enhance the permeability of the formation in the vicinity of the well. Water and polymers, the “fracture fluids”, are pumped into the well at high pressures causing the natural fractures to open and/or create new fractures. Pressures are monitored to control the process and ensure that fracturing is contained within the targeted formation. Sand, or other propant material, is pumped into the well with the fracture fluid and remains in the fractures (called cleats in the CBM wells) after the hydraulic injection pressure is reduced, thereby holding the fractures open and increasing the effective permeability of the formation. Most of the fracture fluid flows back up the well bore when pressure on the well is released and is recovered at the surface. Materials used to keep the fractures or cleats open are inert; therefore, no detrimental impact on groundwater quality would be caused by the hydrofracturing process.

Another common way of developing a CBM well is by cavitation (Section 2.8.5.1). In this method, the operator uses cycles of high and low pressure to stimulate the well. Fracturing is contained within the coal as the production casing string’s primary cement isolates the overlying formation from the pressure changes. The operator collects the water and monitors water rates and well pressures to prevent a blowout. The cavitation process, where applicable, eliminates formation damage by using native CBM water, as opposed to foreign fluids, creates additional coal face surface area for better methane production, and enhances the natural permeability around the well bore. As no external materials (other than recycled water) are pumped into the formation, no impact on groundwater quality would be caused by cavitation.

Producing a CBM well causes a drop in pressure around the well. The methane desorbs and flows to points within the Fruitland Formation of lower pressure. If a new well is co-located on an existing well pad, the existing well(s) may provide an additional conduit for flow of the gas if wellbore conditions allow. Gas would be able to enter the existing well(s) if the Fruitland Formation is not entirely isolated by cement. If isolation is not complete, the natural gas would be able to move into the existing well bore(s) and may be able to migrate to the surface or to an overlying unisolated aquifer (Figure 4-2). This scenario would cause an impact on groundwater quality if the natural gas could migrate into a domestic or stock water aquifer. The possibility of this occurring in any well is low due to the requirement for aquifers and hydrocarbon-bearing zones to be isolated during well drilling and completion. Isolation of aquifers from hydrocarbon-bearing zones is required by 43 CFR 3160 Onshore Order 1, and NTL MDO-91-1, Change 2. However, older wells are more likely to have the potential for poor zonal isolation of the Fruitland coals.

The existence of an unintended vertical conduit in a well may sometimes be discerned by running a cement bond log or by bradenhead testing. Bradenhead testing is required of gas wells in the Ignacio Blanco Field and within BLM jurisdiction by NTL Montrose District Office-91-1. The COGCC Order 112-85 makes a similar requirement for wells located on fee land. The BLM's bradenhead testing program requires the annual monitoring of the pressures in the annular spaces between casing strings to evaluate the mechanical and cement integrity of well bores. A new gas well would not impact potable groundwater supplies unless the cement or casing integrity was inadequate. Impact on groundwater would not occur until the new well goes into production (see discussion below under Production Phase). The potential for a water disposal well to impact groundwater quality is even lower than for a producing gas well due to the casing and cement construction requirements in 40 CFR 146.22. These requirements are typically met by filling all the annular space between the casing and the well bore with cement.

The possibility of degradation of fresh water aquifers could occur if cathodic protection wells associated with pipelines are installed in a manner that allows for the co-mingling of shallow surface aquifers or if they are in communication with adjacent production well(s) due to poor construction. However, as the impact would occur only if the governing regulators (federal agencies or COGCC) failed to protect the resource, the impact is not quantifiable.

Production Phase

Water Resources of the Fruitland Formation and the Disposal Formations - While the Fruitland gas production in the Ignacio Blanco field has increased more than ten-fold since 1991, the water production peaked in October 1993 at an average of 103,485 barrels of water per day (BWPD) (3,018 gpm) and has leveled off to a fairly steady rate of 79,700 BWPD (2,320 gpm) for the entire field. The water production of an individual well within the field is dependent on several factors including the heterogeneity of the coals, location on a structure, and dewatering by nearby production (Kaiser and Ayers 1994). Typical water production for each well would be high initially and then would decrease over time. Initial tests in overpressured coalbeds are reported to be about 200 BWPD (5.8 gpm) (Kaiser and Ayers 1994), with a lifetime average within the Ignacio Blanco field of 92.6 BWPD (2.7 gpm) (SUIT 1997).

Injection of production water into a target zone with poorer quality than the produced water is consistent with BLM policy and the EPA's Underground Injection Control (UIC) Permit Program (40 CFR Part 144). The formations used for water disposal must meet criteria designed to protect present and future sources of drinking water (Appendix I).

The disposal of produced water by injecting it into a deeper, poorer quality aquifer would result in the loss of the resource within the original aquifer and the potential degradation of the resource. Once the produced water has been injected into the disposal reservoir, it would be more expensive to retrieve than from the shallower Fruitland Formation. Also, it would be more saline than it was in the Fruitland Formation due to mixing with the poorer quality water of the disposal reservoir.

The loss of water from the Fruitland Formation does not constitute a significant impact because it is currently uneconomical to use as a water source in most parts of the Study Area with the possible exception of the near outcrop zone. While TDS concentrations within the Fruitland Formation within the near outcrop zone average 500 ppm, the associated natural gas would tend to make the water less desirable as a water supply. No groundwater supply wells completed in the Fruitland Formation are presently known to be used for domestic purposes in the Study Area (Section 3.5.1.2). It is likely that production of water from gas wells decreases the water table near the outcrop. The hydrologic model, completed as part of the 3M project, was the first formal assessment of this potential impact.

FIGURE 4-2
Potential Cross Flow Diagram
8 ½ 11

In 1997, there were 27 active disposal (Class II UIC) wells within the exterior boundaries of the Reservation with a minimum theoretical daily disposal capacity of 155,400 BWPD[4] (EPA 1997). This rate is well above the highest rate of 103,485 BWPD (average rate for October 1993) that has been reported from the Ignacio Blanco field. As discussed above, Fruitland water production is expected to continue similar to the rates of the last five years or decline due to dewatering of the Fruitland Formation. In 1998, the average water produced from Fruitland CBM wells in the Ignacio Blanco Field was 68 BWPD. The existing water production (averaging 79,700 BWPD) correlates to the present disposal rates. Therefore, since the existing disposal wells have excess capacity and water production rates are not expected to increase above available capacity, the present disposal wells should be able to handle the needed disposal capacity. Considering the excess capacity, water production could increase by about 75,700 BWPD (2,208 gpm) without any disposal constraints given a very conservative maximum disposal capacity.

Disposal of production water by injection would locally increase formation pressures and generally decrease salinity within the formation of injection. The disposal wells are typically completed into the Bluff/Entrada Formation at a depth of 8,500+ feet and into depleted Mesaverde Group production wells at a depth of 4,500 to 6000+ feet. Secondary disposal zones include Burro Canyon Sandstone, Morrison Formation, and depleted or uneconomical Dakota Sandstone and Pictured Cliff Sandstone.

Since all disposal wells are designed for “well injection” of wastewater, the wells are subject to the permitting and regulatory control provisions of the Federal Safe Drinking Water Act’s UIC Program (40 CFR Part 144). The EPA administers and implements the UIC program on the Reservation. A permit from EPA is required prior to drilling a new well or recompletion of an existing well. Injection pressures and volumes are monitored to ensure that potable aquifers are not adversely affected by injection of produced water. Potential cross-contamination of groundwater supply aquifers from disposal wells is unlikely because of the required use of appropriate well construction (e.g., entire well bore cased and cemented), restrictions on injection pressures, periodic mechanical integrity testing, and completion of detailed monitoring of produced and injected water volumes.

A UIC or disposal well’s permitted rate is a calculated rate for which the disposal pressure will not increase the formational pressure beyond 0.25 mile of the UIC well (EPA 1997). Presently there is a large geographic separation between disposal wells. Therefore, no regional effect on any of the disposal zone’s potentiometric surface (i.e., mounding of the formation’s head pressure) is expected due to the predicted produced water disposal volumes.

[4]Theoretical daily disposal capacity was based on a summation of the reported allowed injection rate for each disposal well. Where the EPA database did not contain an allowed rate, the highest annual disposal was used to calculate an average daily disposal rate. Comparing the annual disposal rate to the reported allowed injection rate indicates that this is a very conservative estimation of allowed injection rate. When the allowed injection rate was reported to be unlimited, a rate of 10,000 BWPD was used in the theoretical daily disposal capacity calculation.

Neither the Bluff/Entrada nor the Mesaverde is a potable aquifer within the Study Area, and by regulation no zone identified for disposal can be an underground source of drinking water (40 CFR 144.3 and 144.7; see Appendix I). Water quality in these formations is saline with TDS concentrations similar or greater than the Fruitland produced water. The disposal of Fruitland production water would thus not adversely impact the water quality of the disposal zone aquifer.

Water Resources of the Quaternary and Tertiary Aquifers - Water production from the coalbeds would not affect the regional supply potential of the shallow alluvial and Tertiary aquifers in the Study Area because the Kirtland Shale isolates the shallow alluvial and Tertiary aquifers from the coalbeds. Decreasing the hydraulic pressure within the Fruitland Formation would not have a measurable effect on the water levels and/or availability of groundwater in the overlying aquifers used for groundwater supply. One exception may be the near outcrop zone. The near outcrop zone extends into the basin about 1.5 miles. This zone corresponds to the portion of the Fruitland structural basin, which is the sharply dipping part of the monocline, i.e, greater than 4 degrees (Chapter 3, Section 3.4.1.2). Only eight water wells have been identified within this zone (Map 15). Therefore, because of the low number of water wells, no significant regional impact on groundwater supply is expected during this phase of the project. The potential impact within this zone is not quantifiable. The SUIT and BLM have monitoring/mitigation programs in place and are working towards being able to quantify and mitigate impacts (Section 4.4.1.8).

Reports of methane contamination in domestic water wells within the northern San Juan Basin have caused concern. However, production from a CBM well is unlikely to have a direct impact on groundwater resources. All oil and gas wells must have a casing and cement program that is planned and approved in the APD process (43 CFR 3162.5). The surface casing must be set with sufficient cement to fill the annular space from the casing shoe to the surface and at sufficient depth to protect all usable water aquifers and provide adequate pressure control (Oil and Gas Order No. 2). COGCC Order 112-61, specific to all CBM wells and adopted by the BLM, requires that all CBM production casing strings be cemented from the bottom of the casing to the surface by circulation methods, therefore providing adequate isolation (Figure 4-3). This requirement ensures that interzonal flow of fluids behind the casing is precluded. Many operators have extended this practice to conventional wells and either set intermediate casing strings in the Lewis Shale (below the Fruitland), which are then cemented to the surface, or cement the production casing string from a deeper zone to surface. Conventional well casing programs also require isolation or coverage of oil and gas zones and any usable water sources (Figure 4-4).

One potential impact of a CBM well operation involves the carbon dioxide component of the produced natural gas. The carbon dioxide may cause corrosion by reacting with produced water to form carbonic acid. This condition may be precluded by the sodium bicarbonate in produced water, which may have a neutralizing effect on the acid. If corrosion is not monitored and corrected, the carbonic acid could corrode through the steel well casing. Once the acid is in contact with the cement in the annular space between the casing and the well bore wall, the cement would be dissolved and could form potential horizontal and vertical conduits within the annular space. Corrosion could provide a pathway for the natural gas to migrate into a groundwater aquifer.

Environmental protection and monitoring measures are already in place to address the potential for carbonic acid corrosion. Bradenhead testing of the surface casing pressure provides monitoring for potential leaks in the casing. Many operators treat for corrosion with active and batch chemical treatments, and some monitor for corrosion using coupons (pieces of metal, typically rectangular, of the same alloy as the casing) hung in the well.

Natural gas tends to migrate vertically within rock units. The Ignacio Blanco oil and gas reservoirs (Dakota Sandstone, Mesaverde Group Sandstones, Pictured Cliffs Sandstone, and Fruitland Formation coals) are overlain by thick sequences of low permeability shales (Mancos, Lewis, and Kirtland, respectively). These zones of low permeability help to trap the gas within these reservoirs. Intraformational shales in the Fruitland Formation are probably significant to the trapping of methane in the Fruitland coals. Diffusion has the potential to cause migration of gases in very low permeability materials. Diffusion is a process that causes the movement of individual gas molecules through water-saturated pore spaces in response to concentration gradients. This process occurs in contrast to bulk separate phase movement of gas caused by buoyant forces or pressure gradients. Although diffusion can be an important gas transfer process over geologic time, it is an extremely slow process that contributes insignificant quantities of natural gas to the environment (USGS 1994). Little, if any, potential exists for the vertical migration of methane from gas reservoirs without a vertical conduit.

By reducing the formation pressure through removal of Fruitland Formation water, the hydrostatic pressure that was holding the methane to the coal is thereby reduced. The natural gas desorbs and moves, migrating towards lower pressure, which is usually upward or lateral.

The Kirtland Shale, which has low permeability, would restrict the vertical migration of gas (methane and/or ECBM injection gas) and formation waters, even under the increased pressure caused by enhanced recovery operations proposed under Alternative 3 as long as pressures do not exceed breakdown or parting pressure of the shale. Even though the vertical hydraulic gradient may be increased during the gas (nitrogen or carbon dioxide) injection phase of Alternative 3, any potential upward migration would still be limited by the shale. After cessation of gas injection, the wells would continue to produce using primary production methods. CBM production is expected to reduce the hydrostatic pressures to below initial (before CBM production) basin-wide hydrostatic pressures, further reducing the potential for upward migration of high TDS waters.

Natural fractures and existing well bores (oil and gas, water well, etc.) without zonal isolation can become vertical conduits to migration. Although migration of gas by diffusion or through natural fractures and cleats is possible, manmade conduits could also allow the upward migration of gas to near surface environments (USGS 1994). If the manmade conduit provides a lower pressure gradient to the migrating gas, the gas would migrate to that lower pressure point rather than to the well installed for its collection. Methane gas seeps along the Hogback monocline have been well documented over the last decade and are being monitored by the SUIT Energy Department and the BLM within the Study Area (Chapter 3, Section 3.4). The fact that gas seepage at the coal outcrop is in many places quite localized suggests that the specific large fractures in the coal, as well as cleats in the coal or old mine workings, may provide pathways in which gas migrates to the outcrop.

Potential manmade migration pathways identified include any boring that penetrates the Fruitland Formation and does not contain a proper seal to isolate the boring from the coals. These non-isolated penetrations provide a pathway to groundwater aquifers. In the central basin (main and fairway portions), potential borings would include old poorly plugged and abandoned or uncemented conventional gas wells, poorly abandoned dry holes (non-productive oil and/or gas boring), and poorly abandoned stratigraphic test holes. However, the BLM and COGCC monitor old wells for mechanical integrity and have remediated or plugged all known problem wells located in the Study Area.

Where depth to the Fruitland is less than 500 feet, as in the near outcrop zone, the possibilities of penetration types that could be a vertical conduit increases greatly. These include, but are not limited to, the types of borings described above and cathodic protection wells, pylon and piers for bridge and road construction, seismic shotholes, coal mines, and water wells. Records of the locations and the abandonment or completion methods of these penetrations, aside from those associated with oil and gas activities, are often poor and incomplete.

Since the 1980s, the COGCC and BLM have cooperated on protecting groundwater in La Plata County from possible contamination due to oil and gas development. The program includes water well testing, bradenhead testing (Notice To Lessees MDO 91-1, Change 2), and remediation by either the operator or by the COGCC. In the past four years, the COGCC has specifically been allocated about $220,000 per year from the State Environmental Response Fund for remediation of “orphan” wells. This funding allows the COGCC to take remedial action on wells for which the operator no longer exists and no bond money can be accessed. In recent years, the COGCC has remediated between 2 and 40 wells per year. As of March 1999, the COGCC had completed remediation work on all identified problem orphan wells in La Plata County and had no wells that it planned to remediate in 1999 to protect groundwater.

Diffusion of the natural gas (plume extent) around a leaking boring/penetration could be fairly localized as the natural buoyant tendency of the gas would drive the gas upward. However, if migrating gas was vertically impeded, migration would occur laterally until another vertical pathway was provided or until the gas was trapped vertically and laterally. If this gas plume was penetrated by a water well, the pumping of the well and the atmospheric pressure of the water well bore would make the water well a pressure sink (low pressure point) for the migrating gas.

FIGURE 4-3
Fruitland Well Bore Construction
81/2 x 11

FIGURE 4-4
Conventional Well Bore Construction
8-1/2 x 11

Groundwater quality would be impacted if a water well completed in the affected aquifer was present within the gas plume. Methane is not a toxic substance, so it would not pose a health risk if ingested. However, methane within the aquifer could encourage the production of hydrogen sulfide by anaerobic bacteria. Hydrogen sulfide is a toxic gas, and if present in sufficient quantities, it can endanger human health. Additionally, as discussed above, methane within the aquifer could preferentially migrate into the water well. If sufficient quantities of methane are present within a confined space, such as a well or pumphouse, the methane could pose an explosive risk or an environment with asphyxiation potential.

As the conditions that would cause an impact on groundwater are many and quite complex, it is not possible to quantify the impact by alternative. If a landowner's water well is affected, the impact can be significant to the landowner; however, contamination has been found to be localized. Regional contamination within the Study Area is extremely unlikely and therefore not significant. However, based on the possibility for impact due to the many potential vertical conduit scenarios, monitoring and mitigation requirements have been provided (Section 4.5.1.8).

Potential accidental spills of produced water could result in an impact on shallow groundwater. However, due to the probable low volumes of spilled materials, localized geographic extent of such spills, and existence of strict guidelines controlling the clean up of spills, the impact is not anticipated to be significant (Section 4.12).

Abandonment Phase

Little potential exists for fluid migration between formations after injection and production wells have been plugged and abandoned. Present-day methods used for construction and abandonment of the oil and gas wells combined with the monitoring actions described in Section 4.5.1.8 would substantially reduce the potential of leakage and/or migration of fluids after abandonment.

4.5.1.4 Alternative 1 - Continuation of Present Management (No Action)

Construction, production, and abandonment of 269 conventional wells and 81 CBM wells, under Alternative 1 is not expected to result in additional impacts on the groundwater resources within the Study Area, other than those identified in Section 4.5.1.3. As the conditions that must be met to produce an impact are many and quite complex, the potential impacts identified are not quantified. However, due to present monitoring and environmental protection measures and regulatory requirements on construction, production, and abandonment, the impact on groundwater resources should be minimal.

4.5.1.5 Alternative 2 - Coalbed Methane Infill Development

Construction, production, and abandonment of 269 conventional wells and 367 CBM wells, under Alternative 2 is not expected to result in additional impacts on the groundwater resources within the Study Area, other than those identified in Section 4.5.1.3. As the conditions that must be met to produce an impact are many and quite complex, the potential impacts identified are not quantified. Due to the greater number of CBM wells that would be producing as part of this alternative, it is assumed that the potential impact on groundwater resources would be slightly greater than under Alternative 1. However, due to present monitoring and environmental protection measures and regulatory requirements on construction and abandonment, the impact on groundwater resources should be minimal.

4.5.1.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

ECBM production uses gas (nitrogen or carbon dioxide) replacement to increase production rates by lowering the partial pressure in the coal formation (Puri and Yee 1990). This process uses the injection gas to release the methane within the coal into the cleat system. Once in the cleat system, the methane then flows toward the production wells due to the pressure differential caused by the removal of methane and produced water from the formation. The gas (nitrogen or carbon dioxide) is injected at about 2,000 pounds per square inch (psi) surface pressure, which can equate to about 300 to 400 psi higher than the current fluid pressure in the formation (using the Tiffany model, BLM 1996c).

An enhanced recovery project typically would be used in areas where formation pressures have already been reduced from primary methane recovery (reduction of the hydrostatic pressure). In such a case, the increase in pressure due to the gas injection may increase the total formation pressure, but the pressure increase would be controlled to stay well below formation parting pressure. As discussed above, even though the vertical hydraulic gradient may be increased during the gas (nitrogen or carbon dioxide) injection phase, the resultant upward leakage would still be limited by the Kirtland Shale and intraformational shales. Little, if any, additional potential exists for the vertical migration of methane, nitrogen or carbon dioxide from the Fruitland Formation due to the injection process.

Nitrogen flooding the Fruitland Formation is not expected to result in any chemical degradation of groundwater because the nitrogen molecule is very stable and thus would not react with other molecules under the pressure and temperature conditions that would be created in injection zones for the enhanced recovery projects. The two atoms of dinitrogen are bonded together by a very strong chemical bond that requires significant heat (300 thousand calories per mole [kcal/mole]) and pressure, or micro-organisms, to break apart the atoms. This strong chemical bond accounts for the inertness of molecular nitrogen in the gaseous form. Nitrogen can undergo oxidation or reduction to a variety of oxidation states; however, these are energetic reactions that require a large amount of energy to cleave the N N triple bond. For example, in the Haber Process for production of anhydrous ammonia for fertilizers, molecular nitrogen and molecular hydrogen are heated to a temperature of about 1,100ºF at 14,000 psi in order to attain efficient conversion to ammonia (Gould 1956). The typical temperature and pressure at the depth of injection into the coal seam is about 120ºF and 2,000 psi, respectively.

No inorganic chemical reaction is expected to result within the Fruitland Formation from the injection of carbon dioxide into the formation. Carbon dioxide occurs naturally in the produced gas. The water content of the injected gas would be low; however, as the potential exists for the carbon dioxide to combine with water vapor to form carbonic acid, there is a slightly higher probability for corrosion within carbon dioxide injection wells. Carbonic acid is more likely to develop within the production wells because producing wells in a carbon dioxide ECBM project would contain greater quantities of carbon dioxide, especially after breakthrough of the injecting gas. The potential for carbonic acid corrosion is higher in the producing well than the injecting well because the water quantity would be higher in the producing well. Precautions such as special lined pipe, corrosion monitoring (such as use of coupons), and treatments can mitigate these concerns.

The oxygen content of the injected gas would be low. Any oxygen that would be entrained in the injection gas would be rapidly consumed in the highly reducing environment of the coal seam. This would result in some “weathering” of the coal in the immediate vicinity of the injection wells, thereby impacting the economic value of the mineable coal resource. Coal weathering is the process of oxidizing the coal, which reduces its BTU potential. However, as described in Sections 3.4 and 4.4.1, most of the coal in the Study Area is too deep for mining to be economical, and the volume of coal affected is likely to be small relative to the whole coal resource.

Any nitrogen-processing or carbon dioxide-processing micro-organism would not survive the injection process because the compression of the gas at the surface to formation pressures for injection would heat the gas, effectively sterilizing it. Given the absence of microbes, and the fact that natural formation temperatures would be too low to induce any inorganic reactions, the molecular nitrogen or carbon dioxide would remain inert. In conclusion, nitrogen or carbon dioxide flooding would not create chemical reactions that would adversely impact groundwater resources in the Study Area.

Due to the greater number of CBM production wells that would be part of Alternative 3, it is assumed that the impact on groundwater resources would be greater than under Alternative 1. The impact on groundwater resources for Alternative 3 is expected to be similar to, if only slightly greater than, Alternative 2 because of the addition of injection wells which exist in Alternative 3.

4.5.1.7 Impacts Summary

Impacts on groundwater from all alternatives would include some localized water quality degradation during drilling and cementing of production and injection wells. Such impacts are expected to affect only small volumes of groundwater in the immediate vicinity of the wells. No impacts on groundwater supplies are expected from construction, as all water requirements would come from surface waters or from recycled Fruitland produced water. The relocation and possible degradation of Fruitland produced water would occur; however, this water is not economically usable, so no significant impact would be realized. Produced water disposal capacity would not be affected as no additional disposal capacity is expected to be required under any alternative.

The 3M hydrologic model calculated pre-development discharge from the Fruitland Formation to the rivers in the northern San Juan Basin of 200 acre-feet per year. The produced water from CBM development in areas with hydraulic communication to the rivers (mostly north of the Ute Line) exceeds 1,200 acre-ft/yr or six times the Fruitland recharge/discharge. Given that this is the current situation, it can be concluded that CBM development will deplete at least 200 acre-feet/yr of surface flows. Within the Study Area, CBM development will intercept about 37 acre-ft/yr of discharge to the Animas River.

The most controversial potential impact on groundwater, which would be on shallow aquifer water quality, cannot be quantified due to the large number of variables needed to identify the migration pathway. However, because of the regulations controlling the construction of new wells, the monitoring and environmental protection measures that are being taken to prevent methane migration via old wells (Section 4.5.1.8), and the likelihood that any impact would be extremely localized, the impact from fluid migration via well bores is expected to be insignificant. Should an impact on shallow groundwater occur due to a boring/well providing a vertical migration pathway, the area of impact should be locally isolated.

4.5.1.8 Mitigation and/or Monitoring Summary

The following measures will continue to be implemented on new and existing oil and gas facilities to reduce the potential for migration of natural gas into groundwater:

- monitor bradenhead pressures to identify wells that may be acting as vertical conduits. *(Based on Existing Policy or Regulation)*

- monitor (frequency dependent on area) for methane contamination in water wells and compare to baseline conditions to evaluate concentration trends and correlate with bradenhead testing. *(Based on Existing Policy or Regulation)*

- monitor seeps and water levels near the Fruitland outcrop and develop appropriate mitigation measures. *(Based on Existing Policy or Regulation)* and *(Mitigation Developed from SUIT EIS)*

- cement all production casing strings from the casing shoe or total depth, whichever is shallower, to the surface by circulation methods for all wells heretofore and hereafter drilled and completed in the Fruitland coal seams of the Ignacio Blanco Field. *(Based on Existing Policy or Regulation)*

- Monitor additional wells (about 12) in the near Fruitland outcrop zone installed by the SUIT Energy Department in the year 2000. *(Based on Existing Policy or Regulation)*

Monitoring and environmental protection measures that have been identified to provide additional protection against groundwater impacts are as follows:

- Within any areas of concern, the SUIT Energy Department and BLM may require water well monitoring as part of APD approval. *(Mitigation Developed from SUIT EIS)* and *(Based on Existing Policy or Regulation)*

- In the event that domestic groundwater well degradation is caused by a gas well, the gas well must be remediated or other action taken as determined by the appropriate agency. *(Based on Existing Policy or Regulation)*

- Soil monitoring for methane and other component gases will be conducted near the Fruitland outcrop or in proximity to existing wells as specified by the SUIT and BLM in accordance with APD requirements. *(Mitigation Developed from SUIT EIS)* and *(Based on Existing Policy or Regulation)*

- Injection well operations will continue to be monitored monthly at each injection well for cumulative injection volumes and pressures in tubing and tubing/casing annulus. *(Based on Existing Policy or Regulation)*

The following measures would also be implemented for ECBM project areas that may be developed in the future:

- A well survey for all existing oil and gas wells or drill holes within an ECBM Study Area and within 1 mile of the project boundary would be conducted. The following data would be collected for each well or drill hole, summarized in table format, and submitted as part of the ECBM project application *(Based on Existing Policy or Regulation)*:

- well location (township, range, section, quarter/quarter)
- lease number, applicable to BLM jurisdiction wells
- communitization agreement number, if applicable
- operator
- well name
- API number (American Petroleum Institute unique oil and gas well identification number)
- existing wells inside the ECBM project boundary
- existing wells within 1 mile outside of the project boundary
- producing (or target) horizon of gas well
- status (producing, shut-in, abandoned, etc.)
- status of annulus (which zones, what depths, open or cemented, etc.)
- latest bradenhead test results (surface casing pressure), and year of testing
- latest intermediate casing pressure, indicating year of testing
- risk category as identified in Tables 4-20 and 4-21

■ As formation pressure has the potential to be increased over the initial formation pressure in an enhanced recovery project, extra risk evaluation would be conducted within the project and within 1 mile of the project boundary. Gas wells and abandoned wells or drill holes would be evaluated to assess whether effective isolation of the Fruitland Formation was accomplished during primary or remedial cementing. *(Mitigation Developed from SUIT EIS)*

■ Levels of risk would be assigned to each well based on history of mechanical integrity (bradenhead tests), degree of isolation of the Fruitland Formation, and proximity to domestic water supplies and injection facilities. Table 4-20 describes the risk categories for wells or drill holes. Table 4-21 describes the risk categories for abandoned wells. Table 4-22 presents the monitoring frequencies and activities required by each risk category. These monitoring frequencies and activities may be modified to meet site-specific conditions as required by the appropriate authorities. *(Mitigation Developed from SUIT EIS)*

■ Any ECBM project operator would identify all water wells within the Study Area and the 1-mile peripheral buffer. The operator would present this information in map or graphical form to identify the wells in relation to the proposed ECBM project. A spatially distributed selection of groundwater/monitoring wells are to be identified or drilled and access obtained for monitoring prior to and during the ECBM project. Water samples from these groundwater/monitoring wells would be tested for pH, temperature, specific conductance, methane and hydrogen sulfide and may be tested for other component gas concentrations on an initial baseline prior to project operation and at least quarterly for the life of the project.

Additionally, samples would be collected and analyzed at least annually for the following *(Based on Existing Policy or Regulation)*:

- bacteria (fecal coliform, sulfate-reducing, iron-reducing)
- total dissolved solids (TDS)
- total iron and manganese
- major cations (sodium, potassium, calcium, magnesium)
- major anions (bicarbonate, carbonate, sulfate, chloride, fluoride)
- nutrients (nitrogen, as nitrate and nitrite)
- dissolved gases (nitrogen, oxygen, carbon dioxide)

■ Wells would be sampled for carbon isotopic analyses where methane in water is greater than 1 mg/L initially and annually repeated or sampled if the following conditions occur *(Based on Existing Policy or Regulation)*:

- methane concentrations increase from less than 1.0 mg/L to a value greater than or equal to 1.0 mg/L, or
- those wells that were initially greater than or equal to 1.0 mg/L increase by 5 mg/L over the established baseline.

■ A site-specific contingency plan would be developed for each enhanced recovery project to provide specific remedial measures to be implemented in the event monitoring identifies a change in well (oil and gas or water well) or drill hole condition. A change of principal concern would include indications of possible movement of Fruitland Formation gas and/or waters into overlying formations and/or the atmosphere. The contingency plan should identify what constitutes a change from baseline conditions, agency notification, source and safety evaluations, monitoring modifications, and corrective actions to be taken. Appendix M presents the Tiffany Contingency Plan as an example. *(Mitigation Developed from SUIT EIS)*

TABLE 4-20
Risk Categories for Active Producing and Injection Wells

Risk Category	Well Condition	
	Zonal Isolation of the Fruitland	**Surface Casing Pressure measured by a Bradenhead Test (Bhd)**
1	Known or Possibly Exposed Fruitland Coal	generally > 25 pounds per square inch gauge (psig) or 30 minutes residual Bhd pressure / flow
2	Partially exposed Fruitland formation	Measurable Bhd pressure / flow
3	All Fruitland Formation cement covered	generally < 10 psig Bhd pressure
4	Cement essentially to surface / adequate zone isolation	< 2 psig Bhd pressure

TABLE 4-21
Risk Categories for Abandoned Wells

Risk Category	Zonal Isolation of the Fruitland
X	Known or Possibly Uncemented Fruitland Coal
Y	Cement not circulated to surface or abandonment possibly inadequate
Z	Cement to surface or apparently adequate plugs

TABLE 4-22
Monitoring Requirements for Active Oil, Gas and Injection Wells or Plugged & Abandoned, Dry & Abandoned, and Abandoned Wells by Risk Category

Risk Category	Monitoring Requirements	
	Frequency	**Monitoring Activity**
1	Weekly	Chart or gauge Bradenhead (Bhd) pressure
2	Monthly	Chart or gauge Bhd pressure
3	Quarterly	Gauge Bhd pressure

TABLE 4-22
Monitoring Requirements for Active Oil, Gas and Injection Wells or Plugged & Abandoned, Dry & Abandoned, and Abandoned Wells by Risk Category

Risk Category	Monitoring Requirements	
	Frequency	Monitoring Activity
4	Every six months	Gauge Bhd pressure
X	Initially, then monthly	Soil vapor probe at surface for methane concentration and flow
Y	Initially, then quarterly	Soil vapor probe at surface for methane concentration and flow
Z	Initially, then every six months	Soil vapor probe at surface for methane concentration and flow

4.5.1.9 Unavoidable Adverse Impacts

The primary unavoidable adverse impact on groundwater resources is the relocation and potential degradation of the water resource within the Fruitland Formation. However, due to the poor quality and depth of the Fruitland Formation in most of the Study Area, Fruitland water has little utility, and this impact is not considered significant. No other potential impacts due to withdrawal of water from the Fruitland or injection of the produced water into the deeper strata have been formally documented.

4.5.2 Surface Water

4.5.2.1 Issues, Impact Types, and Criteria

This section evaluates potential impacts of the alternatives on surface water resources within the Study Area. Also included is an interpretation of the potential impacts that may extend beyond the Study Area boundaries for rivers and streams that cross the Study Area. The criteria used to assess impacts on surface water resources focus on the potential for changes in water quantity or quality. Measures to mitigate or avoid potential impacts on surface water resources are discussed. Direct impacts are defined as those effects associated with the activity or disturbance that have an immediate impact on surface water quantity or quality. Examples of direct impacts are sedimentation resulting from erosion during drill site, pipeline, and road construction, or contamination resulting from spills. Indirect impacts are defined as those impacts associated with an activity or disturbance that are separated by space or time, and that may result in changes to surface water quantity or quality. Indirect impact may include contaminants migrating into the groundwater system and surfacing in the form of seeps or springs, or reduced flows due to water depletions.

Indirect impacts on surface water quality also can be cumulative in nature because the impact source could include one or more areas. For example, a watershed comprising both tribal and nontribal coal land could contain contaminants in receiving surface waters, with no definitive transport pathway that leads to a point source. This could be the case for sporadic events such as stormwater runoff, or from spatial or temporal changes in groundwater recharge of a stream system

Impacts would be considered significant if state and SUIT water quality standards are exceeded (e.g., accelerated soil erosion, spills of saline water or fuels into streams during transport) (CDPHE 1995; SUIT 1997), if the project causes changes in surface flows that exceed normal maximum or minimum levels (30-year data records) (e.g., depletions exceed the threshold established by the USFWS), or if any surface water tributary to ground water resources is affected.

4.5.2.2 Impact Assessment Methods

In consultation with the SUIT Department of Natural Resources and BIA, impacts on surface water were assessed qualitatively by evaluating, known impacts in the Study Area. Well completion and operation practices (production, injection, and disposal) with chemical properties of produced fluids (natural gas and produced water) were considered. Estimates of area of disturbance for each of the alternatives were considered in terms of potential erosion and sedimentation. Impacts on surface water were assessed quantitatively by calculating the amount of water needed for drilling and well completion and then multiplying those values by the number of wells to be drilled for each of the alternatives.

4.5.2.3 Impacts Common to All Alternatives

Construction Phase

In general, direct impacts on surface waters are related to the areal extent of surface disturbances associated with road or pipeline construction, and well construction and development. Well construction could affect surface water within the immediate vicinity of drill pads, whereas road or pipeline construction could affect surface water along the right-of-way corridors. These impacts generally would be localized and short term, and are related to accelerated erosion from storm events that occur when surface soil is exposed, for example, during and after construction and earthmoving. Increased runoff and erosion also would have a detrimental impact on stream channels, leading to increased bank erosion, channel scour, and on- and off-site sedimentation.

Construction of each new well would result in a maximum disturbed surface area of 3.06 acres, based on a 2-acre drill site and 1.06-acre access road and pipeline rights-of-way. Construction-related activities generally should use already developed roadways and other rights-of-way. The construction of roads necessary for new production sites would be minimal due to the network of existing roads, and potential additional impacts would be small.

Surface disturbances also would result from well re-completions that may require excavation work on drill pads that have been previously reclaimed. Additional gas conveyance pipelines would have to be added because gas from conventional wells cannot be transported via the same lines as CBM. Construction of flow lines and produced water lines would require little additional disturbance since they would primarily be constructed within the existing pipeline rights-of-way or within road rights-of-way for new wells. If the lines do not follow roads, the disturbed areas would be reclaimed and best management practices applied to minimize erosion and sedimentation. Thus, direct surface water impacts in the Study Area from recompleting existing wells would be minimal because pipelines would be located within existing roadways or pipeline rights-of-way where possible, and best management practices would be used to curtail sedimentation from accelerated erosion.

The magnitude of potential impacts on surface water quantity is dependent on (1) the extent of surface disturbance, (2) the hydrologic characteristics of disturbed areas, (3) runoff control measures, and (4) the well pad and right-of-way proximity to surface water bodies and their drainages. Impacts on the perennial streams and rivers also are dependent on the time of year due to seasonal flow considerations and the actual lifespan of the construction phase.

The magnitude of impacts is dependent on the time of year due to seasonal changes in rainfall and snowmelt runoff, and on the actual time period of the construction phase when soil is exposed. Runoff events occurring while surface areas are exposed have the potential to increase streamflow and sediment production. Increased flows would have a self-perpetuating effect on the sediment yield by increasing bank erosion, channel scour, and changing the shape and sinuosity of stream channels. Those sites located in well vegetated areas can expect little or no erosion effects beyond the immediate vicinity of the site. However, many of the impacts from the installation of roads and culverts are long term.

Potential impacts on surface water quality are primarily dependent on the drill site's proximity to receiving bodies of water. Increased sediment production, particularly from storm events or snowmelt runoff, presents the greatest potential risk to surface water quality. The predicted small areas of disturbance associated with individual well development and an enhanced buffer distance of the development site from surface waters would minimize potential impacts. In addition, implementation of best management practices would mitigate erosion and sedimentation impacts.

Potential direct impacts on surface water quality also would occur from accidental contaminant releases associated with machinery fuels, lubricants, and drilling fluids used during the construction phase. Small bermed ponds, which are often lined, are used to contain these fluids in the event of an accidental release, thereby reducing the potential for migration off site.

Water Use

Potential impacts on surface water resources may also result during construction due to fresh water consumption (depletions) for oil and gas well development. All alternatives would require some fresh water for well construction. In the drilling of both conventional wells and CBM wells, including ECBM injection wells, fresh water is usually required only for mixing and displacing cement and for mixing cross linked gels or foams for fracture stimulation. No fresh water is required for cavitation. The drilling mud for all those well types is usually made using Fruitland Formation produced water rather than fresh water. The reservoir sections of Mesaverde and Dakota wells are sometimes drilled using air or gas in place of mud to minimize formation damage. Small amounts of water may also be used for cleaning equipment and for dust suppression.

Table 4-23 provides conservative calculations of the expected amount of fresh water that would be used under each alternative. In this analysis, all Fruitland Formation wells were assumed to be fracture stimulated because most Fruitland wells are expected to be fractured -- fracturing also requires substantially more fresh water than cavitation. This assumption therefore is conservative, making the calculation of fresh water use higher than it probably would be under any of the alternatives. Fresh water requirements for conventional wells, was estimated based on the average volume used for Mesaverde and Dakota wells; few Pictured Cliffs wells are expected. This second assumption causes a slight overestimation of the volume of fresh water that would actually be required under each alternative because Pictured Cliff wells require less fresh water than Mesaverde or Dakota wells

The greatest water use would occur during the construction phase. The water required for drilling, cleaning equipment, cooling engines, and other construction activities is estimated at 450 barrels for each Fruitland and 5,450 for each conventional well. The fresh water required for well stimulation is estimated to be 3,950 barrels for a fractured CBM well and an average of 9,000 barrels for conventional wells (See Section 2.8.4.4 for more discussion of water use requirements). It is assumed that all new wells would require stimulation. The primary source would be municipal supplies or irrigation water purchased from the owner and trucked or pumped to the site. Water also may be trucked to the site from ponds or streams in the area.

This information indicates that surface water depletions resulting from construction under any of the alternatives would be small (less than .005 percent) relative to perennial stream flow in the basin. Thus, no significant indirect impacts on streamflow in ephemeral or perennial streams in the Study Area are anticipated as a result of implementation of any of the alternatives.

Table 4-23
Water Use Requirements
Over 20-year Project Life
11 x 8 ½
1 page

Production Phase

Produced Water

Water produced from development of gas wells has the potential to impact surface water indirectly by depleting streamflow volume or degrading surface water quality. The potential for impacts to occur is dependent upon the source of produced water and the manner in which it is managed.

Many of the conventional gas wells in the Study Area are termed "dry gas" wells that produce little or no water or hydrocarbons commercially recoverable as liquid product. These gas wells typically have small amounts of water and light liquid hydrocarbons called "drip," or condensate (Section 2.8.5.2). In many instances, the volume of produced water is low and can be evaporated from lined surface pits.

Some gas wells produce enough water that a more efficient means for disposal must be provided during operation of the well. In particular, CBM wells produce substantially more water than conventional gas wells and often require artificial lift, such as a rod pump to remove formation water. Production facilities may include a pit or tank for the collection of separated produced water and a small tank for the storage of liquid hydrocarbons. The average amount of produced water for all Fruitland wells on the Reservation was about 72 barrels (3,024 gallons) per day in 1995, 69 barrels (2,898 gallons) per day in 1996, and 59 barrels (2478 gallons) per day in 1998 (Dwight's Energydata Inc. 2000) .

Although most produced waters are brackish to highly saline, some are fresh enough for surface usage. If produced water is to be discharged to surface waters, it must meet water quality standards and be specifically permitted. This permit is separate from the EPA general National Pollutant Discharge Elimination System permit which was issued for the Reservation in 1991. In the early 1990s two reverse osmosis units were permitted to accept and treat produced waters from tribal wells prior to discharge. These units are currently not in operation because of high costs.

Produced water may be trucked or transported via pipeline to a disposal site. A small percentage (±5 percent) of the produced water not evaporated on site is trucked to permitted evaporation ponds. Most of the produced water (±95 percent) from the Reservation is disposed using deep well injection (see Section 4.5.1.3 for a discussion on disposal of produced water).

Any indirect impacts on surface water flow associated with withdrawal of water during production would require a hydraulic connection between the geologic formation from which water is produced and an ephemeral or perennial stream channel. The Fruitland Formation is located at a depth of about 3,000 to 3,500 feet throughout most of the Study Area. Finch (1994) states that "Leakage of groundwater and dissolved gases from the Fruitland Formation is controlled by the overlying low permeability rocks of the Kirtland Shale and younger strate." Along the Indian Creek area, the Fruitland Formation receives a fairly high amount of recharge. Approximately 37 acre-feet of recharge water within the Study Area discharges to the Animas River. Coalbed methane development has effectively intercepted this water, and now the water is disposed into deep injection wells or evaporation ponds. Coalbed methane development has also intercepted the groundwater discharging to two small springs on the western side of the Study Area. A detailed modeling effort is underway to quantify maximum depletions to San Juan Basin rivers from CBM development. Given that most of the Fruitland recharge water is intercepted by wells located north of the Study Area, the primary focus of surface water depletions is CBM development north of the Study Area.

Injection of produced water into the Entrada Formation and Bluff Sandstone that underlie the Fruitland Formation would likewise have little or no impact on surface water bodies within the Study Area. These sandstone units are about 9,000 and 4,500 feet, respectively, below ground surface within the Study Area and therefore do not crop out near any of the principle stream systems that drain the Study Area. Flow in Study Area rivers and streams is not expected to be impacted from re-injection of produced waters in deeper geologic formations which underlie the Kirtland Shale. Impacts are more likely to occur from loss of processed water at the surface during reinjection processes. Leakage of produced water from injection facilities is more likely to occur if the produced water is extremely saline, which causes equipment corrosion.

Gas Migration

Indirect impacts on surface water quality include the potential for migration of dissolved gases, hydrocarbons, or contaminated water from the Fruitland Formation to surface waters within the Study Area. Potential migration pathways include flow through fracture systems, seeps in areas where the formation outcrops, or active and abandoned oil and gas wells. The 1994 Gas Research Institute study focused on the potential for migration of methane from the Fruitland Formation to the Animas Valley alluvium through naturally occurring fracture systems. The study concluded the following:

> "Prior to oil and gas development, historical reports of natural oil and gas occurring as seeps at the surface, as natural reservoirs in Tertiary-age rocks (Nacimiento Formation), and in shallow ground water in the Animas River Valley were documented."
>
> "Fracture flow from gas-producing zones of the Fruitland Formation to the Animas River Valley fill is a probable cause for methane in shallow ground-water wells of the Animas River Valley. The fracture map does not indicate any specific correlation between fractures, gas production wells, and shallow ground-water wells, but indicates geologic conditions below the Animas River Valley are

> favorable for methane to occur naturally in shallow ground water and as seeps at the surface. This evidence might explain the repeated occurrence of methane, over the past 100 years, in shallow ground water and at the surface."

The Gas Research Institute study also acknowledged that as a result of the development of natural gas fields and the associated population growth, the number and proximity of domestic water-supply and gas-production wells has increased, as have documented methane contamination occurrences. A weak positive correlation was established between the number of gas wells per square mile and the percent of surveyed groundwater wells with methane. However, plugged and/or abandoned gas wells, which could also be sources of groundwater contamination, were not included in the survey.

This information suggests that, in addition to gas seepage through naturally occurring fractures, active or abandoned gas production wells also provide a conduit for contaminants to be transported from the Fruitland Formation to shallow groundwater and surface water systems. However, existing impacts of this seepage on surface water quality within the Study Area have not been documented. Further, current stipulations on construction and abandonment practices, as well as monitoring and mitigation of old wells, makes communication of fluids between formations via well bores unlikely.

Abandonment Phase

Impacts on surface water from well abandonment would be similar to construction impacts, and would result from grading and recontouring of disturbed areas associated with drill pads and access roads and would be mitigated using best management practices and site reclamation. After grading the area to a useful layout, restoring the landform as near as possible to its original contour, and using erosion control devices, the area would be reseeded to minimize erosion (as per BIA stipulations, SUIT General Well Site Conditions of Approval or SUIT General Pipeline Right-of-Way Stipulations).

Site restoration and abandonment would adhere to standards and requirement of SUIT, BLM, and BIA APD and right-of-way approval conditions. Regulations require that production wells must be filled with drilling mud and cement. Therefore, little potential exists for direct impact on surface waters from the flow of liquids or gases from within the wells.

4.5.2.4 Alternative 1 - Continuation of Present Management (No Action)

Potential impact types common to all alternatives on surface waters in the Study Area are described in Section 4.5.2.3. Activities more likely to occur near surface water features, possibly changing streamflow or causing stream bank erosion and stream alteration, have the greatest potential to impact surface water quality or quantity. Potential direct impacts on surface waters include soil erosion and resulting runoff and sedimentation of receiving surface waters, as well as accidental releases of contaminants. Total surface disturbance from the construction of new wells and rights-of-way under Alternative 1 is estimated to be about 1,071 acres. The use of existing well pads has the potential to reduce the area of surface disturbance to about 714 acres.

The fresh water use requirement for Alternative 1 is estimated at up to18 acre-feet per year (Table 4-23), most of which is required for cementing and fracture stimulation of wells. Current operation of existing wells indicates that potential impacts on surface water from wellsite activities can be readily mitigated using best management practices for sediment control and spill containment.

4.5.2.5 Alternative 2 - Coalbed Methane Infill Development

Alternative 2 would result in the types of potential impacts described in Section 4.5.2.3, but with a more extensive total area of impact than Alternative 1 due to the increased numbers of developed wells. Implementation of Alternative 2 would increase the likelihood of gas wells being drilled near surface water bodies, on steep slopes, or on highly erosive soils due to the increase in number of wells and resultant increase in area of disturbance. The area of surface disturbance for new wells and rights-of-way is projected to be about 1,946 acres. The use of existing well pads has the potential to reduce the area of surface disturbance to about 1,306 acres.

The fresh water use requirement for Alternative 2 would be up to 25 acre-feet per year (Table 4-23), most of which is required for cementing and fracture stimulation of wells.

4.5.2.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

Alternative 3 includes the same potential infilling and number of production wells as described for Alternative 2, but incorporates enhanced recovery of the CBM gas resource by injection of nitrogen or carbon dioxide using injection wells.

The potential direct and indirect impacts on surface water quality or quantity identified in Section 4.5.2.3 also apply for enhanced recovery under Alternative 3. The potential for gas to contaminate surface water increases with this alternative because of additional formation pressures generated by enhanced recovery methods, and such measures would occur more frequently in areas where gas could migrate through rock fractures.

The estimated area of surface disturbance associated with construction in Alternative 3 would be about 2,160 acres. The use of existing well pads has the potential to reduce the area of surface disturbance to about 1,410 acres. Additional construction activities beyond those required for Alternative 2 are associated with the ECBM production, which requires construction of wells for the injection of nitrogen into the formation. Added piping is necessary for delivery of the nitrogen from the separator/compressor plant to the injection well, although the additional pipelines would follow existing rights-of-way.

The fresh water use requirement for Alternative 3 would be up to 27 acre-feet per year (Table 4-23), most of which is required for cementing and fracture stimulation of wells.

4.5.2.7 Impacts Summary

Direct and indirect impacts on surface waters within the Study Area related to implementation of Alternatives 1, 2, or 3 are predicted to be negligible. The geologic setting is not favorable for significant interaction to occur between Fruitland Formation water and surface streams because of the relative depth of the Fruitland Formation and low permeability of the Kirtland Shale which directly overlies the Fruitland Formation. There are interactions between surface water features and the Fruitland ground water on the outcrop, and several springs have dried up due to CBM development. Gas wells are not expected to provide a conduit to surface water because of required stipulations on new well construction and abandonment and programs by which the mechanical integrity of older wells is monitored and maintained. The volume of fresh water required for gas well construction is relatively low.

The potential for direct impacts on surface water quality is a function of surface water runoff and erosion control and management practices. The greatest potential for impacts on surface water is from construction of roads, pipelines, and well pads that change surface flow dynamics causing channelization and increased erosion. Implementation of mitigation and best management practices described below for the control or containment of surface water runoff during construction and abandonment activities would significantly reduce the potential for surface water quality impacts.

Past water quality studies in the basin have not focused on evaluating the potential impacts of oil and gas development on surface water quality within the Study Area, or in Colorado. Thus, no data exist to assess the effects, if any, of gas extraction activities on surface waters of the Reservation. Recent studies done in New Mexico concluded that the oil and gas industry was not contributing to PAH contamination of groundwater or surface water. Gathering of relevant Colorado data would require separating agricultural practices and other land uses from gas development as causes of surface water quality or quantity changes.

Surface water quality and biological investigations in the San Juan River Basin in New Mexico have identified a data gap with respect to assessment of surface water quality impacts associated with oil and gas development in the basin. No surface water quality studies have been directed towards assessment of hydrocarbon contaminant sources, extent, or fate in surface waters of the Study Area, including the La Plata, Animas, or Pine Rivers.

Extended over the 20-year period covered by this EIS, the expected annual maximum water use requirement for well construction and stimulation associated with Alternative 2 is 25 acre-feet/year (Table 4-23). The expected annual maximum water use requirement for Alternative 3 is 27 acre-feet/year. The water use requirement for Alternative 1 would be less, about 18 acre-feet/year. Because water for drilling and stimulation would be acquired from existing irrigation sources, although it is possible that some water may be acquired from local streams, ponds and formations, significant well construction related water depletion impacts are not anticipated.

Additionally, the 3M Study estimates that CBM gas production within the Study Area will intercept about 37 acre-feet of Fruitland Formation water that would normally discharge into the Animas River. This amount of water is not presently measurable in-stream and is not anticipated to significantly impact fish habitat or agricultural use.

For comparison purposes, the average annual runoff in the Animas River near Cedar Hill, New Mexico (2.5 miles upstream from the Colorado-New Mexico state line) for period 1934 to 1996 was 671,700 acre-feet (USGS 1996). The 3M (Monitoring, Mapping, and Mitigation) project will continue to monitor the situation and report to the participating agencies, the public, and the Fish and Wildlife Service any changes, particularly increases, in the calculated depletion.

Development of additional CBM wells in the Fruitland Formation under all alternatives could occur throughout the central portion of the Study Area. Previous studies indicate that the greatest potential for contamination of surface water resources would occur wherever gas wells are located along water courses such as river channels or irrigation ditches, particularly in areas where groundwater could act as a transport mechanism to the surface water system. These areas typically include the alluvial valley floors of the Animas, Florida, and Pine rivers within the Study Area. Sources of surface water quality impacts could include methane or other contaminant migration from leaking well bores or disposal pits that occur in these alluvial valleys.

There currently are no known surface water data for streams in this area that can be used for the establishment of baseline water quality or quantity conditions, including concentrations of PAHs or hydrocarbons in surface water or sediment.

4.5.2.8 Mitigation Summary

Existing environmental protection measures are provided in Appendix E. In addition, potential impacts on surface water resources would be reduced by adhering to the conditions of approval and stipulations for project-specific APDs and rights-of-way grants. Also, each operator must prepare a storm water management plan when a construction site involves over 5 acres of disturbance in accordance with the regulations at 40 CFR 122. The plans incorporate best management practices, both structural and non-structural, to manage storm water runoff from disturbed areas.

Most environmental protection measures relate to the timing, length of period of activity, and location of construction activities, as well as erosion prevention measures and adherence to local and national codes and laws. Environmental protection measures include, but are not limited to the following:

- Meeting all applicable water quality standards. *(Based on Existing Policy or Regulation)*

- Avoiding construction activities near or through streams during high flows or wet periods. *(Based on Existing Policy or Regulation)*

- Minimizing the time and area of disturbance for road and pipeline surface water crossings and designing crossings at right angles to streams to minimize the area of disturbance. *(Mitigation Developed from SUIT EIS)*

- Requiring operators to map and delineate Waters of the United States, as defined at 33 CFR Part 328.3, prior to the planning of any activity at or in the vicinity of such waters. *(Based on Existing Policy or Regulation)*

- Requiring operators to avoid impacting Waters of the United States whenever practicable. *(Based on Existing Policy or Regulation)*

- Requiring operators to obtain 404 permits from the U.S. Army Corps of Engineers, including 401 certification from the Environmental Protection Agency, for land within the boundary of the Southern Ute Indian Reservation. *(Based on Existing Policy or Regulation)*

- Requiring operators to minimize unavoidable discharges of fill material to Waters of the United States. *(Based on Existing Policy or Regulation)*

- Requiring operators to mitigate Waters of the United States that are adversely impacted by their activities. *(Based on Existing Policy or Regulation)*

- Requiring operators to obtain appropriate permits, including those associated with Section 404 of the Clean Water Act, when crossing surface waters or Waters of the United States, as defined at 33 CFR Part 328.3. *(Based on Existing Policy or Regulation)*

- Developing and implementing spill and recovery plans to contain and remediate spills. *(Based on Existing Policy or Regulation)*

- Implementing best management practices to slow or reduce the flow of surface-water runoff across disturbed areas, including diversion of surface runoff around facilities. *(Based on Existing Policy or Regulation)*

- Routing surface runoff from drill locations into reserve pits, if appropriate. *(Based on Existing Policy or Regulation)*

- Installing road-grade culverts following best management practices. *(Based on Existing Policy or Regulation)*

- Reducing erosion impacts from roads through measures described in the standard environmental protection criteria. *(Based on Existing Policy or Regulation)*

- Preparing storm water management plans when a construction site involves over 5 acres of disturbance and a storm water master plan, if appropriate. *(Based on Existing Policy or Regulation)*

- Implementing 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. *(Based on Existing Policy or Regulation)*

- Implementing non-structural control practices such as interim and permanent stabilization, permanent and temporary seeding and revegetation, and geotextiles. *(Based on Existing Policy or Regulation)*

- Installing culverts as erosion prevention measures in areas of high runoff. *(Based on Existing Policy or Regulation)*

- Reclaiming (including revegetating) all or portions of roads, drill pads and other oil and gas-related surface disturbance, as appropriate. *(Based on Existing Policy or Regulation)*

- Protecting 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. *(Mitigation Developed from SUIT EIS)*

- Minimizing erosion at sites located in steep terrain during the construction phase by measures such as contouring, water bars, temporary ditches, and detention basins, along with minimizing the period of disturbance. *(Based on Existing Policy or Regulation)*

- Complying with standard environmental protection criteria for surface disturbance associated with production and abandonment activities. *(Based on Existing Policy or Regulation)*

- Conducting routine inspections of facilities, pipelines, and well sites to determine if there are erosion problems, sedimentation, spills, or leaks and taking corrective action, as appropriate. *(Based on Existing Policy or Regulation)*

- Timely plugging and abandonment of non-productive wells and associated flow-lines and equipment. *(Based on Existing Policy or Regulation)*

- Developing a comprehensive surface water quality monitoring program for the three principal rivers and major tributaries that drain the Study Area to establish the significance of any concerns regarding surface water contamination from gas migration, or from non-point source runoff. Monitoring should focus on a limited number of conservative chemical and physical parameters that can be used to evaluate the presence or absence of impacts associated with oil and gas development in the Study Area. *(Mitigation Developed from SUIT EIS)*

4.5.2.9 Unavoidable Adverse Impacts

Assuming continued effectiveness of the mitigation measures that are discussed previously, no unavoidable adverse impacts on surface water resources have been identified. There is some potential for depletion of water from the Fruitland coal or injection of produced water in the deeper strata to impact surface water. The 3M modeling work has shown that CBM development will intercept about 200 acre-ft/yr of groundwater that would have discharged to the Animas, Florida, and Pine Rivers. About 37 acre-ft/yr of this depletion will occur as a result of development within the Study Area. Refinement of these models is underway in an effort to predict maximum depletions as regional reservoir pressures fall below the hydraulic heads within the rivers.

4.6 LAND USE AND OWNERSHIP

4.6.1 Issues, Impact Types, and Criteria

The purpose of this section is to analyze the potential impacts of proposed oil and gas exploration and development within the Study Area on land use. Project related issues and potential impact types were identified for each alternative and are described below.

4.6.1.1 Issues

Land use concerns expressed by SUIT, La Plata County, and Archuleta County center around the effects of oil and gas development on existing and planned residential, recreational, and agricultural uses. (Note, the small portion of Montezuma County that is within the Study Area is undeveloped.) Although land uses within the Study Area are diverse, oil and gas development have the most potential for conflict with residential and agricultural land uses.

Specific concerns expressed by La Plata County include "split estate" situations in which the surface owner does not own the underlying minerals. These situations have led to land use conflicts when the land owner is unaware of the severed mineral rights until an oil and gas company is ready to begin drilling. Although surface owners are sometimes compensated for the value of their land displaced by the well pad and access road, they are often displeased with the possibility of having well facilities located near their residences. (Hammer, Siler, George Associates, 1990). An increase in well density to one well per 160 acres would intensify the conflicts arising from the "split estate" situations. Over half of all land within the Study Area is in private ownership, and about one quarter (24 percent) of this land is in "split estate" ownership (about 88,020 acres). However, only one third of this land (28,943 acres) has a split of tribal/allotted subsurface mineral estate overlain by private-/state-held surface.

4.6.1.2 Impact Types

Direct impacts on land use resulting from the proposed alternatives are related primarily to physical restrictions and loss of agricultural, livestock grazing, timber production, and recreational areas. Visual impacts and depreciation of land value may pose direct impacts on surface owners. Indirect impacts consist of activities that impinge on existing uses, such as dust and noise from traffic that may affect residential areas and water contamination that could affect existing agricultural or residential uses. Impacts resulting from each of these activities are discussed in Sections 4.2, 4.5, 4.7, and 4.11. The range of direct and indirect impacts that could result from the proposed activities include (1) loss of land or land value including potential agricultural, and rangeland and forest production; (2) displacement of recreational lands; (3) effects on applicable regional plans, adopted policies, goals, or operations of communities or government agencies; and (4) land use incompatibility with residential, recreational, commercial, and government/public areas. Descriptions of the land use impact types that would potentially result from this project are discussed in the following text.

<u>Agricultural</u>

In general, the impacts on agriculture that could result during construction include those that would reduce the production and value of crops. Short-term impacts on agriculture land include disruption to farming practices, seasonal loss of crops during construction, interference with irrigation patterns, and increased introduction of noxious weeds into disturbed areas. Potential long-term impacts on agriculture include (1) loss of cropland under and around well pads and access roads; (2) replacement or alteration of existing flood and center pivot irrigation systems; (3) modification of farming operations near and around well pads and access roads, resulting in increased farming time and soil compaction; (4) proliferation of noxious weeds; and (5) economic losses.

Grazing

Direct impacts on rangeland include the loss of land, the disruption to grazing practices, and loss of grazing capacity from construction of well pads and roads. Grazing impacts may occur in other locations that were not identified through La Plata Count, BIA, and SUIT sources; however, for purposes of this analysis, only impacts on designated rangeland and grazing units have been identified. Short-term impacts include displacement of fences and cattle guards surrounding grazing areas. Controlling livestock movement by maintaining fence-line integrity is essential for efficient livestock and range management. The construction of roads and pipelines would likely bisect fences, alter grazing practices (e.g., rotational grazing), and would require placement and maintenance of cattle guards and gates. Long-term impacts include loss of rangeland that is used for roads, under and around the well pads, and disturbance or displacement of stock ponds. Unevenly distributed water sources have resulted in overgrazing of rangeland and forage where water is available and the underutilization of drier rangeland and forage areas. Therefore, loss of stock ponds could be a high impact, unless mitigated by replacement of such ponds with other water sources.

Indirect impacts could result from the potential invasion of noxious weeds in disturbed areas. Noxious weeds reduce rangeland value to livestock by displacing preferred forage species. Severe infestations can result if weeds are not controlled, decreasing rangeland capacity for grazing. Additionally, some weed species are poisonous to livestock, causing illness, mechanical injury, or death when ingested.

Forest Resources

Direct impacts on commercial woodland include the immediate and long-term loss of commercial woodland resources and the income that it can generate and the long-term change in land use from a forest resource to industrial. These impacts would be caused by the construction of well pads, access roads, and pipelines. These sites would not be returned to forest for at least 50 to 100 years after the sites are abandoned and revegetated, the time required to regenerate woodland or forest. Thus the change in land use would be long term. Roads that are not revegetated upon abandonment would result in a permanent loss of forest resources.

Indirect impacts associated with the losses of forest resources include the following:

- fragmentation of the forest resource and its effect on wildlife and visual resources
- vegetation mortality from methane seeps, coal fires, and accidental release of fuels, lubricants, and other products
- loss of forest cover and effects on wildlife, soil stability, water yields, runoff patterns, and forage yields
- fuel loading from active fuel generation
- increase of forest insect and disease problems caused by construction activities.

Residential and Recreation Areas

Other types of potential impacts on land uses in the Study Area include conflicts with residential, recreational, and community areas due to the presence of truck traffic, dust, noise, and visual impacts. The quality of recreational experiences would be diminished over the life of the project due to the presence of industrial activities in recreational areas. These impacts may be long or short term.

No direct physical conflicts with residential or recreational structures are predicted as a result of the proposed project, due to existing SUIT oil and gas regulations stating that well facilities must be located a minimum of 200 feet away from any building. Impacts on residential and recreational land also would occur where access roads and pipelines cross these lands; however, these impacts can be mitigated by aligning the access roads on parcel boundaries.

4.6.1.3 Impact Criteria

Land uses within the Reservation most sensitive to impacts from oil and gas development include residential, commercial, government/public uses, recreation, agricultural, livestock grazing, and timber production. Impacts on land use would be considered significant if project activities permanently altered or removed continuation of the use. Examples of significant impacts on land uses if displaced by project activities include the following:

- loss of irrigated agricultural areas including flood- and sprinkler-irrigated cropland and inability to develop or reclaim potential farmland or agricultural uses, or removal of an appreciable amount of productive land such that a tribal member’s assignment or allotment would no longer support a commercially viable operation

- loss of grazing areas and/or stock ponds or removal of an appreciable amount of rangeland such that livestock grazing would not be supported in a given area
- loss of recreation opportunities, especially if such loss affected the viability of commercial recreational activities
- reduced or restricted housing availability where suitable surface acreage cannot be developed
- loss of potential economic or revenue opportunities where suitable commercial acreage cannot be developed
- loss of surfaces suitable for the tribal facilities development (residential, government, public or commercial uses)

The following discussions of land use impacts have been organized into the four general categories listed below:

- surface land ownership
- consistency with regulations and land use plans
- land use and recreation (includes grazing and commercial woodland or timber production)
- utilities and rights-of-way

4.6.2 Impact Assessment Methods

Many issues relating to land use concerns on tribal land were identified through agency scoping and discussions with SUIT representatives in the departments of Energy Resources, Planning, Lands Branch, Natural Resources, and the Realty Office. Land-use issues on private land were identified through scoping and discussions primarily with county planners. Other agencies contacted include the Navajo Reservoir State Recreation Area and the Colorado Department of Wildlife (CDOW).

Impacts on land use were based on estimates of surface disturbances for each of the alternatives. The amount of surface disturbance for each resource was calculated using GIS resource delineations on a map base that included likely well window locations. Land use types included split estates (private surface and tribal/allotted subsurface), agricultural, livestock grazing, timber production, recreational areas, residential, commercial and government/public areas.

4.6.3 Impacts Common to All Alternatives

4.6.3.1 Surface Land Ownership

Lands under the surface jurisdiction of the SUIT, State of Colorado, La Plata County, Montezuma County, and Archuleta County are shown on Map 17. Each alternative potentially would have both short-term and long-term effects on SUIT lands, with potential impacts also on state land and private land. The maximum acres of short-term and long-term disturbance on tribal and private land that would occur are provided below in the discussions on each alternative.

4.6.3.2 Consistency with Regulations and Land Use Plans

The Reservation is covered by the *SUIT Natural Resource Management Plan, 1990-2010* (SUIT 1990). Oil and gas development and the actions and decisions in this EIS are in conformance with this plan.

The majority of nontribal land within the Study Area are in La Plata County and therefore under the planning jurisdiction of La Plata County. While La Plata County does not have zoning regulations, the La Plata County Planning Commission has recently approved a future land use plan for Florida Mesa (La Plata County 1996). This plan has not been adopted by the Board of Commissioners and so is only an advisory document (Kellar 1999). A goal of the Florida Mesa Land Use Plan is to minimize the adverse impacts of oil and gas development on other land uses. Objectives stated in the Florida Mesa Land Use Plan include providing “support to the board of County Commissioners in their opposition to infill gas development beyond that already approved” (La Plata County 1996). The plan encourages the COGCC to regulate additional well development requiring gas development via directional drilling from existing well pads, and advises the county to regulate issues of local concern related to groundwater contamination, light and noise disturbances from well facilities, heavy equipment and truck traffic, disposal of formation waters, and infill of wells.

4.6.3.3 Land Use

Direct impacts that may result from implementation of any of the alternatives include removal or loss of land currently used for agricultural production, rangeland forest resource production, timber production, and recreation areas. No physical displacement of residences are predicted to result from project alternatives, due to SUIT oil and gas regulations that specify a minimum 200-

foot setback from residences. However, development on residential properties beyond this 200-foot setback is possible.

4.6.3.4 Utilities and Rights-of-way

There are no expected disruptions to utilities as a result of the construction, production, or abandonment of project alternatives. Most flow lines and produced water lines would be located within the existing pipeline rights-of-way or within roads to new well pads.

4.6.4 Alternative 1 – Continuation of Present Management (No Action)

4.6.4.1 Surface Land Ownership

Lands under the surface jurisdiction of the SUIT, State of Colorado, La Plata County, Montezuma County, and Archuleta County are shown according to surface status on Map 17. Table 4-24 gives the maximum acres of disturbance on tribal, state, and private land that would occur from construction of this alternative.

TABLE 4-24
Anticipated Surface Disturbance Within Surface Land Ownership from Alternative 1

	Surface Jurisdiction		
	Tribal	**State**	**Private**
Resource Acreage Within Study Area	179,669	800	240,505
Resource Area as a Percent of Study Area	42.7%	0.2%	57.1%
Total Number of Wells Potentially Impacting the Resource	312	0	63
Construction - Maximum Acres Disturbed (Percentage of Resource)	955 (0.5%)	0	193 (0.1%)
Construction - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	646 (0.36%)	0	108 (0.1%)
Production - Maximum Acres Disturbed (Percentage of Resource)	643 (0.4%)	0	130 (0.1%)
Production - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	483 (0.2%)	0	86 (0.1%)

Split Estate

About 186 acres (0.6 percent) of land in split estate situations potentially would be affected (Table 4-25), if all existing well pads are used.

TABLE 4-25
Anticipated Surface Disturbance
Within Split Estate Situations from Alternative 1

	Tribal/Allotted Subsurface with Private/State Surface
Resource Acreage Within Study Area	28,943
Resource Area as a Percent of Study Area	6.9%
Total Number of Wells Potentially Impacting the Resource	81
Construction - Maximum Acres Disturbed (Percentage of Resource)	248 (0.9%)
Construction - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	184 (0.6%)
Production - Maximum Acres Disturbed (Percentage of Resource)	167 (0.6%)
Production - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	134 (0.5%)

4.6.4.2 Consistency with Regulations and Land Use Plans

Alternative 1 is consistent with the Tribe's Natural Resource Management Plan. If mitigation is effective, then Alternative 1 would be in conformance with the Florida Mesa District Land Use Plan, although that plan has no jurisdiction over allotted or tribal lands.

4.6.4.3 Land Use

Potential impacts from surface disturbances on land use types within the Study Area for Alternative 1 were calculated and are provided in Table 4-26.

Table 4-26
Anticipated Surface Disturbance Impacts on Land Use Types from Alternative 1
11 x 8 ½
2 pages

Table 4-26
Page 2

Agricultural

Agricultural land within the Study Area falls into two main categories—agricultural land and prime farmland. Within the Study Area, both are used for agricultural production; however, prime farmland produces the highest yields with minimal amounts of energy and economic resources. Land classified as agricultural and prime farmland is identified on Map 19. Agricultural land comprises 9.5 percent of the Study Area and prime farmland about 4.9 percent. Approximately 31 wells may be located on agricultural lands, resulting in a maximum disturbance of 95 acres, or 0.2 percent of all the agricultural land within the Study Area. If all existing well pads, which are already present within this resource (i.e., available), were used to reduce the amount of surface disturbance, the impacts on agricultural land would be reduced, resulting in a disturbance of 80 acres (0.2 percent). An estimated 14 wells could be established in prime farmland areas, resulting in a maximum loss of about 43 acres from agricultural production during the construction phase, or 0.2 percent of prime farmlands within the Study Area. Impacts on prime farmland can be reduced by using available existing well pads, resulting in a loss of about 37 acres (0.2 percent) of prime farmland from agricultural production.

Grazing

County-designated rangelands occur in about 42,502 acres (10.0 percent of the Study Area) (Table 4-26). Twenty-four wells may be located within county-designated rangelands, resulting in a maximum disturbance of 73 acres, or about 0.2 percent of all county-designated rangelands. If all existing well pads present within this resource were used to reduce the amount of surface disturbance, the impacts on county-designated rangelands would be reduced, resulting in a disturbance of 47 acres (0.1 percent). Animal Unit Month (AUM) losses for county-designated land were not estimated since existing AUM values were not available. (Note: An AUM equals 900 pounds of air-dried forage, enough to feed a 1,000 pound lactating cow for one month.)

SUIT-designated rangelands occur in about 24 percent of the Study Area. Most of the SUIT-designated grazing is allocated to the Picnic Flats, Mesa Mountains, and Sambrito grazing units, and totals 100,807 acres (Table 4-27). These units vary in grazing capacity, ranging from a high of 6.2 acres per AUM for the Mesa Mountains unit, to 23.2 acres per AUM for the Picnic Flat unit, and 74.5 acres per AUM for the Sambrito unit. Losses from Alternative 1 for construction impacts are estimated to be 504 acres, which is about 0.5 percent of the total area of the grazing units. The maximum loss of AUMs from construction without the use of existing well pads from Alternative 1 totals 44.5 AUMs for the three units ranging from the loss of 1.0 AUM for the Sambrito unit to 34.5 AUMs for the Mesa Mountains units (Table 4-27). Use of existing well pads would reduce the surface impacts, and AUM losses would be reduced from 44.5 to 27.7 AUMs, which appreciably reduces the resource loss. Revegetation of parts of the well pad during the production phase of the project would return 1.6, 7.1, and 0.2 AUMs in production for the Picnic

Flats, Mesa Mountains, and Sambrito units, respectively, and less than 0.1 percent of the grazing acreage would be lost through the implementation of this alternative.

Forest Resources

Commercial woodland, consisting of medium-to-high density pinõn-juniper, occurs on about 32.4 percent (136,483 acres) of the Study Area;191 wells could potentially affect 584 acres or 0.4 percent of this resource type (Table 4-26). The use of existing well pads would reduce the acreage to 446, or 0.3 percent of the woodland resource. Commercial timber resources, consisting of ponderosa pine forests, occur in about 4 percent of the Study Area (16,904 acres), and 60 wells could potentially impact this resource, affecting 184 acres (1.1 percent) of the resource. Use of existing well pads would reduce the disturbance to 161 acres, or 1.0 percent of the commercial timber resource.

Residential and Recreation Areas

Recreation areas occur on about 800 acres, or 0.2 percent of the Study Area. No wells are anticipated to be developed within recreation areas.

About 9 wells may be located within the area of residential properties, resulting in a maximum disturbance of 27 acres (0.4 percent). If all existing well pads were used, impacts on residential properties would be reduced, resulting in a disturbance of 25 acres (0.4 percent).

Commercial areas occur on about 351 acres, or 0.1 percent of the Study Area and 5 wells may be located within commercial lands, resulting in a maximum construction disturbance of 15 acres or 4.3 percent of this resource area (Table 4-26). No existing wells are located on commercial lands.

Industrial areas occur on about 224 acres, or 0.1 percent of the Study Area and one well may be located within industrial lands, resulting in a maximum construction disturbance of three acres or 1.4 percent of this resource area (Table 4-26). No existing wells are located on commercial lands.

Table 4-27
Impact Analysis Summary of Alternative 1 on SUIT-Designated Grazing Areas
11 x 8 ½
1 Page

4.6.4.4 Available and Suitable Land for Future Tribal Development

Land designated by the Tribal Planning Department as "suitable and available" for future tribal development is located primarily within the Pine River and Florida Mesa management units. Land "suitable and available" for future tribal development was identified by the Tribe's Department of Natural Resources based on several factors; sufficient acreage, terrain, transportation access, potential relative to roads, and other development and population sectors. This land occupies about 9,682 acres or 2.3 percent of the Study Area. Designated suitable and available tribal land is shown according to surface status on Map 17. There is no tribal policy or regulation specifically limiting development of gas resources on available and suitable land.

Twenty-eight wells may be located within designated suitable and available tribal land, resulting in a maximum of 86 acres, or 0.88 percent of all suitable and available tribal land. If all existing well pads within this resource were used to reduce the amount of surface disturbance, the impacts on suitable and available tribal land would be reduced 64 percent, resulting in a disturbance of 31 acres. Only one development window under Alternative 1 has 100 percent overlap with a section of suitable and available tribal land. In all but this one development window, the opportunity exists to avoid disturbance within suitable and available tribal land, if desired, by constructing the proposed well outside this designated land, yet within the development windows.

4.6.5 Alternative 2 – Coalbed Methane Infill Development

4.6.5.1 Surface Land Ownership

Lands under the surface jurisdiction of the SUIT, State of Colorado, La Plata County, Montezuma County, and Archuleta County are shown according to surface status on Map 17. Table 4-28 gives the acres of disturbance on tribal and private land that would occur from construction of this alternative.

TABLE 4-28
Anticipated Surface Disturbance
Within Surface Land Ownership from Alternative 2

	Surface Jurisdiction		
	Tribal	**State**	**Private**
Resource Acreage Within Study Area	179,669	800	240,505
Resource Area as a Percent of Study Area	42.7%	0.2%	57.1%

TABLE 4-28 Anticipated Surface Disturbance Within Surface Land Ownership from Alternative 2			
	Surface Jurisdiction		
	Tribal	State	Private
Total Number of Wells Potentially Impacting the Resource	598	0	149
Construction - Maximum Acres Disturbed (Percentage of Resource)	1,830 (1.0%)	0	456 (0.1%)
Construction - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	1,179 (0.7%)	0	326 (0.1%)
Production - Maximum Acres Disturbed (Percentage of Resource)	1,232 (0.7%)	0	307 (0.1%)
Production - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	897 (0.5%)	0	240 (0.1%)

Split Estate

The potential for impacts from the construction of Alternative 2 on split estate situations is given in Table 4-29. Approximately 633 acres (2.2 percent) of land in split estate situations potentially would be affected.

TABLE 4-29 Anticipated Surface Disturbance Within Split Estate Situations from Alternative 2	
	Tribal/Allotted Subsurface with Private/State Surface
Resource Acreage Within Study Area	28,943
Resource Area as a Percent of Study Area	6.9%

TABLE 4-29 Anticipated Surface Disturbance Within Split Estate Situations from Alternative 2	
	Tribal/Allotted Subsurface with Private/State Surface
Total Number of Wells Potentially Impacting the Resource	207
Construction - Maximum Acres Disturbed (Percentage of Resource)	633 (2.2%)
Construction - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	528 (1.8%)
Production - Maximum Acres Disturbed (Percentage of Resource)	426 (1.5%)
Production - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	372 (1.3%)

4.6.5.2 Consistency with Regulations and Land Use Plans

Consistency of construction under this alternative with tribal plans would be the same as described for Alternative 1. The increased density of wells under Alternative 2 potentially would result in greater conflicts with the Florida Mesa Land Use Plan's goals and objectives. However, the Florida Mesa Land Use Plan is an advisory document to the county, not a regulation. Further, it has no jurisdiction over tribal land.

<u>Land Use</u>

Potential impacts from surface disturbances on land use types within the Study Area for Alternative 2 were calculated and are provided in Table 4-30.

<u>Agricultural</u>

About 93 wells may be located within agricultural lands, resulting in a maximum disturbance of 285 acres for Alternative 2, or 0.7 percent of all the agricultural land within the Study Area. If all existing well pads already present within this resource were used to reduce the amount of surface disturbance, the impacts on agricultural land would be marginally reduced, resulting in a disturbance of 264 acres (0.7 percent). Prime farmlands constitute about 4.9 percent of the Study Area. An estimated 29 wells could be established in prime farmland areas, resulting in a maximum loss of about 89 acres from agricultural production during the construction phase, or 0.4 percent of prime farmlands within the Study Area. Impacts on prime farmland can be reduced by using available existing well pads, resulting in a loss of about 83 acres (0.4 percent) of prime farmland from agricultural production.

Grazing

County-designated rangelands occur on about 42,502 acres (10 percent of the Study Area). Fifty-one wells may be located within county-designated rangelands, resulting in a maximum construction disturbance of 156 acres (0.4 percent of all county-designated rangelands). If all existing well pads already present within this resource were used, the impacts on county-designated rangelands would be reduced and would result in a disturbance of 96 acres (0.2 percent) of the Study Area.

Surface disturbances during construction of Alternative 2 would affect about 1,191 acres (1.2 percent) of the SUIT-designated units, resulting in a loss of 105.5 AUMs (Table 4-31). Individual unit grazing losses are 80.0 AUMs in the Mesa Mountain, 23.5 AUMs in the Picnic Flats, and 2.0 AUMs in the Sambrito. Use of existing well pads would reduce the total affected area to 757 acres (0.75 percent of the total area) and would reduce the AUM loss to 56.1 AUMs (Table 4-31). Revegetating parts of the well pads during production would reduce the area of disturbance to 802 acres and would reduce the AUM loss to 71.3 AUMs. If existing well pads are used, the maximum area of disturbance during production would be 578 acres and the AUM loss during production would be 45.7 AUMs.

Forest Resources

Of the 136,483 acres of commercial woodland that occurs in the Study Area, about 1.1 percent (1,472 acres) could be affected by construction of 481 new wells (Table 4-30). This acreage would be reduced to 1,258 acres (0.9 percent) of woodlands if existing well pads are used for the development. Similarly, about 535 of 16,904 acres of commercial timber could be affected by Alternative 2, which is about 3.1 percent of this resource. Reductions to less than 3.0 percent (509 acres) could be achieved by using existing well pads.

Residential and Recreation Areas

No well development is anticipated in designated recreation areas.

About 33 wells may be located within residential properties, resulting in a maximum disturbance of 101 acres (1.6 percent). If all existing well pads were used, impacts on residential properties would be reduced, resulting in a disturbance of 99 acres (1.5 percent).

Commercial areas occur on about 351 acres, or 0.1 percent of the Study Area and five wells may be located within commercial lands, resulting in a maximum construction disturbance of 15 acres or 4.3 percent of this resource area (Table 4-30). No existing wells are located on commercial lands.

Industrial areas occur on about 224 acres, or 0.1 percent of the Study Area and two wells may be located within industrial lands, resulting in a maximum construction disturbance of six acres or 2.7 percent of this resource area (Table 4-30). No existing wells are located on commercial lands.

4.6.5.3 Available and Suitable Land for Future Tribal Development

Land designated by the Tribal Planning Department as suitable and available for future tribal development is located primarily within the Pine River and Florida Mesa management units. This land comprises about 2.3 percent of the Study Area. Designated suitable and available tribal land is shown according to surface status on Map 17.

There is no tribal policy or regulation limiting development of gas wells or facilities on these lands. Sixty-two wells may be located within suitable and available tribal land, resulting in a maximum of 190 acres, or 1.93 percent of all designated suitable and available tribal land. If all existing well pads within this resource were used to reduce the amount of surface disturbance, the impacts on suitable and available tribal land would be reduced 43.5 percent, resulting in a disturbance of 107 acres. There currently are four undeveloped development windows under Alternative 2 that have 100 percent overlap with a section of suitable and available tribal land. In all but these four development windows, the opportunity exists to avoid disturbance within suitable and available tribal land, if desired, by constructing the proposed well outside these designated lands, yet within the development windows.

Commercial areas occur on about 351 acres, or 0.1 percent of the Study Area and five wells may be located within commercial lands, resulting in a maximum construction disturbance of 15 acres or 4.3 percent of this resource area (Table 4-30). No existing wells are located on commercial lands.

Industrial areas occur on about 224 acres, or 0.1 percent of the Study Area and two wells may be located within industrial lands, resulting in a maximum construction disturbance of six acres or 2.7 percent of this resource area (Table 4-30). No existing wells are located on commercial lands.

Table 4-30
Anticipated Surface Disturbance . . .
11 x 8 ½
2 pages

Table 4-30
Page 2

4.6.5.3 Available and Suitable Land for Future Tribal Development

Land designated by the Tribal Planning Department as suitable and available for future tribal development is located primarily within the Pine River and Florida Mesa management units. This land comprises about 2.3 percent of the Study Area. Designated suitable and available tribal land is shown according to surface status on Map 17.

There is no tribal policy or regulation limiting development of gas wells or facilities on these lands. Sixty-two wells may be located within suitable and available tribal land, resulting in a maximum of 190 acres, or 1.93 percent of all designated suitable and available tribal land. If all existing well pads within this resource were used to reduce the amount of surface disturbance, the impacts on suitable and available tribal land would be reduced 43.5 percent, resulting in a disturbance of 107 acres. There currently are four undeveloped development windows under Alternative 2 that have 100 percent overlap with a section of suitable and available tribal land. In all but these four development windows, the opportunity exists to avoid disturbance within suitable and available tribal land, if desired, by constructing the proposed well outside these designated lands, yet within the development windows.

4.6.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

4.6.6.1 Surface Land Ownership

Lands under the surface jurisdiction of the SUIT, State of Colorado, La Plata County, Montezuma County, and Archuleta County are shown according to surface status on Map 17. Table 4-32 shows the acres of disturbance on tribal and private land that would occur from construction of this alternative.

Split Estate

The potential for impacts from the construction of Alternative 3 on split estate situations is shown in Table 4-33. Approximately 652 acres (2.3 percent) of land in split estate situations would be potentially affected by full development of Alternative 3.

Table 4-31
Impact Analysis Summary of Alternative 2 on SUIT-Designated Grazing Areas
11 x 8 ½
1 page

TABLE 4-32 Anticipated Surface Disturbance Within Surface Land Ownership from Alternative 3			
	Surface Jurisdiction		
	Tribal	**State**	**Private**
Resource Acreage Within Study Area	179,669	800	240,505
Resource Area as a Percent of Study Area	42.7%	0.2%	57.1%
Total Number of Wells Potentially Impacting the Resource	661	0	155
Construction - Maximum Acres Disturbed (Percentage of Resource)	2,023 (1.1%)	0	474 (0.2%)
Construction - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	1,275 (0.7%)	0	330 (0.1%)
Production - Maximum Acres Disturbed (Percentage of Resource)	1,362 (0.8%)	0	319 (0.1%)
Production - Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	977 (0.5%)	0	245 (0.1%)

TABLE 4-33 Anticipated Surface Disturbance Within Split Estate Situations from Alternative 3	
	Tribal/Allotted Subsurface with Private/State Surface
Resource Acreage Within Study Area	28,943
Resource Area as a Percent of Study Area	6.9%
Total Number of Wells Potentially Impacting the Resource	213
Construction-Maximum Acres Disturbed (Percentage of Resource)	652 (2.3%)
Construction-Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	538 (1.9%)
Production-Maximum Acres Disturbed (Percentage of Resource)	439 (1.5%)
Production-Acres Disturbed if All Available Existing Well Pads are Used (Percentage of Resource)	380 (1.3%)

4.6.6.2 Consistency with Regulations and Land Use Plans

Construction under this alternative is consistent with tribal land use plans. The addition of 70 injection wells under Alternative 3 potentially would result in greater conflicts with the Florida Mesa Land Use Plan's goals. However, the Florida Mesa Land Use Plan is an advisory document to La Plata County and has no jurisdiction over Indian Lands.

Land Use and Recreation

Potential impacts from surface disturbances on land use types within the Study Area for Alternative 3 were calculated and are provided in Table 4-34.

Agricultural

Agricultural land comprises 39,874 acres, or 9.5 percent of the Study Area. About 96 wells may be located within agricultural land, resulting in a maximum disturbance of 294 acres, or 0.7 percent of all the agricultural land. If all existing well pads, which are already present within this resource, were used to reduce the amount of surface disturbance, the impacts on agricultural land would result in a disturbance of 269 acres (0.7 percent). Prime farmlands constitute about 4.9 percent of the Study Area. An estimated 30 wells could be established in prime farmland areas, resulting in a maximum loss of about 92 acres from agricultural production during the construction phase, or 0.5 percent of prime farmlands within the Study Area. Impacts on prime farmland can be reduced by using available existing well pads, resulting in a loss of about 86 acres (0.4 percent) of prime farmland from agricultural production.

Grazing

County-designated rangelands occur on about 42,502 acres (10 percent of the Study Area). Fifty-three wells may be located within county-designated rangelands, resulting in a maximum disturbance of 162 acres, or 0.3 percent of all county-designated rangelands. If all existing well pads, which are already present within this resource, were used, the impacts on county-designated rangelands would be reduced and would result in a disturbance of 98 acres (0.2 percent) of the Study Area.

Construction activities from Alternative 3 would affect a maximum of 1,309 acres (1.3 percent) of the SUIT grazing resources, resulting in a loss of 117 AUMs (Table 4-35). AUM losses from construction vary from 2.1 AUMs on the Sambrito unit to 25.7 AUMs in the Picnic Flats unit, and 89.2 AUMs in the Mesa Mountains unit. The use of existing well pads would reduce the total affected area to 815 acres (0.8 percent), and reduce the AUM loss to 61.5 (Table 4-35). Revegetating parts of the well pad during production would reduce the area of disturbance to 882 acres and reduce the AUM loss to 78.9 if wells are placed on new pads. If existing well pads are used, the area of disturbance during production would be 628 acres and the AUM loss during production would be 50.2 AUMs.

Forest Resources

Alternative 3 would affect slightly more commercial woodland than Alternatives 1 and 2 at 1.2 percent of the resource (Table 4-34). This acreage could be reduced to 1.0 percent by using existing well pads (Table 4-34). Commercial timber occurs on about 16,904 acres of the Study Area, of which 3.2 percent could be affected by Alternative 3 construction activities. The affected acreage for both construction activities and production could be reduced somewhat (3.2 to 3.1 percent and 2.2 to 2.1 percent, respectively) if existing well pads were used.

Table 4-34
Anticipated Surface Disturbance Impacts on Land Use Types from Alternative 3
11 x 8 ½
2 pages

Table 4-34
Page 2

Residential and Recreation Areas

No well development is anticipated in designated recreation areas.

Approximately 33 wells may be located within residential properties, resulting in a maximum disturbance of 101 acres (1.6 percent). If all existing well pads were used, impacts on residential properties would be reduced, resulting in a disturbance of 99 acres (1.5 percent).

Commercial areas occur on about 351 acres, or 0.1 percent of the Study Area and five wells may be located within commercial lands, resulting in a maximum construction disturbance of 15 acres or 4.3 percent of this resource area (Table 4-26). No existing wells are located on commercial lands.

Industrial areas occur on about 224 acres, or 0.1 percent of the Study Area and two wells may be located within industrial lands, resulting in a maximum construction disturbance of six acres or 2.7 percent of this resource area (Table 4-26). No existing wells are located on commercial lands.

4.6.6.3 Available and Suitable Land for Future Tribal Development

Implementation of this alternative within suitable and available tribal land would be similar as described for Alternative 2. The addition of 70 injection wells under Alternative 3 would potentially result in greater conflicts with designated suitable and available tribal land. It is not within the scope of this EIS to project where these 70 injection wells might coincide with suitable and available tribal land. There is no policy or regulation prohibiting gas development on this land, and the tribe can assess individual situations as they arise.

4.6.7 Impacts Summary

Overall, each of the alternatives, including the no-action alternative, would directly impact agricultural and grazing lands, and individual well sites would be incompatible with existing residences and possibly with dispersed recreation areas. Impacts for Alternatives 2 and 3 would be very similar to each other, while Alternative 1 would have the least impacts.

Table 4-35
Impact Analysis Summary of Alternative 3 on SUIT-Designated Grazing Areas
11 x 8 ½
1 page

4.6.8 Mitigation Summary

The following environmental protection measures are proposed to minimize land use impacts associated with this project:

- Situate project facilities, including roads, away from or at the edges of irrigated and nonirrigated agricultural land to the maximum extent practical, to reduce direct and indirect effects on agricultural resources and operations. *(Based on Existing Policy or Regulation)*

- 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. *(Based on Existing Policy or Regulation)*

- If facilities (e.g., fences, gates, cattleguards) 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. *(Based on Existing Policy or Regulation)*

- Restrict project-related construction equipment and vehicle movement to specific, designated access roads to minimize disturbance to potentially sensitive areas. *(Based on Existing Policy or Regulation)*

- Continue to require responsibility for fence, gate, and cattle guard maintenance and for noxious weed control as conditions of approval and stipulations for APDs and right-of-way grants. *(Based on Existing Policy or Regulation)*

- Develop reclamation plans for all areas that have been disturbed during production, and specify techniques for reclamation of well pads, pipeline rights-of-way, and roads. *(Based on Existing Policy or Regulation)*

- 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. *(Mitigation Developed from SUIT EIS)*

- Site roads, pipelines, and well pads away from residences and out of view from residences as much as possible. *(Mitigation Developed from SUIT EIS)*

- Work with surface owner, when possible, to picks sites for roads, pipelines, and well pads. *(Based on Existing Policy or Regulation)*

- Continue to paint facilities so as to minimize visual impacts. *(Based on Existing Policy or Regulation)*

4.6.9 Unavoidable Adverse Impacts

Unavoidable adverse effects include long-term impacts on existing agricultural, grazing, and timber resource land resulting from the long-term removal of land from these uses for CBM and conventional well facilities, including access roads. Unavoidable short-term impacts would include dust, noise, traffic, and visual effects from facility construction and operations on existing residential and recreational areas. The industrial character of project facilities and activities would slightly change the rural quality of life currently afforded in rural residential areas, including impacts on residences which are located on non-Indian land within the exterior boundaries of the Reservation.

4.7 TRAFFIC AND TRANSPORTATION

4.7.1 Issues, Impact Types, and Criteria

The three types of considerations that must be addressed in analyzing the effects of the alternatives on transportation in the Study Area include (1) the impact that additional traffic volume is expected to have on area residents and settlements; (2) the impact each alternative is expected to have on existing roadway congestion; and (3) the impact each alternative is projected to have on the number of traffic accidents in the area. The following discussions present each of these three impact types and the associated impact criteria for each type regarding all alternatives.

4.7.1.1 Traffic Volume

Traffic volume is the base variable in each of the latter two impact types. The total amount of traffic on a roadway is used to determine both capacity constraints and traffic accident rates. Percentage changes in traffic volumes resulting from each alternative will be presented to identify impacts on area residents and settlement. A significant traffic volume impact would exist if the proposed alternative is projected to generate 25 percent or more additional daily vehicle trips than are projected in the future for the background traffic volume[44]. An impact is defined as an alternative that generates 10 percent or more daily vehicle trips than the expected background traffic volume. An alternative would be considered to have no perceivable impact if it generates less than 10 percent additional daily vehicle trips. State highways are used for evaluation due to the nature of the trip distribution system in the Study Area. The system works in such a way that all trips eventually will flow to or from the state highways. This level of

[44] Background traffic volume is the number of vehicles expected on the roadways in the future without development of any oil and gas in the Study Area.

network analysis allows for impact evaluation at the point where trips are at their highest concentration.

The distribution of trips on the state highway (SH) network assumes that all wells and compressors are evenly distributed throughout the Study Area. Distributing the associated trips evenly throughout the Study Area allows for easy definition of capture areas for each of the state highways. For the purposes of this analysis, capture areas are reported in terms of the proportion of total land area from which the highway draws. Through this analysis it was determined that SH 140 would capture about 32 percent of all trips, US Route 550 would capture about 34 percent of all trips, SH 172 would capture approximately 23 percent of all trips, and SH 151 would capture the remaining 11 percent of all trips.

4.7.1.2 Roadway Congestion

Roadway congestion is defined by the relationship between traffic volume and roadway capacity, which is reported as the number of vehicles per hour the roadway can accommodate. Traffic engineers and planners use the concept of level-of-service (LOS) to rate roadways on how well they accommodate the required traffic levels. The Transportation Research Board produces the Highway Capacity Manual, which provides guidelines for determining capacity and LOS. Capacity is determined from multiple factors such as the number of lanes on the roadway, the proportion of traffic moving in the primary direction, the existence and adequacy of shoulders. The relationship between capacity and volume is reported as LOS rankings from A to F. Roadways rated at LOS A are characterized as having minimal traffic volume to the point at which travelers will not interfere with the safe and efficient vehicle operation of other travelers. At this LOS, people are free to travel unimpeded with no delay created by congestion. At the other end of the scale, LOS F implies that travelers are experiencing significant delay and travel speeds are almost at a stop. LOS F is considered an unacceptable condition, LOS D is considered the least acceptable condition, and LOS B and C are considered to be good service levels in which travelers experience limited delay due to other traffic.

A significant impact would exist if the additional traffic created by an alternative is expected to degrade the LOS on a particular roadway segment to LOS E. LOS E is generally considered to be the level at which the roadway begins to fail at providing adequate capacity. An impact would result from an alternative that generates enough traffic to cause the LOS to degrade to LOS D. No impact would be identified if the increased traffic created by the alternative does not degrade the roadway beyond the baseline LOS or LOS C.
Table 4-36 presents 1996 traffic volume and associated LOS along with projected 2017 background volumes and associated LOS. The 2017 background volume is the traffic volume expected on the roadways created by natural growth in the Study Area regardless of any future oil and gas development in the area. The traffic volumes generated from each alternative are added to the background traffic to determine the total volume expected on the roadway with the

alternative in place. Colorado Department of Transportation (CDOT) expansion factors are used to project 2017 traffic volume.

As illustrated in Table 4-36, expected growth in background traffic (i.e., growth without further oil and gas development) is expected to degrade the LOS from B to C on segments of SH 140 and SH 151. On segments of SH 172 and US Route 550, the LOS is expected to degrade from D to E.

TABLE 4-36
2017 Background Traffic Volume and LOS

State Highway (segment)	1996 Daily Volume	1996 LOS[1]	CDOT Annual Growth Factor	2017 Daily Background Volume	2017 LOS[1]
SH 140					
South of CR 134 (Kline)	2,000	B	1.08	2,333	**C**
CR 134 (Kline) to CR 141 (Breen)	1,700	B	1.08	1,983	B
SH 151					
SH 172 to Shoshone Avenue (Ignacio)	2,700	C	1.085	3,179	C
Shoshone Avenue (Ignacio) to CR 80 (Arboles)	690-2,050	A-B	1.085	812-2,413	A-**C**
SH 172					
CO/NM State Line to SH 151	590-8,200	A-E	1.065	669-9,301	A-E
SH 151 to Browning Avenue (Ignacio)	6,550	D	1.065	7,429	**E**
North of SH 151 (Ignacio) to CR 220/221	5,050-6,100	D-D	1.065	5,728-6,919	D-D
US Route 550					
CO/NM State Line to CR 213	5,250	D	1.075	6,067	D
CR 213 to CR 220	4,750-6,250	D-D	1.075	5,489-7,223	D-**E**

Bold typeface in right column indicates a change in the LOS.
Source: Colorado Department of Transportation, 1996 Traffic Volume Report.
1. *Highway Capacity Manual, Third Edition*, Transportation Research Board, Washington D.C., 1994.
Table 8-10, Rolling Terrain, various K-factors.
Reported ranges in 1996 LOS identified in the table correspond to the ranges in 1996 traffic volume.

4.7.1.3 Accidents

Accidents are commonly rated in terms of severity of the personal injury that resulted from the accident. The three categories are property damage only (those in which no personal injuries resulted), injury accidents (those where one or more persons were injured and required medical attention), and fatal accidents (those in which one or more persons died as a result of the accident). The total number of accidents in each of these classifications are combined, with appropriate weighting on the more severe accidents, to produce a total accident rate for specific roadway segments across the state. Each year the state analyzes all accidents to determine an average statewide accident rate for various interstate, non-interstate Federal-aid, and non-interstate highways in urban and rural parts of the state. For 1994 and 1995, the statewide accident rate for non-interstate rural highways was 1.43 and 1.45 accidents per million vehicle miles traveled (MVMT), respectively. The state also has published accident rates for the state highway segments within the study corridor, all of which currently exceed the statewide average with the exception of SH 172.

Significant traffic accident impacts would result from alternatives that have the potential to increase the existing accident rate by more than 1.0 accidents per MVMT. Moderate traffic accident impacts would result from alternatives that increase the accident rate by 0.1 to 1.0 accidents per MVMT. Insignificant impacts would result from alternatives that have the potential to increase the existing accident rate by less than 0.1 accidents per MVMT.

4.7.2 <u>Impact Methods</u>

Due to the programmatic nature of the project, it is assumed that traffic impacts from well and compressor site development would occur evenly throughout the Study Area and be evenly distributed between the projected development years. It is further assumed that well development would occur at an even and constant pace over the 20 years of the project and that compressor development also would occur at an even and constant rate over the first 10 years of the project. (See Section 2.5)

4.7.2.1 Traffic Volume

Traffic volume for each of the alternatives was projected from the well and compressor trip generation methods presented in Section 3.7.5. Each alternative would require a defined number of well and compressor trips for both facility installation and facility maintenance. The average number of trips for each of these activities and facilities are known from previous oil and gas development experience. The increase in traffic volumes are used to identify impacts on area residents and settlement.

4.7.2.2 Roadway Congestion

Existing roadway capacities are assumed to remain throughout the 20-year planning horizon. Future traffic volumes generated from each alternative are added to the predicted background volumes to determine the incremental impact on congestion and LOS from the specific alternative.

Site-specific traffic operational improvement projects would likely occur within the Study Area. CDOT is nearing completion of the widening of US Route 550 north from the New Mexico border, although details regarding construction through the Study Area are not completed. CDOT is also planning to widen SH160 between Durango and Bayfield, which lies just north of the Study Area although, again, details have not been completed. La Plata County is studying ways to improve traffic flow in many parts of the county by expanding capacity.

4.7.2.3 Accidents

The majority of traffic accidents occur at locations where the physical roadway causes vehicles to interact in conflicting movements, such as a lane merge or intersection. An increase in the accident rate would be expected if the number of such locations is expected to increase or if the number of new vehicles entering existing intersections is significantly higher than (10 percent or more) background conditions. Stated in general terms, the more vehicles on the roadway, the greater the propensity for those vehicles to collide. None of the alternatives being evaluated propose to build any new public roadways or require any new intersections.

4.7.3 Impacts Common to All Alternatives

As specific drilling sites are identified, bridge weight limitations may require overweight drilling units to find alternate routes to remote sites. Given the programmatic nature of this project, it is not possible to determine how many trips would be affected, per alternative.

4.7.4 Alternative 1 – Continuation of Present Management (No Action)

4.7.4.1 Overview of Alternative

Alternative 1, the no-action alternative, includes the potential drilling of 350 wells, 269 conventional wells and 81 CBM wells. Some of the CBM wells could be infill wells. Infill wells would not have any unique impacts on traffic and transportation compared to CBM “parent” wells.

4.7.4.2 Traffic Volume

Alternative 1 is estimated to generate about 200,000 one-time well development trips over the 20-year development program. The alternative would generate an additional 42 daily vehicle trips (152,850 annual trips/365 days per year/10 well sites per vehicle) over the background level in the Study Area related to ongoing well maintenance upon full implementation of the program. Detailed information on the trip calculations is presented in Table N-1.

Table N-2 identifies compressor maintenance vehicle trips generated from the alternative. Alternative 1 would generate 16,300 total compressor installation trips over the planned 10-years of compressor development in the area, and an additional 22 daily vehicle service trips upon full development of the programmed compressors.

Table N-3 presents the distribution of the previously discussed trips annually throughout the 20-year development period. For purposes of this study, new compressors would be developed at a constant rate over the first 10 years of the project. Similarly, new wells would be placed into production at a constant rate over a 20-year period. Under this alternative, the peak number of daily vehicle trips would occur in the year 2017 with 315 more trips than expected with background traffic volumes.

This alternative results in no perceivable impacts on residents and settlements from increased traffic volumes on SH 140, 151, 172, and US Route 550. The projected additional vehicle trips would result in an average increase of 5 percent in daily traffic on SH 140, 2 percent average increase on SH 151, 1 percent average increase on SH 172, and a 2 percent average increase in daily traffic on US Route 550.

4.7.4.3 Roadway Congestion

Alternative 1 results in no impacts on roadway congestion for all identified highway segments because there is no change in LOS. Table 4-37 presents 2017 background daily traffic volume and associated LOS and the 2017 daily volume and associated LOS created by development of the alternative.

TABLE 4-37
Full Development LOS - Alternative 1

Highway (segment)	2017 Daily Background Volume	2017 LOS[1]	2017 Daily Volume with Alternative	2017 ALT LOS[1]
SH 140				
South of CR 134 (Kline)	2,333	C	2,433	C
CR 134 (Kline) to CR 141 (Breen)	1,983	B	2,083	B

TABLE 4-37
Full Development LOS - Alternative 1

Highway (segment)	2017 Daily Background Volume	2017 LOS[1]	2017 Daily Volume with Alternative	2017 ALT LOS[1]
SH 151				
SH 172 to Shoshone Avenue (Ignacio)	3,179	C	3,214	C
Shoshone Avenue (Ignacio) to CR 80 (Arboles)	812-2,413	A-C	847-2,448	A-C
SH 172				
CO/NM State Line to SH 151	669-9,301	A-E	743-9,375	A-E
SH 151 to Browning Avenue (Ignacio)	7,429	E	7,503	E
North of SH 151 (Ignacio) to CR 220/221	5,728-6,919	D-D	5,802-6,993	D-D
US Route 550				
CO/NM State Line to CR 213	6,067	D	6,173	D
CR 213 to CR 220	5,489-7,223	D-E	5,595-7,329	D-E

Bold typeface in right column would indicate a change in the LOS.

Source: Colorado Department of Transportation, 1996 Traffic Volume Report.

1. *Highway Capacity Manual, Third Edition*, Transportation Research Board, Washington D.C., 1994. Table 8-10, Rolling Terrain, various K-factors.

4.7.5 Alternative 2 - Coalbed Methane Infill Development

4.7.5.1 Overview of Alternative

Alternative 2 associated with drilling or recompleting 636 wells—269 conventional wells and 367 CBM wells on tribal minerals. This alternative considers widespread infill development of the Ignacio Blanco Fruitland Coal Field. The greater number of wells would result in a greater increase in traffic volume in the future compared to Alternative 1.

4.7.5.2 Traffic Volume

Alternative 2 is estimated to generate 468,000 well development trips over the 20-year program. Upon full development of all proposed wells, this alternative would generate an additional 98 daily vehicle trips (356,900annual trips/365 days per year/10 well sites per vehicle) over the baseline background traffic volume in the Study Area. Detailed information on the trip calculations is presented as Table N-4.

Table N-5 identifies compressor maintenance vehicle trips generated from the alternative. Alternative 2 would generate 25,600 total compressor installation trips over the planned 10 years of compressor development in the area, and an additional 27 daily vehicle service trips upon full development of the programmed compressors.

Table N-6 distributes the previously discussed trips annually throughout the 20-year development period. For purposes of this study, new compressors would be developed at a constant rate over the first 10 years of the project. Similarly, new wells would be placed into production at a constant rate over a 20-year period. Under this alternative, the peak number of daily vehicle trips would occur in 2017 with 410 more than under existing conditions.

This alternative results in no perceivable impacts on residents and settlements from increased traffic volumes on SH 140, 151, 172, and US Route 550. The projected additional vehicle trips would result in an average increase of 6 percent in daily traffic on SH 140, 2 percent average increase on SH 151, 2 percent average increase on SH 172, and a 2 percent average increase in daily traffic on US Route 550.

4.7.5.3 Roadway Congestion

Alternative 2 results in no impacts on roadway congestion for all identified highway segments because the additional traffic generated by the alternative does not result in any changes to the future LOS. Table 4-38 presents 2017 background daily traffic volume and associated LOS and the 2017 daily volume and associated LOS created by development of the alternative.

TABLE 4-38
Full Development LOS - Alternative 2

Highway (segment)	2017 Daily Background Volume	2017 LOS[1]	2017 Daily Volume with Alternative	2017 ALT LOS[1]
SH 140				
South of CR 134 (Kline)	2,333	C	2,463	C
CR 134 (Kline) to CR 141 (Breen)	1,983	B	2,113	B
SH 151				
SH 172 to Shoshone Avenue (Ignacio)	3,179	C	3,224	C
Shoshone Avenue (Ignacio) to CR 80 (Arboles)	812-2,413	A-C	858-2,459	A-C
SH 172				
CO/NM State Line to SH 151	669-9,301	A-E	766-9,397	A-E
SH 151 to Browning Avenue (Ignacio)	7,429	E	7,526	E
North of SH 151 (Ignacio) to CR 220/221	5,728-6,919	D-D	5,824-7,015	D-D
US Route 550				
CO/NM State Line to CR 213	6,067	D	6,205	D
CR 213 to CR 220	5,489-7,223	D-E	5,627-7,360	D-E

TABLE 4-38
Full Development LOS - Alternative 2

Highway (segment)	2017 Daily Background Volume	2017 LOS[1]	2017 Daily Volume with Alternative	2017 ALT LOS[1]

Bold typeface in right column would indicate a change in the LOS.
Source: Colorado Department of Transportation, 1996 Traffic Volume Report.
1. *Highway Capacity Manual, Third Edition*, Transportation Research Board, Washington D.C., 1994. Table 8-10, Rolling Terrain, various K-factors.

4.7.5.4 Accidents

The increase in daily traffic volumes in the Study Area as a result of this alternative would not generate enough potential conflicts to alter existing accident rates in the Study Area.

4.7.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

4.7.6.1 Overview of Alternative

Alternative 3, the Agency's and Tribe's Preferred Alternative, includes all the developments of Alternative 2 with the addition of ECBM recovery through injection of nitrogen, carbon dioxide, or other fluids into the Fruitland Formation. Regarding Alternative 3, potential impacts are associated with the drilling of 122 injection wells, 269 conventional wells, and 693 CBM wells on tribal minerals. The greater number of wells would result in a greater increase in traffic volume in the future compared to Alternatives 2 and 1. Construction and operation of injection wells would not result in any appreciable difference in traffic compared to impacts from construction and operation of CBM production wells.

4.7.6.2 Traffic Volume

Alternative 3 is estimated to generate 527,400 well development trips over the 20-year program. Upon full development of all proposed wells, this alternative would generate an additional 110 daily vehicle trips (402,200 annual trips/365 days per year/10 well sites per vehicle) over the background baseline traffic volume in the Study Area. Detailed information on the trip calculation is presented as Table N-7.

Table N-8 identifies compressor maintenance vehicle trips generated from the alternative. Alternative 3 would generate 37,800 total compressor installation trips over the planned 10 years of compressor development in the area and an additional 37 daily vehicle service trips upon full development of the programmed compressors.

Table N-9 distributes the previously discussed trips annually throughout the 20-year development period. For purposes of this study, new compressors would be developed at a constant rate over the first 10 years of the project. Similarly, new wells would be placed into production at a constant rate over a 20-year period. Under this alternative, the peak number of daily vehicle trips would occur in 2017 with 436 additional daily vehicle trips above the 2017 background traffic volumes.

This alternative results in no perceivable impacts on residents and settlements from increased traffic volumes on SH 140, 151, 172, and US Route 550. The projected additional vehicle trips would result in an average increase of 6 percent in daily traffic on SH 140, 2 percent average increase on SH 151, 2 percent average increase on SH 172, and a 2 percent average increase in daily traffic on US Route 550.

4.7.6.3 Roadway Congestion

Alternative 3 results in no impacts on roadway congestion for all identified highway segments because the additional traffic generated by the alternative does not result in any changes to the future LOS. Table 4-39 presents 2017 background daily traffic volume and associated LOS and the 2017 daily volume and associated LOS created by development of the alternative.

TABLE 4-39
Full Development LOS - Alternative 3

Highway (segment)	2017 Daily Background Volume	2017 LOS[1]	2017 Daily Volume with Alternative	2017 ALT LOS[1]
SH 140				
South of CR 134 (Kline)	2,333	C	2,463	C
CR 134 (Kline) to CR 141 (Breen)	1,983	B	2,113	B
SH 151				
SH 172 to Shoshone Avenue (Ignacio)	3,179	C	3,224	C
Shoshone Avenue (Ignacio) to CR 80 (Arboles)	812-2,413	A-C	858-2,459	A-C
SH 172				
CO/NM State Line to SH 151	669-9,301	A-E	766-9,397	A-E
SH 151 to Browning Avenue (Ignacio)	7,429	E	7,526	E
North of SH 151 (Ignacio) to CR 220/221	5,728-6,919	D-D	5,824-7,015	D-D
US Route 550				
CO/NM State Line to CR 213	6,067	D	6,205	D
CR 213 to CR 220	5,489-7,223	D-E	5,627-7,360	D-E

Bold typeface in right column would indicate a change in the LOS.
Source: Colorado Department of Transportation, 1996 Traffic Volume Report.
1. *Highway Capacity Manual, Third Edition*, Transportation Research Board, Washington D.C., 1994. Table 8-10, Rolling Terrain, various K-factors.

4.7.6.4 Accidents

The increase in daily traffic volumes in the Study Area as a result of this alternative would not generate enough potential conflicts to alter existing accident rates in the Study Area. Because there is not expected to be any change in the total accident rate between this alternative and the baseline data, this alternative would result in no impacts on accidents or traffic safety.

4.7.7 Impacts Summary

4.7.7.1 Traffic Volume

Projected increased traffic volumes resulting from full development (on tribal and nontribal land) of either of the three alternatives would not result in impacts on residents and settlements in the area. The gas and oil development activities in all three alternatives are not expected to create more than an additional 6 percent traffic above naturally occurring 2017 background traffic volumes.

4.7.7.2 Roadway Congestion

The projected traffic volumes generated from any of the three alternatives are not expected to create any perceivable or measurable increase in traffic congestion above the level of service predicted for the 2017 background traffic volumes.

4.7.7.3 Accidents

Traffic accident rates or the number of accidents are not expected to increase from any of the three alternatives considered. Projected increases in traffic volumes are not sufficient to create additional hazards or vehicle conflicts.

4.7.8 Mitigation Summary

No mitigation measures are required as no oil and gas development traffic-related impacts are expected in the Study Area should the future development be distributed throughout the Study Area as assumed for the analysis.

4.7.9 Unavoidable Adverse Impacts

There are no expected unavoidable adverse impacts for transportation systems in the Study Area as a result of increased oil and gas development in the Study Area.

4.8 CULTURAL RESOURCES

4.8.1 Issues, Impact Types, and Criteria

Once destroyed, the significant values of cultural resources are lost to future generations. Significant impacts on cultural resources are defined as unavoidable adverse effects that cannot be satisfactorily mitigated. In response to project scoping and regulatory requirements, the assessment of impacts on cultural resources focuses on archaeological and historical sites, and traditional cultural places and resources. This section summarizes the regulatory framework that defines criteria used to determine impacts on cultural resources that would be considered significant. Appendix K presents a more detailed discussion of the criteria used to define significant impacts and the methods used to assess impacts.

Regulations implementing NEPA stipulate that defining "significant" impacts requires consideration of "context" (such as national, regional, or local), and "intensity" (40 CFR Part 1508.27). The Study Area encompassing about the western two-thirds of the Reservation is the context for evaluation of impacts.

NEPA regulations identify one factor to be considered in evaluating intensity of impacts as "the degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources" (40 CFR Part 1508.27[8]). The principal laws that provide guidance for identifying significant impacts on properties eligible for the National Register and other types of cultural resources include the following:

- National Historic Preservation Act
- Archaeological Resources Protection Act
- American Indian Religious Freedom Act
- Native American Graves Protection and Repatriation Act

The following discusses the intensity of potential impacts with respect to guidance provided by each of these laws.

4.8.1.1 National Historic Preservation Act

Regulations for Protection of Historic Properties (36 CFR Part 800), which primarily implement Section 106 of the National Historic Preservation Act, stipulate that federal agencies consult with State Historic Preservation Officers, the Federal Advisory Council on Historic Preservation, and other interested parties to make one of three possible determinations of effect:

- no historic properties effect
- no adverse effect
- adverse effect

The available inventory data indicate that no cultural resources within the Study Area have actually been listed on the National Register, but many are undoubtedly eligible. The vast majority of cultural resources previously recorded within the Study Area are archaeological sites. Although few of these sites have been formally evaluated, many have potential to yield important information and therefore are National Register-eligible. (Refer to the discussion of regulatory requirements in Appendix K.) The regulations for Protection of Historic Properties acknowledge that such informational values often can be substantially preserved through appropriate research conducted in accordance with applicable professional standards and guidelines. However, the alteration of archaeological sites through excavation and removal of archaeological resources from their contexts is considered to be an adverse effect (Federal Register, Vol. 64, No. 95, Page 27064).

Although the compiled inventory data indicate that potentially National Register-eligible properties are relatively dense within the Study Area, many specific oil and gas development projects would have small impact zones that could be adjusted and modified. Therefore, potential to avoid direct impacts on cultural or historic properties is high, and determinations of no properties or no effect are likely to be the case for many projects. While it may be impossible to completely avoid all cultural or historic properties regardless of which alternative is selected, per CFR 800.6(b)(iv), the execution of an MOU between the Agency Official and SHPO to implement mitigative data recovery studies could resolve any potential adverse effects.

4.8.1.2 Archaeological Resources Protection Act

The Archaeological Resources Protection Act prohibits unauthorized excavation, collection, or damage of archaeological resources on federal and tribal land, as well as trafficking in such resources. Resources protected by this act would be routinely considered as part of Section 106 consultations.

4.8.1.3 American Indian Religious Freedom Act

The American Indian Religious Freedom Act reiterates First Amendment guarantees of religious freedom with specific reference to the inherent right of indigenous peoples to believe, express, and exercise their traditional religions, including, but not limited to, access to religious sites, use and possession of sacred objects, and freedom to worship through ceremonial and traditional rites. The types of resources protected by the American Indian Religious Freedom Act usually are considered in conjunction with Section 106 consultations.

4.8.1.4 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act gives Native Americans ownership or control of human remains, funerary objects, sacred objects, and objects of cultural patrimony found on federal and tribal land.

Human remains and objects protected by this Act are likely to be present at some archaeological sites within the Study Area. Therefore these remains and objects would be considered under Section 106 consultations, and impacts on such remains and objects would be characterized as adverse effects. Prior development on SUIT has resulted in disturbance of only two or three human burials (Harrell, 1996, pers. comm.).

4.8.1.5 Project Specific Assessments

Because detailed inventory data would be compiled only for specific projects pursued after completion of this EIS, the impact assessment conducted at this programmatic phase of analysis is by necessity a projection of the probable outcomes of subsequent formal Section 106 consultations. These consultations, inventories, and evaluations can be conducted only after the impact zones of specific projects are identified. Previous Section 106 consultations for oil and gas developments on SUIT typically have resulted in determinations of no historic properties or no effect. It is quite likely that consultations for the majority of specific oil and gas projects that are approved for future development would result in similar such determinations of no historic properties affected. Determinations of adverse effect are expected to be rare, and measures to avoid or satisfactorily mitigate such effects are likely to be developed through Section 106 consultations.

Damaged or destroyed cultural resources sometimes may be partially restorable or reconstructible, but they are essentially non-renewable. Guidance provided by laws and regulations protecting cultural resources indicate that the permanent loss of significant cultural resources is considered “adverse,” but this does not necessarily correlate to a “significant” impact within the context of NEPA. The laws protecting cultural resources create opportunities to consult with interested parties and usually ways to avoid or mitigate impacts are identified through these consultations. Therefore, a determination of “adverse effect” for impacts on a single cultural resource site, in most cases, would not warrant preparation of an EIS for a specific project if it has no potential for significant impacts on other types of resources.

4.8.2 Impact Assessment Methods

The potential extent of direct impacts on cultural resources is based on modeled sensitivity zones. As described in Chapter 3 (Section 3.8.3) and Appendix K, two sensitivity models were developed. One addressed prehistoric and ethnohistoric archaeological sites reflecting aboriginal occupation of the region prior to and during initial contact with Europeans. Low, moderate, and high sensitivity zones that reflect variation in the density and types of archaeological sites in different parts of the project area were defined. The second model reflects post-contact historic area resources, and very low, low, moderate, and high sensitivity zones were defined. The GIS database developed for this EIS was used to project the number of acres of disturbance within each of the sensitivity zones identified by these two models, and derive an approximation of the number of resources that might be affected within each zone. The results provide another parameter for comparing the alternatives.

Analyses of erosion potential and subsidence potential provide the basis for a more qualitative consideration of potential indirect impacts on archaeological and historical sites.

Because the species of plants used traditionally and the extent of such uses are not well documented, no quantitative impact analysis was possible. Similarly, no traditional cultural places other than historic sites were identified, and so no impacts on them were assessed.

The impact models in combination with the sensitivity models indicate that the numbers of sites that could be affected is relatively limited compared to the regional resource base.

4.8.3 Impacts Common to All Alternatives

4.8.3.1 Archaeological and Historical Sites

Thousands of archaeological and historical sites are present within the Study Area, but, as explained in Section 3.8, only a small sample of these sites has been recorded and the significance of even fewer sites has been formally evaluated. Existing regulatory review procedures, discussed in more detail in Appendix K, are routinely followed to identify and address impacts for specific projects proposed for development on the Reservation. These procedures ensure that cultural resources are carefully considered before any project is authorized for development. The analysis for this programmatic EIS only generally addresses the types and extent of impacts that may be expected on archaeological and historical sites, and would be supplemented by subsequent review of specific projects.

The majority of direct and indirect impacts are projected to occur in association with construction activities. Analysis indicates that direct ground disturbance activities associated with construction of drill pads, pipelines, central delivery points, access roads, and other facilities have the greatest potential for adverse impacts on archaeological and historical sites. A closely related factor is the simple increase of human presence associated with construction and operation. Members of work crews could inadvertently damage or intentionally vandalize archaeological and historical sites. The assessment of these direct impacts was based on description of the proposed alternatives, estimated extent of ground disturbance of each alternative within projected cultural resource sensitivity zones, and consideration of standard procedures for development and production.

Identified potential indirect impacts include (1) soil erosion due to construction of new facilities, and (2) ground subsidence. Evaluation of the potential extent of these various types of secondary impacts was based on analyses of erosion and subsidence potential.

Archaeological and historical sites within the Study Area are very susceptible to most direct and indirect types of impacts. The resources are of relatively moderate to high quality, and most impacts would be of permanent duration. Archaeological and historical sites are relatively abundant within the Study Area; some parts of the Study Area are documented to have densities in excess of 40 sites per square mile. However, because the areas of potential effects are relatively small, the number of resources that could be disturbed or destroyed by oil and gas developments are expected to be a small percentage of the extant resources in the Study Area. Given the potential for avoiding or satisfactorily mitigating adverse impacts that might be identified during review of subsequent specific projects, the intensity of impacts on archaeological and historical sites, considered within the regional context of the Study Area, is not expected to be significant.

4.8.3.2 Traditional Cultural Resources

Traditional cultural concerns about proposed oil and gas development focus primarily on protection of archaeological sites, disturbance of traditionally used plants, and, more generally, preservation of aspects of traditional Ute culture and the environmental resources of the Reservation.

The direct ground disturbance resulting from construction activities is the source of greatest potential damage to traditional cultural resources that may be present in archaeological sites and to traditionally used plants. Although the vegetation within construction zones is likely to be temporally eradicated, areas not occupied by project facilities would be reseeded, with a focus on restoring grazing potential. The species of plants that continue to be used in traditional ways, and the extent and nature of those uses, is not well documented (see Sections 3.3.2.3 and 4.3), but traditionally used plants constitute only a portion of the natural vegetation that would be disturbed by construction activities. Two of the species identified as being used traditionally are endangered (Knowlton's cactus) or threatened (Ute lady's tresses) and probably are not present within the project area, but would be protected in compliance with the Endangered Species Act. Other species are found in riparian area (cattail, cottonwood, willow) and impacts in these area would be minimized in accordance with tribal policy to protect such areas. Other species (bear root, banana yucca, juniper) are relatively common upland species.

More indirect impacts could result from increased erosion that could alter natural vegetation and introduce non-native species, which could lead to losses of native species. Again, traditionally used plants would be only a subset of this disturbed vegetation, and these impacts are expected to be relatively low based on the projected limited extent of impacts on vegetation in the Study Area and in consideration of the tribal policy of avoiding impacts on riparian areas.

The loss of plants within project facilities would be long term, but potentially could be recovered after the life of the project. Loss of plants in temporary construction areas would be short term. There is substantial potential to mitigate impacts that might be identified during evaluation of subsequent specific projects by modifying projects to avoid any particular sensitive species or propagating those species in other settings, although such artificial manipulation may be deemed culturally unacceptable (Northern Arizona University and SWCA 1996). The SUIT has a policy of avoiding impacts on the riparian environment, which is where many culturally important species grow. In sum, the intensity of impacts on traditionally used plants is not expected to be significant.

4.8.4 Alternative 1 - Continuation of Present Management (No Action)

The No Action Alternative would continue present management and is expected to the result in a maximum of about 1,298 acres of ground disturbance over the 20-year life of the project. The estimate is based on the projection that the currently authorized maximum number of wells would be drilled. The impact model projects that as many as 612 acres (about 47 percent) of this ground disturbance could occur in high sensitivity zones for prehistoric and ethnohistoric sites, with the remaining 493 acres in moderate and 193 acres in low sensitivity zones. In contrast, only about 30 acres (2 percent) of ground disturbance would occur in areas rated as having high sensitivity for historical resources. The impact model indicates about 59 prehistoric, ethnohistoric, or historic sites could be expected within the aggregate of 3.03 square miles within the disturbance zones.

This estimate is only an approximation, but even it is doubles or tripled, the area disturbed is less than 0.8 percent of the high sensitivity zones for archaeological and ethnohistorical sites and about 0.2 percent of high sensitivity zones for historic resources. Therefore, the number of resources potentially affected is likely to be a comparably minor percentage of the regional resource base. Also, because specific projects would be relatively flexible, modifications probably could be made in many cases to avoid direct impacts on any archaeological and historical sites that might be identified by pre-construction surveys.

Routine measures used to minimize erosion, confine activities within project boundaries, and educate work crews about regulations protecting cultural resources and the penalties for vandalism are expected to minimize indirect impacts. Review of specific projects would provide an opportunity to address particular situations where indirect impacts could be a concern.

4.8.5 Alternative 2 - Coalbed Methane Infill Development

The increase in the number of new wells projected for Alternative 2 is estimated to result in a maximum of about 3,822 acres of ground disturbance. This is nearly three times more disturbed acreage than projected for Alternative 1. The impact model indicates that as many as 1,484 acres (nearly 39 percent) of this disturbance could occur in zones rated as having high sensitivity for prehistoric and ethnohistoric sites, with 1,775 acres in moderate and 563 acres in low sensitivity zones. In contrast, a maximum of about 73 acres (only about 2 percent) of the disturbance is likely within zones rated as having high sensitivity for historic resources. Given this distribution of ground disturbance, the model suggests about 166 prehistoric, ethnohistoric, or historic sites might be present within the aggregate of about 6.97 square miles that potentially could be disturbed. Again this estimate is approximate, but even if doubled or tripled, the area disturbed represents less than 2 percent of the high sensitivity zones for archaeological and ethnohistoric sites and less than 0.5 percent of the high sensitivity zones for historic resources. The number of resources affected is likely to be a comparably small percentage of the regional resource base. As with Alternative 1, there is good potential for modifying specific projects to avoid direct impacts on any archaeological and historical sites that may be identified by pre-construction surveys.

4.8.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

The extent of ground disturbance associated with Alternative 3, which involves infilling plus pressurization to enhance recovery, is only about 7 to 8 percent greater than in Alternative 2. Pressurization is projected to require 70 injection wells, which would result in an estimated additional 297 acres of ground disturbance. An additional 116 acres (about 39 percent) of this additional ground disturbance is likely to be in high sensitivity areas, with 150 acres in moderate and 31 acres in low sensitivity areas. The additional disturbance is estimated to potentially affect 13 more archaeological or historical sites than Alternative 2.

Gases vented from the compressors needed to develop injection pressures have the potential to alter air emissions and degrade air quality over special status publicly interpreted cultural resources within the region, such as Mesa Verde or Chimney Rock. However, the analysis of air quality impacts in Section 4.2 indicates that impacts of any alternative would not be significant.

4.8.7 Impacts on Traditional Cultural Resources

There is no documentation of prior oil and gas development on the Reservation having disturbed human burials, funerary objects, sacred objects, or objects of cultural patrimony within archaeological sites. The impact analysis indicates there is a high potential for continued avoidance of direct impacts on archaeological sites.

There are no shamans among the Southern Utes who continue to practice traditional ceremonies. Therefore, no plants are used specifically for ceremonial purposes. Continuing traditional uses of native plants are primarily for herbal medicines or condiments, but the species of plants used and the extent of these traditional uses have never been documented. Consultation with tribal members during development and revision of the tribal natural resource management plan has never identified traditional plant uses as a major concern among tribal members. No direct conflicts with preservation of traditionally used native species and oil and gas development have been documented. Standard development procedures seek to minimize the extent of ground disturbance and, concomitantly, of impact on any traditionally used plants.

The potential for disturbance of native vegetation is expected to be proportional to the extent of ground disturbance associated with each alternative. Although the number of acres disturbed by Alternative 2 and Alternative 3 are about three times greater than Alternative 1 and therefore impacts on plants used in traditional cultural ways could be greater. However, culturally important species are not well documented and not mapped. Many of the species appear to be found in wooded riparian areas, and the impact model indicates that Alternative 2 and Alternative 3 could disturb 3 to 4 times more acreage in this zone than Alternative 1. However, it is tribal policy to minimize impacts in riparian areas, and individual projects would be designed to do that. Other culturally important species are common upland species. Because concern about impacts on traditionally used plants is a relatively minor issue, and not closely linked to the proposed alternatives, the degree of variation among the alternative is not considered a crucial factor in selecting among them.

Concerns for preserving Southern Ute cultural heritage does not imply that the Southern Utes desire a life way “frozen in time.” In fact, no culture remains static over time. The goal of traditional Southern Utes is to preserve the best of their culture and blend it with the new as their society continues to evolve. No direct linkage has been identified between the proposed oil and gas development and the desire to maintain the Southern Ute language and other aspects of the Southern Ute heritage. The economic benefits of the proposed development, in fact, have the potential to promote self determination, and, if the Tribe so chooses, funds could be directed to more proactively plan and promote preservation of Southern Ute heritage. In sum, heritage preservation issues do not appear to be significantly related to differences among the alternatives.

4.8.8 Impacts Summary

The projected impacts on the various sensitivity zones modeled for prehistoric and ethnohistoric sites as well as historic resources are summarized in Tables 4-40 and 4-41. In general, Alternative 1 is expected to disturb only about 50 percent of the acreage that would be disturbed by Alternatives 2 and 3, and therefore has less potential for direct impacts on archaeological and historical sites.

TABLE 4-40
Summary of Projected Levels of Construction Disturbance Within High Sensitivity Prehistoric And Ethnohistoric Resource Zones

Alternative 1 - Continuation of Present Management (No Action)	
	Maximum Acres Disturbed
Conventional Wells	468
Fruitland Wells	144
All Wells	612
Acres of High Sensitivity Zones within Analysis Area	234,583
Percentage of High Sensitivity Zones Disturbed	0.26%
612 acres = 47 percent of 1,298 acres of projected total disturbance, including moderate (493 acres) and low (193 acres) sensitivity zones Assumptions: 40 sites per square mile in high sensitivity zones = 38 sites potentially affected 20 sites per square mile in moderate and low zones = 21 sites potentially affected 59 sites potentially affected	
Alternative 2 - Coalbed Methane Infill Development	
	Maximum Acres Disturbed
Conventional Wells	468
Fruitland Wells	1,016
All Wells	1,484
Acres of High Sensitivity Zones within Analysis Area	234,583
Percentage of High Sensitivity Zones Disturbed	0.63%
1,484 acres = 39 percent of 3,822 acres of projected total disturbance, including moderate (1,775 acres) and low (563 acres) sensitivity zones Assumptions: 40 sites per square mile in high sensitivity zones = 93 sites potentially affected 20 sites per square mile in moderate and low zones = 73 sites potentially affected 166 sites potentially affected	
Alternative 3 - Enhanced Coalbed Methane Recovery (Agency and Tribal Preferred Alternative)	
	Maximum Acres Disturbed
Conventional Wells	468
Fruitland Wells	1,016
Injection Wells	116
All Wells	1,600
Acres of High Sensitivity Zones within Analysis Area	234,583

TABLE 4-40
Summary of Projected Levels of Construction Disturbance Within High Sensitivity Prehistoric And Ethnohistoric Resource Zones

Percentage of High Sensitivity Zones Disturbed	0.68%

1,600 acres = 39 percent of 4,119 acres of projected total disturbance, including moderate (1,925 acres) and low (594 acres) sensitivity zones

Assumptions:	40 sites per square mile in high sensitivity zones =	100 sites potentially affected
	20 sites per square mile in moderate and low zones =	79 sites potentially affected
		179 sites potentially affected

TABLE 4-41
Summary of Projected Levels of Construction Disturbance Within High Sensitivity Historic Resource Zones

Alternative 1 - Continuation of Present Management (No Action)	
	Maximum Acres Disturbed
Conventional Wells	15
Fruitland Wells	15
All Wells	30
Acres of High Sensitivity Zones within Analysis Area	45,074
Percentage of High Sensitivity Zones Disturbed	0.07%
Alternative 2 - Coalbed Methane Infill Development	
	Maximum Acres Disturbed
Conventional Wells	15
Fruitland Wells	58
All Wells	73
Acres of High Sensitivity Zones within Analysis Area	45,074
Percentage of High Sensitivity Zones Disturbed	0.16%
Alternative 3 - Enhanced Coalbed Methane Recovery (Agency and Tribal Preferred Alternative)	
	Maximum Acres Disturbed
Conventional Wells	15
Fruitland Wells	58
Injection Wells	3
All Wells	76
Acres of High Sensitivity Zones within Analysis Area	45,074
Percentage of High Sensitivity Zones Disturbed	0.17%

The additional ground disturbance associated with Alternatives 2 and 3 is projected to have the potential to disturb about 80 or more archaeological and historical sites (although this estimate is highly conservative). Potential indirect impacts, related to erosion, increased human presence, and activities beyond specific project boundaries could add increments to the level of direct impacts for all alternatives. However, standard tribal environmental protection measures would address these issues during review of all proposed site-specific projects and therefore significant indirect impacts are not expected.

With appropriate application of pre-construction surveys and tribal and BIA review procedures, there is good potential for avoiding many direct impacts on sites that might be identified within disturbance zones of site-specific projects, regardless of which alternative is selected. There also is good potential to recover and preserve scientific information from the archaeological sites that might not be avoidable. Although the potential for impacts on archaeological and historical sites associated with Alternatives 2 and 3 is considerably greater than for Alternative 1, the magnitude of residual impacts, considering the potential to avoid or mitigate impacts, is not a crucial factor in choosing among the alternatives. However, it must be recognized that measures to modify projects to avoid impacts or mitigate impacts through archaeological and historical studies prior to construction, in compliance with the National Historic Preservation Act, would require time, effort, and funding.

Specific concerns about protecting human remains, funerary objects, sacred objects, or objects of cultural patrimony focus on a subset of the archaeological sites that might contain such remains and items. The potential for avoiding most significant archaeological sites is high, so the potential for avoiding direct impacts on human remains and other items of special concern also is high.

Although traditionally used plants and preservation of Southern Ute heritage were identified as concerns, the impacts of the proposed oil and gas development does not appear to be sufficiently linked, directly or indirectly, to these resources to be an important factor in evaluating the alternatives.

4.8.9 Mitigation Summary

- All subsequent specific oil and gas developments 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. Details of these requirements are presented in Appendix K. *(Based on Existing Policy or Regulation)*

- 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. *(Based on Existing Policy or Regulation)*

- 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. This measure would be included in all future stipulations and conditions of approval for oil and gas development projects. *(Mitigation Developed from SUIT EIS)*

- 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. *(Based on Existing Policy or Regulation)*

- Environmental assessments of any subsequent authorized individual projects would consider impacts on archaeological sites and also provide additional opportunities for the Tribe to assess and address protection of traditionally used native species and preservation of Southern Ute heritage**.** *(Based on Existing Policy or Regulation)*

4.8.10 Unavoidable Adverse Impacts

The potential to avoid or satisfactorily mitigate impacts on archaeological and historical sites is high. The greatest potential for impacts that would be considered adverse would stem from situations where it might be impossible to avoid archaeological sites that might contain human burials and associated funerary objects, sacred objects, or objects of cultural patrimony.

4.9 VISUAL RESOURCES

4.9.1 Issues, Impact Types, and Criteria

4.9.1.1 Issues

The purpose of this section is to provide a description of the potential effects of the project on visual resources within the Study Area. The primary visual resource issues are the scenic quality of the landscape as well as foreground and middleground views from individual residences, communities, recreational areas, and key travel routes. Potential impacts from project activities relate to project visibility and the introduction of elements of different form, line, color, and texture into the landscape.

4.9.1.2 Impact Types and Criteria

Visual contrast is a measure of the degree of perceptible change to the form, line, color, and texture of the landscape as a result of project construction and operation. The assessment focused on the visual contrast between the setting and project within visually sensitive areas. The contrast levels follows:

- Strong contrast—occurs where project activities would attract attention and dominate the landscape setting
- Moderate contrast—occurs where project activities are noticeable and start to dominate the setting
- Weak contrast—occurs where project activities would be noticeable but would not attract attention, and would be subordinate to the setting

Project/setting contrast anticipated to result from the proposed project facilities is primarily related to the following contrast factors:

- Structure Contrast—through the addition of structures into a landscape.
- Vegetation Contrast—through the removal/clearing of vegetation to accommodate project facilities

Standard techniques and processes were employed in the visual analysis of the proposed project. Through visual resource inventory and analysis, it has been determined that the greatest potential for visual impacts is related to the addition of structural elements in the landscape and the removal of vegetation to accommodate these structural elements. In addition to these factors, the distance from which structures would be viewed contributes to the perception of the project in the landscape and, therefore, the "impact" to visual resources. Structure contrast ranges from strong to weak based on proximity to sensitive vantage points. Vegetation contrast varies based on the type or density of vegetation that is cleared. The denser the vegetation cleared to accommodate facilities such as a well pad or pipeline corridor, the greater the contrast. The model provided in Table 4-42 illustrates the various impact levels (high, moderate, and low) that are anticipated based on proximity to project facilities, structure contrast, and vegetation contrast.

Major components of the analysis include the addition of structural elements into the landscape and vegetation modifications. Vegetation contrast results from clearing trees, shrubs, and grasses, and is primarily related to the density and type of vegetation cleared. Structure contrast results from the introduction of alternative facilities and is primarily related to the distance from which the well components are viewed. The typical structures associated with CBM and conventional wells are most dominant in the immediate foreground (0 to 300 feet) and are less dominant in foreground views (300 feet to 0.25 mile). Well-related facilities become subordinate to the landscape in middleground views (0.25 to 1 mile) and noticeable to the casual observer in background views (1 to 5 miles). Photographs of typical well components associated with CBM and conventional well development are provided in Chapter 3, Section 3.9.

For purposes of this visual assessment, impacts have been modeled based on placement of facilities in proximity to sensitive viewpoints and the extent to which these facilities result in vegetation and structure contrast. Changes associated with the construction of new well pads would include contrast to existing vegetation and the introduction of new structures associated with the project. Changes associated with construction of new facilities on existing well pads would involve the introduction of structures, which are similar to those already existing in the area. Negligible vegetation contrast is predicted to result from the placement of well facilities on existing well pads since only 1 acre of land would be affected, resulting in an incremental change in an already disturbed area.

4.9.2 Impact Assessment Methods

The model used for assessing visual impacts (Table 4-42) identifies all possible occurrences where the placement of new well facilities could result in a high, moderate, or low visual impact. Due to the assessment process of identifying all areas of visual impacts, the potential for high, moderate and low impact occurrences often exceeds the projected number of wells.

TABLE 4-42
Visual Impact Model

Vegetation Contrast	Distance Zones/Structure Contrast				
	Very Strong Structure Contrast	Strong Structure Contrast	Moderate Structure Contrast	Weak Structure Contrast	Very Weak Structure Contrast
Strong	H	H	M	L	L
Moderate	H	H	M	L	L

Weak	H	M	L	L	L
Negligible* (construction on existing well pad)	M	L	L	L	L

* Vegetation contrast resulting from construction of new well facilities on existing well pads are considered to be negligible, due to the incremental change in already disturbed areas. Overall structure contrast is also less noticeable in areas where proposed facilities are placed within existing facilities.

Visual Impact Legend
H = High
M = Moderate
L = Low

Impact levels defined for visual resources are driven by resource sensitivity and estimated contrast levels. A high impact results when the proposed project action is expected to result in a substantial or significant change to the resource and warrants mitigation. A moderate impact would result when the proposed project action is expected to cause some adverse change that may be substantial and selective mitigation may be warranted. A low impact results when the proposed project action would result in slight and insignificant adverse changes to the resource.

Impacts would be considered significant if visual contrast resulting from construction disturbances and the presence of oil and gas facilities would substantially alter the scenic values of the landscape and would dominate views from sensitive viewpoints. This may be the case in areas where the oil and gas facilities would be in the immediate foreground views from sensitive viewpoints or where the facilities would be seen in the foreground to middleground distance zones within previously undisturbed landscapes.

4.9.3 Impacts Common to All Alternatives

With implementation of any of the alternatives, impacts on visual resources as a direct or indirect result of the project could include short- and long-term adverse effects on the character of sensitive settings and on residential, recreation, and roadway views. Components of the project with the highest potential to adversely affect visual resources include the well pad and pipeline right-of-way clearing, as well as large solid components associated with well development such as water disposal well facilities, on-site water storage tanks, and compressor stations.

4.9.3.1 Impacts Associated with Construction of New Well Pads

High visual impacts would result in residential and recreation areas, and on key travel routes where new well pads are cleared within immediate foreground or foreground distance zones. Viewed within the immediate foreground, a well pad and facilities would be visually dominant and would significantly alter residential, recreational, and key travel route settings. Moderate impacts would potentially result from the clearing of new well pads within foreground views, where the overall contrast to vegetation was weak (i.e., clearing of grassland or areas of low density vegetation). Moderate impacts also would result from clearing of well pads within middleground views, with strong or moderate vegetation contrast.

4.9.3.2 Impacts Associated with Construction on Existing Well Pads

Moderate visual impacts resulting from construction on an existing well pad would occur when the facility is within immediate foreground distance zones from sensitive viewers. The addition of new well facilities on an existing well pad results in an incremental change in an already disturbed area. Low impacts would result where the wells are placed on existing well pads within foreground, middleground, and background views.

4.9.3.3 Production Phase

The occurrence of adverse impacts identified under construction for the potential well sites and other above ground facilities would continue to occur during production.

4.9.3.4 Abandonment Phase

Long-term positive effects to visual resources would result from abandonment and reclamation, including re-contouring and revegetation of well pads. However, visual disturbances from construction of the well pads, roads, facilities, and pipelines in form, line, color, and texture would remain for an undetermined period of time.

4.9.4 Alternative 1 - Continuation of Present Management (No Action)

Assessment of impacts on visual resources within the Study Area is based on the relationship between the sensitivity of each area to the disturbance caused by the project. Land considered to be most sensitive to project activities is within immediate foreground and foreground views from residences, recreation areas, and key travel routes.

Immediate foreground views from residences occur in about 3 percent (11,129 acres) of the entire Study Area (Table 4-43). Within these immediate foreground views, about 16 wells may be constructed, resulting in high visual impacts for 0.4 percent (49 acres) of the immediate foreground views from residences within the Study Area (Table 4-44). If all existing well pads which are already present within this resource were used, these impacts would be reduced to 15 occurrences (Table 4-44). Foreground views from residences occur in 12 percent (51,544 acres) of the entire Study Area (Table 4-43). High visual impacts within residential viewsheds would also occur where 14 wells may be located within foreground views and would result in strong to moderate vegetation contrast, resulting in a maximum disturbance of 0.1 percent (43 acres) of foreground views within the Study Area. These occurrences of high impacts could be reduced to 13 sites if existing well pads were used in the placement of new facilities.

Immediate foreground views from recreation areas occur in 0.2 percent (less than 1000 acres) of the entire Study Area (Table 4-43). No wells are anticipated to be developed in the immediate foreground views of recreation areas. Foreground views from recreation areas occur in 0.4 percent (1,701 acres) of the entire Study Area (Table 4-43). No wells are anticipated to be developed in the foreground views of recreation areas.

Immediate foreground views from key travel routes occur in 2 percent (7,754 acres) of the entire Study Area (Table 4-43). Within these immediate foreground views, about 15 wells may be constructed, resulting in a maximum disturbance of 0.6 percent (46 acres) of these views within the Study Area. If all existing well pads present within this resource were used to reduce the visual contrast of new well pad clearing, high impacts within immediate foreground views from key travel routes would be reduced to 14 occurrences. High visual impacts within key travel route viewsheds also would occur where 11 wells may be located within foreground views and would result in strong to moderate vegetation contrast. These occurrences of high impacts could be reduced to 9 sites if existing well pads were used in the placement of new facilities.

TABLE 4-43
Distance Zones as Percent of Study Area

	Immediate Foreground Views (0 to 300 feet)	Foreground Views (300 feet to 0.25 mile)	Middleground Views (0.25 to 1 mile)	Background Views (1 to 5 miles)	Seldom Seen Areas (beyond 5 miles)
Residences	2.6%	12%	23%	27%	35%
Recreation	0.2%	0.4%	0.9%	4.1%	94.4%
Key Travel Routes	2.0%	4.0%	12.0%	25.0%	56.0%

TABLE 4-44
Potential Visual Impact Occurrences under Alternative 1
Based on Use of Existing Wells

Vegetation Contrast	Immediate Foreground Views (0 to 300 feet) Very Strong Structure Contrast	Foreground Views (300 feet to 0.25 mile) Strong Structure Contrast	Middleground Views (0.25 to 1 mile) Moderate Structure Contrast	Background Views (1 to 5 miles) Weak Structure Contrast	Seldom Seen Areas (beyond 5 miles) Very Weak Structure Contrast
Visual Impacts Occurrences within Residential Viewsheds (based on use of existing well pads)					
Strong					
Moderate	15 wells	14 wells	38 wells	76 wells	112 wells
Weak		13 wells	34 wells		
Negligible	1 well	14 wells	38 wells	58 wells	95 wells
Visual Impacts Occurrences within Recreational Viewsheds (based on use of existing well pads)					
Strong					
Moderate	0 wells	0 wells	0 wells	4 wells	173 wells
Weak		0 wells	0 wells		
Negligible	0 wells	0 wells	0 wells	1 well	173 wells
Visual Impacts Occurrences within Road Viewsheds (based on use of existing well pads)					
Strong					
Moderate	14 wells	9 wells	23 wells	74 wells	41 wells
Weak		14 wells	29 wells		
Negligible	1 well	8 wells	16 wells	49 wells	13 wells

Key

High Visual Impacts
Moderate Visual Impacts
Low Visual Impacts

The potential is great for avoidance of high and moderate visual impacts through construction of well facilities on either existing well pads or through placement of new well facilities within background or seldom seen distance zones from sensitive viewers.

4.9.5 Alternative 2 – Coalbed Methane Infill Development

The visual impact resulting from CBM infilling would be similar to, but of greater intensity than that of Alternative 1. Widespread CBM infilling action would result in greater visual "noise" due to the development of 636 CBM and conventional wells proposed under this alternative.

Under Alternative 2, about 53 wells may be constructed within immediate foreground views from residences, resulting in high visual impacts for 1.5 percent (162 acres) of the immediate foreground views within the Study Area (Table 4-45). If all existing well pads present within this resource were used, these impacts would be reduced to 51 occurrences of high visual impact (Table 4-45). High visual impacts within residential viewsheds also would occur where 60 wells may be located within foreground views and would result in strong to moderate vegetation contrast, resulting in a maximum disturbance of 0.4 percent (184 acres) of foreground views within the Study Area. These occurrences of high impacts could be reduced to 59 sites if existing well pads were used in the placement of new facilities.

Approximately 2 wells may be constructed within immediate foreground views from recreation areas, resulting in high visual impacts for 0.7 percent (6 acres) of the immediate foreground views within the Study Area (Table 4-46). Since there are no existing well pads present within this resource, there is no opportunity to mitigate visual impacts through construction on existing well pads (Table 4-45). High visual impacts within recreation area viewsheds also would occur where one well may be located within foreground views and would result in strong to moderate vegetation contrast, resulting in a maximum disturbance of 0.2 percent (3 acres) of foreground views within the Study Area. Again, there are no existing well pads present within this resource; therefore, there is no opportunity to mitigate visual impacts through construction on existing well pads.

About 53 wells may be constructed within immediate foreground views from key travel routes, resulting in a maximum disturbance of 2.1 percent (162 acres) of these views within the Study Area. If all existing well pads present within this resource were used to reduce the visual contrast of new well pad clearing, high impacts within immediate foreground views from key travel routes would be reduced to 50 occurrences. High visual impacts within key travel route viewsheds also would occur where 48 wells may be located within foreground views and would result in strong to moderate vegetation contrast. These occurrences of high impacts could be reduced to 47 sites if existing well pads were used in the placement of new facilities.

TABLE 4-45
Potential Visual Impact Occurrences under Alternative 2
Based on Use of Existing Wells

Vegetation Contrast	Immediate Foreground Views (0 to 300 feet) Very Strong Structure Contrast	Foreground Views (300 feet to 0.25 mile) Strong Structure Contrast	Middleground Views (0.25 to 1 mile) Moderate Structure Contrast	Background Views (1 to 5 miles) Weak Structure Contrast	Seldom Seen Areas (beyond 5 miles) Very Weak Structure Contrast
Visual Impacts Occurrences within Residential Viewsheds (based on use of existing well pads)					
Strong					
Moderate	51 wells	59 wells	128 wells	286 wells	341 wells
Weak		88 wells	158 wells		
Negligible	12 wells	16 wells	43 wells	95 wells	196 wells
Visual Impacts Occurrences within Recreational Viewsheds (based on use of existing well pads)					
Strong					
Moderate	2 wells	1 well	1 well	24 wells	316 wells
Weak		2 wells	2 wells		
Negligible	0 wells	0 wells	1 well	2 wells	317 wells
Visual Impacts Occurrences within Road Viewsheds (based on use of existing well pads)					
Strong					
Moderate	50 wells	47 wells	107 wells	297 wells	158 wells
Weak		62 wells	110 wells		
Negligible	3 wells	14 wells	25 wells	72 wells	17 wells

Key

High Visual Impacts
Moderate Visual Impacts
Low Visual Impacts

TABLE 4-46
Potential Visual Impact Occurrences under Alternative 3
Based on Use of Existing Wells

Vegetation Contrast	Immediate Foreground Views (0 to 300 feet) Very Strong Structure Contrast	Foreground Views (300 feet to 0.25 mile) Strong Structure Contrast	Middle-ground Views (0.25 to 1 mile) Moderate Structure Contrast	Back-ground Views (1 to 5 miles) Weak Structure Contrast	Seldom Seen Areas (beyond 5 miles) Very Weak Structure Contrast
Visual Impacts Occurrences within Residential Viewsheds (based on use of existing well pads)					
Strong					
Moderate	52 wells	13 wells	38 wells	76 wells	112 wells
Weak		13 wells	34 wells		
Negligible	2 wells	14 wells	38 wells	58 wells	95 wells
Visual Impacts Occurrences within Recreational Viewsheds (based on use of existing well pads)					
Strong					
Moderate	2 wells	1 well	1 well	22 wells	332 wells
Weak		2 wells	3 wells		
Negligible	0 wells	1 well	1 well	3 wells	370 wells
Visual Impacts Occurrences within Road Viewsheds (based on use of existing well pads)					
Strong					
Moderate	50 wells	47 wells	68 wells	300 wells	158 wells
Weak		62 wells	111 wells		
Negligible	4 wells	17 wells	30 wells	85 wells	20 wells

Key

High Visual Impacts
Moderate Visual Impacts
Low Visual Impacts

4.9.6 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

The visual impacts of this alternative are considered to be similar to Alternative 2 in change to landscape character and impacts on viewers; however, greater impacts would occur from the addition of 70 injection wells. Alternative 3, the Agency's and Tribe's Preferred Alternative, would result in slightly greater visual "noise" due to the additional injection wells and 135 miles of new pipeline proposed under this alternative.

Under Alternative 3, about 54 wells may be constructed within immediate foreground views from residences, resulting in high visual impacts for 1.5 percent (165 acres) of the immediate foreground views within the Study Area (Table 4-46). If all existing well pads present within this resource were used these impacts would be reduced to 52 occurrences (Table 4-46). High visual impacts within residential viewsheds also would occur where 61 wells may be located within foreground views and would result in strong to moderate vegetation contrast, resulting in a maximum disturbance of 0.4 percent (187 acres) of foreground views within the Study Area. These occurrences of high impacts could be reduced to 59 sites if existing well pads were used in the placement of new facilities.

Impacts on recreational viewsheds from construction of Alternative 3 are anticipated to be similar to those under Alternative 2. About 2 wells may be constructed within immediate-foreground views from recreation areas, resulting in high visual impacts for 0.7 percent (6 acres) of the immediate foreground views within the Study Area (Table 4-48). Since there are no existing well pads present within this resource, there is no opportunity to mitigate visual impacts through construction on existing well pads (Table 4-46). High visual impacts within recreation area viewsheds also would occur where one well may be located within foreground views and would result in strong to moderate vegetation contrast, resulting in a maximum disturbance of 0.2 percent (3 acres) of foreground views within the Study Area.

About 54 wells may be constructed within immediate foreground views from key travel routes, resulting in a maximum disturbance of 2 percent (165 acres) of these views within the Study Area. If all existing well pads present within this resource were used to reduce the visual contrast of new well pad clearing, high impacts within immediate foreground views from key travel routes would be reduced to 50 occurrences. High visual impacts within key travel route viewsheds also would occur where 49 wells may be located within foreground views and would result in strong to moderate vegetation contrast. These occurrences of high impacts could be reduced to 47 sites if existing well pads were used in the placement of new facilities.

4.9.7 Impacts Summary

Impacts from oil and gas activity can result in the introduction of form, line, color, and textures not found in the existing landscape. These modifications to the existing landscape from oil and gas activity could potentially alter the scenic quality of the area and/or impacts on views from sensitive viewpoints. Alternatives 2 and 3 have the greatest potential for impacts because they involve larger numbers of construction sites. All of the alternatives would affect views from a variety of sensitive viewpoints associated with residential areas, recreational lands, and travel routes.

4.9.8 Mitigation Summary

Facility Location

- Locate facilities at the base of slopes where feasible to provide a background of topography and/or natural cover. *(Based on Existing Policy or Regulation)*

- Choose sites that would provide topographic and vegetative screening for the location of well facilities. *(Based on Existing Policy or Regulation)*

- Locate facilities away from prominent topographic features. *(Based on Existing Policy or Regulation)*

- If possible, avoid locations near populated areas, parks, scenic areas, hilltops, and natural or manmade structures. For linear facilities such as access roads, avoid crossing hill crests. *(Based on Existing Policy or Regulation)*

- 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. *(Based on Existing Policy or Regulation)*

Facility Design

- Paint facilities to match the surrounding vegetation/landscape. *(Based on Existing Policy or Regulation)*

- Use low profile tanks and other production facilities to minimize visibility. *(Mitigation Developed from SUIT EIS)*

- Design cut-and-fill slopes to achieve maximum compatibility with the surrounding natural topography. *(Mitigation Developed from SUIT EIS)*

- Align access roads to follow existing grades to minimize cuts and fills. *(Mitigation Developed from SUIT EIS)*

- Provide access roads with side drainage ditches and traverse culverts to prevent soil or road erosion. *(Based on Existing Policy or Regulation)*

- Design exterior lighting of project facilities to minimize visual impacts while meeting applicable safety and security objectives. *(Mitigation Developed from SUIT EIS)*

Landform Disturbance

- 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. *(Based on Existing Policy or Regulation)*

4.9.9 Unavoidable Adverse Impacts

Unavoidable adverse impacts on viewers would result from all three alternatives. Unavoidable impacts on residential areas, recreation areas, and travel routes resulting from the development of well facilities include the introduction of new form, line, color, and texture elements that are not characteristic of the natural landscape.

4.10 SOCIOECONOMICS

4.10.1 Issues, Impact Types, and Criteria

This section describes impacts on social and economic characteristics in the five-county area of interest, including the Reservation, that could result from the project alternatives. The five counties are La Plata, Montezuma, and Archuleta counties in Colorado and San Juan and Rio Arriba counties in New Mexico. Direct economic effects in the area of influence may include the following:

- changes in employment, salaries, and wages paid to oil and gas workers
- purchases of equipment, supplies, and services from local area vendors
- lease, royalty, and production payments
- taxes and other government levies; changes in the fiscal health of tribal and local governments

Indirect economic effects in the area of influence may include the following:

- changes in the employment provided by tribal and local governments
- induced economic activity from local purchases of equipment, supplies, and services
- induced economic activity from purchases of goods and services by project workers
- changes in sources of income for tribal and local governments

Social concerns include the following:

- changes in the services provided by tribal and local governments
- the effects of drilling and related activities on rural lifestyles in the area
- the effects of changes in employment opportunities on communities
- the effects of population changes on local housing and services

The analysis of economic impacts focuses on net changes in employment and earnings (especially for tribal members); royalties paid to individuals; sales of equipment, supplies, and services; and the "multiplier" effect of turning over increased earnings and sales in the local economy. All calculations were performed in 1997 dollars, and a flat gas price of $2.00/mcf (the Enron five-year strip price as of December 1997) was assumed. Employment, royalty, and sales effects are based on typical figures in the San Juan Basin oil and gas industry and on estimates and projections made by the SUIT. Employment, earnings, royalties, and local purchases were scaled to each alternative based, as appropriate, on the number of units developed (e.g., number of wells or compressors), or volume of gas produced. Both direct and indirect effects on employment are considered. Because the SUIT government is the largest employer of tribal members and one of the largest employers in La Plata County, the analysis specifically addresses the indirect effects on employment due to changes in tribal revenues.

The assessment of fiscal impacts considers primarily how local government and tribal expenditures and revenues would be affected by each of the three alternatives. All calculations were performed in 1997 dollars (no inflation), assuming a flat gas price of $2.00/mcf. The analysis of the effects on tribal finances focuses on future projections compared with past conditions. With respect to effects on local governments, the fiscal impact analysis focuses on La Plata County and the school districts within it because most revenues and expenditures related to the alternatives would affect primarily the county in which the wells are located.

The analysis of social impacts explores the potential effects of the alternatives on local communities, lifestyles, and quality of life. Population increases, which burden local housing and services, are a key factor. The projected changes in the local population are compared with the ability of the area to accommodate the change. Extreme changes in employment or types of employment also are considered. The continuation of employment, particularly for tribal members, is a favorable social consequence. Changes in culture and land use are other considerations. The area of interest is already developed for gas and oil production, so the social impacts of the three alternatives are incremental.

4.10.2 Impacts Common to All Alternatives

In all three alternatives, at least 350 additional wells would be drilled or recompleted on tribal land and CBM production would continue through the 20 year project life. However, total annual CBM production and the revenue streams it generates, such as royalties, production payments, and taxes, would be declining rapidly in all three cases. Employment and spending would shift away from construction and into reclamation, and both direct and indirect employment and spending would decline with production.

The decline of energy-related employment, spending, and revenues would put the people and organizations that depend on them at risk. Local governments, particularly La Plata County, and SUIT would have to develop other sources of income or face cutting the services and employment that they provide. Because tribal government is essential to the economy of the

Reservation as a whole, significant decreases in the fiscal health of tribal government almost invariably would lead to a decline in the standard of living of tribal members. Property, sales, and use tax rates in La Plata County would be likely to rise in order to maintain services, including the local school districts. State equalization payments to the La Plata County school districts also would probably rise, diverting funds from other state programs.

4.10.3 <u>Alternative 1 - Continuation of Present Management (No Action)</u>

4.10.3.1 Summary of Alternative 1

According to the Reasonable Foreseeable Development Scenario (RFD), found in Chapter 2, 81 CBM wells on tribal land would be developed evenly over the 20 year life of the project (1998 to 2017). Conventional targets (including Mesaverde, Dakota, and Pictured Cliffs) also would be pursued steadily throughout the project period, resulting in 269 new conventional gas wells.

Under Alternative 1, CBM production from existing wells on the Reservation would decline sharply as shown by the base case wedge in Figure 4-5. Annual production from tribal acreage would decline from a 1997 peak of over 500 million cubic feet of gas per day (mmcfpd) to less than 60 mmcfpd in 2017, a drop of nearly 90 percent over the life of the project (Figure 4-6). Production predictions for nontribal land are shown on Figure 4-7.

4.10.3.2 Alternative 1 - Direct Economic Impacts

This subsection describes the direct economic impacts of Alternative 1 on employment and personal income; direct spending; and lease, royalty and production payments.

<u>Employment and Personal Income</u>

In Alternative 1, employment equivalent to about four full-time positions would be added each year in the project period (20 years) to develop and operate new wells. Activities would include drilling and completing or recompleting well bores; installing roads, compressors, and flow lines; and operating wells and compressors. Table 4-47 shows the average manpower requirements of typical construction, operation, and reclamation activities. The overall employment effect associated with this case peaks in the last year of the project period, when wells are still being drilled and a maximum number of wells and compressors are operating (Figure 4-8). Alternative 1 should have no significant effect on salaries in the five county area of interest during the 20-year life of the project if the rate of development is flat because of the very small impact on total employment.

FIGURE 4-5
Ignacio Blanco (Fruitland) Field Production Projection - All Acreage
81/2 x 11 B&W

INSERT FIGURE 4-6
Ignacio Blanco (Fruitland) Field Production Projection - Tribal Acreage
8 ½ x 11 B&W

INSERT FIGURE 4-7
Ignacio Blanco (Fruitland) Field Production Projection - Nontribal Acreage
8 ½ x 11 B&W

TABLE 4-47
Alternative 1
Employment For Typical Drilling And Operations Activities

	Number of Employees Per Well/Site	**Number of Days Per Site Per Year**	**Total Number of Employee Days Per Site Per Year**
Construction			
Fractured CBM Well			
Drilling and Casing	20	4	80
Completion (Preferred and fractured)	14	1	15
Surface Equipment	4	7	28
Total Fractured Well			
Cavitated CBM Well			
Drilling and Casing	20	4	80
Completion (Cavitated)	20	30	600
Surface Equipment	4	7	28
Total Fractured Well			
N2 Injector Well			
Drilling and Casing	20	4	80
Completion (Preferred, no fracture)	15	1	15
Surface Equipment	8	6	48
Total Fractured Well			
Recompleted Well			
Recompleting	10	3	30
Surface Equipment	4	7	28
Total Fractured Well			
Conventional Well			
Drilling and Casing	20	10	200
Completion	15	1	15
Surface Equipment	4	7	28
Total Fractured Well			
New Road: per 1/4 mile	3	1	3
New Pad: per site	3	2	6
Road and Pad for Recompletion	3	1	3
New Flowline: per 1/4 mile	4	1.25	5
Compressor Installation: per 1,000 hp unit	12	20	240
Total Fractured Well	3	10	30
Operations			

TABLE 4-47
Alternative 1
Employment For Typical Drilling And Operations Activities

	Number of Employees Per Well/Site	Number of Days Per Site Per Year	Total Number of Employee Days Per Site Per Year
Well Operations: employee days/well/year Workover conventional well, employee days/well/year Workover CBM well with pump, employee days/well/year Workover CBM well, flowing, employee days/well/year Road and Pad Maintenance: employee days/well/year Compressor Maintenance: employee days/site/year	1 4 4 4 3	1 hour/day 1 day/4 yrs 2.5 0.75 3	46 1 10 3 9 131
Reclamation			
Plug and Abandon: employee days per well	5	5	25
Well Pad Reclamation	2	6	12
Compressor Removal	4	6	24
Road Reclamation: per quarter mile	4	1	4

INSERT FIGURE 4-8
Employment for Drilling, Completing, and Operating New Wells and Compressors
8 ½ x 11 B&W

TABLE 4-48
Numbers and Costs of New Wells and Compressors

	Alternative 1	Alternative 2	Alternative 3
No. new conventional wells	269	269	269
No. new CBM wells (tribal and nontribal)	81	367	367
No. new N2 injectors (tribal and nontribal)	-	-	70
Total Number of New Wells	350	636	706
Incremental No. CBM	-	286	286
Incremental No. Injectors	-	-	70
Cost per conventional well (M$)	375	375	375
Cost per CBM well (M$)	263	263	263
Cost per N2 injector well (M$)	250	250	250
Total Intangible: all wells (M$)	83,708	122,821	131,746
Total Incremental Intangible (M$)	-	39,113	48,038
% increase over Alternative 1	-	47	57
Total Tangible: all well (M$)	38,470	74,575	83,150
Total Incremental Tangible (M$)	-	36,105	44,680
% increase over Alternative 1	-	94	116
Total Cost All Wells (M$)	122,178	197,396	214,896
Incremental Cost All Wells (M$)	-	75,218	92,718
No. new 1000 hp compressors	12	30	30
No. new 2500 hp compressors	-	-	12
Cost per 1000 hp compressor (M$)	1,000	1,000	1,000
Cost per 2500 hp compressor (M$)	2,500	2,500	2,500
Total Intangible cost all compressors (M$)	1,800	4,500	9,000
Total Tangible cost all compressors (M$)	10,200	25,500	51,000
Total Cost All Compressors (M$)	12,000	30,000	60,000
Incremental Cost All Compressors (M$)	-	18,000	48,000
Total Cost Wells + Compressors (M$)	134,178	227,396	274,896
Incremental Cost Wells - Compressors (M$)		93,218	140,718

Notes:
Incrementals are in comparison to Alternative 1.
Assumed 4:1 ratio to fractured to cavitated CBM wells.
Assumed all N2 injection wells are perforated but not fractured.
Assumed 1:1:1 ratio of KPC:Mesaverde:Dakota wells.
Well costs estimates are from David Gilmore.
Intangible/tangible for well costs are by Sagie, Schwab, and McLean.
Compressor costs and numbers from Dave Brown (Amoco).
M$=$1000.00

Direct Spending

The flat development program projected for Alternative 1 (13 to 14 new wells, 4 to 5 recompletions, and 1 to 2 new compressors per year) would not have a significant incremental impact on the local industry because it is simply an extension of the rate of development which has occurred in recent years. The 350 new wells which are predicted to be developed in Alternative 1 are estimated to cost about $122 million (Table 4-48). Approximately $38 million would be tangible costs (casing, equipment) which pass directly out of the local economy to suppliers and manufacturers elsewhere. The $84 million of intangible costs (primarily labor) would enter the local economy.

Compressors for Alternative 1 development are estimated to cost $12 million (Table 4-48). About 80 percent of the compressor costs would be tangible costs which pass directly out of the local economy to the suppliers or manufacturers. The remaining 20 percent, about $2 million, would be intangible costs, primarily labor, which would turn over in the local economy. Using a multiplier of 1.45, the total Alternative 1 program would add about $124 million to the local economy over 20 years (Table 4-49).

TABLE 4-49
Direct Spending and Incremental Spending Including Multiplier Effect

	Alternative 1 (M$)	Alternative 2 (M$)	Alternative 3 (M$)
Total Spending All Wells	122,178	197,396	214,896
Intangible Spending Wells	83,708	122,821	131,746
Total Spending All Compressors	12,000	30,000	60,000
Intangible Spending All Compressors	1,800	4,500	9,000
Total Program Spending	134,178	227,396	274,896
Total Program Intangible	85,508	127,321	140,746
Incremental Total Program	0	93,218	140,718
Incremental Total Intangible	0	41,813	55,238
Total Intangible (I) x Multiplier* (M)	123,987	184,615	204,082
Incremental Intangible x Multiplier	0	60,629	80,095
Total IM/20 years = Avg. 1M	6,199	9,231	10,204
Incremental IM/20 years - Avg Incr IM	0	3,031	4,005
Notes: * Multiplier = 1.45			

Lease, Royalty, and Production Payments

Lease, royalty, and production payments are based on production volumes and price, and would vary directly with production volumes. The La Plata County Oil and Gas Producers Association estimated a weighted average royalty of 13 percent for the county's landowners and that producers paid a total of over $58 million in royalties to La Plata County landowners in 1994. The SUIT, who is the largest royalty owner in the area of interest, has a slightly higher weighted average royalty and has negotiated production payments in lieu of royalty payments as previously mentioned. The Tribe also collects surface lease fees on a gas volume basis. The impact of lowering the Tribe's royalty/production payment, surface lease income, and other energy-related revenues is discussed below under Direct Fiscal Impacts, Indirect Impacts, and Direct Social Impacts. The lowering of royalty payments to other royalty owners would result in a lowering of personal income for those persons and in a very slight, almost negligible decrease of money in the local economy. The effect of lower royalty payments on the local economy would be dampened by the fact that many La Plata County royalty owners live outside the five-county area of interest.

4.10.3.3 Alternative 1- Direct Fiscal Impacts

This subsection describes direct fiscal impacts of Alternative 1 to the SUIT, La Plata County, State of Colorado, and COGCC.

SUIT Government

Alternative 1 would have significant direct impacts on the fiscal strength of the SUIT government. The steep decline of gas production (Figure 4-5) would reduce the royalty, production payment, and severance tax revenues which have been the financial foundation of the Tribe, as discussed in Chapter 3, Section 3.10. Assuming a flat gas price, the declines in revenues would parallel the declines in production volumes, decreasing by 10 to 15 percent per year. This decline could push the General Fund budget back to the 1992 level by 2002 (Figure 4-9). Over the 20-year life of the project, the Tribe's revenues from severance tax and royalties (production payments) on the tribal acreage are predicted to drop to 14 percent of what they were in 1997. Unless other revenue sources are developed, this would reduce the General Fund to less than 10 percent of the 1992 level, as illustrated on Figure 4-9. The Tribe's interest in Red Cedar Gathering Company (51 percent) also would generate less income each year as transportation volumes decrease.

As described in Chapter 3, Section 3.10 the SUIT government's General Fund has been the main source of funds for programs designed and managed by the Tribe, including tribal police and tribal court, health and wellness programs, and cultural projects and programs. As a result of the decline in revenues, tribal government would have to choose from three options: reduce the General Fund budget, find another source of revenues, or finance current General Fund programs from the Tribe's dedicated funds (principal and interest).

Funding current General Fund programs from the Tribe's dedicated funds would be undesirable. The Tribe's Capital Reserve and Severance Tax Funds were established specifically to finance long range benefit programs, such as buildings and development of new economic enterprises, not to fund current programs. The Tribal Council is committed to the long-term fiscal health of the Tribe and is unlikely to reroute dedicated funds to annual operations. In addition, interest from the dedicated funds is not sufficient to cover the impending revenue deficits in the General Fund.

Finding an alternative source of revenues has been part of the Tribe's development plan for years. The Tribe has been expanding its economic base by developing successful business enterprises such as the Sky Ute Casino; supporting educational programs including Headstart, college scholarships, and vocational training; and promoting agriculture. Unfortunately, the Tribe cannot yet count on significant revenues for the General Fund from any non-energy enterprise except the Casino, and even the Casino cannot replace the revenues currently generated by gas development on the Reservation.

In 1999, the Tribe agreed to an out-of-court settlement with BP/Amoco and other operators concerning production of CBM from Tribal Coal Only lands. Through these settlements, the SUIT gained a working interest of up to 32 percent in over 250 CBM wells. The Tribal Council has specified that the net income from these settlements would be put into the Tribe's newly created Growth Fund and used to fund investment opportunities, not used to fund tribal government operations.

In July 1999, the Tribe bought all the gas production properties of Cedar Ridge LLC on the Southern Ute Indian Reservation. The Cedar Ridge acquisition was seen as a strategic investment opportunity and was funded by the Tribe's Growth Fund. As with the CBM ownership settlements mentioned above, Tribal Council has elected to deposit the net income it receives from the Cedar Ridge properties in the future back into the Tribe's Growth Fund. Like other gas production on the Reservation, production from the Cedar Ridge properties would decline rapidly in future years as natural reservoir depletion occurs.

Reducing the General Fund Budget, though undesirable, might be the unavoidable consequence for the Tribe of Alternative 1. Such an action may initiate a domino effect of economic and social problems for the Tribe. This is discussed below under indirect impacts, Section 4.10.3.4

In 1999, the SUIT restructured its financial plan to more clearly support the Tribe's Long Term Financial Plan. The SUIT recognizes that their current level of energy revenues based on production within the Reservation boundaries would inevitably decrease in the near future with depletion of the reservoirs. The Long-Term Financial Plan aims at establishing a sound financial base for the Tribe in the future by managing spending and investing in a balance of conservative and growth-oriented opportunities. The details of this plan have not been released to the public although the overall structure of the plan has been presented to the tribal members.

La Plata County

Alternative 1 would result in reductions of property tax revenues for the La Plata County school districts, municipal governments, and county government. In recent years, property taxes from the oil and gas industry have contributed up to 50 percent of all property tax collections in La Plata County and almost solely supported the increases in total property tax collections since 1990 (Figure 4-10). As production declines by 80 to 90 percent over the project period, the oil and gas industry's property tax assessments would fall proportionately, assuming prices are flat. This would result in potential losses of more than one million dollars per year from the county's property tax collections in the first five years of the decline. La Plata County is growing faster than the state as a whole, so a loss in property tax revenues is likely to be compensated through increases in other revenue sources rather than allowing the municipal, county, and school district budgets to decrease.

Local sales taxes collected on gas production-related sales and services also would decline with production. No attempt was made to quantify this effect because of the many different taxing districts involved.

State of Colorado

State severance tax paid on production from properties covered by this EIS would fall to zero in the next few years under all alternatives. Colorado's severance tax is assessed on the value of gross production, but allows producers to offset their assessed value with property taxes paid in the same
year as the state assessment. Since property taxes are paid two years following actual production, state severance taxes are not offset completely by property taxes when production is rising, but can be completely offset when production is falling. Thus, sharply declining production from properties would result in an end to state severance tax payments.

Colorado Oil and Gas Conservation Commission

The COGCC imposes a conservation levy on production in Colorado to fund its own administration. The levy is based on oil and gas sales revenues and would decline directly with production. In 1996, levies on gas production from La Plata County alone contributed 22 percent of the conservation levy, nearly $400,000 (COGCC 1997). A drop of 80 percent in gas production in La Plata County therefore could decrease the COGCC's levy collections by 10 to 20 percent, depending on prices and production in other counties.

INSERT FIGURE 4-9
Historical and Projected (15 percent Decline) General Fund Budget as a percent of the 1992 General Fund Budget under Alternative 1
8 ½ x 11 B&W

INSERT FIGURE 4-10
Historical Property Tax Sources In La Plata County

8 ½ x 11 B&W

4.10.3.4 Alternative 1 - Indirect Impacts

This subsection describes indirect impacts from Alternative 1 on SUIT, La Plata County and school districts, as well as induced economic activity.

SUIT

Alternative 1 would have undesirable indirect economic and social impacts on the SUIT. As discussed above under Fiscal Impacts, Alternative 1 would cause tribal revenues to decline by about 15 percent per year during the twenty year project period, possibly forcing a considerable reduction of the Tribe's General Fund budget, which would translate into cuts in program budgets. It is impossible to predict how Tribal Council would allocate limited funds, but given the magnitude of budget cuts that would be necessary under Alternative 1, it is likely that almost all programs would experience budget reductions. Cutting program budgets would adversely affect employment, especially of tribal members, and may affect retail sales in La Plata County, especially in the Ignacio area. The indirect loss of employment as a result of reduced tribal revenues is expected to offset the direct employment generated by this alternative. Loss of jobs and reductions in cultural and recreational programs supported by the Tribe would have undesirable social impacts on tribal members. Decreases in or termination of the per capita payments may cause the number of tribal members seeking employment to increase.

The Tribe is the largest employer of tribal members, so significant personnel reductions in tribal government would increase tribal unemployment. As previously mentioned in Section 3.10, tribal employment has increased as tribal government has grown, and at present over 50 percent of the tribal government's employees are tribal members, so tribal employment logically could be expected to drop if tribal government shrinks substantially. Some nontribal employees may be laid off from the tribal government payroll first, due to Native American employment preferences. However, nontribal employees have generally been hired to do essential work that tribal members are not trained to do. Budget cuts also are likely to affect employees of tribal enterprises, especially those who work at the smaller, less financially successful enterprises, such as the utilities and the cultural center/museum, which have relied on subsidies from tribal government to remain solvent.

The reduced General Fund budget would require tribal government to cut services to tribal members. The increase in unemployment under Alternative 1 would probably cause an increased need for services such as vocational training and health care. If tribal government decides not to cut education, health, and safety programs but instead to cut maintenance, cultural, and recreational programs, there would be adverse effects on social and cultural bonds in the SUIT community. The SUIT General Fund supports numerous cultural programs such as tribal ceremonies and festivals, promotion of the Ute language, and Pow Wows, which are essential to maintaining the Ute culture. Also, if unemployment forces tribal members to leave the Reservation in search of jobs, the resulting reduction of tribal population on the Reservation might weaken the Ute culture.

Sales revenues in La Plata County would drop as an indirect effect of budget cuts in the SUIT government. First, there would be a direct drop in the SUIT government's spending on everything from office supplies to new construction. Second, retail sales in the area would drop due to increased unemployment and lower personal income in the area.

In summary, a decrease in the General Fund of the SUIT would have many adverse indirect effects. It would raise unemployment, especially for tribal members, strain local social services, reduce cultural preservation and quality of life, and reduce the economic health of the area of interest, especially the Reservation.

La Plata County

Under Alternative 1, the decline of gas production may have the adverse indirect effect of causing taxes to rise for all taxpayers in La Plata County. Since 1989, the assessed value of oil and gas property in La Plata County has risen an average of 26 percent per year (see Figure 4-10). Assessments on other properties have risen by only 6 percent per year. The growth of gas production in La Plata County has allowed property tax mill levies to remain among the lowest in the state despite the county's rapid growth by spreading the burden of supporting schools and services onto a large industry tax base. As gas production declines in the next five years, property tax assessments on oil and gas properties would also decline. The burden of supporting the schools, county government, and other taxing districts would have to be increasingly borne by non-oil-and gas related taxpayers, particularly if the services are to continue to expand to meet the county's projected growth. Options would include increasing sales and use taxes as well as increasing mill levies on property.

Declining gas production would probably reduce the funds that La Plata County receives from the state severance tax fund. A portion of the state severance taxes collected each year are allocated back to the counties based on the number of oil and gas industry employees in each county. Oil and gas production from La Plata County, which is almost 90 percent CBM, comprised 25 percent of the value of all oil and gas production in Colorado in 1995. Assuming that no other county has a substantial jump in production and that prices remain steady, a decline in La Plata County CBM production would cause a decline in severance tax collections in the state and therefore in the amount of funds available for distribution back to the counties. Although employment in La Plata County is expected to rise slightly under Alternative 1, this rise would probably not compensate for the decrease in funds available for distribution. Thus, a decline in gas production, which would decrease direct industry employment and severance taxes collected, would decrease both the amount of severance tax money available for distribution and La Plata County's share of those funds.

School Districts

As an indirect consequence of lower gas production and property tax collections, La Plata County school districts could need cumulative incremental state equalization payments of over

$70 million in the next five years under Alternative 1. Property taxes currently make up the largest portion of school district funding in La Plata County, but school districts also receive funds from the state in the form of legislated equalization payments in order to maintain minimum per pupil school budgets. A 15 percent per year decline in gas production and gas related property taxes (Figure 4-11) could result in a tripling of the equalization payments to the Durango 9-R school district within five years, from about $5.4 million per year to over $16 million per year, in 1997 dollars. Bayfield and Ignacio school districts would together require increases in equalization payments of about $800,000 per year in the next few years.

Indirect (Induced) Economic Activity

Induced economic activity from local purchases of equipment, supplies, other goods, and both personal and professional services due to the project and project workers would be minimally changed under Alternative 1. In the next twenty years, local purchases of equipment and services would be maintained or increase slightly as more wells are developed within the Reservation boundaries. Energy-related employment would be steady, increasing by less than 1 percent per year, so the income and spending of energy employees also would increase very slowly in the project period.

4.10.3.5 Alternative 1 - Direct Social Impacts

This subsection addresses direct impacts of Alternative 1 associated with lifestyles, population, housing, and other services.

Lifestyle

Social concerns raised during scoping include disruption of neighborhoods and properties by site workers, effects on quality of life for rural residents, and the effects of boom-bust economies on local communities. Specific issues concerning quality of life relate to water quality, traffic, and other topics that are addressed elsewhere in this EIS. The rural lifestyle that characterizes most of the Reservation should be least affected by drilling and related activities under Alternative 1 because of its relatively low levels of industrial activity. However, with respect to the boom-bust economic cycle, Alternative 1 features the sharpest decline and therefore is expected to have the most dramatic “bust” cycle of the three alternatives. The declines of production under Alternative 2 and 3 should be spread out over more years and their “busts” should also be tempered by having relatively large abandonment program.

Oil and gas development on the Reservation is limited by approvals from various tribal departments as well as by the BLM and BIA. These agencies are charged with protecting homes and other surface uses as well as the Tribe’s natural resources, including wildlife, water quality, visual quality, and air quality. Oil and gas development activities are studied to avoid significant

INSERT Figure 4-11
Durango 9-R School District Revenues Increase in State Equalization with 15 percent Decline in Property Taxes
8 ½ x 11 B&W

negative impacts, such as locating facilities too close to houses or archaeological sites. Surface owners can be compensated for economic losses, such as crop losses, due to oil and gas production activities. The Tribe Severance Tax is intended to help the SUIT to pay for mitigation of losses caused by oil and gas development such as road damage and loss of rangeland.

Oil and gas extraction activities have coexisted with ranching and farming in La Plata County since the 1940's. Ignacio Blanco Field, which lies almost entirely within La Plata County, already contains more than 1700 wells. The Fruitland pool is currently spaced at 320 acres, but producers have obtained orders from the COGCC allowing the development of an optional second well, or infill well, on each of more than 125 spacing units. Most of the Fruitland wells were drilled around 1990 due to federal tax credit legislation, which resulted in a peak of over 200 new wells permitted in one year. The addition of 21 to 22 wells per year on tribal land under Alternative 1 would produce only minor changes in the Reservation's 685,000 acre rural landscape, especially as existing wellbore, roads, and pads would be used wherever possible.

Population

Direct employment under Alternative 1 is expected to be steady or to show very slight growth, about five full time equivalent positions per year, during the life of the project. This magnitude of employment growth is insignificant in a county with a workforce of about 25,000, let alone if the other four counties in the area of interest are included. Given the high rate of growth and development pressures in La Plata County, any additional employment would be a benefit to the area. Both La Plata County, Colorado and San Juan County, New Mexico have experienced the business cycles associated with fluctuations in oil and gas production.

Housing

Because La Plata County is already predicted to grow relatively quickly in the next few years, a very slight increase in employment under Alternative 1 would not strain local housing. Adding relatively high-paying gas field jobs would provide more persons in the area with the income necessary to buy adequate housing.

Other Services

Because Alternative 1 would not directly change the population of the five counties of interest, no noticeable strain on services such as water, school, and police protection is expected from the population (demand) side. However, decreased financial support of these services from the SUIT General Fund may indirectly lead to a supply shortage unless other sources of support are developed.

4.10.3.6 Alternative 1 - Long-term Impacts (2018 to 2065)

This subsection addresses direct and indirect long-term impacts, including economic, fiscal, and social impacts of Alternative 1.

Long-term Direct Economic Impacts

As production and energy related revenues continue to decline after 2017, direct employment in the Ignacio Blanco Field would also decline. Construction jobs are projected to end in 2017. Operations jobs would be lost as wells are plugged and as expense budgets are cut in parallel with falling production revenues. A few jobs would be created in plugging and abandoning, removal of facilities, and land reclamation. Table 4-47 shows typical employment requirements of reclamation activities. Both tribal members and nontribal entities would be affected by the ultimate decline of employment. Alternative 1 contains the fewest wells of the three alternatives, so it would require the fewest cumulative hours of employment to plug and abandon wells and to reclaim locations. The net decline in direct jobs would reduce total personal income in the county and on the Reservation although salaries in the gas industry should not decline in absolute dollars. However, salaries may decline in real terms as unemployment rises, as there would be little pressure on employers to raise salaries.

Sales and service after the year 2017 would be related primarily to operations and reclamation. Construction is projected to end in 2017. Workovers would continue to be done until wells are plugged. The smallest number of workovers would be done under Alternative 1 because that alternative has the fewest wells in operation each year. As with employment, the inevitable decline of production and reaching of economic limits would cause a shift of purchases and services from development and operations into plugging and reclamation. Alternative 1 has no incremental new wells compared to the other alternatives, so it has no incremental sales or labor. Plugging is likely to begin earlier under Alternative 1 than under the Alternative 3.

In Alternative 1, lease, royalty, and production payments would decline with production after 2017.
As was discussed in Sections 4.10.3.3, 4.10.3.4, and 4.10.3.5, reducing the Tribe's energy-related revenues may create a domino effect on the social and economic well being of the Tribe by forcing cuts in employment and services. Because many spacing units include both tribal and non-tribal acreage, lack of infill on tribal land may prevent infill of nontribal land from occurring. This would cause royalty payments to royalty owners other than the Tribe to decline with declining production for nontribal Leases, which would result in a lowering of personal income for those persons. However, the effect on the local economy would be dampened by the fact that many La Plata County royalty owners live outside the five-county area of interest.

Long-term Direct Fiscal Impacts

As energy related revenues decline with gas production, the SUIT would be challenged continually to bring in new revenue sources or else to cut program spending. Under Alternative 1, CBM production on the Reservation ends in 2042 (Figure 4-5).

By the end of the project period, La Plata County probably would be receiving less than 1 percent of its budget from oil- and gas-related property tax collections. Depending on the other revenue sources that the county develops, continued declines in gas-related property taxes may or may not be noticeable to the county. School districts and other taxing entities also would probably become dependent on non-energy related sources of funds.

Long-term Direct Social Impacts

Alternative 1 has no significant long-term direct social effects. Population would neither grow nor shrink noticeably, and so housing and other services would not be strained by population changes. The rural character of the area would not experience any significant effects, as all construction would occur during the project period. Operations and reclamation activities are not expected to have any significant social impact. Reclamation would return the area to a near pre-disturbance rural character.

Long-term Indirect Social and Economic Impacts

Lower revenues to the SUIT would have several negative indirect social and economic effects unless compensating sources of income are found, as has been previously discussed in depth. Most importantly, tribal government would employ fewer people and spend less money in the community. Increased unemployment on the Reservation also would result in less spending at local retail businesses, which may in turn affect the viability of those businesses. Lack of funds from the SUIT government in support of basic services such as water, sanitation, and housing also may lead indirectly to deterioration of basic services on the Reservation, especially for tribal members.

4.10.4 Alternative 2 - Coalbed Methane Infill Development

4.10.4.1 Summary of Alternative 2

In Alternative 2, a 286-well CBM infill drilling program would be completed over the 20-year project period in addition to the 350-well program of Alternative 1. This infill program would raise CBM production compared to Alternative 1 both during the 20-year life of the project and for the additional 25 years beyond (Figure 4-5). Cumulative incremental gas produced is over 262 bcf during the project period. The incremental gas production rate due to widespread infill development (Alternative 2 compared to Alternative 1) swells for 10 years to over 42 mmcfpd.

The incremental gas production in Alternative 2 due to widespread infill development would result directly in substantial, positive impacts on the fiscal health of the SUIT government. A cumulative minimum incremental benefit to the Tribe of about $83 million (approximately $115 million using moderately escalated gas prices) was calculated for the life of the project on production from only the tribal acreage, considering only royalty/production payment revenues and severance tax revenues (Table 4-50). Other revenue streams associated with gas production, e.g., fees, bonuses, penalties, and interest, could add an additional 10 percent per year to the calculated benefits. The Tribe's interest (51 percent) in the Red Cedar Gathering Company also would earn additional income due to increased gas production.

This level of incremental income to tribal government, coming as it would during decades of steep production decline and falling energy revenues, would result in substantial, positive impacts on tribal members compared to Alternative 1. Both employment and services provided by tribal government would increase significantly under Alternative 2. Employment and spending related directly to the infill drilling program and associated well operations also could benefit tribal members. Induced economic activity would benefit both the Reservation and surrounding communities.

The incremental gas production due to widespread infill development would improve the fiscal health of La Plata County and other taxing entities compared to Alternative 1. Increased production would translate into a larger property tax base for La Plata County, thus spreading the burden of supporting local services onto gas producers. Most significantly, tens of millions of dollars to support school districts would be collected from gas producers through property taxes. The incremental gas production due to widespread infill development would improve the fiscal health of La Plata County and other taxing entities compared to Alternative 1. Increased production would translate into a larger property tax base for La Plata County, thus spreading the burden of supporting local services onto gas producers. Most significantly, tens of millions of dollars to support school districts would be collected from gas producers through property taxes. In contrast, without widespread infill development, property tax collections from gas producers would decline more quickly with reservoir depletion and equalization payments from the state would have to be increased more rapidly to fill the gap left in school district budgets.

The construction program of Alternative 2 (32 wells plus 1 to 2 compressors per year) is nearly twice that of Alternative 1 (18 wells and 0 to 1 compressors per year), and would significantly increase drilling, completion, and pipeline construction activities over the life of the project. Operating the new wells would raise employment and spending on equipment and services in the five-county area of interest. Widespread infill development would not defer the start of plugging and-abandonment and reclamation work, but it would almost double the number of wells that eventually need to be plugged, thereby nearly doubling the eventual spending and employment associated with plugging and abandonment and reclamation work. Large numbers of CBM wells probably would not be plugged until after the project period.

4.10.4.2 Alternative 2 - Direct Economic Impacts

This subsection describes the direct economic impacts of Alternative 2 on employment and personal income; direct spending; and lease, royalty, and production payments.

Employment and Personal Income

Direct employment under Alternative 2 would be higher than in Alternative 1, with an average of more than 50 full-time-equivalent jobs per year (Figure 4-8).

Over 2,300 years of equivalent full-time employment would be needed to develop and produce new wells. The annual rate of development would be more than twice that on the Reservation in recent years. About 15 new full-time-equivalent jobs would be added in the Four Corners area in drilling and completing wells compared to no new jobs added in the construction segment in Alternative 1. In addition, nearly 7 jobs per year (149 total jobs by 2017) would be added in operating new wells compared to only 4 per year in Alternative 1. Compressor installation and maintenance is estimated to add 116 years of equivalent employment, peaking at 9 equivalent full-time jobs in 2014.

The increased activity of Alternative 2 could have a small to moderate effect on salaries in the gas industry in the Four Corners area during the 20-year life of the project. As in Alternative 1, however, the gradual nature of the program may dampen the effects of increased industry employment.

Direct Spending

The development program projected for Alternative 2 (32 wells and 1 or 2 compressors per year) would provide an incremental direct spending of about $93 million over the twenty year project life (Table 4-48), or about 4.6 million per year. The impact of the direct spending on the five county area of interest would depend on how many times that spending turns over in the local economy (the multiplier effect).

The 636 new wells that are predicted to be developed in Alternative 2 are estimated to cost about $197 million, an incremental increase of $75 million compared to Alternative 1 (Table 4-48). Approximately $75 million would be tangible costs (equipment, tubulars) that would pass directly out of the local economy to suppliers and manufacturers elsewhere. The $123 million of intangible costs (primarily labor) should turn over in the local economy. Compressors for Alternative 2 development would cost $30 million, an incremental increase of $18 million compared to Alternative 1 (Table 4-48). About $4.5 million of the compressor costs would be intangible costs, primarily labor, which would turn over in the local economy.

Lease, Royalty, and Production Payments

In Alternative 2, production declines less sharply than in Alternative 1. Higher royalties, production payments, and other fees would be paid throughout the life of the project and until the field's economic limit is reached, projected for 2041. The SUIT would receive incremental revenues from royalties and production payments on the tribal acreage alone of $83-115 million (Table 4-50). Lease fees and income from the Red Cedar Gathering Company should add several million dollars more. The impacts of increasing the Tribe's revenues from royalty/production payments and lease fees is discussed below under direct fiscal impacts, indirect impacts, and social impacts. Higher royalty payments to other royalty owners would result in greater personal income for those persons. However, the effect on the local economy would be dampened by the fact that many La Plata County royalty owners live outside the five county area of interest.

TABLE 4-50
Projected Cumulative Incremental Revenue to the Southern Ute Indian Tribe

	20-Year Infill Case ($)	20 Year Infill + ECBM ($)	62 Year Infill Case ($)	62 Year Infill + ECBM ($)
Flat Price (2.00/MCF - $0.30 MCF Transport)				
Tribal Acreage	82,961,385	117,852,362	106,228,902	273,387,139
Escalated Prices ($2.00/MCF in 1998, + 3% Per Year Thereafter, $0.30 MCF Transport)				
Tribal Acreage	114,661,868	162,630,592	163,554,562	608,821,232

Severance Tax and Royalty/Production Payment Income Only
Fees, Bonuses, Interest, and Penalties Could Add Another 10%

4.10.4.3 Alternative 2 - Direct Fiscal Impacts

This subsection describes direct fiscal impacts from Alternative 2 on SUIT, La Plata County, the State of Colorado, and COGCC.

<u>SUIT Government</u>

Alternative 2 has substantial direct positive impacts on the fiscal strength of the SUIT government. Cumulative incremental revenues to the Tribe from royalty/production payments and severance taxes were calculated to be over $82 million ($114 million using moderately escalated gas prices) (Table 4-49). Other energy related fees, bonuses, penalties, and interest could add another 10 percent to the calculated incremental revenue values. As discussed in detail in Section 3.10, the Tribe's incremental revenues, which could average $4-10 million per year under Alternative 2, depending on gas prices and actual production volumes, are likely to be used to fund a variety of programs benefitting the Reservation community, especially tribal members.

<u>La Plata County</u>

Alternative 2 would provide a buffer to reduction of property tax revenues for La Plata County government, municipal governments, and school districts. The incremental production on tribal land under Alternative 2 would result in a cumulative incremental property tax collection in La

Plata County of $28 million in the next 20 years, assuming a flat gas price and an average mill levy of 0.045. The peak annual incremental property tax collection due to infill is projected at $1 million in 2012. If mill levies remain constant, the cumulative incremental revenues would provide about $13 million for the school districts, and $3 million for county government. The exact distribution of tax revenues and incremental revenues to special taxing districts would depend on the locations of the infill wells. Due to the number of other revenue sources which these entities have, estimating how the decline in property taxes from gas production would affect their budgets on a percentage basis is considered beyond the scope of this project.

State of Colorado

State severance tax paid on production from properties covered by this EIS would fall to zero under Alternative 2 as in Alternative 1. Because production would decline even with the widespread infill program, producers are likely to offset their assessed value with property taxes paid in the same year as the state severance tax assessment.

Colorado Oil and Gas Conservation Commission

Alternative 2 would provide incremental revenues to the COGCC's conservation fund compared to Alternative 1. This levy is based on sales revenue and so would decline directly with production. Alternative 2 would produce cumulative incremental revenues to the conservation fund of nearly $2 million during the project period (over $2.8 million with moderately escalated gas prices), assuming that the mill levy remains at the 1996 level.

4.10.4.4 Alternative 2 - Indirect Economic and Social Impacts

This subsection describes indirect economic and social impacts from Alternative 2 on SUIT, La Plata County, the State of Colorado, and COGCC.

Southern Ute Indian Tribe

Alternative 2 has substantial indirect economic and social impacts on the SUIT by providing incremental financial support to tribal government. The millions of dollars of incremental revenues which the Tribe would receive under Alternative 2 would not be enough to stem the overall decline of energy-related revenues from tribal land with declining production, but would allow tribal government to shrink more slowly than it would under Alternative 1. Incremental General Fund revenues would result in higher employment, more and better services, better preservation and development of the Ute culture, and improvements in the Reservation economy as a whole.

Incremental revenues to the Tribe are likely to decrease the loss in tribal employment. The Tribe currently spends over 45 percent of its General Fund on personnel expenses and has a Native American preference policy for employment. Over half of the employees of tribal government are tribal members. Thus a decrease in the General Fund, as under Alternative 1, is likely to result in reducing tribal employment, and a smaller decrease in General Fund revenues, as would occur under Alternative 2, is likely to result in fewer jobs being lost from tribal government, i.e., in relatively more employment for tribal members.

Incremental revenues to the Tribe are likely to decrease reductions in the amount and quality of services provided by tribal government. The Tribe provides numerous basic services both to its members and to the Reservation community as a whole, as previously described in Section 3.10. If the Tribe's General Fund is reduced significantly, services would have to be cut. Conversely, any amount of incremental revenue could be translated into incremental services provided. Also, more employment, which could also be a result of incremental revenues, would probably decrease the need for some services, such as vocational training, thereby freeing up funds for other programs.

Social and cultural bonds in the SUIT community would be stronger in Alternative 2 than under Alternative 1 as an indirect effect of increased revenues to the Tribe. The SUIT's General Fund is the primarily source of financial support for cultural and recreational programs on the Reservation such as tribal ceremonies and festivals, promotion of the Ute language, and Pow Wows. Also, more employment on the Reservation might contribute to maintaining a greater density of tribal members on the Reservation, which could also help to maintain or strengthen the Ute culture.

Sales revenues in La Plata County would be greater under Alternative 2 than under Alternative 1. Increased revenues to the SUIT government would indirectly result in greater spending on everything from office supplies to new construction. Most of this money would be spent in La Plata County. Second, increased employment and higher personal income would increase spending in the area by tribal government employees and further boost the local economy.

La Plata County

Alternative 2 would have a positive indirect impact on La Plata County residents, especially taxpayers, compared to Alternative 1. Alternative 2 results in $16 million more in property taxes assessed on gas production compared to Alternative 1. Assuming that mill levy ratios do not change substantially and wells continue to be located primarily in unincorporated areas, about 80 percent of the tax revenues ($12.8 million) would go to the local school districts, and 19 percent ($3 million) would go to the county, with municipalities and special taxing districts picking up the last 1 percent. All these entities have several revenue sources besides property taxes and are all expected to continue to grow, so it is difficult to predict exactly how the incremental revenues from infill would affect budgets or services within the county.

School Districts

Incremental property taxes due to infill production would allow minimum per pupil school budgets to be maintained with lower mill levies and lower equalization payments from state government. Recently, property taxes from oil and gas production have contributed 25 to 30 percent of school district revenues in La Plata County. Decreases in property taxes due to falling gas production can be compensated for by increasing mill levies or by increasing the state's equalization payments to the school districts. As discussed above, incremental property tax collections totaling $16 million (in 1997 dollars) would be collected over 20 years due to infill production on tribal land, assuming mill levies remain constant. This represents a total of $12.8 million, or an incremental greater than $600,000 per year, in school districts' funding that would come from local gas producers rather than from other taxpayers via increased mill levies or the state education budget.

Induced Economic Activity

Induced economic activity would be incrementally greater over the next 20 years in Alternative 2 compared to Alternative 1. Due to the greater number of wells to be maintained under Alternative 2, local purchases of equipment and services for CBM production would be substantially higher than they would be under Alternative 1. Energy-related employment would increase by about eight jobs per year, so there would be a gradual increase in the total personal income of all energy industry employees and therefore an annual increase in their spending. Finally, incrementally increased revenues to the SUIT and its employees and to other royalty owners should translate into increased spending in the local economy.

4.10.4.5 Alternative 2 - Direct Social Impacts

This subsection describes direct social impacts of Alternative 2 on lifestyles, population, housing, and other services.

Lifestyle

Social concerns raised during scoping include disruption of neighborhoods and properties by site workers, effects on quality of life for rural residents, and the effects of boom-bust economies on local communities. Specific issues concerning quality of life relate to water quality, traffic, and other topics that are addressed elsewhere in this EIS. The rural lifestyle which characterized most of the Reservation would be more affected by drilling and related activities under Alternative 2 than under Alternative 1 because of its relatively higher levels of industrial activity. However, with respect to the boom-bust economic cycle, the decline in the oil and gas economy would be less severe under Alternative 2 than Alternative 1 because of greater activity in the industry for more years under Alternative 2. Oil and gas development on the Reservation is limited by approvals from various tribal departments as well as by the BLM and BIA. These agencies are charged with protecting the homes and other surface uses as well as the Tribe's natural resources, including wildlife, water quality, visual quality, and air quality. Oil and gas development activities are studied to avoid significant negative impacts, such as locating facilities too close to houses or archaeological sites. Surface owners can be compensated for economic losses, such as crop losses, due to oil and gas production activities.

Oil and gas extraction activities have coexisted with ranching and farming in La Plata County since the 1940's. Ignacio Blanco Field, which lies almost entirely within La Plata County, already contains more than 1700 wells. The Fruitland pool is currently spaced at 320 acres, but producers have obtained orders from the COGCC allowing the development of optional infill wells on more than 125 spacing units. Most of the Fruitland wells were drilled around 1990 due to federal tax credit legislation, which resulted in a peak of over 200 new wells permitted in one year. The addition of 32 wells per year under Alternative 2 would produce only minor changes in the Reservation's 685,000 acre rural landscape, especially as existing wellbores, roads, and pads would be used wherever possible.

Population

Employment under Alternative 2 is expected to experience very slight growth (about eight new total full-time equivalent jobs per year for construction and operation of both wells and compressors) during the life of the project. This magnitude of employment growth would not cause significant population changes in La Plata County, which has a workforce of about 25,000, let alone in the five-county area of interest. Many of the service jobs added would be staffed out of Farmington (San Juan County, New Mexico) or Cortez (Montezuma County, Colorado). Given the low wages paid for most jobs in La Plata County, however, any additional employment by the oil and gas industry, which pays relatively well, would be a benefit to the area. Both La Plata and San Juan Counties have experienced the business cycles associated with fluctuations in oil and gas production.

Housing

Because La Plata County is already predicted to grow relatively quickly in the next few years, a slight increase in employment under Alternative 2 should not provide any noticeable strain on local housing. Any employees entering the area due to this project would have relatively high paying gas industry jobs and should be able to afford adequate housing.

Other Services

Because Alternative 2 would not significantly change the population of the five counties of interest, no noticeable strain on services such as water, school, and police protection is expected due to increased demand. However, increased financial support of these services from the SUIT General Fund due to incremental revenues from infill gas production should indirectly result in incrementally better services, especially for tribal members, under Alternative 2 compared to Alternative 1.

4.10.4.6 Alternative 2 - Long-term Impacts (2018 to 2065)

This subsection addresses direct and indirect long-term impacts of Alternative 2, including economic, fiscal, and social impacts.

Long-term Economic Impacts

In Alternative 2 compared to Alternative 1, more people would be employed in operations and in reclamation from 2018 to 2041. This would directly increase overall personal income in La Plata County, including the Reservation, compared to Alternative 1. As production declines in both alternatives, jobs would be lost from operations and be created in plugging and abandoning, removal of facilities, and land reclamation. Alternative 2 develops almost twice as many wells as Alternative 1, so the total employment under Alternative 2 for long term operations and, ultimately, for reclamation would be much higher than in Alternative 1. Table 4-47 shows the employment requirements for operations and reclamation. Both tribal members and nontribal members would be affected by the ultimate decline of employment.

In Alternative 2 as in Alternative 1, sales and services after the year 2017 would be primarily related to operations and reclamation. Because more wells and compressors would be operating each year in Alternative 2, more maintenance work would be done and more equipment would be purchased. As with employment, the inevitable decline of production would cause a shift of purchases and services from operations into reclamation activities. This shift would begin at about the same time in Alternatives 1 and 2, but would involve more employment and money in Alternative 2. Reclamation of each well and well site including the access road, would require about 41 days (Table 4-46), which means the 286 incremental wells in Alternative 2 would require about 47 incremental years of equivalent full-time employment to reclaim. Deinstallation of each compressor would require about 24 days, or a total of approximately 3 years of equivalent full-time employment for deinstallation of all 30 compressors in Alternative 2.

In Alternative 2, royalties, production payments, and other volume-related fees would stay higher in the long-term compared to Alternative 1. This would provide incremental income to all royalty owners, especially the SUIT. The impact of increasing the Tribe's energy-related revenues was previously discussed in detail under Sections 4.10.4.3, 4.10.4.4, and 4.10.4.5 (Direct Fiscal Impacts, Indirect Impacts, and Direct Social Impacts, respectively). The relative increase of royalty payments to other royalty owners would result in a relative increase of personal income for those persons and perhaps of spending in the local economy.

Long-term Fiscal Impacts

In the 20 years following the project period, the SUIT would receive an average of $1 million per year in incremental revenues due to widespread infill. Most of the incremental gas reserves due to infill development would be produced during the 20-year project period, so additional long-term fiscal impacts could accrue depending on how the incremental revenues received during the project period are managed.

La Plata County would collect cumulative incremental property taxes due to widespread infill production of about $4.5 million in the years 2018 to 2041 using a flat price scenario and current mill levies. These incremental taxes would peak in 2018 and decline thereafter averaging $196,000 per year over the 23 years. Using present day mill levy ratios, this equates to about $157,000 in incremental revenues per year for La Plata County school districts, $37,000 per year for the County budget, and $2,000 per year for the other taxing districts.

All five counties in the area of interest could also reap incremental sales taxes from the relatively larger sales to a relatively larger industry and from relatively greater personal income due to greater employment.

Long-term Social Impacts

The long-term social impacts of Alternative 2 would be founded in how the SUIT elects to manage incremental revenues it receives during the project period as well as in the long term. The Tribe's recent budget decisions suggest that it would probably continue to invest its resources in a broad range of programs designed to provide its members and its community with adequate basic services and long-term opportunities including employment in a diversified economy. The additional labor required to operate and ultimately to reclaim infill wells would also have a positive indirect social impact of increasing personal income and quality of life for a few workers.

4.10.5 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

4.10.5.1 Summary of Alternative 3

In Alternative 3, 70 nitrogen injection wells would be added to the Ignacio Blanco field on tribal land for enhanced coalbed methane (ECBM) recovery in addition to completing the 636 well development program of Alternative 2. Nitrogen distribution systems also would be built. Incremental labor and permitting for the nitrogen injection projects was modeled to begin in 1999, but construction and incremental gas production from the ECBM process was modeled to begin in 2000. Twelve additional compressors would be installed compared to Alternative 2.

As illustrated on Figure 4-6, Alternative 3 would add 79 percent, about 1.1 tcf, to the cumulative CBM production after 1997 compared to Alternative 1 and 34 percent, about 780 mcf, compared to Alternative 2. Incremental production from the ECBM program (compared to infill alone) is projected to peak in 2037 at over 19 bcf per year. Although ECBM would add over 122 bcf of production from tribal land during the project period compared to infill alone, the majority of the incremental production from the ECBM program, about 656 bcf, occurs after 2017. This magnitude of incremental production makes the long-term benefits of the program at least as significant as the benefits during the project period.

Incremental gas production in Alternative 3 would have important fiscal, economic, and social repercussions for the SUIT compared to Alternative 1. During the project period, severance tax and royalties/production payments on incremental production from tribal acreage is estimated to add $118 million to tribal revenues ($163 million with moderately escalated gas prices). Over the 62-year life of the field, Alternative 3 would provide the SUIT with incremental annual revenues from the tribal acreage of $273 million ($609 million with moderately escalated gas prices). Other energy-related revenue which the Tribe collects, such as fees, bonuses, penalties, and interest, could add another 10 percent to each of the above calculated incremental revenue values. The Tribe's interest in the Red Cedar Gathering Company would also generate millions of dollars of additional income for the Tribe from transportation of the incremental gas. This level of incremental revenue is expected to provide significant fiscal support to the SUIT government and thereby indirectly provide employment and essential services for tribal members.

Incremental production due to ECBM would result in more property tax collections than under Alternative 1, thereby supporting La Plata County, La Plata County school districts, municipal governments, and other special taxing districts. This would benefit all county taxpayers by spreading expenses over a much larger base of assessed properties, thus allowing mill levies to remain lower. It would also cut the amount of equalization funding needed from the state for the school districts.

In Alternative 3, approximately 35 wells would be drilled or recompleted each year. As a direct result of this relatively larger drilling program, Alternative 3 would increase gas industry employment and sales in the Four Corners area by 10 to 16 percent over Alternative 2 and by 150 to 300 percent compared to Alternative 1. Employment, personal income, and spending would peak in the last year of drilling activities, but would also be increased in the long term due to greater employment and spending for operations and reclamation. Reclamation would be delayed relative to the other alternatives due to the longer economic well lives.

4.10.5.2 Alternative 3 - Direct Economic Impacts

This subsection describes direct economic impacts under Alternative 3 for employment and personal income; direct spending; and lease, royalty and production payments.

Employment and Personal Income

Direct employment would be higher under Alternative 3 than under the other alternatives (Figure 4-8). Nearly 3,800 years of equivalent full-time employment would be needed during the project period for drilling and completing new wellbores; recompleting reusable old wellbores; installing roads, pads, flowlines, compressors, and water lines; and operating the new wells and compressors. The annual rate of development on the Reservation would be more than twice that of recent years, so about 15 new full-time-equivalent jobs would be added in the Four Corners area in the construction industry. Maintaining and operating the new wells and compressors would add about 12 to 14 jobs per year, compared to only 5-6 additional jobs per year in Alternative 1 and 12 to 13 in Alternative 2 (Figure 4-8). Many of the operating jobs would continue well after the project period.

The increased activity of Alternative 3 could have a small to moderate effect on salaries in the gas industry in the Four Corners area during the twenty year life of the project. As in Alternatives 1 and 2, however, the gradual nature of the program may dampen these effects.

Direct Spending

The flat rate of development modeled for Alternative 3 (35 wells per year) would provide the largest sustained increase in the local economy of the three alternatives, an average of $11 million per year from direct spending for construction alone (Table 4-47). The 706 new wells which would be developed in Alternative 3 are estimated to cost $215 million in 1997 dollars (Tables 4-47 and 4-48). Approximately $83 million would be tangible costs (equipment, tubulars) which pass directly out of the local economy to suppliers and manufacturers elsewhere. The $132 million of intangible costs (primarily labor) would turn over in the local economy. Compressors would cost $60 million in Alternative 3 (Tables 4-47 and 4-48), an incremental of $48 million over Alternative 1 and $30 million over Alternative 2. The intangible portion of direct spending in Alternative 3 would provide an incremental value of about $3 million per year to the local economy compared to Alternative 1 (Table 4-49).

Lease, Royalty, and Production Payments

In Alternative 3, production would decline less sharply during the life of the project than in Alternatives 1 or 2. Because of the higher production every year, higher royalties would be paid to all royalty owners, particularly the SUIT. The Tribe would also collect greater revenues each year from surface lease fees. The impacts of increasing the Tribe's income from lease fees and royalty/production payments are discussed below under Direct Fiscal Impacts, Indirect Impacts, and Social Impacts. Higher royalty payments to other royalty owners (e.g., nontribal members whose land is communitized with tribal land) would result in greater personal income for those persons.

4.10.5.3 Alternative 3 - Direct Fiscal Impacts

This subsection addresses the direct fiscal impacts of Alternative 3 to SUIT, La Plata County, the State of Colorado, and COGCC.

SUIT Government

Alternative 3 would have significant direct positive impacts on the fiscal strength of the SUIT government during the project period. The steep decline of gas production from the Ignacio Blanco Field over the next twenty years would inevitably impact the Tribe's fiscal health, but under Alternative 3, production would be higher than under Alternatives 1 and 2 in every year after 1999, so tribal energy revenues also would be higher in every year. The incremental revenues from the tribal land would provide a buffer projected at $5.9 million per year ($8.1 million with moderately escalated prices) compared to Alternative 1 and $1.8 million per year compared to Alternative 2 ($2.4 million with moderately escalated prices). These incremental revenues would be a substantial source of funding for basic health, safety, and quality-of-life programs currently enjoyed by tribal members and their community.

ECBM would extend the economic life of the Ignacio Blanco (Fruitland) Field by 19 years and add hundreds of millions of dollars to tribal energy revenues. The Tribe's revenues from severance tax and royalties/production payments are projected to be about $118 million higher over the life of the project (1998 to 2017) in Alternative 3 than in Alternative 1 (about $163 million higher using moderately escalated prices) (Table 4-49). Over the life of the field (1998 to 2060), the Tribe is predicted to realize incremental revenues of $273 million ($609 million with moderately escalated gas prices) (Table 4-49). Other energy related revenues, such as fees, bonuses, penalties, and interest, could add an additional 10 percent to those calculated values. The Tribe's interest in Red Cedar Gathering Company would also generate tens of millions of additional revenues for the Tribe from transportation of incremental gas.

State of Colorado (Severance Tax)

State severance tax paid on production from properties covered by this EIS would fall to zero under Alternative 3 as in Alternatives 1 and 2. Production would decline even with the ECBM program, and producers are likely to offset the assessed value of their production with property taxes paid in the same year as the state severance tax assessment.

La Plata County

Alternative 3 would buffer La Plata County from the inevitable decline of property tax revenues which would accompany declining gas production. From 1998 to 2017, the incremental production of Alternative 3 would result in an estimated cumulative incremental property tax collection in La Plata County of $23 million compared to Alternative 1 and $7 million compared to Alternative 2, assuming a flat gas price and average total mill levy of 0.045.

Assuming mill levies remain constant, La Plata County school districts would receive a total of about $18 million in incremental revenues during the project period from Alternative 3 compared to Alternative 1. La Plata County government would realize incremental budget revenues of about $215,000 per year during the next twenty years and cumulative incremental revenues of over $4 million compared to Alternative 1. How incremental property taxes from gas production would affect the county and school budgets of the future on a percentage basis would depend largely on changes in other revenue sources such as sales tax.

Colorado Oil and Gas Conservation Commission

Alternative 3 would provide incremental revenues to the COGCC's conservation fund compared to Alternative 1. The levy is based on sales revenue and so would decline directly with production. The incremental production from Alternative 3 compared to Alternative 1 would result in a cumulative incremental levy over twenty years of over $2.6 million in 1997 dollars (nearly $4 million with moderately escalated gas prices), assuming that the mill levy is not changed from 1996. This is about one and one half times the total administrative levy collected in 1996 ($1.8 million).

4.10.5.4 Alternative 3 - Indirect Economic and Social Impacts

This subsection addresses the indirect economic and social impacts of Alternative 3 on SUIT, La Plata County and school districts, and induced economic activity.

SUIT

Alternative 3 would have significant indirect economic impacts on the SUIT. Alternative 3 would provide the Tribe with $118 million of cumulative incremental revenues from severance tax and royalties/production payments compared to Alternative 1 ($163 million with moderately escalated gas prices). An incremental increase in revenues to the SUIT is expected to translate into higher employment, especially for tribal members, less strain on local social services, stronger cultural development/preservation, and improved economic health of the area, especially the Reservation.

Incremental revenue to the Tribe is likely to translate indirectly to jobs, especially for tribal members. The Tribe spends over 45 percent of its General Fund on personnel expenses, is the largest employer of tribal members, and has a Native American preference policy for employment. As was discussed for Alternative 2, a decrease in the Tribe's General Fund due to lower energy-related revenues is likely to decrease employment proportionately. Incremental increases in energy-related revenues are likely to result in incremental increases in employment by tribal government, especially of tribal members.

Services provided by the SUIT government should be greater under Alternative 3 than under the other alternatives. First, the General Fund could be larger so more money would be available to support all services. Second, an incremental increase in employment under Alternative 3 might indirectly cause a decrease in need for some services, such as vocational training, which would free up funds for other programs.

Social and cultural bonds in the SUIT community would be stronger under Alternative 3 than under Alternatives 1 or 2 as an indirect effect of increased revenues to the Tribe. Increased revenues to the SUIT's General Fund would probably lead to more funding for numerous cultural and recreational programs such as tribal ceremonies and festivals, promotion of the Ute language, and Pow Wows. Also, incrementally higher employment on the Reservation may prevent emigration of tribal members from the Reservation.

Increased revenues to the SUIT government would indirectly increase sales revenues in La Plata County and on the Reservation under Alternative 3 compared to Alternatives 1 and 2. With a larger General Fund budget, the SUIT government would spend more on equipment, supplies, and services. Also, increased employment and personal income of tribal members and other SUIT employees would result in higher retail sales in the area.

La Plata County

Alternative 3 would have a positive indirect impact on La Plata County residents, businesses, and property owners compared to Alternatives 1 and 2. Alternative 3 results in greater property taxes assessed on gas production in La Plata County, so the tax base is greater and mill levies can be lower for all taxpayers in the county. It is difficult to predict exactly how much the incremental revenues from Alternative 3 would effect the mill levies, budgets, or services in the future due to the number of variables involved.

School Districts

Oil- and gas-related property taxes have in recent years contributed 25 to 30 percent of school district revenues in La Plata County. As gas production falls, property tax assessments would also fall, and school districts in La Plata County would have to receive larger equalization payments from state government in order to maintain minimum per pupil school budgets. A cumulative incremental property tax collection of $23 million in Alternative 3 (compared to Alternative 1) means about $18 million for the local school districts would be collected from local gas producers during the project period rather than from all state taxpayers via the state school budget or from all property owners via increases in mill levies.

Induced Economic Activity

Induced economic activity would be incrementally greater under Alternative 3 compared to Alternatives 1 and 2. Due to the greater number of wells to be maintained under Alternative 3, local purchases of equipment and services in the gas industry in each of the next 20 years would be nearly twice what they are today. Energy-related employment and total income of energy employees would increase slightly each year. This would have the positive economic effect of increasing retail sales in the county.

4.10.5.5 Alternative 3 - Direct Social Impacts

This subsection addresses the direct social impacts of Alternative 3 on lifestyles, population, housing, and other services.

Lifestyle

Social concerns raised during scoping include disruption of neighborhoods and properties by site workers, effects on quality of life for rural residents, and the effects of boom-bust economies on local communities. Specific issue concerning quality of life relate to water quality, traffic, and other topics that are addressed elsewhere in this EIS. The rural lifestyle which characterizes much of the Reservation would be most affected by drilling and related activities under Alternative 3 since it represents the highest level of industrial activity. However, with respect to the boom-bust economic cycle, Alternative 3 features the most gradual decline of production, spending and employment and therefore is expected to have the least dramatic “bust” cycle of the three alternatives.

Oil and gas development on the Reservation is limited by approvals from various tribal departments as well as by the BLM and BIA. These agencies are charged with protecting the homes and other surface uses as well as the Tribe’s natural resources, including wildlife, water quality, visual quality, and air quality. Oil and gas development activities are studied to avoid significant negative impacts, such as locating facilities too close to houses or archaeological sites. Surface owners can be compensated for economic losses, such as crop losses, due to oil and gas production activities.

Oil and gas extraction activities have coexisted with ranching and farming in La Plata County since the 1940s. Ignacio Blanco Field, which lies almost entirely within La Plata County, already contains more than 1700 wells. The Fruitland pool is currently spaced at 320 acres, but producers have obtained orders from the COGCC allowing the development of an optional second well, or infill well, on more than 125 spacing units. Most of the Fruitland wells were drilled around 1990 due to federal tax credit legislation, which resulted in a peak of over 200 new wells permitted in one year. The addition of 35 wells per year under Alternative 3 would produce only minor changes in the Reservation's 685,000-acre rural landscape, especially as existing wellbores, roads, and pads would be used wherever possible.

Population

Employment under Alternative 3 is expected to show very slight growth (equivalent to 128 full-time positions) over the life of the project. This magnitude of employment growth would be insignificant in La Plata County, which has a workforce of 25,000, let alone if some of the job growth occurs in the other four counties in the area of interest. Given the high rate of growth projected for La Plata County, however, any additional job opportunities would be a benefit to the area. Both La Plata and San Juan counties have experienced the business cycles associated with fluctuations in oil and gas production.

Housing

Because the oil and gas industry pays relatively high salaries, a very slight increase in employment due to Alternative 3 should not provide any significant strain on local housing. Gas field workers who move into the area are likely to have sufficient income to buy or to rent adequate housing. Some of the employment growth is likely to be in Farmington, New Mexico and Cortez, Colorado where numerous oilfield service companies are located and where housing prices are generally lower than in La Plata County (Region 9 Report, 1997).

Other Services

Because Alternative 3 would not significantly change the population of the five counties of interest, no strain on services such as water, schools, and police protection is expected from the population (demand) side. However, increased financial support of these services from the SUIT General Fund
due to incremental revenues from gas production should indirectly lead to better quality and higher quantity services, especially for tribal members.

4.10.5.6 Alternative 3 - Long-term Impacts (2018 to 2065)

This subsection addresses the long-term economic, fiscal, and social impacts of Alternative 3.

Long-term Economic Impacts

No new drilling is projected after the project period in Alternative 3. However, more wells would continue to be operated after the year 2017 than in Alternatives 1 and 2. Because more wells are operated, more persons would stay directly employed in gas well operations every year. It is estimated that at the end of the project period, 60 to 75 additional persons per year would be employed in well operations alone under Alternative 3 compared to Alternative 1. Incremental operations employment would decline through time with the plugging of wells and with declining production. As wells reach economic limits, jobs would be created in plugging and abandoning, removal of facilities, and land reclamation. Table 4-47 shows the typical employment requirements of reclamation operations. Both tribal members and non-members would be affected by the changes in employment opportunities.

In Alternative 3, sales and services after the year 2017 would be limited to maintenance and reclamation. Because more wells and compressors would be operating each year in Alternative 3 compared to the other alternatives, more maintenance and repair tasks would be done, and sales of equipment and services would be higher. Nitrogen cycling equipment or other ECBM equipment would also need maintenance and repairs, which would result in increased sales and service compared to the other alternatives.

As with employment, the inevitable decline of production and reaching of economic limits would cause a shift of purchases and services from development and operations into reclamation. This shift would occur further in the future in Alternative 3 than in Alternatives 1 and 2 because ECBM would give each well a longer economic life. Purchases of reclamation services would be highest in Alternative 3 due to the greater number of sites to be reclaimed.

In Alternative 3, royalties would stay higher in the long term compared to Alternatives 1 and 2. This would provide additional income to the royalty owners, especially the SUIT. The impact on the Tribe's royalty and production payment income is discussed below under Long-Term Fiscal Impacts and Long-Term Social Impacts. The relative increase of royalty payments to other royalty owners would result in an increase of personal income for those persons and a relatively insignificant increase in spending in the local economy.

Long-term Fiscal Impacts

In the 42 years following the project period, the SUIT would receive an average of $3.7 million per year in incremental revenues from the tribal acreage ($10.6 million with moderately escalated gas prices) alone under Alternative 3 compared to Alternative 1, a cumulative benefit of over $155 million ($446 million with moderately escalated prices). Depending on the other revenue sources which the Tribe develops in the coming decades, these incremental revenues could be a substantial part of the Tribe income. These incremental revenues should be sufficient to fund numerous valuable programs and services for tribal members.

La Plata County would collect about $30 million more in cumulative property taxes after 2017 under Alternative 3 than under Alternative 1. Using present day mill levy ratios, this equates to about $24 million in incremental revenues for La Plata County school districts, and $6 million for the County budget. As with incremental property tax payments during the project period, these incremental values represent dollars paid by gas producers instead of by other taxpayers in order to maintain services and schools in the county.

Long-term Social Impacts

The long-term social impacts of Alternative 3 would depend on how the Tribe elects to manage incremental revenues it receives. As has been previously stated, the Tribe's recent budget decisions and the structure of the new financial plan suggest that it would probably continue to invest its resources in a broad range of programs designed to provide its members and its community with adequate basic services and long-term opportunities including employment in a diversified economy.

The additional labor required to operate and ultimately to reclaim wells and other facilities would also have a positive indirect social impact by increasing personal income and quality of life for hundreds of workers. Reclamation of industrial sites would restore the rural character of the area.

4.10.6 Impacts Summary

The Agency's and Tribe's Preferred Alternative, Alternative 3, provides substantial socioeconomic benefits compared to the current management case, Alternative 1, and to infill alone, Alternative 2. Alternative 3 does not have any significant adverse impacts compared to Alternatives 1 and 2. Alternatives 2 and 3 provide similar types of benefits, but Alternative 3 provides the greatest quantity of benefits due to the much greater incremental gas reserves it develops.

First, Alternative 3 would improve local socioeconomic condition on the Reservation by providing the SUIT government with additional revenues during the 20-year project period alone of over $118 million (flat prices) and as much as $163 million (escalated prices). In the long term, Alternative 3 could provide nearly $600 million dollars of incremental revenue to the Tribe, depending on pricing and actual production. This incremental funding is likely to improve the local economy, community cohesion, and quality of life on the Reservation by providing employment, basic services, local spending, and recreational and cultural resources. These benefits are designed primarily for tribal members, but many extend to nontribal members as well.

Second, Alternative 3 would directly increase employment and sales in the five-county area of interest. The infill and ECBM projects would be funded through private sources of capital. Drilling and completing wells and installing production equipment would require hundreds of millions of dollars in labor and sales of equipment and services. In addition, about 175 relatively high- paying new jobs would be created in maintaining the new wells and related field equipment.

Third, incremental gas production under Alternative 3 would provide a substantial source of property tax revenues for local school districts and governments. The three local school districts in La Plata County would gain about $18 million more from Alternative 3 compared to Alternative 1 during the project period. La Plata County's budget would receive about $215,000 per year. The COGCC's administrative levy also would receive substantial revenues.

Finally, Alternative 3 would have no significant negative social impacts. It would not raise population or strain public services. Overall, Alternative 3 would improve social conditions by increasing employment and the revenues of tribal and local governments. It would increase the amount of money which individuals have to spend on themselves and their families and also the amount that is spent on providing public services.

4.10.7 Cumulative Impacts

The five-county area of interest encompasses the northern half of the San Juan Basin, the second most productive gas basin in the continental United States. The cumulative economic, fiscal, and social effects of the oil and gas industry on the basin have been enormous, bringing billions of dollars in taxes and wages while coexisting with much of the pre-existing ranch and agricultural surface uses. These effects have been no more or less intense on the Reservation than elsewhere in the basin, but the fiscal and economic aspects have been particularly important to the SUIT.

Although oil and gas exploration in the San Juan Basin began in the 1920s, the cumulative socioeconomic impacts of the industry were largely dictated in the late 1980s when the development of unconventional gas wells qualified for tax credits. Nearly 700 tax-credit-qualified coalbed methane wells were drilled on the Reservation in just four years, forming the base of gas production on the Reservation today.

Oil and gas development in the San Juan Basin has had positive economic and fiscal impacts on the five-county area. Because the oil and gas industry pays relatively high salaries, as well as substantial royalties and property, severance, and sales taxes, it injects a relatively large amount of money into communities relative to the increase in population which it brings. Rather than straining basic services, growth in the oil and gas industry improves the local economy and the services provided in an area. First, both oil and gas workers and the companies they work for pay substantial taxes, which supports publicly provided services. Second, oil and gas workers spend their income primarily in the communities of the basin, thus supporting thousands of other local jobs. The oil and gas industry has directly provided hundreds of relatively high-paying, long-term jobs for a broad range of skill levels in the San Juan Basin. The economy of Farmington, New Mexico is largely dependent on the San Juan Basin oil and gas industry.

Oil and gas development has been a socioeconomic boom for the SUIT. Because tribal government is the largest employer of tribal members and provides a broad range of services, the economic and social well-being of the Tribe as a whole is tightly linked to the fiscal health of tribal government. In the past decade, the Tribe's General Fund budget has roughly tripled due to growth in energy- related revenues. The quality and quantity of fundamental programs and services has increased, as has employment, particularly of tribal members. The Tribe has simultaneously been investing in enterprises to diversify the Reservation economy and making per capita payments.

Oil and gas development has proven itself to be compatible with ranching and agricultural surface uses and would not disrupt the rural culture of the Reservation. As described in Chapter 3.6.4, Existing Land Uses, about 90 percent of the Reservation land is classified as "tribal or fee multi-use" or "Southern Ute Designated Grazing Units," both of which imply by definition the coexistence of grazing with gas production. Another 260 producing gas wells are located on acreage with other agricultural classifications.

4.10.8 Mitigation Summary

The economic and fiscal impacts of the three alternatives are generally positive because additional drilling and operating activity is generated in each. The greatest amount of activity is generated in Alternative 3. A combination of formal reviews by the Tribe, county, state, BIA, and BLM, and informal relationships between operators and surface owners already minimizes the effects of oil and gas development on ranching, agricultural, and open space surface uses on the Reservation.

The most undesirable socioeconomic scenario considered (large-scale losses of employment, personal income, and basic services) would follow from the large declines in revenues, especially to the SUIT, under Alternative 1. These impacts would be reduced by additional diversification by the SUIT. However, the SUIT government is already aggressively pursuing means to diversify and while many of these measures (e.g. the Casino) have been successful, they are inadequate to address the magnitude of the reduction in oil and gas revenues or the rate at which the reduction may occur.

4.10.9 Unavoidable Adverse Impacts

The inevitable decline of production from all productive horizons in Ignacio Blanco field would have unavoidable, adverse, direct and indirect socioeconomic impacts. Direct economic impacts would include losses of jobs and declines in sales of equipment and services. Direct fiscal impacts would include loss of revenues to the SUIT Government, La Plata County, and other taxing entities. Indirect economic impacts would include loss of employment financed by the SUIT and by industry contractors and loss of spending in the local economy due to lower employment and lower spending by the SUIT. Negative social effects could include loss of cultural programs and basic services previously financed by the SUIT and possibly loss of services in the county or in the school districts.

The losses of employment and spending which would accompany production declines under any alternative would be modestly buffered by a temporary increase in well plugging and reclamation services. Employment, sales, and services would shift from development and maintenance areas to reclamation.

4.11 NOISE

4.11.1 Issues, Impact Types, and Criteria

Noise impacts associated with oil and gas development vary according to the activities and processes used in development and production phases. Construction phase noise levels would be associated with access roads and well pad construction, drilling, installation of compressor equipment, and construction of pipelines. Production phase noise levels would be associated with well completion and dewatering and compressor engine operation. Other production noise would be associated with well workovers and maintenance operations involving a variety of equipment and vehicles. Produced water not directed to a pipeline gathering system would be trucked to offsite water disposal wells or permitted evaporation ponds resulting in additional vehicle trips and noise.

The key issues regarding noise are (1) protection from hearing loss for industry personnel, (2) prevention of noise levels which would result in distraction from or unawareness of a potentially dangerous situation, such as heavy equipment in motion, and (3) prevention of annoyance to other nearby but unrelated land uses. The oil and gas industry is generally very safety conscious, including the issue of hearing loss and noise-related accidents. Industry personnel are commonly trained to use hearing protection and to use extra caution when working around noisy machinery to prevent accidents. The EPA has published guidelines for the threshold sound loudness level above which hearing loss may occur (see Section 3.11). The COGCC has noise standards for oil and gas industry operations on fee (nontribal) land.

There are no guidelines from the EPA, BLM, Tribe or State for what constitutes noise at the "annoyance" level. Sounds that are annoying to one person may be innocuous to a second person and even pleasant to a third person. Sounds come in an enormous variety of pitches, loudnesses, timbres, and rhythms. Based on different land uses, noises that are annoying in one area may be completely innocuous in other areas. Recognizing the inherent subjectivity around noise issues on the Reservation, the SUIT has elected to handle them on a case-by-case basis. Criteria for imposing mitigation include the source of the noise, ease and cost of making changes in the source or adding mitigation features, level of annoyance from the noise, and benefits that are related to the source of the noise.

4.11.2 Impacts Common To All Alternatives

4.11.2.1 Construction

Impacts from construction would be temporary and would result primarily from heavy equipment operation and vehicle traffic. The specific location of wells within well windows within the Study Area are not known and therefore not addressed in this programmatic EIS. In cases where existing well pads cannot be used, ambient noise levels would increase as a result of clearing, grading and construction of pads and access roads, requiring an average of three days per site. Rigging up, drilling, and rigging down would generate noise at all well sites. Specific noise generating activities would include hauling equipment and supplies to the well site, rig construction, drilling wells to the required depth, and removal of drilling equipment. This work would require about eight days per well and would result in noise generated by truck traffic on unimproved roads, noise from diesel-fired drilling rig engines, and noise from operation of drilling rig drawworks, such as braking.

Construction equipment may include truck transported drill rigs, cement, pump, and water trucks; miscellaneous hauling and pick-up trucks; cranes, bulldozers, backhoes and welding equipment. Construction traffic carrying materials and heavy equipment to well sites would cause a temporary increase in the normal vehicular traffic noise on access roads.

New compressor capacity is anticipated to be installed within existing operational compressor stations or at other existing oil and gas facilities. Noise associated with compressor installation would be limited to noise of heavy vehicles used to transport the compressor equipment for installation. Most new compressor station sites are anticipated to be constructed at the same locations as existing oil and gas facilities. However, slight modifications to existing sites, such as clearing and grading, may be necessary to accommodate additional compressors.

Well completion and testing would generate noise. Operation of equipment for cementing well casing, fracturing the well, and flaring of gas at the surface during completion would produce noise. The duration of these activities would average 25 days per well with flaring of natural gas occurring over a maximum period of about seven full days. When possible, completion operations would occur only in daylight hours.

Typical noise levels from construction equipment are presented on Figure 4-12. The sound levels shown in the figure are at a distance of 50 feet. Estimates of noise attenuation can be made by reducing noise levels by a factor of 6 dBA for each doubling of distance. The actual noise levels experienced by a receptor would depend on the distance of the receptor from construction activities, topography, vegetation, and meteorological conditions. Residences located in close proximity to construction activities could experience a high impact level of noise. However, less than 2 percent of the land area within the Study Area is occupied by residences; therefore, the overall potential for construction noise impacts on sensitive receptors is predicted to be low.

4.11.2.2 Production

Typical noise impacts during production would include light vehicle traffic related to well supervision and vehicle traffic and tasks associated with the maintenance of surface production equipment. Maintenance tasks could use pump trucks, welding trucks, backhoes, and wench trucks. These activities would be expected to generate noise levels in the range of 50 to 80 dBA at 50 feet. In addition, it is anticipated that each well would be worked over using a truck-mounted rig on an annual basis. Noise levels from this source would be expected to be in the range of 70 to 90 dBA and would normally require one day per workover.

Compressor station operations and pumpjacks represent the major noise source associated with production. Pumpjacks create an incessant, moderately loud type of noise. Compressors create incessant, loud noise. As part of a study of oil and gas development, sound levels were measured at existing oil and gas facilities in the Cottonwood Gulch and Ignacio areas (Woodward Clyde 1988). The average Ldn ranged from 44 to 69 dBA, the highest value being recorded at a distance of 500 feet from a compressor station. A summary of the measured levels is presented in Table 4-51. Worst case sound levels were corrected to a reference value of 50 feet.

TABLE 4-51
Noise Levels Associated with Oil and Gas Activity

Noise Source	Sound Level at 50 feet*
Well Drilling	83 dBA
Pump Jack Operation	82 dBA
Produced Water Injection Facilities	71 dBA
Gas Compressor Facilities	89 dBA

Source: Woodward Clyde 1988 (raw noise data)
*Sound levels are based on highest measured sound levels and are normalized to a distance of 50 feet from the source.

Additional compressor capacity when added at existing compressor facilities would result in a small cumulative impact. Since decibels are logarithmic, individual unit noise levels cannot be added together. For example, if noise levels of two compressors located side-by-side were measured at 70 dBA each, the combined noise would be 73 dBA, not 140 dBA. A simplified method for summing two or more noise sources is as follows:

When Two Decibel Values Differ By	Add the Following Amount to Higher Value
0-1 dBA	3 dB
2-3 dBA	2 dB
4-9 dBA	1 dB
10 or more dBA	0 dB

Source: FHWA 1980

FIGURE 4-12Typical Construction Equipment Noise Generation Levels81/2 x 11, b/w

When it is necessary to add more than two noise levels together, the levels are ranked in ascending order and then added together two at a time starting with the lowest two levels.

Therefore the combined noise levels of more than one compressor at a facility, generally, would not be more than 3 dBA higher than the noisiest of the individual compressors. This is a small and generally insignificant cumulative impact. The additional compressors can be designed and operated to reduce noise to acceptable levels. The duration of compressor station operation is anticipated to be the period of project life. Rod pumps are the most commonly used type of pump for producing water from CBM wells. Although an operating pumpjack is not particularly loud, some people may find the regular, mechanical sounds associated with it unpleasant.

4.11.3 Alternative 1- Continuation of Present Management (No Action)

This alternative represents the lowest level of continued development and the lowest overall noise impact above baseline noise levels. Construction and production noise impacts would be as described in Section 4.11.1.

4.11.4 Alternative 2- Coalbed Methane Infill Development

Due to increased well development and reduced well spacing under this alternative, there is an increased potential of a sensitive receptor being located in proximity to construction or production activities. Much of the additional compressor station capacity would be added under this alternative. Construction and production noise impacts would be as described in Section 4.11.1.

4.11.5 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

This alternative involves a combination of CBM development, including widespread infill wells (two wells per 320-acre spacing unit), applying enhanced recovery technology through injection of nitrogen or carbon dioxide, and while also allowing conventional gas development to take place. The additional noise impact of this alternative, over and above that of Alternative 2, would result from installation of 70 injection wells and extraction, transportation, and injection of compressed nitrogen. Construction and production noise impacts would be as described in Section 4.11.1.

4.11.6 Impact Summary

Noise impacts from construction and production activities depend on conditions at each site. The actual noise impact on a receptor is determined by the equipment used; the distance between the noise source and the receptor; topography, vegetation, and meteorological conditions. The type of mitigation measures also would play a significant role in determining noise impacts. Since there are no tribal noise guidelines or standards, the Tribe would continue to evaluate receptors affected by noise and determine appropriate mitigation measures for sources located on tribal lands. Considering the mitigation that has been performed to date and the distance to receptors from existing compression facilities, no adverse impacts are anticipated.

4.11.7 Mitigation Summary

Effective noise abatement measures are unique for each situation. The physical techniques to mitigate noise vary in their sound reduction capabilities. Factors to consider when evaluating potential noise mitigation include the amount of noise reduction desired and situations where physical techniques would be most effective. Recommended measures that may be used to reduce noise impacts include but are not limited to the following:

- **Muffling**: Equipment-specific noise reduction techniques may be used to reduce noise levels for each piece of equipment. Several different grades of muffling systems have been developed for gas compressor engines and pumping units ranging from standard mufflers to hospital grade mufflers and supercritical muffling systems. Muffling systems can reduce noise levels up to 15 dBA with hospital grade mufflers. *(Based on Existing Policy or Regulation)*

- **Sound Barriers**: Sound barriers such as walls and earthen berms are commonly used to mitigate noise. Sound barriers can be effective in reducing noise from the cooling fans associated with compressor engines. The effectiveness of a barrier depends upon factors such as the relative height of the barrier and the distance from the barrier to the source. To be effective, a barrier must block the line-of-sight path from the noise source to the receptor. Properly installed barriers reduce sound levels in a range of 15 to 20 dBA. *(Mitigation Developed from SUIT EIS)*

- **Enclosures**: Construction of a building to enclose the frame portion of a compressor is very effective in reducing noise levels. Reductions between 20dBA and 30dBA can be achieved depending upon the acoustical design of the building. *(Mitigation Developed from SUIT EIS)*

- **Existing Topography**: With proper siting, existing topography and vegetation can act as natural barriers to reduce noise generated by well construction and production activities. Hills, trees, and other vegetation can be effective in reducing noise levels at sensitive receptors. The effectiveness of noise level reduction is dependent on the frequency of the noise source and the orientation of the noise source in relation to the topography and vegetation. Proper siting allows the topography and vegetation to block the line-of-sight path from the noise source to the receptor. The type and thickness of the vegetation also is a factor. *(Mitigation Developed from SUIT EIS)*

- Electric motors would be installed where practicable. *(Based on Existing Policy or Regulation)*

- Motors or compressors would be located and/or oriented to reduce noise transmission. *(Based on Existing Policy or Regulation)*

4.11.8 Unavoidable Adverse Impacts

In general, unavoidable adverse noise impacts would be minimized by locating new project facilities away from sensitive receptors and using mitigation measures to reduce noise levels. The Tribe would continue a policy of assessing each situation where noise impacts have been identified to determine the need for mitigation. This would apply to situations involving nontribal land affected by noise originating from tribal land and situations where tribal sources affect tribal lands.

4.12 HEALTH AND SAFETY

4.12.1 Issues, Impact Types, and Criteria

Potential human health and safety risks associated with implementation of well field development would include the following:

- wildfire ignitions, including those caused by direct human error
- natural gas flow line leakage, rupture, and possible fire and/or explosion
- spills of condensate or produced water
- air emission exposure
- risks associated with well field construction and operation
- fires, explosions, excessive heat, or collapse of ground surface at the Fruitland outcrop caused by coal fires
- risks potentially associated with methane seeps

Impacts would be considered significant if serious health risks were to occur to project workers and/or the general public. Impacts would be considered significant if it was determined that CBM development caused an increase in methane seeps or coal fires in heavily populated areas near the Fruitland outcrop.

Potential human health and safety risks associated with implementation of well field development that do not pose serious risks to human health and safety would include the following:

Cavitation and other well fracturing operations.

4.12.2 Impacts Common to All Alternatives

Increased human use of land within the Study Area can lead to increased risk of wildfire. Use of the area by construction crews and the general public is of concern; however, construction and production personnel would be required to adhere to fire prevention measures in all authorized activities. Use of the area by the general public should not lead to an increased risk of fire with the exception that the public may increase the potential of the introduction of an ignition source (e.g., cigarettes, campfires, chainsaws, or vehicles) to the area of a natural gas leak. All wildfires endangering life or property would be suppressed.

Hazards associated with the well field development program, including construction, production, and abandonment activities, are those hazards normally associated with the oil and gas extraction industry. A minimal risk to the public does exist for the spread of wildfire accidentally initiated by industry employees or contractors; however, the risk is minimized by the relative absence of public habitation in proximity to proposed facilities. Equipment such as compressors or heater treaters can ignite natural gas leaked from equipment or pipeline failures. Air emissions from compressor generators and other minor sources could pose a health risk to industry employees and contractors and to the public. However, as stated in Section 4.2, there would not be any significant air quality impacts under any Alternative.

Encountering high pressures while drilling (blowouts) is always a possibility. However, offset well information can be used to anticipate subsurface pressures. Over 1,000 wells have been drilled into and through the Fruitland Formation and its elevated pressures are well recognized. Generally, abnormally high formation pressures are safely and effectively controlled by the approved blowout preventer. Because it is impossible to know exactly what pressures would be encountered, all wells drilled are required to have blowout prevention equipment that would safely control any abnormal pressures encountered. Onshore Oil and Gas Order No. 2 (Drilling Operations) establishes the minimum equipment necessary to safely drill and handle specific pressure situations. All wells drilled on Indian or federal mineral estate would adhere to this order. Wells drilled on fee acreage have similar requirements administered by the COGCC. Pressure control equipment is prescribed on a site-specific basis during the APD approval process.

Hydrogen sulfide is not typically encountered while drilling any wells within the Study Area. Should hydrogen sulfide be encountered, operations involving hydrogen sulfide on federal or Indian leases are regulated by Onshore Oil and Gas Order No. 6 (Hydrogen Sulfide Operations). This order requires monitoring of hydrogen sulfide beginning at levels of 10 ppm at each drilling well or production facility. Should hydrogen sulfide levels increase, additional drilling and production equipment along with a drilling plan and public protection plans would be required.

The potential for spills or releases of produced water and/or petroleum products at the well head or during transportation exist for all alternatives. Section 3.12.5 presents a discussion of the types of spills and releases and the preventive measures required in the Reservation. Using the Tribe's release database, about 21 spills or releases could be expected annually. As identified in Section 3.12.4, none of the industry's commonly used materials are classified as acutely hazardous.

The potential for natural gas flowlines/pipeline leaks or ruptures exists for all alternatives. According to the DOT (1992), an average rupture frequency of 1 rupture per 12,000 miles of natural gas pipeline could be expected. This number includes ruptures occurring in highly populated areas, which have a high density of natural gas lines and a high incidence of construction activity unrelated to the gas lines, and thus over estimates the probability of pipeline ruptures in more rural areas such as the Study Area. Most ruptures are the result of heavy equipment accidentally striking the pipeline while operating in proximity to the gas pipeline. Such ruptures could lead to a fire and/or explosion should a spark or open flame ignite the gas being released from the rupture. Potential ignition sources include vehicles, compressors, heater treaters, or most ordinary electrical equipment. According to the DOT, 61 percent of the pipeline ruptures in the United States in 1983 occurred as a result of third-party damage.

Pipeline design, materials, construction, operations, maintenance, and abandonment practices shall be in accordance with safe and proven engineering practices and shall meet or exceed the DOT regulations (49 CFR Part 192, Transportation of Natural and Other Gas by Pipelines: Minimum Federal Safety Standards) and standard construction specifications recommended by the American Society of Mechanical Engineers (ASME-31.8) and the American Petroleum Institute (API Standard 1004).

The principal concern regarding a rupture of a pipeline carrying produced natural gas is the possibility of creating a combustible mixture of air and hydrocarbon, igniting the mixture, and causing a fire. To assess impacts, a dispersion model and gas concentration equivalent to the material's lower flammable limit was used to determine under what conditions and duration a fire hazard could exist during a rupture (BLM 1996). The dispersion model used was the SLAB model (Ermak, 1990), which was developed and updated to simulate accidental release and dispersion of materials that are denser, lighter, or neutrally buoyant to air.

In summary, the modeling results on a 12-inch diameter pipeline, a 10-inch diameter pipeline, and the smaller diameter gathering pipelines are as follows:

- for a 12-inch line, the lower flammable limit would exist only for two minutes and not exceed an area 25 to 35 feet from the rupture

- for a 10-inch line, a lower flammable limit would exist only for one minute and not exceed an area of 20 to 30 feet from the rupture

- for smaller diameter gathering lines, the gas would not provide sufficient concentrations to produce flammable conditions in the event of a rupture

The buoyancy of natural gas causes the gas to disperse quickly and reduces the probability of a rupture-related fire. Considering the low probability of a rupture combined with the low probability of homes or permanent structures existing within proximity to where flammable conditions produced from a rupture could occur, risks to property and individuals are very low.

At this time, there is not sufficient data to evaluate the impacts of infill or ECBM recovery on outcrop seeps and fires, and gathering the necessary data was considered outside the scope of this EIS. The SUIT, BLM, and industry are involved in several projects to address these issues.

4.12.3 Alternative 1 - Continuation of Present Management (No Action)

No additional impacts beyond those identified as common to all alternatives were identified for this alternative.

4.12.4 Alternative 2 - Coalbed Methane Infill Development

No additional impacts beyond those identified as common to all alternatives were identified for this alternative. Due to the increased number of wells drilled under this alternative, the aggregate probability of a health and safety incident increases during the construction phase, although the risk associated with any individual well is not affected. As most of the larger diameter pipelines and compression facilities already would be in place, the increase in potential for pipeline rupture is minimal, assuming pipeline locations are well marked and construction crews practice normal diligence when digging or excavating in close proximity to buried pipelines.

4.12.5 Alternative 3 - Enhanced Coalbed Methane Recovery (Agency's and Tribe's Preferred Alternative)

No additional health and safety impacts of natural gas development beyond those identified under Alternative 2 have been identified. However, as this alternative includes the extraction, transportation, and injection of compressed nitrogen, additional health and safety impacts were identified.

Since nitrogen is non-flammable, no explosion or fire would occur during a nitrogen pipeline rupture. However, flying soils, rocks, and other debris could occur as a result of depressurization of the pipeline.

Concentration of nitrogen in the atmosphere near a release could be very high immediately following a rupture. The exact concentration would depend on how rapidly the nitrogen is liberated from the pipeline. The main issue of concern for nitrogen is asphyxiation if oxygen in the area of the release fell below 18 percent. Assuming a 10-inch pipeline were to completely rupture with a line pressure of 2,300 psi, SLAB modeling results indicate that since the line is underground, any rupture would have some amount of vertical lift which would keep the cloud of nitrogen above the ground. Any danger zone that develops would be very close to the rupture (10 to 15 feet). This danger zone would last for about six minutes. If the release occurs from the smaller diameter pipelines, such as those within a ECBM unit, there would not be a danger zone except for the area immediately on top of the rupture. Again, block valves would be provided within the nitrogen pipelines to isolate ruptured segments.

Under the Agency's and Tribe's Preferred Alternative, each operator must have a spill contingency plan that deals with both produced water and chemical spills that could occur from construction, drilling, and production operations. Additional procedures for ECBM operators have not yet been designated.

4.12.6 Impacts Summary

Hazards associated with well field development including construction, production, and abandonment activities are those hazards normally associated with the oil and gas extraction and production industry. A minimal risk to the public does exist for the spread of wildfires accidentally initiated by industry employees or contractors; however, the risk is minimized by the relative absence of public habitation within the Study Area. Hazards on the Reservation associated with outcrop gas seeps and coal fires would continue to be monitored, evaluated, and managed by the SUIT, BIA, BLM, and operators as appropriate.

4.12.7 Mitigation Summary

The potential risks to health and safety are minimal with implementation of standard industry practices and those presented or referenced in Chapter 2, Section 2.9.2 and 2.9.3.

- ECBM operators would be required to submit a Environmental and Safety Contingency Manual to the Tribe, the BIA and the BLM. The manual would describe procedures to be used to contain spills and stop or control the source of the spill. *(Mitigation Developed from SUIT EIS)*

  Items to be addressed include the following:

  - location of spill equipment.

- procedures for immediately shutting down ignition sources in the vicinity of the release or pipeline rupture.

- location and authorization to actuate isolation block valves.

- emergency telephone numbers (company and outside notification).

- emergency chain of command.

- procedures for handling and disposing of spilled chemicals, condensate, oil, or hazardous substances and soil and other materials contaminated by the spilled substance.

- wells flowing to a central point should be identified in case the incident requires that the wells be temporarily shut in.

4.12.8 Unavoidable Adverse Impacts

Minimal risks to the health and safety of primarily the oil and gas extraction and production worker and, to a lesser extent, the public would be present for as long as oil and gas development and production occurs within the Study Area. Upon abandonment equipment and facilities that could pose a health and safety risk would be removed.

4.13 CUMULATIVE IMPACT ASSESSMENT

4.13.1 Introduction

A cumulative impact is defined in Counsel on Environmental Quality (CEQ) regulation 40 CFR §1508.7 as an impact on the environment which results from the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The cumulative impacts analysis considers the appropriate geographic area and the appropriate time period over which to evaluate each resource. La Plata County is used as the area of interest for cumulative impacts assessment for most resources. However, a larger area is considered in evaluating wildlife, air quality, water quality, and socioeconomic impacts.

4.13.2 Projects Evaluated

The actions evaluated for this cumulative impacts analysis include existing oil and gas development, other reasonably foreseeable oil and gas development in the San Juan Basin (with emphasis on development on non-Tribal land within the Study Area), community expansion, Highways, Gravel Mining, and the Animas-La Plata Water Storage Project.

Oil and gas development is expected to continue both on and off the Southern Ute Indian Reservation. The Agency's and Tribe's Preferred Alternative, is described in detail in this EIS (Section 2.4.3). In summary, it represents the continuation of oil and gas well development on tribal land at about the current pace, plus the development of 367 additional CBM infill wells, 70 injection wells for ECBM projects, and associated facilities. Other reasonably foreseeable oil and gas development includes development on nontribal land within the Study Area (586 new CBM and conventional gas), development in the San Juan Basin north of the Study Area (346 new CBM wells), and development in the New Mexico portion of the San Juan Basin (CBM, conventional gas, and oil).

With the exception of the Animas-La Plata water project, the non-oil and gas related actions that are expected are primarily related to population increases in the area. The existing environment of La Plata County and the surrounding area has been described in Chapter 3 of this document. In brief, La Plata County contains a blend of agricultural, industrial, residential, and recreational land uses. Population has increased significantly in the past decade and is expected to continue to grow in the near future. A majority of the people moving to the area do so because of the lifestyle in the area rather than due to growth in job opportunities. The growing population creates demands on community facilities, especially housing, water, and roads. Gravel mining is predicted to continue because of continued construction in the area related to growth. The two state highways through the area, Highway 550 and Highway 160, are predicted to expand as part of the Colorado Department of Transportation's statewide plans. The Animas-La Plata project is a federal project which has been the subject of negotiations for over a decade in order to satisfy in part water rights claims of the Southern Ute and Ute Mountain Ute Indian Tribes.

4.13.2.1 Existing Environment and Ongoing Oil and Gas Development

The existing environment of the Study Area and surrounding areas is described in detail in Chapter 3. In summary, the Study Area and surrounding areas are highly diverse in terms of environments and resources. Coexistence of land uses is widespread.

The oil and gas industry development within the Study Area and adjacent areas has been described in this document in Sections 1.2 , 2.1 and 3.4. The San Juan Basin is already substantially developed for oil and gas production. Today there are more than 26,000 wells in the San Juan Basin operated by hundreds of operators. Production of gas from conventional sand reservoirs was the most important play until passage of the Section 29 tax credit in the 1980 Crude Oil Windfall Profit Tax Act spurred coalbed methane development. Where the productive trends in different geologic formations overlap or where oil is produced in New Mexico, there are often more than a dozen wells in a single 640-acre section. In less prospective areas, there are only one or two producing wells in a section. Each productive trend, or play, is evaluated and has a well spacing dictated for private land by the appropriate state authorities. tribal, state, and federal authorities generally work together to set spacing on tribal or federal lands, although jurisdiction rests with the tribal and federal authorities.

Under existing COGCC spacing orders, over a dozen different wells targeting many different reservoirs could be drilled on a single section in the Colorado portion of the San Juan Basin. However, no productive conventional reservoirs have been found north of the Southern Ute Indian Reservation, so only coalbed methane is developed there. This results in a well density of two to four wells per section, depending on whether or not optional infill wells have been approved and developed.

South of the Study Area, in New Mexico, CBM is developed only on 320 acre units with no infill wells. However, infill drilling has been approved by the NMOCD for the Mesa Verde Pool in some areas. The New Mexico portion of the San Juan Basin also contains many productive horizons which are not productive in the Colorado portion of the Basin, e.g., the Gallup, and many oil fields. This results in a generally greater density of wells than in the Colorado portion of the Basin.

4.13.2.2 **Oil and Gas Development**: Summary of Impacts

Three alternatives are examined in detail in this EIS (see Chapter 2). All three describe development on tribal land. Alternative 1 considers development at about the current pace of both CBM and conventional wells under the 1990 BIA EA and existing spacing orders, which includes some CBM infill development. Alternative 2 considers the widespread development of infill CBM wells in addition to the Alternative 1 wells. Alternative 3 considers the Alternative 2 wells plus ECBM. Thus Alternative 3, has the greatest number of wells and would be expected to have the greatest potential for cumulative impacts followed by Alternatives 2 and 1.

Impacts from implementation of the Agency's and Tribe's Preferred Alternative are discussed in detail in Sections 4.1 to 4.12. The Agency's and Tribe's Preferred Alternative would, on its own, result in some significant impacts. Foremost, it would result in an irretrievable commitment of gas and oil resources to production. The development of resources would in turn have significant socioeconomic impacts on the counties near the Reservation, particularly La Plata County, Colorado and San Juan County, New Mexico. Noise and activity impacts on elk ranges would be significant. Small percentages of several wildlife habitats would be taken up by new roads and wellpads. However, riparian and wetland areas would be selectively avoided on a project basis. TES species impacts would be mitigated in compliance with federal, state, and tribal laws and practices. Other potential impacts, including increased noise, potential annoyance or disruption of other surface uses, and degradation of water and air quality, can be largely mitigated as described in Chapter 4. Impacts at the Fruitland outcrop due to CBM development are also likely to occur. These include localized vegetation die-offs, methane surface seeps, and dropping water tables. Other possible impacts include increased generation and seepage of hydrogen sulfide and increased frequency of subterranean coal fires. There is insufficient data to conclude that generation of hydrogen sulfide and increased frequency of coal fires are directly linked to CBM production. The historical occurrence of these phenomena indicate these are natural processes, but there are no quantitative data regarding the frequency, intensity, and other characteristics of hydrogen sulfide and coal fires.

4.13.2.3 Future Oil and Gas Development on Nontribal Land

Future oil and gas development on nontribal land is expected to vary within the San Juan Basin due to differences in geological potential, regulatory jurisdictions, and public health and safety issues. Three areas with different expected development futures were delineated in the Basin: the nontribal land within the exterior boundaries of the Study Area, the area north of the Reservation, and the New Mexico part of the Basin. No development is expected within the boundaries of the Reservation except in the Study Area.

Development on private land (state jurisdiction) within the Study Area was evaluated using the same quantitative GIS methods as were used to evaluate the three alternatives for development on tribal lands. Impacts from development in La Plata County north of the Study Area and development in the New Mexico portion of the basin were separately evaluated using trend analysis methods. A GIS analysis on those portions of the Basin is not reasonably available or attainable, given the many dissimilar jurisdictional, geological, and other aspects with the tribal portion of the Basin.

Gas production on nontribal land within the exterior boundaries of the Reservation is predicted to occur at about the same rate, for the same targets, and in the same physical manner, for the most part, as development on nontribal land. Non-tribal mineral interest is interspersed with tribal land (Map 2). The geologic potential of the nontribal land is similar to the potential of the nearby tribal land. Development would be almost entirely for gas, both conventional gas and CBM. Production from tribal and nontribal land is communitized in many spacing units, i.e., produced from a common wellbore. Cooperation between the Tribe, BLM, BIA, and COGCC has kept jurisdictional issues from creating non-technical boundaries on development. Most of the nontribal mineral interest acreage is already developed in approximately the same density of wells as tribal mineral interest acreage.

North of the Reservation boundary Ute line, many factors change related to development. First, there are geological changes. No significant conventional gas or oil resources have been found north of the boundary line and none is expected in the future. Map 11 shows that conventional wells are developed in the southern part of the Study Area but are uncommon near the northern boundary of the Study Area. CBM wells north of the boundary line tend to produce both more water and more gas than wells just south of the Reservation. Second, the physical surface environment is different north of the Reservation. Topography is steeper, there is more forest and less agricultural land, and there is more precipitation, particularly in the form of snow. These factors create operational issues, generally driving up operating costs. Third, residential development is denser north of the Reservation. Public use, including residential development and roads, exists close to and even on top of the Fruitland outcrop. Finally, north of the Ute Line, the COGCC and BLM have jurisdiction over development without tribal involvement, whereas south of the Ute Line, the SUIT's considerable mineral interest holdings and desire to manage those holdings in the best interests of the tribal membership could lead to substantially different development scenarios and decisions.

To date, both regulatory agencies and operators have been proceeding steadily with infill north of the Ute Line. The COGCC and BLM have not denied APD's for infill wells north of the Ute Line. However, both agencies are continuing to gather evidence regarding the impacts of infill drilling with the goal of mitigating potentially significant impacts. Substantial monitoring stipulations were imposed on the first operator to drill infill wells north of the Ute Line. The COGCC and BLM have participated, along with the Tribe and operators, in a multifaceted project called "3M" which is designed to gather and interpret data regarding the potential connection between CBM production and environmental changes at and near the Fruitland outcrop (see Section 3.4.2.1 - San Juan Basin).

J. M. Huber received a spacing order from the COGCC in 1997 allowing them to drill infill wells on 20 spacing units. Huber is drilling the wells in a phased approach (5 to 10 well per year) in order to test the performance and economics of infill wells in the area. In 1998, BP-Amoco obtained a spacing order approving infill wells on 22 spacing units scattered throughout the Ignacio Blanco Field. Four of these units lie north of the Ute Line. The units included in that application were specifically picked to test reservoir and economic factors in a variety of locations, recognizing that not all parts of the field may support infill development. South of the Ute Line, orders for infill well development in the south-central and northwestern parts of the Study Area have been granted by the COGCC to Vastar, Four Star, Red Willow, Cedar Ridge, and EnerVest. Markwest was recently granted an order allowing infill development in 15 spacing units in the southeastern portion of the Study Area. By the end of 1999, the COGCC had approved optional infill wells for 188 CBM spacing units. The BLM and COGCC independently issued optional infill spacing orders for the majority of remaining land in the Study Area by the end of 2000 (see Appendix O).

The technical and non-technical issues surrounding development north of the Reservation make it difficult to predict the future pace of development there. For the purpose of cumulative impacts analysis, infill was conservatively assumed to occur over most of the field north of the Ute Line but with fewer wells within the 1 ½ mile "near outcrop zone" adjacent to the Fruitland outcrop. It was assumed that impacts would be similar to those observed south of the Ute line, with recognition of the need to make appropriate adjustments for the differences in environmental factors, land use, and jurisdiction. The BLM and Forest Service are preparing an EIS for oil and gas development north of the Ute Line which would analyze impacts on this area in greater detail.

South of the Reservation, in the New Mexico portion of the San Juan Basin, it is similarly difficult to predict many details concerning future oil and gas development. The New Mexico portion of the San Juan Basin is different in many respects from the Colorado portion of the Basin. Most significantly, the geologic potential is different and the land use and jurisdictional situation is much different due to the substantial acreage managed by the BLM under Federal

Land Policy and Management Act (FLPMA) and the relatively small amounts of Indian, fee, and state lands. Production is governed by the New Mexico Conservation Commission, the BLM, and tribal authorities, depending on jurisdiction.

The New Mexico portion of the San Juan Basin has production from numerous reservoirs, including numerous oil reservoirs, which do not exist in the Colorado portion of the Basin. Small independent companies are likely to continue to search for and to develop small oil and gas fields. Infill of the Blanco Mesa Verde Pool to an effective 80 acre density has been approved by the New Mexico Oil Conservation Division for a specific area. This reportedly could lead to the drilling of up to 2,000 wells over the next ten years. Infill of the 320-acre CBM spacing units has not yet been approved in New Mexico. However, several pilot projects have been approved for infill spacing in the areas outside the fairway. A committee has been formed including operators and regulatory agencies to study the areas for CBM infill in New Mexico.

The New Mexico portion of the Basin is subject to different land use demands and land management considerations than in Colorado. There is substantially more federal acreage and less tribal, state, and fee acreage than in Colorado. The federal land in New Mexico is subject to the FLPMA and to the multiple use demands of the public. Tribal land in New Mexico is limited to small tracts on the east and west edges of the Basin belonging to the Ute Mountain Ute Indian Tribe, the Jicarilla Apache Indian Tribe, and to the Navajo Nation. To date, the BLM has handled development on the Ute Mountain Ute, Jicarilla, and Navajo land in New Mexico separately from its FLPMA land in its planning and decision making. The jurisdiction of FLPMA exerts a significant influence on the BLM in land use decision making.

For purposes of cumulative impacts analysis, the New Mexico portion of the San Juan Basin is predicted to have further development for the Mesa Verde reservoir (infill) and in new small fields, but no significant development of new CBM wells, including infill or ECBM injection wells. Development in New Mexico may also be impacted by the findings of future environmental or reservoir studies.

Future oil and gas development on nontribal land located north and south of the Study Area would have surface use impacts similar to impacts from development in the Study Area but in slightly different percentages on the various environments due to the different distributions of environments and land uses in each area. The distributions of land uses and differing jurisdictions would also affect development and impacts. For example, north of the Study Area much more forest would be impacted because there is a greater percentage of forest resource there. Many of the potential impacts can be mitigated.

4.13.2.4 Community expansion

Community expansion in La Plata County is expected to include growth in the residential population, related increases in commercial operations and development of county roads, and small industrial developments unrelated to mineral resources. No major industrial project, such as a power plant or new factory, is foreseen in La Plata County. Instead, community growth is expected to be based on influx of individuals, families, and retirees attracted to the Four Corners area life style. The economy of the Study Area and other nearby counties is predicted to expand but to stay distributed over the same industries that comprise it now. Road and bridge projects by La Plata County to accommodate the future growth are included in the community expansion project. Population would continue to be concentrated in the communities of Durango, Bayfield, and Ignacio, but residential development would also continue to encroach on agricultural and forested land and on oil and gas production facilities, especially in the central and northern parts of the county. Gas development is already spread throughout the area where the San Juan Basin overlaps the county. Residential development in those areas would in many places coexist with gas well development. Growth in counties adjacent to La Plata will also contribute to increased traffic on County roads

Southwestern Colorado is generally growing faster than most areas of the country (see Section 3.10.2). According to the Florida Mesa and Bayfield District Land Use Plans, population growth rates of over 3% per year were recorded during 1992-1996 (La Plata County Planning Department 1997 and 1998). La Plata County does not have any burgeoning industry which would cause people to move there for job opportunities. In fact, the opposite appears to be true: people move to the area despite poor job prospects because they value the non-urban lifestyle and recreational opportunities of the Four Corners area. Some new residents are independent of the local economy, for example retirees, telecommuters. The population of La Plata County would probably continue to grow as long as the current community attributes are maintained.

The economy of the Study Area and its surroundings is predicted to grow but to remain distributed over the same industries that comprise it now. Tourism would continue to be a vibrant and visible piece of the economy (hotels and motels, restaurants, Purgatory ski area, resorts, gift shops, and other recreational services). The SUIT would remain one of the largest single employers in the area, continuing to fund itself primarily with current energy revenues and earnings on invested revenues. About half of the Tribe's employees work at the Tribe's Sky Ute Casino, which funds itself and funnels earnings back to the Tribe. Fort Lewis College, the public school districts, and the Mercy Medical Center are also predicted to remain large employers in the area, growing in service to the area's growing population. The oil and gas industry would decline in the future with depletion of reserves and the associated decline of operations and investments.

Residential development is likely to be spread around the county although Durango, Ignacio, and Bayfield would also continue to grow. As discussed in the Florida Mesa Land Use Plan, factors such as clean air and water, wildlife, and long uncongested views have made the rural areas of the County attractive to residential developers. Durango is physically constrained from growing, and so housing there is relatively expensive and tends to be comprised of older houses. More modern and affordable houses can be found out of town, for example in Durango West, Mesa Heights subdivision, and Bayfield. Many county residents choose to live on land selected for amenities such as attractive views, isolation, space for horses, and irrigation water. Such amenities and the availability of services and utilities control the price of vacant land, which varies widely. No residential development is expected on the Fruitland outcrop within the boundaries of the

Southern Ute Indian Reservation or outside the Reservation. Map 19 shows the distribution of land uses in La Plata County, with residential use mostly clustered in the northern part of the Study Area.

The increase in broadly spaced, rural residential development in La Plata County is recognized as a problem on several counts. First, it reduces wildlife habitat. Second, it increases the cost of providing basic services, to residents such as roads and bridges, water, sewage control, electricity, and natural gas. Third, it degrades scenic views. As stated in the Florida Mesa Land Use Plan, "current subdivision practices are developing the Mesa into smaller and smaller lots, gradually eroding the very qualities that attracted most residents." Finally, it has increased in the potential for conflict between residents and gas industry development. La Plata County government is promoting the development of district plans, which include substantial input from the district residents, and has attempted to place regulations on the oil and gas industry to address residential development issues.

Commercial development in La Plata County would likely increase to meet the demands of a growing population. Commercial development is predicted to be concentrated in and near population centers due to County regulations and to the advantages of businesses being located near each other. Both the Bayfield and the Florida Mesa District Land Use Plans call for concentration of commercial uses to specific, small areas of their respective districts adjacent to major roads. This is likely to result in less conflict with oil and gas land use than residential development. Specific commercial projects that are foreseen include development of a conference center in Durango and additional development south of the Durango Mall. The conference center would increase traffic in the area but would not increase population significantly.

Recreational development is not predicted to conflict with oil and gas development in the Study Area during the project period. Most recreational development in the Four Corners is likely to occur in the towns themselves (e.g, Durango Recreation Center, Bayfield Recreation District) or in mountainous and desert public land (e.g., trails, trailhead facilities) and would not conflict with oil and gas development. A small number of recreational facilities may be developed in association with residential subdivisions (e.g., bike paths), but such development could be coordinated with oil and gas facilities. The Animas-La Plata project could include a large recreation development (reservoir) but would be outside of the current oil and gas development area. No expansion of the Lake Navajo Recreation Area is foreseen.

Community expansion would impact biological resources by changing land use and degrading habitat. Houses and new roads take away grazing and forage areas. Roads threaten migration routes, and animals of all types are often killed while attempting to cross roads. Human activity disturbs wildlife, can stress and weaken individual animals, and lowers reproduction rates. Community expansion would also potentially remove habitat (cover and forage), add noise, affect visual resources, decrease water quality and or quantity, and add traffic. It may impact soils by replacing agriculture with subdivisions. It should not impact geologic resources except by encouraging the development of gravel resources. It should be an overall positive economic impact because of increased and maintained job opportunities, diversification of the employment base, and increased tax revenues to various taxing entities which in turn provide services to residents.

The contribution of community expansion to cumulative impacts would depend on exactly where development occurs. Cumulative impacts would be less if development is concentrated, leaving more of the existing uses and wildlife habitat untouched, and greater if development is spread out so that larger areas are impacted. Both the Florida Mesa and the Bayfield District Land Use Plans call for concentrating development and maintaining agricultural land uses and wildlife habitat, especially riparian areas and migration routes, in order to minimize impacts of development on both wildlife and visual resources. However, these Land Use Plans are advisory documents only and are not binding on County Commissioners in making land use decisions for the county.

4.13.2.5 Highways

The proposed highway development projects in La Plata County are part of a long range state transportation plan and would occur regardless of growth or other occurrences in La Plata County. In contrast, road and bridge projects undertaken by La Plata County would-be directly related to changes in transportation needs within the County due to changes in residential patterns and tourism.

Highway projects which are reasonably foreseeable in La Plata County are the expansions of both State Highway 160 and US Route 550 from two to four lane roads through La Plata County. Both are tied to projections of increased population and tourism in the Four Corners area and throughout Colorado. Route 550 has been improved north from Durango to Purgatory Resort and is currently being improved and widened from Aztec, New Mexico north across the state line towards Durango. Plans are being made to expand Highway 550 all the way north from New Mexico to the south side of Durango. Highway 160 has been improved and expanded in the Durango area, and plans are being made for expansion of Highway 160 east to Bayfield.

Highway expansions would have positive socio-economic impacts but have potential for negative impacts on traffic, air quality, and biological resources. Because four lane highways would encourage travel through the county, they would encourage tourism, which brings money into the area and provides jobs. The projects themselves also bring jobs and both direct and indirect spending to the area in which the projects occur. However, increased traffic and tourism may also degrade air quality by increasing emissions and increasing travel on gravel roads. Highways can be barriers to wildlife migration and therefore can be detrimental to winter survival, especially of deer and elk, by reducing the animals' ability to access appropriate winter habitat. Highway expansion could also lead to an increased accidents involving wildlife if adequate safe crossings, such as underpasses or overpasses are not built. CDOT is consulting with state Division of Wildlife personnel regarding the development of safe crossings for wildlife between Durango and Bayfield (Kloster, 1999).

4.13.2.6 Gravel Mining

Gravel mining is the only significant solid rock mining that is expected to occur in or near the Study Area in the foreseeable future. Gravel mining is already occurring on both tribal and nontribal land in La Plata County as well as in New Mexico and would need to continue in order to provide gravel for the area's growth. Even if construction continues at the current pace, the impacts of new mines would be minimal. Few new mines are anticipated, and their potential impacts would be partially mitigated by federal and state stipulation. Also, the new mines would likely replace old mines rather than being incremental disturbances.

In July 1999, there were 43 gravel sites operating in La Plata County. These mines produced over 600,000 tons of gravel annually in recent years (County Assessor's Office Abstracts). Transportation is a major part of the cost of gravel, so local mining of gravel is desirable. New gravel mining would have minimal contribution to cumulative impacts. Although some mines could be positioned in river valleys, which tend to be valuable environmentally, they are more commonly located on topographic terraces. They are relatively small, localized in both time and space, and commonly are open for decades.

Federal, state, and local controls on mining should prevent any significant impacts. Permitting of gravel mines depends on the location of the mine. Gravel mining on tribal land requires a lease approved by the BIA, which would make stipulations regarding NEPA compliance and avoidance or mitigation of environmental impacts. Gravel mining on nontribal land is administered by the State of Colorado through its Mine Land Reclamation Board and the Division of Mines and Geology and requires a Reclamation Permit. Additional permits for discharges into the water or air, as well as county use permits, may be required for operations on nontribal land. Mines must be abandoned in compliance with federal and state stipulations.

New coal mining is not considered foreseeable. There is currently only one relatively small coal mine active in La Plata County, the King Coal Mine. It is located west of the Fruitland outcrop and mines coal from the relatively older Menafee Formation.

4.13.2.7 Animas-La Plata Water Storage Project

The Animas-La Plata project (A-LP) is a federal water storage project that has been proposed in order to partially fulfill water rights claims of the Southern Ute and Ute Mountain Ute Indian Tribes. These claims are specified by the 1988 Colorado Ute Indian Water Rights Settlement Act. A-LP originally included two reservoirs (Ridges Basin and Southern Ute) contained by two dams. The Ridges Basin dam would be located on Pictured Cliffs outcrop just southwest of Durango. Water would be pumped from the Animas River to fill the reservoir in a valley (Ridges Basin) located northwest of the dam. Total annual water depletions of about 57,000 acre feet would be made available for industrial, municipal, and limited agricultural uses. The A-LP project is considered reasonably foreseeable because there are few other alternatives for satisfying part of the Indian water rights claims.

The A-LP project was described in a 1979 Definite Plan Report and a 1980 Final Environmental Impact Statement (INT FES 80-18) to provide water for non-Indian irrigation on the western side of the Southern Ute Indian Reservation as well as partially fulfilling Indian water rights claims. Environmental concerns have prompted the consideration of much smaller and less costly projects, nicknamed "A-LP Lite" and "A-LP Ultralite", which sacrificed both Indian and non-Indian agricultural water but left both Indian and non-Indian municipal and industrial water in the project. After years of negotiations involving federal agencies, state agencies, the Ute tribes, environmental groups, and other stakeholders, the concepts for a reduced project are undergoing further environmental review. A supplement to the 1980 EIS was made available for public comment in January 2000. The Record of Decision for the Final Supplemental EIS for the A-LP Project/Colorado Ute Indian Water Rights Settlement was signed on September 25, 2000.

The A-LP was redefined by Congressional Legislation. The A-LP project is now described as a water storage project that would divert flows of the Animas and San Juan Rivers for municipal and industrial uses. It also would provide for fish and wildlife preservation, recreation facilities, and a cultural resources program. The project would store water pumped from the Animas River in Ridges Basin Reservoir.

A-LP has been challenged for many potential impacts including the conversion of an elk wintering area with the Ridges Basin reservoir, potential impacts on aquatic life in the Animas, La Plata, and San Juan Rivers, and potential impacts on businesses and recreationists due to changes in flow in the Animas River. These potential impacts and others are addressed in detail in the NEPA documents related to the A-LP Project itself. The A-LP project area is northwest of the Study Area.

4.13.3 <u>Cumulative Impacts Assessment</u>

Cumulative impacts were assessed by various resource-appropriate methods. The same Geographical Information System (GIS) that was used to estimate potential impacts from the alternatives in terms of acres disturbed was used to estimate the potential cumulative impacts in the Study Area on biological resources and land use. Where GIS evaluation was not available or appropriate, impacts were evaluated by trend analysis, extrapolation, or qualitative methods. For example, air quality modeling for the evaluation of Alternatives was done on a regional basis and results were assessed in conjunction with what is known about future non-oil-and gas pollution sources in order to assess cumulative impacts on air quality.

4.13.3.1 Air Quality

As detailed in Section 4.2.7. (Air Quality) Cumulative Impacts, no significant cumulative air quality impacts are expected under any Alternative in conjunction with other foreseeable developments in the area. As discussed in Section 4.2.1 and 4.2.5, the air quality impact assessment should be considered as a "reasonable, but conservative" upper estimate of predicted impacts which showed that no significant impacts are likely under any alternative. None of the other foreseeable development projects in the area would degrade air quality significantly. Therefore, it is unlikely that a significant cumulative impact on air quality would occur in the area under any of the Alternatives.

The Study Area currently has acceptable air quality. A recent survey determined that 87 percent of the respondents feel air quality in La Plata County is good or excellent (Seis and Fitzgerald, 1999). The survey respondents ranked vehicle emissions, the Durango-Silverton Narrow Gauge (DSNG) Train, and wood burning as the most significant sources of air pollution in La Plata County. A study of fine particulate matter ((PM_{10}) found that key particulate sources in Durango are fugitive dust (from dirt roads, winter sanding of paved roads, and windblown soil), vehicle emissions, and residential wood burning (CDPHE-APCD 1999b). Further, the Study Area's PM_{10} levels are well below the applicable Colorado and NAAQS.

Other than those sources analyzed in this assessment, no major commercial/industrial air pollution sources are anticipated to be developed in or near the Study Area. Increases in tourism, a major source of employment in the Study Area, would cause increases in air pollution primarily through increased vehicle emissions. However, potential increases in exhaust emissions would be offset by increasingly better motor vehicle control measures, required by the Clean Air Act. No increased air quality impacts from the DSNG train are anticipated. In fact, impacts from the train are likely to decrease by installation of new scrubber system in the DSNG roundhouse to reduce night-time train emissions. Pollution from the train operation between Durango and Silverton is also not likely to increase because the number of trips are limited due to operational constraints in their system.

Community expansion could contribute to air quality degradation by increasing truck and automobile traffic (increasing vehicle emissions and road dust) and increasing the volume of wood burning. However, technological advances in engine and vehicle design, an increase in public transportation, and the distributed nature of the vehicular sources over a large area, which should result in substantial dispersion of emissions and road dust, would minimize the impact from traffic growth. The amount of paved road in the area should increase over time, which would decrease road dust during most of the year. Wood burning is also unlikely to increase substantially in the future. First, new residents are likely to prefer other forms of heating which are easier and cleaner. Second, natural gas is likely to become better distributed in the county in the future, giving all residents an alternative to wood burning which is more affordable than the current alternatives, propane and electric heat.

Gravel mining is not expected to contribute significantly to air pollution in the Study Area. Individual gravel mines periodically create local dust and diesel exhaust. However, dust control is stipulated in the gravel mine permitting process and diesel emissions are a function of the number and sizes of engines used. The rate of mining today is sufficient to meet current construction needs, which includes substantial growth in the community, and future growth and construction needs are expected to remain the same. Thus, new gravel mines would simply replace existing mines and would have little or no increased air quality impacts in the Study Area.

4.13.3.2 Biological Resources

Introduction

Cumulative impacts on biological resources could be significant if adequate mitigation measures are not enacted. The key threat to biological resources is the disruption, destruction, or fragmentation of habitat, particularly in migration routes. All of the reasonably foreseeable future projects and trends would cause habitat degradation by impacting meadows, hedgerows, and forests with houses, roads, well pads, gravel pits, and other manmade structures. Future oil and gas development necessarily displaces small pieces of habitat throughout the prospective area because the oil and gas resources are broadly distributed according to established spacing patterns. In addition, community expansion is likely to be broadly distributed based an historical development patterns. Highways in the area, particularly Highway 160, disrupt migration routes.

Indirect destruction or fragmentation of habitat along the Fruitland outcrop could also occur due to environmental degradation (resulting from methane seeps and associated vegetation loss) which have been linked to CBM development. The extent of the impact is limited to the areas of coalbed outcrops, and not all outcropping coalbed seep methane in quantities sufficient to kill vegetation. The 3M model runs, completed in January 2001, indicate that methane seepage rates will increase significantly through time. These increases will occur via increased seepage rates at existing seeps, and through an increase in the areas affected by methane seepage. At this time, it is not possible to predict exactly where seeps may occur. Coalbed outcrops have been mapped in detail, yet many of the coalbeds have yet to have measurable methane seepage.

The cumulative impacts on biological resources were assessed over the geographic area of the Study Area in detail using GIS as described in Section 2.5.3. Impacts outside the Study Area were assessed by quantitative evaluation of past and anticipated CBM gas development. The species specific evaluations from the project analysis were extrapolated to take in the larger geographic area that would be impacted by the other projects considered in the cumulative impacts analysis. The cumulative impacts of Alternative 2 would be very similar to the impacts described for the Agency's and Tribe's Preferred Alternative. Alternative 1impacts would be less than Alternative 2 and 3 impacts due to less well construction and production. Percentages of habitats impacted are likely to be similar to the percentages calculated for the proposed action because expanding the area of analysis adds un-impacted areas as well as impacted areas. The absolute acreage of habitat lost may not be great compared to the acreage of habitat available. What could be detrimental, however, is widespread distribution of human development throughout the county so that no large undeveloped areas are retained or so that seasonal migration routes are disturbed.

Mitigation of potential cumulative impacts on biological resources for some species is largely possible. Impacts from continued development of oil and gas wells would be as described in Section 4.3. Potential impacts on Threatened, Endangered, and Special Status Species would be mitigated as described in Section 4.3. Community expansion projects, such as residential and commercial developments, could be specifically located and concentrated in order to lessen impacts on deer and elk habitats. Highway development should include overpasses or underpasses as needed to preserve safe migration routes.

Mitigation of potentially hazardous conditions at the outcrop is primarily through restrictions on building structures over the Fruitland outcrop. Loss of habitat or fragmentation of habitat on the Fruitland outcrop is more difficult to mitigate because vegetation die-offs do not occur on all coalbed outcrops, and the timing of die-offs differ. For example, in one area, vegetation die-offs were evident about 6-12 months after nearby CBM wells began production. In other areas, die-offs did not occur for several years after the onset of production. After 10+ years of CBM production, seepage areas appear fairly well-established although some of the affected areas are increasing in extent.

Cumulative Impacts Assessment

In the Study Area—GIS evaluation indicates that current oil and gas development plus reasonably foreseeable development on tribal and nontribal acreage would cumulatively impact less than 10 percent of the resource area (Table 4-52). Low density pinon-juniper may have just over a 10 percent resource area impacted due to the relatively large coincidence of that resource with potential CBM infill development windows. Potential loss of deer and elk severe winter range, in terms of acres, would be difficult to lower further because the potential drilling windows for wells that impact severe winter ranges would not include locations that are out of the severe winter ranges.

TABLE 4-52
Disturbance to Biological Resources from Oil and Gas Development in the Study Area

	Acres of Resource in Study Area	Current Disturbance (acres)	Current Disturbance (%)	Future Disturbance (acres)	Future Disturbance (%)	Cumulative Disturbance (%)
Bald Eagle Winter Range	58640	2462	4.2	649	1.1	5.3
Bald Eagle Winter Concentration Areas	16129	550	3.4	196	1.2	4.6
Deer Summer Range	416495	16597	4.0	3314	0.8	4.8

TABLE 4-52
Disturbance to Biological Resources from Oil and Gas Development in the Study Area

	Acres of Resource in Study Area	Current Disturbance (acres)	Current Disturbance (%)	Future Disturbance (acres)	Future Disturbance (%)	Cumulative Disturbance (%)
Deer Winter Range	391250	14904	3.8	3176	0.8	4.6
Deer Severe Winter Range	165949	7875	4.7	1114	0.7	5.4
Deer Winter Concentration Area	72046	1463	2.0	251	0.3	2.4
Elk Summer Range	73363	4066	5.5	1285	1.8	7.3
Elk Winter Range	391309	14912	3.8	3176	0.8	4.6
Elk Severe Winter Range	158365	7807	4.9	1949	1.2	6.2
Elk Winter Concentration Area	50974	2130	4.2	811	1.6	5.8
Grassland/ Shrubland	168018	8917	5.3	2558	1.5	6.8
Gambel Oak	10751	204	1.9	404	3.8	5.7
Low-Density Piñon-Juniper	14617	785	5.4	835	5.7	11.1
Medium and High-Density Piñon-Juniper	136483	4389	3.2	2604	1.9	5.1
Ponderosa Pine	16904	354	2.1	710	4.2	6.3
Wooded Riparian	8156	220	2.7	272	3.3	6.0

As discussed in Section 4.3, direct vegetation losses would affect elk and mule deer populations by reducing forage availability and thermal and hiding cover, and are of greater concern in unique and important areas, such as calving, fawning, and winter habitats. However, the most serious impact from increased well densities within wildlife habitats is likely to be the greater disturbance levels associated with increased construction and production activity, human intrusion, and additional roads and traffic. Elk have been known to be disturbed by human activities within 0.5 mile, although topography and vegetation can act as buffers and may affect this distance (Hayden-Wing Associates 1990). Deer acclimate reasonably well to disturbances such as low levels of vehicular traffic and appear to avoid areas within 600 feet of roads (Rost and Bailey 1979). Linear facilities such as roads and pipelines have the potential to cause a greater impacts on wildlife habitat than well sites since a more extensive area would be affected.

Responses of elk to installation of oil wells suggest that elk compensate for disturbances through shifts in use of range and activity centers, rather than abandonment of range, provided that the activity occupies a relatively small portion of total range of the population (Van Dyke and Klein 1996). Physiological responses to disturbances can include elevated heart and respiration rates, increased disease frequency (Ward and Cupal 1979), reduced reproduction rates and smaller body size (Douglas 1971). Therefore, level of disturbance plays a critical role in over-winter survival for elk and deer. Since elk and deer cannot consume enough calories in the winter to meet their daily minimum requirements, they depend on stored fat reserves for their metabolic needs. Even minimally disruptive actions and disturbances associated with project activities can adversely affect elk and deer populations.

Long-term direct impacts on wildlife ranges include the increased potential for disturbance of habitats as a result of project operation and maintenance activities. The zone of disturbance for elk and deer in a producing gas field can be expected to extend for a 0.25-mile radius from a well site, road, or compressor station. During this phase, disturbances would occur from production and maintenance activities at well sites and compressor stations and from traffic to and from those sites. Maintenance visits at compressor stations typically are frequent and can be as often as two to five vehicle visits per day for some of the larger compressors, although the majority of the compressors each require five to seven visits per week.

TABLE 4-53
Anticipated Noise/Human Activity Disturbance Impacts from Operation Activities on Wildlife Resources

	Acres of Resource in Study Area	Current Disturbance (acres)	Future Disturbance (acres)	Cumulative Disturbance (acres)	Cumulative Disturbance (%)
Bald Eagle Winter Range	58640	2,500	650	3,150	5.3
Bald Eagle Winter Concentration Areas	16129	550	200	750	4.6
Deer Summer Range	416495	180000	106000	286000	68.6
Deer Winter Range	391250	90000	99000	189000	48.3
Deer Severe Winter Range	165949	88000	41000	129000	77.8
Deer Winter Concentration Area	72046	4100	7400	11500	16.0
Elk Summer Range	73363	39600	19400	59000	80.0
Elk Winter Range	391309	90000	99000	189000	48.2
Elk Severe Winter Range	158365	54000	40000	94000	59.3
Elk Winter Concentration Area	50974	15000	17000	32000	62.7

Wildlife ranges that would experience some of the larger operation/maintenance disturbance impacts (Table 4-53), assuming full buildout, include elk summer range (80 percent), elk severe winter range (77 percent), elk winter concentration areas (63 percent) deer severe winter range (78 percent), and deer summer range (69 percent).

Of the other reasonably foreseeable actions for the La Plata County Area besides future oil and gas development, only community expansion has the potential to impact large percentages of biological resources habitat in the Study Area. The A-LP project, if completed, would have the majority of its impacts outside the Study Area. Gravel mining and highway development would impact relatively small areas, although they do have the potential to occur in essential locations such as on migration routes or near raptor nesting areas. Continued development of residences and commercial development throughout the Study Area, however, could significantly impact many types of wildlife, especially elk and deer. As noted in Section 3.3, these animals require forage, water, and shelter, and prefer less developed areas, that is, those with less road and housing. Acreage that is attractive for these animals, as well as for smaller wildlife, would diminish as the density of housing and roads in the Study Area increases.

Expansion of US Route 550 would probably cause an increase in traffic on that road and thereby also cause an increase in wildlife killed on the road. Route 550 lies near the Animas River (Map 20) and bisects severe winter range for both elk and mule deer (Maps 7 and 8). Expansion of Route 550 is also expected to increase residential and commercial development between Durango and New Mexico, which would also remove habitat and impact wildlife.

Cumulative oil and gas development may also potentially impact biological resources by degradation of habitat at the Fruitland outcrop. Increased methane seepage appears to be directly related to CBM development. In some areas, methane seeps at a high enough rate to kill trees and other plants growing along the outcrop. An increase in coal fire frequency may be linked to CBM development; however, the link between increased coal fire frequency and CBM development is hypothetical and little data exist to document a cause-effect relationship. Coal fires also kill vegetation. Wildlife could also be indirectly impacted, particularly as a cumulative impact, through loss of habitat.

Coal fires are a hazard because they create toxic fumes, sink holes, and areas of high heat flow as discussed in Section 3.4. Although the exact mechanism by which coal fires have started in the Fruitland outcrop is not known, it has been hypothesized that dewatering of the outcrop has contributed either to starting the fires or to perpetuating them. If dewatering is a factor in the coal fires' development, then continued dewatering in the future may contribute to the ignition or perpetuation of other coal fires on the outcrop.

North of the Study Area—The BLM and U.S. Forest Service are currently preparing an EIS for future CBM development north of the Study Area. Although oil and gas field development is only expected to occur south of the Fruitland outcrop, community expansion would continue north another 5 to 15 miles from the Fruitland outcrop to the edge of public lands. Impacts from the oil and gas industry and from community expansion would, similar to the Study Area, involve primarily the degradation of habitat, especially migration corridors. The land north of the Study Area is generally higher, cooler, and wetter, with more forest and less range and agricultural land than the Study Area. However, it includes essential migration routes such as the river valleys which provide attractive pathways through steep topography from the high mountains to the winter range. Because of the topography north of the Study Area, people would tend to develop houses and roads in the migration pathways and near riparian areas, thus increasing the probability of impacting wildlife.

Projecting northern Basin impacts, CBM development within the west side of the Northern Basin EIS study area is proceeding at a pace that would result in a density of four wells per section within the next 5-7 years based upon spacing orders issued by the BLM and COGCC in 2000. The entire west side of the analysis area contains deer and elk winter range. In contrast, CBM development within the east side of the Northern Basin EIS analysis area in the HD Mountains could proceed at a slower ten year development pace. The HD Mountains, with the exception of Sauls Creek are substantially undeveloped. The HD Mountains contain elk and deer winter range, severe winter range and winter concentration areas. In terms of overall impacts, we anticipate most of the 125,000 acre Northern Basin analysis area could be developed at a density of 4-wells per section within ten years. Direct disturbance and noise and activity disturbance would therefore affect all of representative deer and elk range in the north Basin in ways similar to that anticipated for big game range in this Southern Ute EIS Study Area.

The widening of State Highway 160 could be particularly disruptive to the essential seasonal migrations of mule deer and elk. Highway 160 traverses La Plata County from east to west. At present it is a two lane blacktop road without fencing or a median. CDOT plans to widen Highway 160 to a four lane road. There is already a problem with deer and elk mortality by traffic on Highway 160. As Highway 160 is widened and traffic increases over time, there would-be more traffic incidents on the highway involving wildlife and significant impacts on elk and mule deer populations unless mitigation measures, such as overpasses or underpasses, are constructed to accommodate safe migration. CDOT is currently preparing an Environmental Assessment to analyze improvements to Highway 160 for the stretch of road from Durango to one mile east of Bayfield, Colorado. The Environmental Assessment is tentatively scheduled to be completed in 2002.

Environmental degradation at the Fruitland outcrop could also potentially impact biological resources. Methane seepage has also been documented at the Fruitland outcrop north of the Study Area (BLM 1999). Although some of this seepage is historical and natural, the 3M Study concludes that much of the seepage has been caused or exacerbated by CBM production. As is true in the Study Area on the Reservation, the methane seeps are associated with areas of dead vegetation, but no direct impact on wildlife has been documented. Cumulative impacts could thus include increased degradation of the vegetation along the Fruitland outcrop and loss of foraging habitat and hiding cover.

South of the Study Area—Habitat fragmentation is the most serious issue affecting wildlife habitat in the New Mexico portion of the San Juan Basin (Hansen 1999). Cumulative impacts would result from the continued development of the gas industry in conjunction with development of recreational use of the public land and with residential development on private lands, especially in the La Plata, Animas, and San Juan River basins. The La Plata Coal Mine and the haul road connecting it to the San Juan Generating Station have also destroyed a large area of habitat, and numerous deer have been killed by trucks on the haul road. Because of the larger area of federal land, residential development is expected to be more concentrated around existing development than occurs in Colorado. However, residential development would still cause deer to concentrate on remaining agricultural land, which causes conflicts with farmers and ranchers.

Potential Mitigation of Cumulative Impacts on Biological Resources

Mitigation of potential cumulative impacts on biological resources includes avoidance of TES species and their environments and minimizing impact on other biological resources as presented in Section 4.3.2.8. Threatened, Endangered, and Special Status Species would continue to be protected by federal, state, and tribal regulations, such as the Endangered Species Act. Wetlands would be protected primarily by total avoidance or mitigation plans established in cooperation with the U.S. Army Corps of Engineers (Appendix B., Table B-1). Mitigation for potential disruption of deer and elk migration routes should include in State reconstruction plans, construction of wildlife overpasses or underpasses where roads, especially highways, intersect wildlife migration routes. Development of housing and commercial areas should also be concentrated in order to leave relatively large tracts of elk and deer winter range and severe winter range relatively undeveloped.

4.13.3.3 Geology, Mineral, and Soils

The cumulative impact of the reasonably foreseeable projects on geology, minerals, and soils is primarily the direct impact of irretrievable removal of gas for human consumption. There are also potential indirect impacts: the increased loss of gas due to seeps and possibly of mineable coal due to fires at the outcrop. However, the future removal of gas via wells, including infill wells, may actually decrease seepage at the outcrop and decrease the occurrences or magnitudes of coal fires. Thus, continuing production, including infill, may actually reduce seeps at the Fruitland outcrop and prevent economic loss of gas. The role of production, including infill, in exacerbating or mitigating seepage has been studied in the 3M Project (see Section 3.4).

As discussed in Section 3.4, CBM production, and specifically the dewatering that is associated with it, appears to be causing or exacerbating seepage of methane at the Fruitland outcrop. An alternate hypothesis is that this seepage is entirely natural degasification of the coal. This second hypothesis does not explain the relatively sudden and localized increases in dead vegetation near some of the seeps ~~and~~ coincident with production trends from wells located downdip of the seeps. Statistical analyses of vapor tube data shows increasing trends in methane concentrations in soil gas at Valencia Canyon, Carbon Junction, Florida River, Ridges Basin and at the Pine River. At this time it is not clear whether the fires that have been discovered are new fires or just newly discovered. In the case that they are newly discovered, it is not understood whether dewatering has caused them to flare up or not. It is also not understood at this time whether methane or other gas seepage is feeding the fires so that they burn differently than they would without the seepage.

Some soil resources may be lost to development of residences, commercial areas, recreation areas, and roads. Because of the relatively small areas needed for development and the mitigation measures that can be taken as described in Section 4.4.2.8, it is considered unlikely that significant soil resources would be lost.

Mitigation of Potential Impacts on Geological Resources

The Tribe, BLM, COGCC, and operators are cooperating in gathering data and developing models to further understanding of how CBM production may or may not interact with the seeps and coal fires. The Mapping and Modeling phases of the 3M study are complete. The results from these studies show:

- that some coalbeds can be correlated over fairly long distances (3+ miles in many cases),
- that infill wells may reduce the amount of methane seepage compared to continued production with the current well spacing,
- 160-acre spacing is needed over large regions of the Northern San Juan Basin to efficiently recover the gas resource (320-acre spacing would leave much of the resource economically unrecoverable)

The parties mentioned above continue to collect data to validate the reservoir model, and the monitoring phase of the 3M study is continuing. Operators are now collecting stabilized bottomhole pressures from new wells, and on many older wells they are collecting annual shut-in pressures to better understand CBM reservoir dynamics.

Development of additional wells in the San Juan Basin may prevent loss of gas resources at the outcrop. If dewatering has already proceeded to the point where gas is moving throughout the basin towards the outcrop, then a logical mitigation measure is simply to produce the gas before it reaches the outcrop. This removes the gas in a controlled, and possibly economic way rather than allowing it to leak out in an uncontrolled, way.

Mitigation for potential soil loss would be careful selection of locations for developments to minimize disturbance of valuable soils, stockpiling of soils during construction, and replacement of soils during mitigation. Appropriateness and applicability of the minimum disturbance measure would depend on project specifics. The latter two steps are already required for pipeline right-of-way projects under tribal stipulations (Appendix E).

4.13.3.4 Water Resources

No significant cumulative impact on water resources is expected as a result of past and projected oil and gas development on the Reservation. Future development of oil and gas resources, both within the Study Area and elsewhere in the San Juan Basin of Colorado, would use produced water and fresh water obtained by permit or commercially. The total volume of fresh water needed for all oil and gas development in the Colorado portion of the San Juan Basin is estimated to be about 81 acre-feet per year, or three times the 27 acre-feet per year needed for the Agency's and Tribe's Preferred Alternative. Additionally, about 155 to 200 acre-feet per year of instream flow will be lost to the riverine system due to interception of Fruitland Formation recharge into the Pine, Florida, Piedra, and Animas Rivers by producing CBM wells along the Fruitland outcrop north of the Study Area and in the Indian Creek area. Thus, the amount of water that would be consumed through construction or lost through depletion would total about 280 acre feet per year over the life of the field.

Community expansion, particularly residential development, may in the future be limited in some places by the availability of fresh water. La Plata County residents have expressed concern over groundwater resources (Florida Mesa and Bayfield District Land Use Plans). However, residences generally use less water than irrigated farmland, so the trend towards increasing rural residential development and away from irrigated farmland is actually a trend to lower water use. On the other hand, irrigation may be a source of recharge for aquifers on the Florida Mesa (Florida Mesa District Land Use Plan). A public water project is in planning to distribute water from Vallecito Reservoir throughout the Pine River Valley and on the mesa south of Highway 160.

As described in Section 3.5, construction, operations, and abandonment procedures would conform to regulations designed to protect water resources from contamination. Groundwater resources are protected by the Colorado Department of Natural Resources through the Water Resources Division and by federal laws, including regulations and stipulations governing oil and gas well drilling and operations. Gravel mining, which is permitted through the State or BIA, would not be permitted without stipulations to protect water resources. Potential impacts from the construction and operation of the Animas La Plata Water Project are described in that project's NEPA documents.

4.13.3.5 Land Use and Ownership

The reasonably foreseeable future projects may cumulatively impact land use. Relatively small acreage of forest, meadow, range, and agricultural land are expected to become at least partially developed with houses and additional oil and gas facilities. Areas of the Fruitland outcrop may degrade environmentally due to methane seeps and coal fires. There would be a long- term loss of land use, in the case of the outcrop. There is potential for loss of land value due to visual impacts and from loss of use of the outcrop as a result of seeps and coal fires.

The Florida Mesa Land Use Plan describes many of the land use trends occurring in La Plata County. The stated primary purpose of the Florida Mesa Land Use Plan is to preserve agricultural and rural character while accommodating growth. Key issues include water supply, controlling subdivision, controlling commercial growth to preserve property value and attraction, septic systems, and controlling the costs of providing services such as roads, schools, and fire protection.

Overall land use and ownership is not expected to change substantially as a cumulative impact of future oil and gas development. Each oil or gas well requires the long term use of about 2.06 acres of surface area in order to drain resources from a spacing unit of 160, 320, or 640 acres, depending on the reservoir. On the reservation, about 14,800 acres have been directly impacted as a result of oil and gas development and an additional 7,400 acres of disturbance are expected as a result of future development (Table 4-52). North of the Study Area, industry has drilled 280 CBM wells and plans to drill an additional 345 wells in the Northern San Juan Basin EIS analysis area (125,000 acres) over the next 7-10 years. The direct impact associated with past and future CBM development in the northern San Juan Basin equals about 2,200 acres. When, the Reservation and North Basin study area are take together, total surface disturbance would equal 24,300 acres. Within one section of land (640acres), the surface disturbance of well pads and roads would equal about 2 % of each spacing unit during the production period.

The two acres of surface actually used for each well pad and the roads constructed to access wellsites is less significant than the impact on visual resources and the loss of land value due to the existence of a well on or near a potential home site, particularly if the well has a pump jack on it. Loss of value may depend on the size of the land tract on which a well is placed. For example, a two acre well pad consumes a two acre tract, but may be insignificant to the buyer of a wooded 160 acre tract. The Florida Land Use Plan recommends concentrating residential and commercial development to areas which are already affected by development or, in the case of residential developments, to areas which have low visual impacts such as in pinon-juniper forest.

In rapidly growing La Plata County, visual resources, land value, and land use should not be substantially impacted from the Agency's and Tribe's Preferred Alternative, but may be more substantively impacted by current and future CBM development and community growth in the northern San Juan Basin EIS analysis area. Land and residential value impacts from CBM development in La Plata County are the subject of a County sponsored study that should publish preliminary results by December, 2001. At this time we cannot quantify the negative consequences of CBM development on land and residential values. The oil and gas industry is required to mitigate the visual impacts of oil and gas facilities, for example, by screening facilities with topography or vegetation.

4.13.3.6 Traffic and Transportation

Continued CBM development in the Study Area is not expected to significantly impact traffic congestion or accident rates. In the future, increased traffic would result primarily from community expansion and increased tourism and secondarily from oil and gas resource development. Impacts on level of service (LOS) would occur regardless of the road improvement projects which are now in progress.

Section 4.7.6 presents a cumulative transportation impact assessment for the Study Area. Table 4-36 shows that the level of service on four of the nine highway segments analyzed would continue to deteriorate through 2017 even without future oil and gas well development. Using Colorado Department of Transportation (CDOT) expansion factors to calculate 2017 traffic, the alternatives result in no perceivable incremental traffic impacts on residents in the Study Area.

North of the Study Area, traffic increases over the next 20 years should be similar to those projected for the Study Area. Residential growth and increased tourism would-be the key factors leading to more traffic with continued oil and gas development a secondary factor. The anticipated increase in well density in the northern San Juan Basin would-be the same as the increase in well density in the Study Area. Residential development may be greater North of the Ute Line due to proximity to urban centers and the greater percentage of forest and lower percentage of irrigated agricultural land. Widening of Highway 160 would improve its LOS, as would the County's project of widening County Road 240 (Florida Road), which is the other major east-west route through the County north of the Ute Line. These improvement projects are already in progress. These improvements would reduce impacts on LOS from increased vehicle trips in the area. Thus traffic increases due to oil and gas well development, which are insignificant even without road improvements, would be even less significant to improved roads.

Increases in traffic south of the Reservation, in New Mexico, would probably be similar to those on the Reservation, with a slight to moderate increase around the Navajo Dam, towns, and the City of Farmington. The State of New Mexico is widening U.S Highway 550 between Aztec, New Mexico, and the Colorado border, which would improve the LOS on that road. US 550 is an important access route between Ignacio Blanco Field and the many oil and gas field service contractors located in the Farmington area. The Mesa Verde pool infill program would increase traffic in the northern half of the New Mexico portion of the San Juan Basin.

4.13.3.7 Cultural Resources

No significant cumulative cultural resource impact is expected. Development of oil and gas wells and other facilities on federal and tribal land would follow federal and tribal guidelines to protect cultural resources as described in Chapter 3.8.2. Negative impacts would be avoided wherever possible.

As shown on Table 4-54, oil and gas development in the Study Area would cumulatively impact 7 percent or less of each category of cultural resources considered without mitigation or avoidance. Onsite inspections completed at the time that APD's are filed on tribal land would result in much lower impacts due to tribal policy of avoiding cultural sites. Developments on private land would be guided by State Historical Preservation Office guidelines, which include enforcement of federal historic preservation policies, as discussed in Section 3.8.2. Thus, the actual impact level which occur from oil and gas development are likely to be lower than those arrived at through the GIS analysis.

TABLE 4-54
Disturbance to Cultural Resources from Oil and Gas Development in the Study Area

	Acres of Resource in Study Area	Current Disturbance (acres)	Current Disturbance (%)	Future Disturbance (acres)	Future Disturbance (%)	Cumulative Disturbance (acres)	Cumulative Disturbance (%)
Prehistoric: High Sensitivity	234583	9643	4.1	2448	1.1	12131	5.2
Prehistoric: Moderate Sensitivity	156899	6239	4.0	1925	1.2	8164	5.2
Prehistoric: Low Sensitivity	45074	805	2.8	593	2.1	1398	4.9
Historic Homestead: High Sensitivity	108842	2249	5.0	548	1.2	2797	6.2
Historic Homestead: Moderate Sensitivity	167591	3784	3.5	933	0.9	4717	4.3
Historic Homestead: Low Sensitivity	95334	6248	3.7	1643	1.0	7891	4.7
Historic Homestead: Extremely Low Sensitivity		4332	4.5	1294	1.4	5626	5.9

On federal land both north and south of the Study Area, activities that potentially affect cultural resources are coordinated in consultation with the respective State Historic Preservation Officers. The same mitigation requirements outlined in Section 4.8.9 apply to this non-Reservation federal land. A quantitative estimate of potential impacts on archaeological resources is not possible outside of the Study Area. The policy of site avoidance during project planning, generally provides adequate protection of archaeological resources.

4.13.3.8 Visual Resources

Because of spacing requirements, oil and gas well development would be distributed somewhat uniformly throughout the area, as discussed in Section 4.13.2.3 above, inevitably placing some wells and equipment in scenic views and near individual residences and subdivisions. Instances where wells conflict with homes would present a significant impact on individuals, by altering the views that they are accustomed to. Table 4-55 shows current visual quality impacts due to gas resource development, and the cumulative impacts that would result from unmitigated development on both tribal and nontribal land within the Study Area. Development on nontribal land was modeled at the same density as development on tribal land. The oil and gas industry attempts to mitigate visual impacts through careful placement of facilities behind natural screens such as vegetation and topography, and by painting facilities to blend into the background. Thus the impacts shown on Table 4-55 are probably higher than would actually occur under Alternative 3. Visual impacts attributable to Alternative 2 would essentially be the same as predicted for Alternative 3. Alternative 1, when combined with development on private land, would result in less cumulative impact than either of the other two alternatives, due to the fact that fewer wells would be constructed, reducing the likelihood of visual impact.

Community expansion, particularly widespread development of housing, is likely to result in new houses fragmenting otherwise scenic views. The extent of the impact would depend largely on where development occurs and on the types of development that are allowed. La Plata County residential building codes do not specify mitigation for potential loss of visual quality due to individual structures. The Florida Mesa and Bayfield District Land Use Plans recommend placement of subdivisions behind vegetative screens, concentration of development, and other steps to preserve agricultural views. These regional planning documents were developed with substantial resident input, but they are not binding upon the County Commissioners.

The other “reasonably foreseeable future development” projects in La Plata County would probably not significantly affect visual quality. Highway-widening projects would for the most part follow existing rights-of-way, and so would cause incremental changes in views that are already impacted. Gravel mining would have primarily local impacts on visual quality. The potential visual impacts from the A-LP project are described in that project’s NEPA documents. Such impacts would, because of the proposed dam and reservoir locations, be situated primarily out of the area of oil and gas development. The A-LP project could be nearly neutral with regard to visual impacts, as it would result in the creation of a reservoir, which could be a positive visual resource to some and balance the addition of the diversion and impacts on the Animas River. Any associated canals or irrigation ditches would have relatively small impacts on visual quality.

TABLE 4-55
Cumulative Visual Impacts on Tribal and Non-tribal Acreage within the Study Area
8 ½ x 11 Landscape, Excel

Planning efforts and permitting stipulations could decrease cumulative impacts on visual resources. First, permitting of residential developments should consider the cumulative impact on visual resources. As recommended in the Florida Mesa and Bayfield District Land Use Plans, permitting of subdivisions could require the concentration and visual screening of new development so as to preserve pastoral and mountainous views for both residents and tourists. Second, all developers, including oil and gas well operators, could be required not only to limit impacts from their own development projects, but also to contribute to the improvement of views, e.g., by removing abandoned buildings and planting vegetation screens to shield pre-existing development.

4.13.3.9 Socioeconomics

Cumulative socioeconomic impacts were considered over a five-county area: La Plata, Montezuma, and Archuleta Counties, Colorado, and San Juan and Rio Arriba Counties, New Mexico. The time frame considered was the 20-year life of the project. In general, the five-county area is growing regardless of oil and gas development. The cumulative impacts of all future projects would include increases in direct and indirect spending, increased fiscal strength for local and tribal governments, and positive social impacts.

As discussed in Section 4.10, local government, especially La Plata County and the school districts, would benefit financially from additional production due to infill and ECBM in their taxing districts. Incremental production would result in incremental tax revenues, which directly support the budgets of the county government, school districts, and other tax districts. These incremental revenues would come at a time when the trend of gas-related revenues is otherwise downward due to overall reservoir decline, and at a point in time when population growth is placing increased demands on services. Oil and gas paid $0.50 of every property tax dollar collected in La Plata County in 1998, so a decline trend would significantly impact the county's tax collections. Thus, the timing of the incremental tax revenues makes them an important offset for anticipated declines.

The incremental revenues that the SUIT would receive from infill and ECBM were discussed in Section 4.10. As with County property taxes, the incremental revenues from infill and ECBM would be particularly beneficial to the Tribe in the next few years, when overall gas related revenues are dropping and during a point in time when the Tribe is in a financial transition, trying to develop other sources of revenue to support tribal programs. There is no particular synergistic effect of the incremental infill and ECBM revenues with other projects for the Tribe. The A-LP water project, if approved, would allow the Tribe to use its water rights to benefit the Tribe and tribal members, but not for many years. Non-tribal community development would probably make the relatively undeveloped areas of the Tribe's natural resources management areas and grazing units more important to the welfare of wildlife. Community development near Ignacio is largely concentrated in housing developments being built by the Tribe for the benefit of its members.

All the future projects are projected to have positive, direct economic benefits on the area, because of their potential to increase employment, income, and spending for services and equipment.

Population in the five-county area of interest is expected to continue to increase regardless of oil and gas development, and demographic changes would probably be slight. As population increases in the area, demand for services increases. This creates jobs in a wide range of positions. The potential gravel mines would not create many new jobs; they would for the most part employ people who are already employed in the area at other mines, or who are in the construction industry in the area.

Housing and related resources and services may continue to be stretched because of continued growth in the area. Affordable housing is already recognized as a problem, especially given the service-oriented nature of the economy, which results in an economy with a large percentage of relatively low-paying jobs. Residential services and resources, especially water resources, are also becoming recognized as limiting factors on development (e.g., the Bayfield and Florida Mesa District Land Use Plans). Finally, the increased development in the County has already consumed many of the accessible and affordable places for development, making the siting of housing, especially affordable housing, a challenge. County regulations would be very important in limiting impacts from all types of development. As discussed under 4.13.3.5, District Land Use Plans recommend concentrating residential and commercial development so as to minimize impacts from growth.

In summary, the cumulative socioeconomic impacts of future development would be positive. Incremental revenues to the SUIT, the county, and state allow services to keep pace with growth. Jobs would be maintained both directly and indirectly. However, uncontrolled growth could bring problems, particularly in the areas of housing and residential services. Control of growth could include zoning and planned development of the county so that services such as water, sanitation, fire protection, and schools, could be provided efficiently.

4.13.3.10 Noise

The number of noise sources and receptors is likely to increase during the project period, due to increased population and activities from anticipated future projects. The most prominent sources of future noise would be oil and gas development, traffic (including air traffic), and residential and commercial activities. The most sensitive receptors are likely to be rural residents. Noise from existing oil and gas development is discussed in Sections 3.11 and 4.11. Noise would not continue beyond the life of the individual project that causes it.

The most significant noise issue is not cumulative noise, but local noise. With the exception of the towns and the City of Durango, noise sources such as residences, traffic, and oil and gas facilities are well distributed throughout the Study Area. Noise from each individual noise source is attenuated with distance, and noise from multiple sources in the same area is much less than the sum of individual noise sources, as discussed in Section 4.11.2.2. Thus most of the noise sources have no effect on most of the noise receptors, and the total numbers of sources and receptors are not significant. Impacts occur when sources and receptors are near each other.

As growth and oil and gas development continue, the number of noise sources and noise receptors near each other would increase. There would-be more traffic on every road, more houses, and more oil and gas facilities. Thus, rural residents would-be more likely to be located near noise sources. Oil and gas facilities would-be distributed throughout the Study Area in order to economically recover the resources. Homes and businesses, as previously discussed, could be clustered in order to maintain wildlife habitat, to protect rural and scenic views, to preserve land value, to provide services economically, and perhaps to segregate noise sources. The potential for noise to interfere with residences is greatest with alternatives 2 and 3 and least with Alternative 1 due to the lesser number of wells in the Alternative. Infill development is projected both within the Study Area and north of the Study Area where the potential for noise conflict is greater because of higher population density.

Noise from future gravel mining would simply replace noise which is currently being made at existing gravel mines. There would be some local noise impacts from any new individual gravel mines. However, there are no general state or Federal noise regulations.

Mitigation of noise could include use of noise baffles, siting of wells to use terrain features, and other measures outlined in Section 4.11.7. The COGCC regulations and tribal noise management practices would manage noise from oil and gas facilities.

4.13.3.11 Health and Safety

An increase in number of gas wells in La Plata County simultaneous with an increase in population density would result in an increased number of interactions between the two. The potentially significant cumulative impacts on health and safety include an increase in the likelihood of accidents involving both oil and gas facilities and personnel, and non-oil and gas facilities and personnel. Second, there is potential for environmental changes at the Fruitland outcrop that are related to CBM production to impact residents and non-oil and gas facilities. The potential impacts at the outcrop would most likely continue in the future beyond the twenty-year life of the project. Additional wells may actually mitigate methane seeps by preventing gas from reaching the outcrop.

One potential cumulative health-and-safety impact is increased accidents. Population density is expected to increase in the County in the future, due to community expansion. The density of gas wells and associated facilities in the area is also expected to increase in the area of the San Juan Basin that is currently developed. The increase in the number of wells would result in an increased number of interactions between gas wells/facilities and non-industry personnel and an increase in well drilling and production near residences.

Most of the potential health-and-safety issues related to development from oil and gas are mitigated by existing regulations. As discussed in Sections 2.8, 2.9, and 3.12 and in Appendices B and E, federal, State and tribal laws and regulations for oil and gas operations are designed to protect not only the oil and gas field workers, but also the environment and competing land uses. For example, regulations control how close a well can be drilled to a residence and how ground water must be protected during drilling, production, and abandonment procedures. Although the regulations that govern safe drilling and operating practices should almost completely mitigate the chance of an injury, a slim chance of an accident would always remain.

A second potential health-and-safety impact is from environmental changes at the Fruitland outcrop. As discussed in Sections 3.4.2.1, 3.12.7 and 3.12.8, methane seeps have been linked to dewatering of the Fruitland while near-outcrop coal fires have been hypothetically linked to dewatering of the Fruitland Formation. Development of infill wells and, less likely development of ECBM projects, as proposed in the Agency's and Tribe's Preferred Alternative, could increase or exacerbate the number and magnitude of seeps and coal fires at the Fruitland Formation outcrop. Hazards associated include explosion, collapse of the ground surface into underground caverns formed by fires, toxic gases, and fire. As population increases in the La Plata County area, more people would potentially be living, working, and traveling near the Fruitland coal outcrop north of the Reservation. This means a future methane seep or coal fire on non-Reservation land would have a greater chance of impacting a local landowner. Seeps and coal fires on the SUIT are unlikely to directly harm anyone because of the isolated location of the outcrop and the Tribe's ability to restrict access to the outcrop.

The 3M work has lead to a better understanding of the linkage between CBM development and methane seepage along the outcrop. Seepage will occur and increase even if no additional wells are drilled and produced. Infill wells may actually decrease the total amount of methane lost at the outcrop. The 3M study cannot be used to predict the frequency or location of coal fires. As noted earlier in this chapter, there is insufficient data to conclude a cause-effect relationship between CBM development and coal fire frequency.

Mitigation measures for impacts due to methane seeps could include producing CBM before it seeps and closing off potentially hazardous parts of the outcrop from access except by trained personnel. Potential mitigation for hazards from coal fires include identifying fires while they're small, controlling or quenching coal fires, clearing trees and brush around coal fires, and monitoring the fires in addition to the mitigation methods listed above. Mitigation for water depletions are being investigated. Possible alternatives include recharge basins using less saline produced water, constructed wetlands, water ponds, among others.

4.13.4 Summary of Mitigation for Cumulative Impacts

Significant cumulative impacts that could occur in the Study Area and vicinity, due to the implementation of the Alternatives in conjunction with other unrelated but foreseeable projects and developments, are:

- loss of wildlife habitat,
- disturbance of wildlife migration pathways,
- irretrievable removal of gas resources,
- long-term commitment of land to specific uses,
- loss of visual resources,
- increased noise,
- health-and-safety issues due to increased density of gas well development near residences, or
- health-and-safety issues related to coal fires or methane seeps at the Fruitland outcrop.

Community expansion has the potential to contribute to many cumulative impacts, by impacting resources in many different ways. For example, it can impact groundwater resources by changing irrigation practices, over-pumping aquifers, and polluting groundwater via inadequate septic systems and careless household use and disposal of oils and poisons. Many of these impacts and their related cumulative impacts might be limited through controls on development, such as the following:

- concentrate residential and commercial construction,
- encourage further development in areas which are already developed in part,
- screen residential development, if possible, with topography and vegetation,
- protect migration pathways from development,
- where migration pathways must be crossed (e.g., by highways), require development of wildlife overpasses or underpasses to accommodate wildlife,
- protect and promote continuation of agricultural use by discouraging subdivision of large agricultural holdings,
- educate residents about the benefits to wildlife of maintaining hedgerows and other wildlife habitat, **and**
- educate the public, especially construction workers, about how to avoid damaging buried gas pipelines inadvertently.

Widespread future oil and gas development would also affect many resources in many different ways. Numerous mitigation and environmental-protection measures are already required of industry operators through federal, state, and tribal regulations and stipulations, as discussed elsewhere in this EIS. Cumulative impacts on visual resources and land use would be difficult to avoid, because oil and gas facilities must be widely distributed in order to capture the resources. However, impacts would be mitigated through measures including the following:

- concentrating of oil and gas industry facilities where ever possible,
- minimizing road building,
- situating facilities where they can be screened from view by topography and/or vegetation,
- quick reclamation of abandoned facilities, and
- continued study and pursuit of mitigation measures to prevent or lessen impacts from methane seepage and coal fires at the Fruitland outcrop.

4.14 Irreversible or Irretrievable Commitment of Resources

Resources committed to the project would be material and nonmaterial, including financial. For the purposes of this section, "irreversible commitment of resources" has been interpreted to mean that those resources once committed to the project would continue to be committed throughout the life of the project. "Irretrievable commitment of resources" has been interpreted to mean that those resources used, consumed, destroyed, or degraded during construction, operation, maintenance, and abandonment could not be retrieved or replaced for the life of the project, or beyond. Irreversible and irretrievable commitment of resources associated with the project are summarized in Table 4-56.

Table 4-56

Resource	Type of Commitment/ Reason for Commitment	Irreversible	Irretrievable
Air Quality	■ Degradation of air quality ■ Construction activities ■ Operation Emissions	No	No
Biological Resources	■ Disturbance to and/or loss of vegetation, habitat, and wildlife species ■ Increased spread of noxious weeds ■ Construction and operation	Yes Possibly	Project life and beyond in some cases Possibly
Geology	■ None (see construction materials below)	-	-
Minerals	■ Loss of oil and gas resources ■ Loss of other mineral resources	Yes	Yes
Soils	■ Soil loss and erosion ■ Construction activities	Yes	Yes
Water Resources	■ Loss of water resources ■ Degradation of water resources ■ Construction and operation	No No	No No
Land Use and Ownership	■ Disturbance to agriculture, grazing, and recreation ■ Exclusion of residential, institutional, and industrial uses ■ Construction and operation	Yes No	Project life Project life
Traffic and Transportation	■ Increased traffic volumes resulting from development ■ Increased traffic accident rates	No No	No No
Cultural Resources	■ Disturbance or removal of sites ■ Interference with visual setting, aural disturbance	Yes Yes	Yes Project life
Visual Resources	■ Degradation of natural scenic quality, viewshed intrusion ■ Construction and operation	Yes	Project life
Socioeconomics	■ Increased regional and local employment and revenues ■ Construction and operation	Yes	Project life
Noise	■ Noise exceeding ambient levels ■ Construction and operation	Yes	No
Health and Safety	■ Potential adverse health effects from methane seeps ■ Operation	Unknown	Unknown
Construction materials and fuels	Use of : Aggregate Water Steel Aluminum Concrete Wood Fossil Fuels	 Yes Yes Yes Yes Yes Yes Yes	 Yes Yes No No Yes No Yes

4.15 Short-term Uses Versus Long-term Productivity

"Short term" is defined as 5 years or less–the typical period necessary to construct, drill, and complete an oil or gas well. "Long term" is defined as a period of longer than 5 years: the life of a typical oil or gas well, including plugging and abandonment of the well.

The basic objective of this EIS is to investigate efficient and environmentally sound long-term management strategies for oil and gas resources contained within the Reservation boundary and managed by the SUIT. Oil and gas are non-renewable resources. However, planned use of these resources would help meet current energy demand. Wise management of these resources would contribute income and would provide significant long-term socioeconomic benefits to the Tribe.

During the construction, drilling and completion of an oil or gas well, short-term impacts on some surface resources may be realized. Many of these short-term impacts would be mitigated during the life of the well, following completion operations (i.e., erosion control, reclamation, revegetation). Many of these impacts would cease to be adverse following reclamation and rehabilitation. Similarly, short-term impacts for the associated pipeline would-be realized. These impacts would be mitigated with the rehabilitation of the pipeline. However, certain ecological, archeological, and historical values may be irretrievably lost. Mitigation measures can be designed to avoid or reduce these impacts, including transplantation, timing requirements, monitoring, data recovery, and other site-specific measures.

For a productive well, long-term impacts on other resources would result in those areas dedicated to the well production for the life of the well, including the cleared well-pad area and access road. For these site-specific areas, long-term surface productivity would be reduced through vegetation loss and soil disturbance. Soil erosion and the loss of vegetative productivity may affect wildlife and livestock. These and other surface impacts can be greatly reduced through consideration of other resources and site-specific mitigation. After the well's productive life is over, the surface impacts should be minimized via final reclamation and revegetation.

If a dry hole is encountered, short-term impacts would be limited to a period of about 30 days associated with the construction and drilling operations, including access road. The well then would be plugged. Upon the plugging and abandonment of any well, rehabilitation of all surface impacts would be accomplished and many adverse impacts would cease.

United States Department of the Interior

Bureau of Land Management
San Juan Public Lands Center, Durango, Colorado

Bureau of Indian Affairs
Southwest Regional Office, Albuquerque, New Mexico

Southern Ute Indian Tribe

Oil and Gas Development on the Southern Ute Indian Reservation
Final Environmental Impact Statement July 2002

Volume 2

CHAPTER 5—CONSULTATION AND COORDINATION

5.1 INTRODUCTION

In accordance with requirements set forth in NEPA, Title 40 CFR, Part 1506.3(c) and the Council of Environmental Quality, a consultation and coordination program was developed and implemented for the preparation of the EIS. The purpose of the program was to ensure that appropriate members of the public and federal, state, and local agencies were contacted, consulted, and given an adequate opportunity to be involved in the environmental analysis and EIS process. This section describes the public and agency scoping process, consultation and coordination program, and issues and concerns identified from public and agency comments and the EIS review process.

5.2 PUBLIC AND AGENCY SCOPING PROCESS

Soliciting comments from various federal, state, county, and local agencies as well as interested organizations and individuals is the first step in the EIS preparation process. Scoping is an information gathering process conducted early in the course of the EIS preparation to identify the range, or scope, of issues to be addressed during the environmental studies and in the EIS, and is required under NEPA 40 CFR 1501.7, 1506.6, and 1508.25.

The scoping process for this EIS began September 15,1995 with publication of a Notice of Intent to prepare an EIS and conduct a public scoping meeting in the *Federal Register*. This began the 30-day comment period. Also, a news release announcing the scoping meeting was sent to local papers and news media (Durango Herald, Southern Ute Drum, and Southern Ute radio station KSUT). A scoping meeting was held on September 26, 1995 at the Rolling Thunder Hall at Sky Ute Casino Lodge and Dining in Ignacio, Colorado.

Meeting attendees were asked to sign an attendance sheet and were provided with a handout containing project information. The meeting began with an opening statement by the BLM. Meeting topics included purpose of the EIS, EIS process, meeting objectives, EIS scope and alternatives, potential public concerns, and opportunities for public comment. A comment period allowed meeting participants the opportunity to voice their questions and concerns. The comment period was followed by an information breakout session. Agency participants included BLM, BIA, and SUIT. A total of 38 individuals attended the scoping meeting. Oral comments provided at the meeting were recorded. Eight comment letters were submitted to the BLM during the comment period.

5.3 SCOPING SUMMARY

A scoping summary report was prepared that documented the scoping process and included copies of attendance sheets; a record of verbal comments; copies of written comment letters; and list of the key issues, questions, concerns, and comments received. The scoping summary report is available for review and inspection at the BLM office in Durango, Colorado and SUIT office in Ignacio, Colorado. Some of the major issues identified during scoping are presented below (refer to Table 1-1 in Chapter 1 for detailed listing of scoping issues).

- increase the overall scope of the EIS to include oil and gas development in the entire San Juan Basin;
- evaluate the nature and effects of increased production by CBM infill development and/or enhanced recovery by nitrogen/carbon dioxide injection;
- evaluate the cumulative and synergistic impacts of development;
- evaluate the nature and effect of gas migration;
- assess the potential impacts on public health, safety, and welfare;
- describe the environment and analysis of impacts (groundwater, socioeconomic, vegetation, and wildlife resources were most commonly identified);
- determine the effects of nitrogen injection on neighboring wells;
- assess potential air quality impacts, particularly in Class I airsheds (Weminuche Wilderness Area and Mesa Verde National Park);
- assess impacts on surface and groundwater quality;
- address jurisdiction and ensure compliance with rules, regulations, and other land use decisions;
- address impacts on roads and traffic safety concerns;
- determine techniques and effectiveness of long-term reclamation;
- evaluate noise impacts;
- evaluate interim reclamation and maintenance of development sites; and

- general questions about the EIS preparation, process, and content.

5.4 CORE TEAM

At the start of the preparation of this EIS, the BLM, BIA, and SUIT formed a steering committee that has directed the preparation of this EIS. This group is known as the "Core Team" and is composed of representatives from BLM, BIA, and SUIT. The primary purpose of the Core Team is to coordinate all matters of project management, to provide relevant data for analysis to the EIS contractor, to provide statements of purpose and need for action, to define the alternatives to be considered, and to review and comment on the methods used for each stage of the environmental analysis process (e.g., inventory, impact assessment, and comparison of alternatives). Also, the Core Team reviews the results of each stage of the environmental analysis process (e.g., EIS report sections). The Core Team will continue to manage and direct the preparation of the EIS through the final EIS (FEIS) and the Record of Decision.

5.5 AGENCY AND ORGANIZATION CONTACTS

During the preparation of the DEIS, the Core Team and the EIS contractor communicated with and received information and input from various federal, state, and local agencies and private organizations. Table 5-1 lists the agencies and organization that were contacted through letters meetings and telephone by the Core Team or its contractors.

TABLE 5-1 Agencies and Organizations Consulted During the EIS Process
Federal Agencies
Department of Agriculture
Natural Resources Conservation Service ● J.P. Pannel, Soil Scientist ● Chuck Betz, Soil Scientist
San Juan National Forest ● Jim Powers ● Sharon Hatch, Archaeologist

TABLE 5-1
Agencies and Organizations Consulted During the EIS Process

Department of the Interior

Bureau of Indian Affairs
- Fred Ellenbecker, Range Resource specialist
- Jim Freidley, Forester
- Bruce Harrill, Archaeologist
- Jay Herrera, Roads Engineer
- Lee Maytubby, Area Realty Specialist
- Dee Olguin, Realty Officer
- Tony Recker, Forester
- Wayne Wood, Chief of Conservation Department
- Ken Young, Petroleum Engineer, EIS Core Team
- Al Sedik, Area Environmental Coordinator

Bureau of Land Management, Colorado State Office
- Harley Armstrong, Regional Paleontologist
- Jim Rhett, Geologist, Cultural Resource Advisor

Bureau of Land Management, National Science and Technology Center
- Scott Archer, Senior Air Resources Specialist

Bureau of Land Management, Montrose District
- Roger Alexander, Natural Resource Specialist
- Jerry Jones, Physical Resource Advisor

Bureau of Land Management, San Juan Resource Area
- Kent Hoffman, Assistant Area Manager
- Kristie Arrington, Archaeologist
- Ilyse Auringer, Minerals Team Supervisor
- Don Englishman, Environmental Protection Specialist, EIS Core Team
- Terry Galloway, Petroleum Engineering Technician
- Jim Lovato, Minerals Staff Chief
- Leon Lujan, Archaeologist
- Jeff Olson, Geologist
- Dan Rabinowitz, Petroleum Engineer
- Pat Roddy, Petroleum Engineer

Bureau of Land Management, San Juan Resource Area (continued)
- Dave Suanson, Physical Scientist
- Loren Wickstrom, Geologist

Bureau of Reclamation
- Warren Hurley, Archaeologist

TABLE 5-1
Agencies and Organizations Consulted During the EIS Process

Fish and Wildlife Service
- Terry Ireland, Ecological Services, Grand Junction
- Gary Patton, Ecological Services, Denver
- Keith Rose, Ecological Services, Grand Junction
- Mark Wilson, Ecological Services, Albuquerque

Geological Survey, Water Resource Division
- John Turk, Water Quality Specialist

Environmental Protection Agency

Air Quality Division
- Gordon Macrae, Air Quality Monitoring Specialist, Region VIII
- Robert Wilson, Air Quality Permitting Specialist, Region X

Water Quality Division
- Dan Jackson, Water Quality Specialist

Minerals Management Service

- Claire Schaefer, Management Assistant
- Steve Rawlings, Analyst

Indian Tribes and Nations

Southern Ute Indian Tribe

Tribal Council
- Clement J. Frost, Chairman
- Marvin E. Cook, Vice Chairman
- Vida B. Peabody, Council Member/Treasurer
- Leonard C. Burch, Council Member
- Pearl E. Casias, Council Member
- Byron Red, Council Member
- Howard Richards, Council Member

Maynes Bradford Shipps & Sheftel (Attorneys to the Tribal council)
- Sam Maynes
- Sam Maynes, Jr.
- Tom Shipps

Executive Office
- Eugene Naranjo, Executive Officer
- Debbie Garner, Assistant to Executive Officer

Community Action Programs
- Donna Young, Executive Director

Cultural Preservation Committee
- Alden Naranjo, Chairman

TABLE 5-1
Agencies and Organizations Consulted During the EIS Process

Department of Economic Development
- Jim Owen, Director

Department of Energy
- Robert Santistevan, Director
- Bob Zahradnik, Manager of Exploration and Production
- Dick Baughman, Geologist, EIS Core Team
- Jerry Bruner, Gas Marketing
- Rex Richardson, Land
- Rob Voorhees, Engineering Manager
- Robert Jefferson, Red Willow Production Company Operations Manager
- Barbara Wickman, Economist/Geologist, EIS Project Management
- David Gilmore, EIS Project Management
- Karen Anderson, Accounting
- Carl Beal, Severance Tax Administrator

Engineering Department
- Tom Brown, Engineer

Environmental Programs
- Mike Frost, Director
- Cheryl Wiescamp, Environmental Quality Specialist
- Cindy Crist, Water Quality Specialist
- Fran King Brown, Water Quality Specialist
- Virgil Frazier, Air Quality Specialist

Department of Finance
- Larry Beck, Director

Natural Resources Division
- James M. Olguin, Director
- Wayne Wood, Conservation Division Manager

Agricultural Office
- Latitia Tayor, Agriculture Division Head
- Jim Oglesby, Soil Conservationist
- Don Wickman, Soil Conservationist

Forestry Department
- Buff Jebsen-Ross, Forestry

Lands Branch
- Howard Richard, Sr., Chief
- Pathimi Goodtracks, Lands Division Head

TABLE 5-1
Agencies and Organizations Consulted During the EIS Process

Tribal Planning
- Ed Knight, Planner

Wildlife Department
- Terry Stroh, Wildlife Division Head
- Steve Whiteman, Fisheries Biologist
- Sam Diswood, Wildlife Biologist

Department of Public Works and Operations
- Bob Piccoll, Director (Acting)
- Tom Brown, Utilities Division Manager

Jicarilla Apache Nation

Natural Resources Department
- Alberta Velardy, Natural Resources Planner

State Agencies

Colorado Department of Education

- Brian Pendilay, Director of Public School Finance

Colorado Department of Labor and Employment

- Leslie Moya, Research Analyst

Colorado Department of Local Affairs

- Steve Colby, Administrative Program Specialist
- Teri Davis, Administrative Program specialist
- Michael McGrane, Administrative Officer

Colorado Department of Natural Resources

Division of Wildlife
- Carolyn Adams, Wildlife Biologist
- Gerry Craig, Raptor Biologist
- Scott Wade, Wildlife Biologist

Colorado Oil and Gas Conservation Commission
- Sharon Tansey, Production Accounting Supervisor
- Jessie Dunbar, Levy Analyst

Colorado Department of Public Health and Environment

Air Pollution Control Division
- Nancy Chick, Environmental Protection Specialist
- Mike Paukstis, Database Manager

TABLE 5-1 Agencies and Organizations Consulted During the EIS Process
Colorado Department of Revenue
● Rhonda Edfrick, Research Analyst
Colorado Department of Transportation
● Thomas Koglin
Colorado Historical Society
State Historic Preservation Office ● Kaaren Hardy-Hunt, Preservation Planner ● James Green, Compliance Reviewer ● Mary Sullivan, Database Administrator
New Mexico Environmental Department
Air Quality Bureau ● Mary Uhl, Program Manager, Technical Analysis Unit
New Mexico Oil Conservation Division
● Frank Chavez, Supervisor
New Mexico State Revenue Department
● Thomas Clifford, Senior Economist
New Mexico Bureau of Business and Economic Research
● Guy Dameron
County Agencies
Archuleta County, Colorado
Assessor's Office ● Alice Jelnick, Deputy County Assessor Planning Department ● Kathy Ruth, Director
La Plata County, Colorado
Agricultural Extension Office ● Ron Cook, Weed Technician ● Warren Holland ● Frank Joswick Assessor's Office ● Craig Larson, Assessor

TABLE 5-1 Agencies and Organizations Consulted During the EIS Process
Controller's Office • Carla Distell, Controller Finance Department • Wayne Bedor, Director Planning Department • Joe Crane, Director
Montezuma County, Colorado
Assessor's Office • Nancy Newman, Administrative Assistant
Planning Department • Lyle Bilberry, Planner
San Juan County, New Mexico
Planning Department • Linda Thompson, Project Development Administrator
Rio Arriba County, New Mexico
Planning Department • Patricio Garcia, Director
Local
Bayfield School District 10JTR Durango 9-R School District • Donna Chase, Finance Assistant • Amy Malick, Communications Director Ignacio School District 11JT
Organizations and Groups
Alpine Archaeologist Consultants • Susan Chandler, Archaeologist
Archaeological Consultants • William Biggs, Archaeologist
Durango Herald • Amy Maestas, Reporter
Ecosphere Environmental Services • Ken Heil, Biologist
La Plata County Energy Council • Gail Aalund, Executive Director

TABLE 5-1 Agencies and Organizations Consulted During the EIS Process
La Plata Archaeological Consultants ● Steven Fuller, Archaeologist
Navajo Reservoir State Recreation Area ● John Weiss, Director
Purgatory Resort ● Linda Kornelson, Payroll Administrator

5.6 PUBLIC AND AGENCY REVIEW OF THE EIS

Public review and comment on the DEIS will occur during a 45-day comment period and will include a formal public hearing to be held during the comment period.

5.6.1 Notice of Availability of the Draft EIS

Concurrent with the distribution of this DEIS, a Notice of Availability (NOA) was published in the *Federal Register* announcing the availability of the DEIS for public review and comment, and the date and location of the public hearing. The NOA publication date marks the beginning of the 45-day review and comment period. The BLM public notice was issued the same day to announce DEIS availability and hearing date.

5.6.2 Public Hearing

About midway through the 45-day review and comment period, a public hearing will be held in Ignacio, Colorado. An open house will precede the hearing to provide opportunity for people to view maps and project information displays and ask questions. A hearing officer will conduct the hearing allowing individuals to formally provide comments on the DEIS. The comments will be documented by a court reporter. Written comments will be accepted at the public hearing and during the 45-day comment period.

5.6.3 Final Environmental Impact Statement

All comments received during the DEIS review and comment period and public hearing will be compiled, analyzed, and summarized. An FEIS will be prepared that provides responses to each substantive comment received on the DEIS. The FEIS also will contain additional information as necessary to support the response to comments. Following publication of a NOA in the *Federal*

Register, distribution of the FEIS, and a 30-day public availability period, the BLM and BIA will issue a Record of Decision summarizing its findings and decisions regarding the Agency and Tribal Preferred Alternative and its determination regarding compliance with NEPA and other regulations.

5.7 DEIS DISTRIBUTION LIST

Table 5-2 presents a list of agencies, organizations and individuals to whom the DEIS was distributed.

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Federal
Department of Agriculture
National Forest Service
Director – Environmental Coordination, Washington DC
Environmental Coordination Staff, Washington DC
Rocky Mountain Region
San Juan-Rio Grande National Forest
Department of Defense
Army Corps of Engineers, Sacramento District/Regulatory
HQ-USAF/LEEV, Environmental Division
Office of the Deputy A/S of the USAF, Environmental, Safety, and Occupational Health
Department of Energy
Federal Energy Regulatory Commision
Office of Environmental Compliance, Washington DC

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

- Department of the Interior
  - Bureau of Indian Affairs
    - Southern Ute Agency
    - Albuquerque Area Office
  - Bureau of Land Management
    - Director, Washington DC
    - Resource Planning Team, Washington DC
    - National Science and Technology Center
    - Montrose CO
    - Durango CO
    - Farmington NM
    - Miles City MT
  - Bureau of Reclamation
    - Denver CO
    - Durango Projects Office
  - Corps of Engineers, Grand Junction CO
  - Fish and Wildlife Service
    - Division of Environmental Coordination, Washington DC
    - Environmental Quality Division, Washington DC
    - Regional Director, Denver Federal Center
    - Western Colorado Office, Ecological Services
  - Geological Survey
    - National Center, Washington, DC
  - National Park Service
    - Division of Environmental Compliance, Washington, DC
    - Mesa Verde National Park
      - Natural Resources Division
      - Superintendent
  - OEPC, Denver Federal Center
    - Head – Acquisitions and Serials
  - Natural Resources Library
  - Office of the Secretary
    - Office of Environmental Policy and Compliance, Washington, DC
  - Office of Surface Mining
- Department of Labor
  - Mine Safety and Health
- Department of Transportation
  - Environmental Division
  - Federal Highway Administration, Office of Environmental Policy
- Environmental Protection Agency
  - Director – Environmental Coordination Staff
  - Office of Federal Activities, NEPA Compliance Division, Washington DC
  - Region VIII, Environmental Review/Compliance
- SDI Office of Public Affairs

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Southern Ute Indian Tribe
Energy Office Natural Resources Division
State of Colorado

Board of Land Commissioners
Department of Public Health and Environment
    Hazardous Materials and Waste Management Division
Department of Transportation
Division of Wildlife
Highway Department
Historical Society
    State Historic Preservation Office
Oil and Gas Conservation Commission
Parks

County

Archuleta County
    Archuleta County Commissioners
La Plata County
    La Plata County Commissioners
Montezuma County
    Board of Commissioners

Municipal
City of Durango Town of Bayfield Town of Ignacio
Other

Amoco, Denver CO
    Doug Blewitt
    Dave Brown
Conoco, Inc., Farmington NM
Vastar Resources, Inc., Houston TX
    Margaret Melly

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Air Quality Modeling Protocol Contributors

Federal
- Department of Agriculture
  - Forest Service
    - Rocky Mountain Region
      - Tamara Blett
      - Dennis Haddow
- Department of the Interior
  - Bureau of Indian Affairs
      - Ken Young
  - Bureau of Land Management
    - National Sciences and Technology Center
      - Scott Archer
    - Colorado State Office
      - Jim Rhett
      - Kermit Witherbee
    - Montrose Field Office
      - Jerry Jones
    - San Juan Field Office
      - Jim Lovato
      - lyse Auringer
  - National Park Service, Air Quality Division
    - Erik Hauge
    - John Notar
- Environmental Protection Agency, Region VIII
    - Jim Berkley
    - Kevin Golden
    - Shawn McCaffery
    - Mike Strieby

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Air Qulaity Regulatory Agencies
State of Colorado
- Department of Public Health and Environment
  - Air Pollution Control Division
    - Phyllis Breeze
    - Coleen Campbell
    - Chuck Machovec

State of New Mexico
- Environment Department
  - Air Quality Bureau
    - Mary Uhl
    - Martin Rinaldi

Southern Ute Indian Tribe
- Energy Resource Division
  - Dick Baughman
  - David Gilmore
  - Barbara Wickman
  - Bob Zahradnik
- Environmental Programs
  - Mike Frost

Private Organizations
- BP-Amaco
  - Doug Blewitt
  - Dave Brown
- Dames & Moore
  - John Lague
  - Randy Schultz
- Earth Tech, Inc.
  - Francoise Robe
  - Joe Scire
  - Douglas Sheadel
- Vastar Resources, Inc.
  - Margaret Melly

Other Elected Officials

Federal
- Senator Ben Nighthorse Campbell
- Senator Wayne Allard
- Representative Scott McInnis

State
- The Honorable Bill Owens, Governor
- Representative Jim Dyer
- Representative Mark Larson

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

The following are oil and gas operators and/or lessees that currently are operating near or within the exterior boundaries of the Southern Ute Indian Reservation boundaries.

BP/Amoco Production Company
 Durango CO
 Houston TX
Apache Corporation, Farmington NM
Robert L. Bayless, Farmington NM
Benson, Montin, Greer Corporation, Farmington NM
Burlington Resources, Farmington NM
Cedar Ridge LLC, Durango CO
Centennial Oil Company, Fort Collins CO
Central Resources Incorporated, Bloomfield NM
Davis Oil Company, Denver CO
Dugan Production Company, Farmington NM
Enervest San Juan Operating, LLC, Durango CO
Famcor Oil Company, Scottsdale AZ
Vernon Faulconer, Inc, Tyler TX
Forty Four Canyon, LLC, Denver CO
Four Star Oil and Gas Company, Farmington NM
Gosney & Sons, Bayfield CO
Joseph B. Gould, Las Vegas NV
Hallwood Petroleum, Inc., Denver CO
J.M. Huber Corporation, Houston TX
Hugoton Energy Corporation, Oklahoma City OK
KCS Mountain Resources, Ltd., Worland WY
Craig Meis – KN Field Services, Grand Junction CO
Mallon Oil Company, Denver CO
Markwest Energy Partners, Ltd., Englewood CO
T.H. McElvain Oil & Gas Limited Partnership, Santa Fe NM
Merrion Oil & Gas Company, Farmington NM
Murchison Oil & Gas Incorporated, Durango CO
Murchison Trusts, Durango CO
Nassau Resources Incorporated, Jerome P. McHugh & Associates, Denver CO
Natural Gas Processing Company, Worland WY

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Oklahoma Silurian Partners, Tulsa OK
Pablo Operating Company, Arlington TX
Palo Petroleum Incorporated
    Dallas TX
    Witchita Falls TX
Questar Energy Company, Farmington NM
Red Willow Production Company, Ignacio CO
SG Interests, Ltd., Durango, CO
San Juan Basin Consortium, Denver CO
Stewart Petroleum Corporation, Durango CO
Texaco, Farmington NM
Thompson Engineering & Production Company, Farmington NM
Universal Resources Corporation, Denver CO
Vastar Resources, Inc.
    Farmington NM
    Houston TX
Williams Production Company, Tulsa OK

Individuals

Gail Aalund; Durango, CO
Jane Dreyer; Durango, CO
Jim and Theresa Fitzgerald; Bayfield, CO
H. Paul Friesema; Evanston, IL
Stanley Frost; Ignacio, CO
Brian Hoffman; Durango, CO
Jamie Karlson; Durango, CO
Laura Lindley – Bjork, Lindley & Danielson, P.C.; Denver, CO
Bob Miller – McDaniel, Baty & Miller, LLC; Durango, CO
Carole McWilliams; Bayfield, CO
Ann Rilling, Durango, CO
Linda Talley-Branch
David and Patti Temple; Durango, CO
Neil Whitehead, Conifer CO
William Zimsky – Dugan & Associates, Durango, CO

TABLE 5-2
List of Agencies, Organizations, and Individuals Receiving Copies of the DEIS

Organizations/Agencies

Boulder Exchange Corporation, Boulder CO
Colorado Environmental Coalition, Denver CO
Colorado Oil & Gas Association, Denver CO
Greystone Environmental Consultants, Inc., Greenwood Village CO
Independent Petroleum Producers of Mountain States, Denver CO
Rocky Mountain Elk Foundation, Longmont CO
San Juan Audubon Society, Durango CO
Travis Stills Living Land Ranch, Durango, CO
Chairman – Ute Mountain Ute Tribe, Towaoc CO
Western Area Power Administration, Montrose CO

Libraries

Colorado School of Mines Arthur Lakes Library, Golden CO
Colorado State University Libraries Document Department, Fort Collins CO
Cortez City Library, Cortez CO
Department of Agriculture National Agricultural Library, Beltville MD
Dine College Shiprock Campus Library, Shiprock NM
Durango Public LibraryDurango CO
Farmington Public Library, Farmington NM
Fort Lewis College Reed Library, Durango CO
Library of Congress – Anglo-American Acq. Division, Washington DC
Mancos Public Library, Mancos CO
University of Colorado Library, Boulder CO
University of New Mexico Zimmerman Library, Albuquerque NM

SECTION 5.8
FEIS DISTRIBUTION LIST

SECTION 5.9
DEIS COMMENTS AND RESPONSES

CHAPTER 6 - PREPARERS AND CONTRIBUTORS

6.1 INTRODUCTION

This EIS was prepared under the direction of the BLM, BIA, and SUIT (Core Team) by Dames & Moore, Inc., an environmental and engineering consulting firm. Editorial assistance was provided by Pioneer Corporation USA. The Core Team conducted the scoping process and provided much of the baseline data. The consultant assisted with supplementing the baseline data, which served as a basis for the impact assessment. The impact assessment was completed jointly by the Core Team and consultant. The consultant prepared and assembled the DEIS text and maps, and the Core Team reviewed, edited, and approved the documents. Table 6-1 is a list of the individuals, including their education and experience and EIS involvement, who participated and/or contributed in the preparation of the EIS.

TABLE 6-1
Preparers and Contributors

Name and Title	Education and Experience	Involvement
BUREAU OF LAND MANAGEMENT LEAD FEDERAL AGENCY		
Jim Rhett, Colorado State Office ■ Environmental Protection Specialist	BS Geology ■ 24 years of experience	■ Document Coordination and Review
Jim Powers, San Juan Public Lands Center ■ Lands and Minerals Program Leader	MS Forest Resource Management ■ 23 years of experience	■ Document Coordination and Review (FEIS)
Walt Brown, San Juan Public Lands Center ■ EIS/RMP Team Leader	BS Geology ■ 14 years of experience	■ Document Coordination and Review (FEIS)
Scott F. Archer, National Science and Technology Center ■ Senior Air Resource Specialist	BS Environmental Science and BS Chemistry ■ 19 years of experience	■ Air Quality, Climate and Noise
Jerry Jones, Montrose District Office ■ Physical Resource Advisor	BS Geology ■ 26 years of experience	■ EIS Core Team
Jim Lovato, San Juan Field Office ■ Minerals Staff Chief	BS Geological Engineering ■ 15 years of experience	■ EIS Core Team
Don Englishman, San Juan Field Office ■ Environmental Protection Specialist	MS Geology ■ 24 years of experience	■ EIS Core Team
Ilyse Auringer ■ Minerals Supervisor	MS Range Ecology ■ 23 years of experience	■ EIS Core Team
BUREAU OF INDIAN AFFAIRS		
Jim Friedly ■ Forester	BS Forest Management ■ 15 years of experience	■ Threatened and Endangered Species
Dee Olguin ■ Realty Officer	■ 9 years of experience	■ Land Use Management

TABLE 6-1
Preparers and Contributors

Name and Title	Education and Experience	Involvement
Tony Recker ■ Forest Manager	BS Forest Management	■ Environmental Coordination
Kenneth Young ■ Petroleum Engineer	BS Geology ■ 17 years of experience	■ EIS Core Team

TABLE 6-1
Preparers and Contributors

Name and Title	Education and Experience	Involvement
SOUTHERN UTE INDIAN TRIBE		
Bob Zahradnik ■ Manager of Exploration and Production	BS Mechanical Engineering ■ 20 years of experience	■ EIS Core Team
Dick Baughman ■ Geologist	MS Geology ■ 13 years of experience	■ EIS Core Team
David Gilmore ■ Project Management	BS Geology ■ 25 years of experience	■ EIS Core Team
Tom Shipps ■ Attorney	JD ■ 19 years of experience	■ Document Review
Barbara Wickman ■ Operator/Government Liaison ■ Project Management	MBA MS Geology ■ 13 years of experience	■ EIS Core Team ■ Socioeconomics
Mike Frost ■ Director, Environmental Programs	■ 14 years of experience	■ Air, Water Resources
Terry Stroh ■ Wildlife Division Head	BS Wildlife and Fisheries ■ 10 years of experience	■ Biological Resources
Sam Diswood ■ Wildlife Biologist	BS Wildlife Biology	■ Wildlife
Cheryl Wiescamp ■ Environmental Quality Specialist	MPH Environmental Health Sciences ■ 7 years of experience	■ Water, Air, Noise, Health and Safety
Cindy Crist ■ Water Quality Specialist	BS Soil Science ■ 7 years of experience	■ Water Quality
Ed Knight ■ Planner	BS Social Assessment and Policy ■ 20 years of experience	■ Lands, Access
Alden Naranjo ■ Chairman, Cultural Preservation Committee		■ Cultural Resources
Fran King-Brown ■ Water Quality Specialist	BS Geology, Chemistry ■ 5 years of experience	■ Water Resources
Virgil Frazier ■ Air Quality Specialist	BS Electronic Engineering ■ 3 years of experience	■ Air Quality, Noise
CONSULTANTS		
Dames & Moore		
Garlyn N. Bergdale	MS Landscape Architecture ■ 24 years of experience	■ Principal-in-Charge
Tim R. Tetherow ■ Senior Planner	MS Landscape Architecture ■ 25 years of experience	■ Project Director
Leslie M. Ellwood ■ Project Biologist	MA Ecology/Mammology ■ 11 years of experience	■ Project Manager ■ Wildlife, Threatened and Endangered Species

TABLE 6-1
Preparers and Contributors

Name and Title	Education and Experience	Involvement
Cindy Smith ■ Senior Planner	BS Liberal Arts and Sciences ■ 22 years of experience	■ Document Preparation
John Everingham ■ Senior Environmental Scientist	MS Systems Ecology ■ 21 years of experience	■ Senior Review and Coordination
John Lague ■ Senior Air Quality Control	MS Meteorology ■ 25 years of experience	■ Air Quality Consulting
Jeff Fuller ■ Senior Acoustician	MS Environmental Health ■ 7 years of experience	■ Noise Assistance
Loren R. Hettinger ■ Senior Ecologist	PhD Ecology ■ 17 years of experience	■ Vegetation/Wetlands Reclamation
Sarah Barnum ■ Staff Biologist	MS Wildlife Biology ■ 7 years of experience	■ Wildlife, Threatened and Endangered Species
Laura Backus ■ Staff Biologist	MA Biology ■ 8 years of experience	■ Vegetation, Threatened and Endangered Species
Karen L. Spray ■ Associate	MS Geology Professional Geologist ■ 13 years of experience	■ Geology ■ Groundwater
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CHAPTER 8 - GLOSSARY

Abandonment - Termination of operations from production from a well. Permanent abandonment involves plugging the well and removal of the installations.

Acre-foot - A unit of volume of water for the amount covering one acre to a depth of one foot, equal to 43,560 cubic feet, or approximately 325,829 gallons or approximately 7758 barrels (bbls). (One cubic foot equals 7.48 gallons, one bbl equals 42 gallons)

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)

A-weighted - A weighting function applied to the noise spectrum, which approximates the response of the human ear.

Alkalinity - Quantity and type of compounds in water that collectively cause a pH shift to alkalinity.

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.

Alluvial Plains - Floodplains produced by the filling of a valley bottom and consisting of fine mud, sand, or gravel.

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.

Animal Unit Months (AUM) - Amount of forage required to sustain a cow/calf unit for one month.

Annular – Having the form of a ring; ring-shaped.

Areas of Critical Environmental Concern (ACEC) - A BLM designation pertaining to areas where specific management attention is needed to protect and prevent irreparable damage to important historical, cultural, and scenic values, fish or wildlife resources, or other natural systems or processes, or to protect human life and safety from natural hazards.

Aspect - The direction in which a slope faces.

Barite (BaS04) - A mineral used to increase the weight of the drilling mud.

Basin - A depressed area having no surface outlet (*topographic basin*); a physiographic feature or subsurface structure that is capable of collecting, storing, or discharging water by reason of its shape and the characteristics of its confining material (*water*); a depression in the earth's surface, the lowest part often filled by a lake or pond (*lake basin*); a part of a river or canal widened (*drainage, river, stream basin*)

Benthic - Of, pertaining to, or living in or on the bottom of a waterbody.

Bentonite - A naturally occurring clay used to keep the cuttings in suspension as they move up the bore hole.

Biogenic Rock - An organic rock produced directly by the physiological activities of living organisms, either plant or animal; e.g., coral reefs, shelly limestone, pelagic ooze, coal, peat.

Blowout - An uncontrolled expulsion of gas, oil, or other fluids from a drilling well. A blowout occurs when formation pressure exceeds the pressure applied to it by the column of drilling fluid and when blowout prevention equipment is absent or fails.

Bored Crossing - A subterranean crossing of a road, railway, river, or other obstacle, by a pipeline, transmission line, or other transport system.

Bradenhead Testing - The bradenhead is the portion of the wellhead that is in communication with the annular volume between the surface casing and the next smaller casing string. Conceptually, if there is positive pressure at the bradenhead, this indicates that a casing leak or an inadequate cement job could exist on a well.

Brine - A highly saline solution.

Bureau of Indian Affairs - An agency of the Department of the Interior responsible for encouraging and assisting Indian people to manage their own affairs under the trust relationship to the Federal government; to facilitate, with the maximum involvement of Indian people, full development of their human and natural resource potential, and promote self-determination by using the skills and capabilities of Indian people in the direction and management of programs for their benefit.

Bureau of Land Management - An agency of the Department of the Interior responsible for managing most Federal government subsurface minerals. It has surface management responsibility for Federal lands designated under the Federal Land Policy and Management Act of 1976.

Cambrian - The oldest of the periods of the Paleozoic Era; also the system of strata deposited during that period.

Carbonaceous - Coaly; pertaining to, or composed largely of, carbon.

Carbon Isotope Ratios - The ratio of the most common carbon isotope, carbon-12, which is non-radioactive, to either of the less common isotopes, carbo-13 (non-radioactive) or carbon-14 (radioactive), or the reciprocal of one of these ratios. If unspecified, the term generally refers to the ratio (carbon-12/carbon-13).

Casing - Steel pipes of varying diameter and weight, joined together by threads and couplings,"inserted" into the well bole 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 latter perforated for production.

Centralizer - A device secured around the casing at various intervals to center the casing in the hole and provide a uniform cement sheath around the casing.

Christmas Tree - An assemblage of valves, located at the top of casing, from which tubing in the well is suspended.

Clean Air Act - Public Law 84-159, established July 14, 1955, and amended numerous times since. The Clean Air Act: establishes Federal standards for air pollutants emitted from stationary and mobile sources; authorizes states, tribes and local agencies to regulate polluting emissions; requires those agencies to improve air quality in areas of the country which do not meet Federal standards; and to prevent significant deterioration in areas where air quality is cleaner than those standards. The Act also requires that all Federal activities (either direct or authorized) comply with applicable local, state, tribal and Federal air quality laws, statutes, regulations, standards and implementation plans. In addition, before these activities can take place in non-attainment or maintenance areas, the Federal agencies must conduct a Conformity Analysis (and possible Determination) demonstrating the proposed activity will comply with all applicable air quality requirements.

Cleat - In a coal seam, a joint or system of joints along which the coal fractures.

Coal - A readily combustible rock containing more than 50 percent weight and more than 70 percent by volume of carbonaceous material including inherent moisture, formed from compaction and induration of variously altered plant remains similar to those in peat. Differences in the kinds of plant materials (type), in degree of metamorphism (rank), and in the range of impurity (grade) are characteristic of coal and are used in classification.

Coal Bed - A coal seam.

Coalbed Methane - A gas associated with a coal seam.

Cogeneration - Production of fuel-fired steam sold initially (usually to a utility) to generate electricity and subsequently to a private enterprise for product processing.

Colluvium - A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits.

Completion - the activities and methods to prepare a well for production. Includes installation of equipment for production from an oil or gas well.

Conditions of Approval - Conditions or provisions (requirements) under which an Application for a Permit to Drill or a Sundry Notice is approved.

Connate Water - Water entrapped in the interstices of a sedimentary rock at the time the rock was deposited.

Conspecific - Of the same species.

Corridor - For purposes of this environmental assessment, a wide strip of land within which a proposed linear facility could be located.

Council on Environmental Quality (CEQ) - An advisory council to the President of the United States established by the national Environmental Policy Act of 1969. It reviews Federal programs for their effect on the environment, conducts environmental studies, and advises the president on environmental matters.

Cow-Calf Livestock Operation - A livestock operation in which a base breeding herd of mother cows and bulls is maintained. The cows produce a calf crop each year, and the operation keeps some heifer calves from each calf crop for breeding herd replacements. The operation sells the rest of the calf crop between the ages of 6 and 12 months along with old or non-productive cows and bulls.

Cretaceous - The third and latest of the periods included in the Mesozoic Era; also the system of strata deposited in the Cretaceous Period.

Critical Habitat - An area occupied by a threatened or endangered species "on which are found those physical and biological features (1) essential to the conservation of the species, and (2) which may require special management considerations or protection" (16 USC 1532 (5)(A)(I)1988). Unoccupied by suitable habitat for the threatened or endangered species is not automatically included unless such areas are essential for the conservation of the species (50 CFR 424.12(e)0.

Crucial Habitat - An area that is essential to the survival of any wildlife species sometime during its life cycle.

Cultural Resource Inventory Classes:

Class I - Inventory of existing data: A study of a defined area designed (1) to provide a narrative overview (cultural resource overview) derived from existing cultural resource information and (2) to provide a compilation of existing cultural resource site record data on which to base the development of the BLM's site record system.

Class III - An intensive field inventory designed to locate and record, from surface and exposed profile indications, all cultural resource sites within a specified area. A Class III inventory is appropriate on small project areas, all areas to be disturbed, and primary cultural resource areas.

Cultural Resources - Remains of human activity, occupation, or endeavor, as reflected in sites, buildings, artifacts, ruins, etc.

Cumulative Impact - The impact on the environment that results from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

Cuttings - Fragments of rock dislodged by the bit and brought to the surface in the drilling mud.

Debitage (cultural resources) - Waste flakes from tool-making activities.

Depth of Burial - The depth below the ground surface and/or thickness of overlying stratum over a particular rock unit of geologic interest. Coals buried at a depth of more than 4,000 feet do not have the flow capacity needed for economic methane gas development.

Depth to Coal Pay - The depth below the ground surface of a potential economic coal unit.

Desiccation - The removal of moisture; to become dried up.

Development Well - A well drilled within the known or proven productive area of an oil field with the expectation of producing oil or gas from the producing reservoir.

Dewatering - The act of removing water.

Directional Drilling - The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the drilling site.

Disposal Well - A well into which produced water from other wells is injected into an underground formation for disposal.

Diurnal - Describes a cyclic event recurring daily; or the nature or habit of an organism to be active during daylight hours.

Drilling Fluids - The circulating fluid used to bring cuttings out of the wellbore, cool the drill bit, provide hole stability, and pressure control.

Drilling Rig - The derrick, draw-works, and attendant surface equipment of a drilling or workover 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.

Dry Hole - Any well incapable of producing oil or gas in commercial quantities. A dry hole my produce water, gas, or even oil, but not enough to justify production.

Embargo - A restriction imposed on commerce by law; especially a prohibition of trade in a particular commodity.

Emission - Air pollution 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.

Enhanced Recovery - The use of artificial means to increase the amount of hydrocarbons that can be recovered from a reservoir. A reservoir depleted by normal extraction usually can be restored by secondary or tertiary methods of enhanced recovery.

Entrained Methane - Methane that is picked up and carried along; the collecting and movement by currents.

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.

Ephemeral Stream - A stream that flows only in direct response to precipitation.

Exploration Well - A well drilled in the area where there is no oil or gas production (also known as wildcat well).

Exsolve - From exsolution, the process whereby an initially homogeneous solid solution separates into two (or possibly more) distinct crystalline phases without addition or removal of material to or from the system; i.e., without change in the bulk composition. I generally, though not necessarily, occurs on cooling. Synonym: *unmixing*.

Eyrie - The nest of birds of prey.

Fan - An accumulation of debris brought down by a stream descending through a steep ravine and debouching in the plain beneath, where the detrital material spreads out in the shape of a fan, forming a section of a very low cone.

Federal Candidate Species - Sensitive wildlife species currently under consideration for inclusion to the list of Federal threatened or endangered species. Species are placed in one of the following categories:

1 . Available data on biological vulnerability and threat(s) support listing, but additional data are needed on precise habitat and/or critical habitat boundaries.

2. Available data indicate that listing may be appropriate, but substantial data on vulnerability and threats are not available to support immediate listing.

3A. Probably extinct.

3B. Taxa do not meet the USFWS definition of species; taxa may be re-evaluated in the future.

3C. Taxa that have proven to be more abundant or widespread than was previously believed and/or those that are not subject to any identifiable threat; further research may indicate re-evaluation to Category 1 or 2.

Federal Land Policy and Management Act of 1976 (FLPMA) - Public Law 94-570 signed by the President of the United States on October 21, 1976. Established public land policy for management of lands administered by the Bureau of Land Management (BLM).

Federal Listed Species - Animal or plant species listed by the USFWS as threatened or endangered.

Fiduciary - Held in trust.

Flare - An arrangement of piping and a burner to dispose of surplus combustible vapors, usually situated around a gasoline plant, refinery, or producing well.

Floodplain - The flat ground along a stream that is covered by water when the stream overflows its banks at flood stages.

Forage - All browse and herbaceous foods available to grazing animals, which may be grazed or harvested for feeding.

Foreground View - The landscape area visible to an observer within a mile.

Formation - A body of rock identified by lithic characteristics and stratagraphic position; it is prevailingly, but not necessarily tabular, and is mappable at the earth's surface or traceable in the subsurface (NACSN, 2984, Art. 24).

Fossil - Any remains, trace, or imprint of a plant or animal that has been preserved by natural processes in the earth's crust since some past geologic time.

Fractured - Fissured, broken, or cracked. See also Hydraulic Fracturing.

Free Market - An economic market operating by free competition.

Fugitive Dust - Airborne particles emitted from any source other than through a controllable stack or vent.

Game Management Unit (GMU) - Colorado is divided into approximately 150 geographic areas called Game Management Units. Game species are managed on a unit specific basis.

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 Type - An aggregation of all land areas potentially capable of producing similar plant communities at climax.

Herpetofauna - Reptiles and amphibians.

Highest and Best Use - Use of a resource (i.e., property) that maximizes its potential.

Historic - Archaeological and archivally known sites related to the activities of non-native peoples, whether they be of Euro-American, Afro-American or Asian-American origin, in the period after the European discovery of the New World (ca. A.D. 1492).

Hydraulic Fracturing - A method of stimulating production by increasing the permeability of the producing formation.

Hydric Soils - Saturated soils.

Hydrocarbons - Organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed only 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.

Hydrogeologically Connected - The connection of two or more hydrologic systems, usually refers to separate aquifers in which water can pass and exchange with other aquifers.

Hydrophytic - Water-loving; ability to grow in water or saturated soils.

Hydrostatic Test - The testing of pipeline integrity by closing of all openings and pumping water into the pipe at a pressure greater than the normal operating pressure to determine whether or not leaks are present.

Immigrant - Individual who moves into the project area from another part of the country.

Impact - A modification of the existing environment caused by an action (such as construction or operation of facilities).

Incised Channels - Deeply and sharply cut stream channels.

Indian Mineral Estate - A mineral estate owned by the Federal government and held in trust for the Indian people. The Bureau of Indian Affairs and Bureau of Land Management, as agents of the Secretary of the Interior, have the responsibility for administering the leasing and development of oil and gas resources in such a case. However, under the auspices of the Indian Self Determination Act of 1968 and Indian Mineral Development Act of 1982, Indian people may take a leadership role in the management of their mineral resources.

Indicator Species - A species of animal or plant whose presence is a fairly certain indication of a particular set of environmental conditions. Indicator species serve to show the effects of development actions on the environment.

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.

Injection - The forcing, under abnormal pressure, of material (downward from above, upward from below, or laterally) into a pre-existing deposit or rock, either along some plane or weakness or into a pre-existing crack or fissure.

Injection Well - A well used to inject fluids into an underground formation to increase reservoir pressure.

Insignificant or Non-significant Impacts - Impacts that are perceptible or measurable relative to those occurring naturally or due to other actions, and would not exceed significance criteria.

Intermittent Stream - A stream or reach of a stream that is below the local water table for at least some part of the year.

Joint Patterns - Patterns of fractures in rock, generally vertical or transverse to bedding, along which no appreciable movement has occurred.

Jurisdiction - The legal right to control or regulate use of a transportation facility. Jurisdiction requires authority, but not necessarily ownership.

K-factor - Soil erodibility factor.

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 which is determined by interacting ecosystems.

Landscape Character - Particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique.

Landscape Setting - The context and environment in which a landscape is set; a landscape backdrop.

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.

Lek - An area where grouse gather for ritualistic display and breeding; also, a sage grouse strutting ground.

Lenticular - Shaped approximately like a double convex lens.

Level of Service (LOS) - In transportation studies, a qualitative measure of traffic flow along a given road considering a variety of factors, including speed and travel time, traffic interruptions and freedom to maneuver. Levels of service are designated "A" through "F"; "A" being a free-flow condition with low volumes at high speeds and "F" being a congested condition of low speeds and stop-and-go traffic. Intermediate levels describe conditions between these extremes. A level of service below "C" involves unstable to forced traffic flow in which a driver's freedom to select a speed is restricted and in which traffic stoppages cause congestion.

Liquefaction - A change in the phase of a substance to the liquid state; usually a change from the gaseous to the liquid state, especially of a substance that is a gas at normal pressure and temperature.

Lithic Scatter - A scatter of chipped stone materials, which may include fragments, flakes, or stone tools.

Lithology - The physical characteristics of a rock, generally as determined megascopically or with the aid of a low-power magnifier.

Logging Tool - Electric tools that are able to be lowered down a well bore by wire cable and are capable of taking measurements of the physical properties of the rock formations downhole (i.e., resistivity, self-potential, gamma-ray, intensity, or velocity). The data is recorded and displayed on well logs that aid in defining physical rock characteristics such as lithology, porosity, pore geometry, and permeability.

Management Indicator Species - Those species that are commonly hunted or whose habitat requirements and population changes are believed to indicate effects of management activities on a broader group of wildlife species in the ecological community.

Middleground View - One of the distance zones of a landscape being viewed. This zone extends from the limit of the foreground to three to five miles from the observer.

Migration (oil and gas) - the movement of liquid and gaseous hydrocarbons from their source or generating beds, through permeable formations into reservoir rocks.

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. It is an exception 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 the exercising of 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 fife of a project, or (5) replacing or providing substitute resources to the environment or (6) gathering archaeological and paleontological data before disturbance.

Multiple Use - Multiple use as defined by the Multiple Use - Sustained Yield Act 1960 means the management of all the various renewable surface resources so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will given the greatest dollar return or the greatest unit output.

National Ambient Air Quality Standards (NAAQS) - 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 (NEPA) - An Act that encourages productive and enjoyable harmony between man and his environment and promotes efforts to prevent or eliminate damage to the environmental and biosphere and stimulate the health and welfare of man; enriches the understanding or the ecological systems and natural resources important to the Nation, and establishes the Council on Environmental Quality.

National Natural Landmarks - Sites designated by the Secretary of the Interior as containing the best representative examples of geologic features and natural communities composing the nation's natural history. The purpose of the designation is to encourage preservation of such sites through well-informed management and use, and consideration of these sites in public and private land use planning. Designation has no legal effect on land ownership, use, or management (National Park Service, not date, National Natural Landmark Designation).

Negligible Impact - Impact that is small in magnitude and importance and are difficult or impossible to quantify relative to those occurring naturally or due to other actions.

Non-Conventional Energy Sources - Energy sources not commonly used (e.g., solar energy).

Non-Range - Areas that are not suitable for livestock grazing due to low forage production, steep slopes, dense brush, or other reasons.

Notice of Review Species - A species that is being considered as a candidate for listing as either endangered or threatened under the Endangered Species Act of 1973, as amended.

Noxious Weed - An undesirable weed species that can crowd out more desirable species.

Off-Highway Vehicle (OHV) - A vehicle (including four-wheel drive, trail bikes, all-terrain vehicles, and snowmobiles but excluding helicopters, fixed-wing aircraft, and boats) capable of traveling off road over land, water, ice, snow, sand, marshes, and other terrain.

One-Hundred-Year Flood - A hydrologic event with a magnitude that has a recurrence interval of 100 years.

Paleontology - A science dealing with the life of past geological periods as known from fossil remains.

Palustrine - A system of wetlands that includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens.

Particulate Matter - A particle of soil or liquid matter (e.g., soot, dust, aerosols, fumes and mist).

Peidmont - Lying or formed at the base of mountains.

Perennial Stream - A stream receiving water from both surfaces and underground sources that flows throughout the entire year.

Perforations - Holes that are made through the casing and cement, and extend some distance into the production zone.

pH - A numeric value that gives the relative acidity or alkalinity of a substance on a 0 to 14 scale with the neutral point at 7. Values lower than 7 show the presence of acids, and values greater than 7 show the presence of alkalis.

Plan of Development - A mandatory plan, developed by an applicant of a mining operation or construction project, that specifies the techniques and measures to be used during construction and operation of all project facilities on public land. The plan is submitted for approval to the appropriate Federal agency before any construction begins.

Plug - Any object or device that serves to block a hole or passageway, as a cement plug in a borehole.

Prehistoric - Archaeological sites resulting from the activities of aboriginal peoples native to this region, and because dating is often difficult, extending up to the reservation era (ca. A.D. 1868).

Prevention of Significant Deterioration (PSD) - A regulatory program under the Clean Air Act (P.L. 84-159, as amended) to limit air quality degradation in areas currently achieving the National Ambient Air Quality Standards. The PSD program established air quality classes in which differing amounts of additional air pollution is allowed above a legally defined baseline level. Almost any additional air pollution would be considered significant in PSD Class I areas (certain large national parks and wilderness areas in existence on August 7, 1977, and specific Tribal lands redesignated since then.) PSD Class II areas allow that deterioration associated with moderate, well-controlled growth (most of the country). Although Class III areas would allow greater incremental impacts planned individual growth, no Class III areas have been established.

Primary Range - Areas where the majority of livestock grazing is concentrated, due to high forage production, easy accessibility, nearby water sources, or other reasons.

Prime Farmland - Land that is best suited for producing food, feed, forage, fiber, and oilseed crops. The inventory of prime agricultural land is maintained by the USDA Natural Resources Conservation Service, (formerly the Soil Conservation Service).

Production Well - A well drilled in a known field that produces oil or gas.

Proposed Action - Construction activities, alignments, and other activities proposed by the applicant.

Proppants - Sandgrains, aluminum pellets, glass beads, or similar materials used in hydraulic fracturing. When injected into the production formation, these materials leave channels allowing gas to flow through them into the well.

Quaternary - The younger of the two geologic periods or systems in the Cenozoic Era.

Rare or Sensitive Species - Species that have no specific legal protection under the Endangered Species Act as threatened or endangered species, but are of special concern to agencies and the professional biologic community due to low populations, limited distributions, ongoing population decline, and/or human or natural threats to their continued existence.

Reasonable Foreseeable Development Scenario – The prediction of the type and amount of oil and gas activity that would occur in a given area. The prediction is based on geologic factors, past history of drilling, projected demand for oil and gas, and industry interest.

Reciprocation - A technique performed while cementing, whereby casing is moved up and down the wellbore in order to move the cement slurry uniformly around the wellbore to eliminate channelling and provide an effective cement bond on the casing and formation walls.

Reclamation - The process of converting disturbed land to its former use or other productive uses.

Rest Rotation Grazing System - A grazing system in which one of several pastures in an allotment or group is "rested" (not grazed) each year, with each pasture being rested in turn.

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 - (1) Usually an excavated pit that may be lined with plastic that holds drill cuttings and waste mud. (2) 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.

Riverine - A system of wetlands that includes all wetland and deep-water habitats contained within a channel that lacks trees, shrubs, persistent emergents, and emergent mosses or lichens.

Rotation - A technique performed while cementing, whereby casing is rotated in the hole in order to move the cement slurry uniformly around the casing to eliminate channelling and provide an effective cement bond on the casing and formation walls.

Salinity - A measure of the amount of dissolved salts in water.

San Juan Basin - A large geologic basin located in northwestern New Mexico and southwestern Colorado that has been extensively drilled for oil and gas and is reportedly the second largest gas-producing basin in the continental United States. (A summary of the mineral development history is provided in Chapter 1.)

Saline water - Water containing high concentrations of salt (see also brine).

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.

Scraper Trap - A device on the pipeline used to receive a scraper pig or inside pipe inspection pig.

Scratchers - A device fastened to the outside of the casing that removes drilling mud from the wall of the hole to condition the hole for cementing. By rotating or moving the casing up and down as it is being inserted into the hole, the scratcher, formed of stiff wire, removes drilling mud so that cement can bond solidly to the formation wall.

Screened - The depth at which a well screen has been placed on a well. A well screen allows fluids to enter the well casing.

Secondary Range - Areas where livestock grazing occurs but at lower intensities than primary range, due to less favorable conditions of forage production, terrain, distance from water source, or other factors.

Secondary Succession - The process by which ecosystems recover toward pre-existing conditions after removal of a disturbance, such as the recovery process of a forest after a fire.

Sediment - Soil or mineral transported by moving water, wind, gravity, or glaciers, and deposited in streams or other bodies of water, or on land.

Sensitive Plant Species - Those plant or animal species susceptible or vulnerable to activity impacts or habitat alterations.

Sensitivity Levels (visual resources) - A measure of people's concern for scenic quality.

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.

Significance Criteria - Criteria identified for specific resources used to determine whether or not impacts would be significant.

Slope - The degree of deviation of a surface from the horizontal.

Slug Tests - A test used to calculate hydraulic conductivity, transmissivity, and the storage coefficient (i.e. the wells potential yield).

Soil Productivity - The capacity of a soil to produce a plant or sequence of plants under a system of management.

Soil Texture - The relative proportions of sand, silt, and clay particles in a mass of soil. Basic textural classes, in order of increasing proportions of fine particles, are: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, and clay.

Split Estate - A given area where either the surface or mineral estate is Federally owned.

Stipulations - Requirements that are part of the terms of a mineral lease. Some stipulations are standard on all Federal leases. Other stipulations may be applied to the lease at the discretion of the surface management agency to protect valuable surface resources and uses.

Storage Coefficient - The volume of water released from storage in a vertical column of 1 square foot when the water table or other piezometric surface declines one foot.

Structural Trap - One in which entrapment results from folding, faulting, or a combination of both.

Sundry Notice - Standard form to notify of or propose change of approved well operations subsequent to an Application for Permit to Drill in accordance with 43 CFR 3162.3-2 .

Sustainability - The ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time.

Tertiary - The older of the two geologic periods comprising the Cenozoic Era; also the system of strata deposited during that period.

Thermogenic - Of or pertaining to the rise in temperature in a body from reactions in that body, as by oxidation, or the decay of radioactive elements.

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).

Threatened Species - Any plant or animal species likely to become endangered within the foreseeable future throughout all or part of its range.

Thrust Fault - A reverse fault that is characterized by a low angle of inclination with reference to a horizontal plane.

Toe-slope - The most distant part of a landslide; the downslope edge of a landslide or slump.

Total Dissolved Solids - A term that describes the quantity of dissolved material in a sample of material.

Total Suspended Particulates (TSP) - All particulate matter less than approximately 70 micrometers (microns) in effective diameter.

Total Suspended Solids - A term that describes the quantity of solid material in a sample of material.

Transmissivity - The rate at which water is transmitted through a unit width of aquifer under a hydraulic gradient.

Trap - A body of reservoir rock completely surrounded by impervious rock; a closed reservoir.

Turbolator - A type of centralizer that induces turbulent flow for better drilling mud displacement and cement sheath placement.

Unionized Ammonia - A species of nitrogen that is toxic to aquatic life.

Vegetation Type - A plant community with distinguishable characteristics described by the dominant vegetation present.

Vent - An opening in a vessel, fine, or pump to permit the escape of air or gas.

View - Something that is looked toward or kept in sight, especially a broad landscape panorama. Act of looking toward this object or scene.

Viewshed - Total visible area from a single observer position, or the total visible area from multiple observer positions. Viewsheds are accumulated seen-areas from viewer locations. Examples are corridor, feature, or basin viewsheds.

Visual - A mental image attained by sight.

Visual Absorption Capability - The relative ability of a landscape to accept management practices without affecting its visual characteristic. The capability to absorb visual change. A prediction of how difficult it will be for a landscape to meet recommended VQOs.

Visual Quality Objectives - Descriptions of a different degree of alteration of the natural landscape based upon the importance of aesthetics.

Visual Resource Management Class (VRM Class) - The degree of visual change acceptable within the existing characteristic landscape. An area's classification is based upon the physical and sociological characteristics of any given homogeneous area and serves as a management objective.

Walking Beam Pumping Unit - A unit consisting of a pump jack and engine that is used to lift the produced stream (water and natural gas) from the production zone, allowing gas to flow by reducing the hydrostatic pressure on top of a rock unit (i.e., coals).

Well Logging - A logging truck equipped with various electronic logging tools and a computer that goes out to a well site after drilling operations are completed. The data from the logging tools are recorded on film and stored digitally in the on-site computer. The logging engineer generates printed well logs for use in analyzing the stratigraphic units traversed by a borehole.

Wellbore - The hole made by the drilling bit.

Wellhead - The equipment used to maintain surface control of a well. It is formed of the casing head, tubing head, and Christmas tree. Also refers to various parameters as they exist at the wellhead, such as wellhead pressure, wellhead price of oil, etc.

Wetlands – Those areas that are inundated by surface or ground water with a frequency sufficient, under normal circumstances, to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth or reproduction. Wetlands include marshes, bogs, sloughs, potholes, river flows, mud flats, wet meadows, seeps, and springs.

Wildcat Well – An exploratory well drilled in an are where there is no oil or gas production (see exploration well).

Wilderness Study Area (WSA) - A roadless area or island that has been inventoried and found to have wilderness characteristics as described In Section 603 of the Federal Land Policy and Management Act and Section 2(c) of the Wilderness Act of 1964 (78 Stat. 891).

Work Force - The total number of workers on a specific project or group of projects. The work force also is referred to as direct employment and primary employment.