Draft Environmental Assessment of Proposed Oil and Gas Exploration, Baca National Wildlife Refuge, Saguache County, Colorado

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Prepared by the U.S. Fish and Wildlife Service

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The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations.

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Acronyms and Abbreviations

°F	degrees Fahrenheit
3D	three dimensional
afy	acre-feet per year
AIRFA	American Indian Religious Freedom Act
APCD	Air Pollution Control Division
APD	applications for permit to drill
APE	area of potential effect
APEN	Air Pollutant Emission Notice
AQRV	air quality related values
ARPA	Archaeological Resource Protection Act
BEA	Bureau of Economic Analysis
BMP	best management practices
BOP	blowout preventer
Btu	British thermal units
Ca	Calcium
CAAQS	Colorado Ambient Air Quality Standards
CCP	comprehensive conservation plan
CDA	Colorado Department of Agriculture
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDWR	Colorado Department of Water Resources
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	Methane
Cl	Chloride
CNHP	Colorado Natural Heritage Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_3	carbonate
COGCC	Colorado Oil and Gas Conservation Commission
CR	County Road
CRS	Colorado Revised Statute
CU	consumptive use
dBA	decibels on the “A” weighted scale
DOLA	Colorado Department of Local Affairs

DOT	Department of Transportation
DST	Drill Stem Test
EA	Environmental Assessment
EO	Executive Order
ESA	Endangered Species Act
FLAG	Federal Land Manager's Air Quality Related Values Work Group
FLM	Federal Land Managers
GPS	Global Positioning System
GSDNPP	Greater Sand Dunes National Park and Preserve
HAPs	Hazardous Air Pollutants
HCO_3	Bicarbonate
HDN	Hardness
HGM	Hydrogeomorphic
K	Potassium
kaf/yr	Kilo-acre feet per year
LAPS	Land Acquisition Priority System
L_{dn}	sound level day/night
$L_{eq(24)}$	24-hour equivalent sound level
Lexam	Lexam Explorations (U.S.A.) Inc.
MBTA	Migratory Bird Treaty Act
MCF	thousand cubic feet
MD	measured depth
Mg	Magnesium
mg/L	milligrams per liter
m/s	meters per second
Na	Sodium
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NCA	Network of Conservation Areas
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMPM	New Mexico Prime Meridian
NOAA FSL	National Oceanic and Atmospheric Administration's Forecast System Laboratory
NO_x	nitrogen oxides
NPS	National Park Service
NRAs	Natural Resource Advisors
NRCS	Natural Resources Conservation Service

NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OSHA	Occupational Safety and Health Administration
PCA	Potential Conservation Area
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
PSD	Prevention of Significant Deterioration
Refuge	Baca National Wildlife Refuge
RFFA	Reasonably Foreseeable Future Actions
RGDSS	Rio Grande Decision Support System
RIMP	Resource Inventory and Monitoring Plan
SCF	standard cubic feet
Service	U.S. Fish and Wildlife Service
SH	State Highway
SHPO	State Historic Preservation Office
SLV RETAC	San Luis Valley Regional Emergency Medical Services/Trauma Advisory Council
SO_2	Sulfur dioxide
SO_4	Sulfate
SPCC	Plan Spill Prevention, Control, and Countermeasure Plan
SWMP	Storm Water Management Plan
SVOC	Semi-volatile organic compound
SWSP	substitute water supply plan
TCP	traditional cultural property
TDS	total dissolved solids
TNC	The Nature Conservancy
TVD	total vertical depth
U.S.	United States
USACE	United States Army Corp of Engineers
USC	United States Code
USDA	United States Department of Agriculture
EPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound
µs/cm	Micro semens per centimeter

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*These figures also include the well pad location of Baca #6 which was not previously permitted by the Colorado Oil and Gas Conservation Commission. Lexam has proposed drilling at Baca #7 instead of Baca #6. Therefore, Baca #6 was excluded from all analyses in this document.

Executive Summary

The U.S. Fish and Wildlife Service (Service) has prepared this Draft Environmental Assessment (EA) of Proposed Oil and Gas Exploration, Baca National Wildlife Refuge (Refuge), Saguache County, Colorado in accordance with the procedures for implementation of the National Environmental Policy Act (NEPA) as stated by the Council of Environmental Quality. The purpose of this Draft EA is to ensure that the proposed oil and gas exploration on the Refuge by Lexam Explorations (U.S.A.) Inc. (Lexam) does not unreasonably impact the surface estate (including all surface and subsurface natural resources not considered to be minerals) of the Refuge and associated cultural, socioeconomic, and aesthetic resources. The Service seeks to protect Refuge resources while honoring a mineral owner's rights to access and explore the oil and gas mineral estate. The Service will ensure protection of the surface estate and associated resources occurring on the Refuge from unreasonable damage by requiring that Lexam follow specific protective measures during all phases of the proposed oil and gas exploration (project), including the intended drilling of two exploratory wells on the Refuge. This Draft EA evaluates and compares the No Additional Protective Measures Provided by the Service Alternative (no action alternative), Acquisition of the Mineral Estate Alternative, and a Maximum Protection of Refuge during Exploration Alternative (preferred alternative).

Project Location

The proposed exploration by Lexam would be located within the Refuge, Saguache County, in the San Luis Valley of south-central Colorado. The proposed exploration is focused in an area located in the north-central portion of the Refuge approximately 4 miles south of Saguache County Road T.

Project Description

Lexam has provided documentation to Service showing that it is an owner of mineral rights below portions of the surface estate on the Refuge, and therefore is entitled to make use of the surface for exploration. The Service would deny surface access without such evidence. Lexam acquired their mineral interest prior to acquisition of the surface interest in the Baca Ranch by the Service. As an owner of portions of the Refuge subsurface oil and gas mineral estate, Lexam has contacted the Service regarding its proposal to explore the subsurface for oil and gas, including the drilling of two 14,000 foot wells.

With respect to State of Colorado law on subsurface mineral rights in Colorado, the subsurface mineral property owner has the right to pursue recovery of its minerals.

The Service has reviewed Lexam's Plan of Operations for oil and gas exploration on the Refuge and is requiring specific protective measures be followed by Lexam to ensure that impacts from exploration are less than significant. These protective measures are designed to ensure that the manner, location, and timing of Lexam's activities constitute a reasonable use of the Refuge's surface estate.

Project Scoping

The Service sought public involvement regarding Lexam's proposed exploration activities, as part of the NEPA process, during a 30-day comment period and by hosting a public meeting in Crestone, Colorado. This process allowed the Service to gather public input and solicit concerns regarding Lexam's proposed oil and gas exploration on the Refuge. Refuge staff along with the Service's Region 6 Division of Refuge Planning conducted the public scoping meeting.

Project Impacts

Implementation of the Preferred Alternative – the Service is requiring that specific protective measures and standards are followed during all phases of oil and gas exploration being proposed by Lexam, including the intended drilling of two exploratory gas wells on the Refuge, to ensure maximum protection of the surface estate (including all surface and subsurface natural resources not considered minerals) of the Refuge and associated cultural, socioeconomic, and aesthetic resources from unreasonable degradation or impacts. With these requirements incorporated into Lexam's Plan of Operations, potential impacts are expected to be less than significant in regards to NEPA. Information gathered in this Draft EA indicates that the temporary nature of the proposed exploration (<180 days), along with implementation of the preferred alternative, will not unreasonably degrade or result in significant impacts to the surface estate (including all surface and subsurface natural resources not considered to be minerals) of the Refuge and associated cultural, socioeconomic, and aesthetic resources.

1.0 Introduction

The purpose of this Draft Environmental Assessment (EA) is to ensure that initial exploration of the oil and gas mineral estate under the Baca National Wildlife Refuge (Refuge) by Lexam Explorations (U.S.A.) Inc. (Lexam) does not unreasonably degrade or impact the Refuge and associated resources. The U.S. Fish and Wildlife Service (Service) seeks to protect Refuge resources while at the same time honoring a mineral owner's vested right to access and explore the oil and gas mineral estate. The Service's preferred alternative would ensure maximum protection of the Refuge by requiring that Lexam follow specific protective measures and standards during all exploration activities. The Service would request that any of these protective measures applicable to the Colorado Oil and Gas Conservation Commission's (COGCC) regulation authority, be considered as conditions for permit approval for any permit applications by Lexam for wells on the Refuge. The Draft EA provides a comparison of three alternatives: 1) No Additional Protective Measures (no action), 2) Acquisition of the Mineral Estate and 3) Maximum Protection of Refuge during Exploration (preferred alternative). This comparison of alternatives assesses a range of potential effects to all surface and subsurface resources protected by the Refuge and associated cultural, socioeconomic, and aesthetic resources may be affected during Lexam's proposed exploration activities.

1.1 Baca National Wildlife Refuge

Authorized in 2000, the Refuge is a large and recent addition to the National Wildlife Refuge System (NWRS) administered by the Service, Department of the Interior. Currently, the Refuge consists of 78,670 acres of fee-title land and has an approved acquisition boundary of over 92,500 acres. The Nature Conservancy (TNC) has the largest inholding of land remaining within the approved acquisition boundary. The Refuge is located in Saguache and Alamosa counties in the San Luis Valley of south-central Colorado (**Figure 1-1**) and includes some lands which were part of the "Luis Maria Baca Grant No. 4" - commonly referred to as the "Baca Ranch." Congress approved this Refuge boundary and authorized acquisition of lands within it with passage of Public Law 106-530, also known as the "Great Sand Dunes National Park and Preserve Act of 2000," as amended by Section 117 of the 2009 Omnibus Appropriations Bill (Public Law 111-8). This legislation focused not only on protecting the region's hydrology, which the unique sand dunes ecosystem depends upon, but also protecting the ecological, cultural, and wildlife resources of the area.

The purpose of the Refuge is to restore, enhance, and maintain wetland, upland, riparian, and other habitats for native wildlife, plant, and fish species in the San Luis Valley. In administering the Refuge, the Secretary shall, to the maximum extent practicable - (A) emphasize migratory bird conservation; and (B) take into consideration the role of the Refuge in broader landscape conservation efforts; and (C) subject to any agreement in existence as of the date of enactment of this paragraph, and to the extent consistent with the purposes of the Refuge, use decreed water rights on the Refuge in approximately the same manner that the water rights have been used historically (as amended by Section 117 of the 2009 Public Law 111-8).

The Refuge is situated within the San Luis Valley, which is considered a high mountain desert. However, abundant snowfall in the two 14,000 foot mountain ranges (San Juan Mountains to the west and Sangre de Cristo Mountains to the east) contributes to the dynamic hydrological regime and wetland complex in the San Luis Valley. Although the valley floor only receives an average of seven inches of precipitation on an annual basis, wetland and riparian habitat throughout the San Luis Valley are sustained by runoff from snowfall in the surrounding mountain ranges. Numerous streams also flow across the Refuge creating abundant surface water in an otherwise arid landscape. The Refuge contains a diverse suite of habitats including desert shrublands, grasslands, wet meadows, playa wetlands, and riparian corridors and is home to a large number of wildlife and plant species, many of which are endemic to the San Luis Valley.

The Refuge abuts lands owned or controlled by other conservation entities including: the National Park Service (NPS), TNC, The Colorado Division of Wildlife, and the Colorado State Land Board. This complex of lands, totaling more than 500,000 acres, contains one of the largest and most diverse assemblages of wetland habitats remaining in Colorado.

The San Luis Valley also is rich in prehistoric and historic resource sites, some of which date over 12,000 years ago. Many of these are eligible to be placed on the National Register of Historic Places. On federally managed lands, such as the Refuge, eligible sites share the same management status as already listed sites.

1.2 Background

Mineral Ownership

Lexam's mineral interest underlies portions of the Refuge that were originally granted to the Baca family by the United States (U.S.) government as replacement for land lost in the Mexican American War. The original grant was located in the Las Vegas, New Mexico area and was granted by the King of Spain to the Baca family. There are 100,000 acres of land in the Luis Maria Baca Grant #4 (Baca Grant), which is located in Townships 41 to 43 North (T41N to T43N) and Ranges 10 to 12 East (R10E to R12E), New Mexico Prime Meridian (NMPM) in Saguache County.

Lexam's signed a Surface Use Agreement in 1992 with American Water Development, Inc. ("AWDI"), a previous owner. The Surface Use Agreement is a 20-year agreement (of two 10-year terms) that describes Lexam's rights to use the surface of the Baca Grant. The agreement includes provisions for extensions of the agreement beyond 20 years. In a Memorandum of Understanding dated May 5, 2010, the parties to the lawsuit *San Luis Valley Ecosystem Council*, *et al. v. U.S. Fish and Wildlife Service*, Civil Action No. 07-CV-00945-WDM-MEH (D. Colo.) agreed that the expiration of the Surface Use Agreement would be tolled beginning September 3, 2009 and would continue to be tolled until completion of the NEPA analysis and the conclusion of any subsequent litigation, including appeals.

Previous Exploration

Prior oil and gas exploration activities began on the Baca Grant in the early 1980s by other companies. Lexam began conducting its own mineral exploration drilling in the early 1990s before the Refuge was established. In 1992 and 1993, 42 shallow mineral exploration boreholes were drilled by Challenger Gold Inc. (a predecessor to Lexam), 27 of these encountered oil in fractured Precambrian rocks and Mesozoic sediments (including Morrison Formation, Dakota Sandstone and Mancos Shale) (Watts et al. 2006). These oil shows were not indicative of commercially producible oil and gas (Watkins et al. 1995; Cappa and Wallace 2007). The 42 shallow mineral boreholes drilled in 1992 and 1993 were located approximately seven miles from the currently proposed well sites on the Refuge. While the oil shows provide evidence that oil exists in a concealed seep located more than 4 miles along the east margin of the San Luis Valley, the 42 shallow boreholes drilled may not be indicative of any producible hydrocarbons at Baca #5 and Baca #7. Results from the 42 boreholes indicate that the oil is Cretaceous in origin, similar to produced oil and gas origins in other areas of the Rocky Mountains.

Data available in the public domain and proprietary data obtained by Lexam were combined with data from the mineral exploration drill holes to map and interpret the geology beneath the Baca Grant. This mapping by Lexam led to the drilling of two exploration wells, Baca #1 and Baca #2 wells (**Figure 1-1**). These wells were permitted with the COGCC and were drilled in 1995 before the Refuge was established. The Baca #1 was drilled to a depth of 4,322 feet and the Baca #2 was drilled to a depth of 6,932 feet. The wells were plugged and abandoned in 1996 in accordance with COGCC rules and plugging orders (COGCC approved surface reclamation January 2007 [COGCC 2009]). Data obtained from the Baca #1 and Baca #2 wells along with two dimensional seismic data acquired in 1996, 1998, 1999, and 2002 and data from other exploration techniques indicated that thicker Cretaceous sections (located in the Baca Graben) may be present on deeper blocks under parts of the Baca Grant (Watts et al. 2006). This information along with data gathered during the 3D seismic surveys led to Lexam's current Plan of Operations that targets exploration activities in a prospective area in the north-central portion of the Baca Grant generally located in the southern portions of T43N, R11E NMPM (**Figure 1-1**). Lexam's Plan of Operations identifies two proposed wells for exploration, both of which are within the boundaries of the Refuge. These wells, Baca #5 and Baca #7, were previously permitted with the COGCC, but both permits expired on May 20, 2010 and are no longer valid. Baca wells #3 and #4 were permitted but never drilled and were located in the southern part of T43N, R11E. Because permits for Baca #5 and Baca #7 are expired, Lexam would need to resubmit an application to drill for oil and gas at Baca #5 and Baca #7 as described in their current Plan of Operations

In 2004, Lexam signed a 2-year agreement with Petro-Hunt to evaluate Lexam's oil and gas mineral estate in the San Luis Valley, to process and interpret approximately 50 miles of the previously mapped Chevron 2D seismic data and an additional 60 miles of 2D seismic data, and to assist Lexam in defining the structural closure in Lexam's Crestone Prospect (Watts et al. 2006).

Events Leading to the Current Proposal by Lexam

In May 2006, Lexam announced their intent to explore for natural gas or oil. Lexam conducted a cultural resource inventory of the Baca #5 and Baca #6 drill sites and access roads and the entire length of the lines to be used in conducting the 3D seismic program. During January 2007, Lexam performed a 3D seismic exploration survey on the Refuge after receiving a permit from the COGCC to further define their target for drilling exploration. Lexam and the Service jointly negotiated an operating plan to mitigate impacts to the surface estate of the Refuge prior to carrying out the actual 3D seismic survey. The 3D seismic survey area is shown on **Figure 1-1**. New information gathered from the 3D seismic survey led to the identification of the current proposed exploration targets, Baca #5 and #7 drill locations (**Figure 1-2**). Drilling is proposed to occur on Baca #5 and Baca #7 locations, each with one vertical well to 14,000 feet.

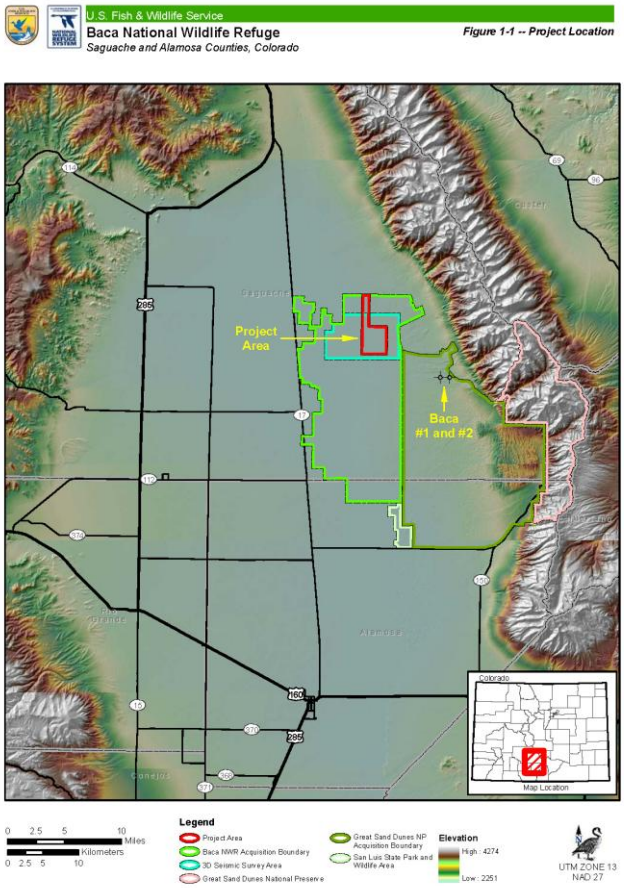
In May 2007, the San Luis Valley Ecosystem Council and Citizens for San Luis Valley Water Protection Coalition filed a complaint in U.S. District Court of Colorado alleging the Service did not comply with the NEPA and the Administrative Procedure Act while working with Lexam to develop measures to protect the surface estate. All Service activities to this point in time had followed agency policy and draft agency guidelines (**Appendix A**) for directing exploration of excepted minerals on NWRs. In response to the complaint and without challenging its legal applicability, the Service began the NEPA process in June 2007 by initiating preparation of an EA. In November 2007, the court remanded the matter back to the Service to complete the NEPA analysis started earlier in the year.

After completing the EA, a Finding of No Significant Impact (FONSI) was signed by the Service's Mountain-Prairie Regional Director during October, 2008. The FONSI indicated that an Environmental Impact Statement was not warranted because the Service was confident the EA contained restrictions on the time, place and manner of Lexam's exploration activities that were reasonable to protect the surface estate of the Refuge, without infringing on a mineral owner's private property rights. If, after preparing the EA, the Service had determined the proposed oil and gas exploration project could not be conducted without significant impacts to the human environment, an Environmental Impact Statement would have been required before exploration could occur.

In February 2009, the plaintiffs amended their original complaint against the Service, resuming litigation. After a motion by the plaintiffs and a subsequent evidentiary hearing on May 20, 2009 the court granted a preliminary injunction on September 3, 2009. The injunction had several elements, the most significant of which were that it prevented the Service taking any action that would result in Lexam's use and occupancy of the Refuge to explore for minerals, and it prevented the Service from relying on the 2008 Final EA and FONSI.

Starting in November 2009, a series of settlement conferences were held in the U.S. District Court of Colorado. The parties included the plaintiffs, the Service as defendant and Lexam as an intervener. Settlement was reached and the case administratively closed during September 2010. As part of the settlement, all parties agreed to the Service conducting a new NEPA process and a schedule for completion.

1.3 Purpose and Need



The purpose of this Draft EA is to ensure that the proposed exploration for oil and gas is conducted in a reasonable manner. The Service is requiring specific protective measures that would protect the surface estate and associated resources of the Refuge from unreasonable damage be followed by Lexam in their Plan of Operations, while at the same time recognizing a mineral owner's vested rights to access and explore the oil and gas mineral estate.

The scope of this Draft EA does not address potential future production of oil and gas from any of the wells described above. If Lexam determines that production is viable as a result of exploration, then a separate analysis pursuant to NEPA would be applicable and required.

The federal government owns the surface estate of the Refuge (including all surface and subsurface natural resources not considered to be minerals), and it is administered by the Service as part of the National Wildlife Refuge System (NWRS) pursuant to the Great Sand Dunes National Park and Preserve Act of 2000, the NWRS Administration Act, and other applicable laws and regulations. As the surface owner, the Service has a responsibility to protect the surface estate of the Refuge and its associated resources. Pursuant to Colorado law and the Surface Use Agreement that was entered into between the previous landowner and Lexam's predecessors-in-interest, the Service policy (612 FW 2.7(c), USFWS 2007a; **Appendix A)** requires that the Refuge is protected from all unnecessary damage resulting from oil and gas activities. Thus, the Service has the responsibility to require protective measures to ensure that the surface estate (including all surface and subsurface natural resources not considered to be minerals) of the Refuge and associated cultural, socioeconomic, and aesthetic resources are not unreasonably impacted by Lexam's proposed activities.

1.4 Conformance with Service Management Plans

Currently management on the Refuge is being guided by an interim plan which is referred to as a Conceptual Management Plan (CMP; USFWS 2005). The CMP provides a broad overview of the Service's proposed management approach to wildlife and their relative habitats, public uses, facilities, interagency coordination, and other operational needs of the Refuge until such a time that a full comprehensive conservation plan (CCP) can be created. The CCP planning process for the Refuge is scheduled to start with baseline data collection in 2011, but completion of the CCP is not expected until 2014. The CCP will provide a thorough, in-depth analysis of all facets of current and future Refuge management activities. Given the limited scope of Lexam's current proposal, which includes drilling two exploration wells over a period less than 180 days, the Service has determined that it is not reasonable to delay consideration of the Lexam's Plan of Operations prior to the completion of the CCP.

1.5 Relation to Statutes, Regulations, and Other Plans

Service Regulations

Oil and gas management is not new to the Service as the agency has managed oil and gas operations on approximately one quarter of the over 553 National Wildlife Refuges in the NWRS. Under the National Wildlife Refuge Administration Act of 1966, as amended, the Service is responsible for managing all activities on Refuges including oil and gas operations on non-federally owned (private) mineral rights on Refuges. It is the policy of the Service "to protect Service resources to the maximum extent possible without infringing on the rights of sub-surface owners". The following sections describe the legal framework under which the Service regulates oil and gas exploration that takes place on Refuge lands when the Service does not own the subsurface rights. In addition to Service regulations concerning oil and gas activities, other statutes and regulations are cited.

Excepted Mineral Rights

The Service Manual, Land Use Series, 612 FW 2, Oil and Gas (Manual) (USFWS 2007a; **Appendix A**) provides standard policy guidance and background information on management of oil and gas activities on NWRS lands (USGAO 2003). In this Manual, the Service provides for the exercise of non-federally owned mineral rights while protecting Service resources to the maximum extent possible. The provisions of the Service Manual are applicable to Lexam's oil and gas mineral interest that are discussed below.

On a large portion of the Refuge, the mineral owner holds "excepted rights" that also are referred to as "outstanding rights" (USFWS 2007a; **Appendix A**). Excepted rights occur when oil and gas rights are owned by third parties at the time the Service acquires title to the lands. The "owner of excepted (outstanding) oil and gas rights has the right to sell, lease, explore for, and remove those minerals subject to the terms of the instrument by which that interest was acquired or reserved and to the State laws governing protection of the surface and the rights of the surface owner." Section 2.9.B of the Manual provides the procedural requirements for permitting oil and gas activities on Service lands (USFWS 2007a; **Appendix A**).

In addition to the Manual, reserved and excepted rights are addressed in the NWR System Administration Act of 1966 and addressed by the regulation in Title 50 Code of Federal Regulations (CFR) 29.32 (Mineral Rights Reserved and Excepted). This regulation provides general rules governing the exercise of reserved and accepted mineral rights on NWR System lands. 50 CFR 29.32 states the following:

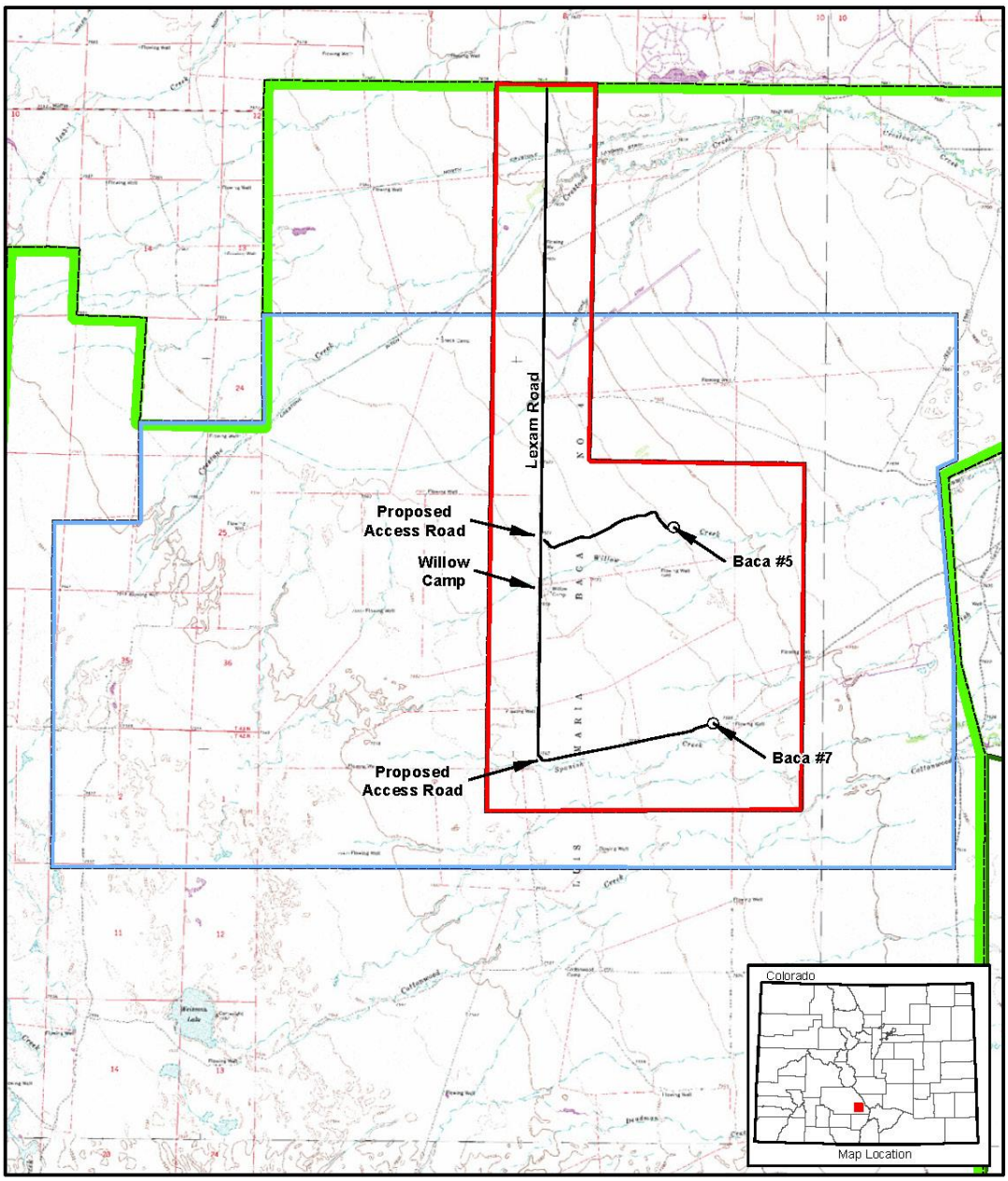
> Persons holding mineral rights in wildlife refuge lands by reservation in the conveyance to the United States and persons holding mineral rights in such lands which rights vested prior to the acquisition of the lands by the United States shall, to the greatest extent practicable, conduct all exploration, development, and production operations in such a manner as to prevent damage, erosion, pollution, or contamination to the lands, waters, facilities and vegetation of the area. So far as is practicable, such operations also must be conducted without interference with the operation of the Refuge or disturbance to the wildlife.
>
> Physical occupancy of the area must be kept to the minimum space compatible with the conduct of efficient mineral operations. Persons conducting mineral operations on refuge areas must comply with all applicable federal and state laws and regulations for the protection of wildlife and the administration of the area. Oil field brine, slag, and all other waste and contaminating substances must be kept in the smallest practicable area, must be confined so as to prevent escape as a result of rains and high water or otherwise, and must be removed from the area as quickly as practicable in such a manner as to prevent contamination, pollution, damage, or injury to the lands, waters, facilities, or vegetation of the refuge or to wildlife. Structures and equipment must be removed from the area when the need for them has ended. Upon the cessation of operations the area shall be restored as nearly as possible to its condition prior to the commencement of operations. Nothing in this section shall be applied so as to contravene or nullify rights vested in holders of mineral interests on refuge lands.

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure 1-2 -- Proposed Lexam Gas Exploration Wells



Compatible Uses Policy

The NWRS Administration Act of 1966, Policy 603 FW 2 Compatible Uses Policy (USFWS 2000) and the National Wildlife Refuge System Improvement Act, set forth general rules and provides guidelines for determining compatibility of proposed and existing uses of Refuge. However, provisions of 603 FW 2, as they relate to the compatibility standard of the NWRS Administration Act to the exercise of reserved and excepted mineral rights on NWRS lands, state the following:

> The Service must recognize and allow owners' property rights that are not vested in the federal government, such as reserved or excepted rights, to explore and develop minerals or oil and gas beneath a refuge, regardless of whether the use is compatible. In these situations, a compatibility determination is not required and should not be completed. Therefore, the compatibility standard of the NWR System Administration Act does not apply to Lexam's exploration program on the Refuge.

Appropriate Refuge Use Policy

The NWRS Administration Act of 1966, Policy 603 FW 1 Appropriate Refuge Uses Policy (USFWS 2006a), sets forth general rules and provides guidelines for determining appropriate uses of NWRs. The Appropriate Refuge Use Policy of the NWRS Administration Act, does not apply because exercise of the subsurface mineral holder's rights is not at the Service's discretion and jurisdiction.

Other Laws Relating to Oil and Gas Activity on NWR System Lands

National Environmental Policy Act (NEPA)

NEPA (42 United States Code [USC] 4321-4370f) requires federal agencies to examine the environmental impact of their actions, incorporate environmental information, and utilize public participation, as appropriate, in the planning and implementation of their actions. NEPA compliance is required only whenever a federal agency takes an action. A federal action typically takes the form of a permit or other explicit land use authorization without which the activity cannot proceed. As discussed above, although Service regulations and the Manual (USFWS 2007a) explicitly recognize that the Service has the right and is obligated to prevent unreasonable degradation of the surface resources of the Refuge, Service does not have the authority to completely deny a mineral owner's activities on the Refuge. Pursuant to the Final Settlement Agreement, the Service initiated this Draft EA as part of the NEPA process to ensure that the surface estate is not unreasonable degraded by Lexam's proposed oil and gas exploration.

National Historic Preservation Act (NHPA) of 1966, as amended

Section 106 of the NHPA requires federal agencies to assess the effects of an undertaking on historical and cultural resource sites. This is accomplished by inventorying proposed disturbance areas or area of potential effect (APE), evaluating site importance and eligibility to the National Register of Historic Places (NRHP), assessing the effect of the undertaking on NRHP-eligible sites, and consulting with appropriate historic preservation agencies. Compliance with section 106 of NHPA was followed for the oil and gas exploration activities described in this Draft EA.

Archaeological Resources Protection Act of 1979

The Archaeological Resources Protection Act of 1979 (16 USC 470aa-470mm) and amendments provide for the protection of archaeological resources on public and Native American lands and provide for exchange of information between governmental entities and academic or private archaeological researchers. An archaeological resource under this Act is defined as material remains of past human life or activities that are of archaeological interest and includes but not limited to pottery, basketry, bottles, weapons, tools, structures, rock paintings or carvings, intaglios, graves, and human skeletal materials.

Migratory Bird Treaty Act and Migratory Bird Conservation Act

The Migratory Bird Treaty Act (MBTA) (16 USC 703-712) implements various treaties between the United States and other nations of the MBTA and provides for the protection of migratory birds and specifies penalties for harming or unlawfully killing migratory birds. Section 715e of the MBTA provides statutory authority for regulation of reserved mineral rights on NWRs (it subordinates oil and gas interests to such rules and regulations as may be prescribed by the Secretary of the Department of the Interior from time-to-time).

Endangered Species Act

The Endangered Species Act (ESA) (16 USC 1531-1544) provides for the protection of endangered and threatened species and the habitats upon which they depend. Section 7 of the act requires federal agencies, to consult with the Secretary of the Interior or the Secretary of Commerce in cases where the agencies' action may affect a listed species, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat for these species.

Other Federal Regulations

The proposed Lexam exploration activities also are governed by a number of other federal regulatory programs. The list below is not intended to be exhaustive:

- Clean Water Act
- Clean Air Act
- American Indian Religious Freedom Act (AIRFA)
- Native American Grave Protection and Repatriation Act (NAGPRA)
- Resource Conservation Recovery Act
- Occupational Health and Safety Administration (OSHA) regulations
- Department of Transportation (DOT) regulations

State Regulations and Rules

The major regulatory agencies and programs under which the proposed exploration activities are regulated are discussed below:

Colorado Oil and Gas Conservation Commission

The COGCC regulates oil and gas drilling on state and private mineral lands in Colorado. COGCC oil and gas rules cover all phases of oil and gas drilling operations, address pollution prevention, and provide for penalties and fines for non-compliance with the rules. The oil and gas rules give the COGCC staff latitude when developing conditions of approval for applications for permit-to-drill (APDs) depending on specific site concerns or conditions.

In the case of the Baca #5 and Baca #7, site-specific conditions of approval were applied to the permits, but these conditions expired on May 20, 2010 and are no longer assumed to be valid by the Service. Lexam would be required to re-apply for a COGCC permit on Baca #5 and Baca #7 prior to drilling at any time in the future.

Colorado Department of Public Health and Environment

Major regulatory programs of the Colorado Department of Public Health and Environment (CDPHE) that apply to the exploration activities include the regulation of storm water discharges during construction activities, storage and disposal of solid waste, and air emissions sources.

1.6 Description of Lexam's Plan of Operations

The following provides a description of Lexam's Plan of Operations, as provided by Lexam, including references to protection measures that have were previously incorporated into the expired COGCC permits to drill at Baca #5 and Baca #7 (**Appendix B**). At minimum, Lexam would need to re-apply to the COGCC to permit Baca #5 and Baca #7 oil and gas wells because the permits expired on May 20, 2010. It is unclear if Lexam would voluntarily request any of the previous permit conditions listed below to the COGCC during re-application. The Service considers any protective measures in the previous permits to be invalid because they are expired. The Service made this determination in compliance with COGCC rule 303(j)(1) (COGCC 2009) which states:

- **"For Applications for Permit-to-Drill, Form 2.** If drilling operations are not commenced on the permitted well within one (1) year after the date of approval, then the approval shall become null and void."

Consequently, the Service will require that new protective measures be implemented as part of the preferred alternative (alternative C), which ensures maximum protection of the Refuge during the proposed oil and gas exploration activities. Under alternative C, the Service also will require that Lexam resubmit a new Plan of Operations that addresses deficiencies identified in the current Plan of Operations and implements protective measures required by the Service.

Lexam's Plan of Operations is based on their proposal to drill two exploration oil and gas wells (Baca #5 and Baca #7) on the Refuge. The Service is using this Plan of Operations as the basis for evaluation of their proposed activities. The Service also included this Plan of Operations as part of the NEPA process (i.e., public scoping, public comment, and on the Refuge's website [http://fws.gov/alamosa/Baca NWR.html]) during the development of this Draft EA.

Road and Drill Pad Construction

Lexam's proposed activities will incorporate Best Management Practices (BMPs) to lessen impacts. The COGCC defines BMPs as "practices that are designed to prevent or reduce impacts caused by oil and gas operations to air, water, soil, or biological resources, and to minimize adverse impacts to public health, safety and welfare, including the environment and wildlife resources (COGCC 2009)"

Before drilling can occur, access roads and well pads would be constructed. The following describes the general procedure for construction. No construction would occur during the months of May, June, or July (**Appendix B**). **Table 1-1** summarizes Lexam's approximate total acres of disturbance for access roads and well pads. Construction would be conducted in accordance with COGCC 1000 Series rules and a Storm Water Management Plan for construction disturbances greater than 1.0 acre in accordance with CDPHE storm water rules that were revised in 2007 (CDPHE 2007a).

Table 1-1. Total Surface Disturbance

Total Surface Disturbance Baca #5 and Baca #7 Drill Sites	
Baca #5 Location	2.1
Baca #5 Access Road	3.3
Baca #7 Location	2.1
Baca #7 Access Road	4.2
Total Acres	**11.7**

The following summarizes the requirements of the COGCC regarding surface disturbance and site reclamation for non-crop land sites (COGCC 2009). The following procedures apply to site preparation, drilling, and reclamation:

- "The operator shall separate and store the A soil horizon or the top six (6) inches, whichever is deeper, and mark or document stockpile locations to facilitate subsequent reclamation. When separating the A soil horizon, the operator shall segregate the horizon based upon noted changes in physical characteristics such as color, texture, density, or consistency."
- "When the soil horizons are too rocky or too thin for the operator to practicably segregate, then the topsoil shall be segregated to the extent possible and stored. Too rocky shall mean that the soil horizon consists of greater than thirty five percent (35%) by volume rock fragments larger than ten (10) inches in diameter. Too thin shall mean soil horizons that are less than six (6) inches in thickness. The operator shall segregate remaining soils on crop land to the extent practicable to a depth of three (3) feet below the ground surface or bedrock, whichever is shallower, based upon noted changes in physical characteristics such as color, texture, density or consistency and such soils shall be stockpiled to avoid loss and mixing with other soils."
- "All stockpiled soils shall be protected from degradation due to contamination, compaction and, to the extent practicable, from wind and water erosion during drilling and production operations. Best management practices (BMPs) to minimize erosion and offsite sedimentation by controlling storm water runoff shall be implemented." The best management practices can include, depending on site conditions, silt fences, plant buffers, rock filter dikes, slope roughening, and mulch."
- "The drilling location shall be designed and constructed to provide a safe working area while reasonably minimizing the total surface area disturbed. Consistent with applicable spacing orders and well location orders and regulations, in locating drill pads, steep slopes shall be avoided when reasonably possible. The drill pad site shall be located on the most level location obtainable that will accommodate the intended use. Deep vertical cuts and steep long fill slopes shall be constructed to the least percent slope practical. BMPs minimize erosion and offsite sedimentation by controlling storm water runoff shall be implemented."
- "In order to reasonably minimize land disturbances and facilitate future reclamation, well sites…and access roads shall be located, constructed and maintained so as to reasonably control dust, minimize erosion, alteration of natural features and removal of surface materials. BMPs to minimize erosion and offsite sedimentation by controlling storm water runoff shall be implemented."
- "Existing roads shall be used to the greatest extent practicable to avoid erosion and minimize the land area devoted to oil and gas operations. BMPs to minimize erosion and offsite sedimentation by controlling storm water runoff shall be implemented. Where feasible and practicable, operators are encouraged to share access roads in developing a field. Where feasible and practicable, roads shall be routed to complement other land usage. To the greatest extent practicable, all vehicles used by the operator, contractors, and other parties associated with the well shall not travel outside of the original access road boundary."
- "During drilling, production, and reclamation operations, all disturbed areas shall be kept reasonably free of noxious weeds and undesirable species as practicable."
- "Upon the plugging and abandonment of a well, all mouse and rat holes and cellars shall be backfilled. All debris, abandoned gathering line risers and flow line risers, and surface equipment shall be removed within three (3) months of plugging a well. All access roads to plugged and abandoned wells and associated production facilities shall be closed, graded and recontoured. Culverts and any other obstructions that were part of the access road(s) shall be removed. Well locations, access roads and associated facilities shall be reclaimed. As applicable, compaction alleviation, restoration, and revegetation of well sites, associated production facilities, and access roads shall be performed to the same standards as established for interim reclamation under Rule 1003." Additionally, "All such reclamation work shall be completed within three (3) months on crop land and twelve (12) months on non-crop land after plugging a well or final closure of associated production facilities. The Director may grant an extension where unusual circumstances are

encountered, but every reasonable effort shall be made to complete reclamation before the next local growing season."

Successful reclamation of the well site and access road will be considered completed when:

- "On non-crop land, reclamation has been performed as per Rules 1003. and 1004., and the total cover of live perennial vegetation, excluding noxious weeds, provides sufficient soils erosion control as determined by the Director through a visual appraisal. The Director shall consider the total cover of live perennial vegetation of adjacent or nearby undisturbed land, not including overstory or tree canopy cover, having similar soils, slope and aspect of the reclaimed area."
- "A Sundry Notice, Form 4, has been submitted by the operator which describes the final reclamation procedures and any mitigation measures associated with final reclamation performed by the operator."
- "A final reclamation inspection has been completed by the Director, there are no outstanding compliance issues relating to Commission rules, regulations, orders, permit conditions, or the act, and the Director has notified the operator that final reclamation has been approved."

In addition to the COGCC 1000 Series rules concerning erosion control and reclamation, the CDPHE has a permit system under the Clean Water Act to provide control over storm water discharges and minimize soil erosion and degradation of water resources. The storm water permit system specifies reclamation goals and requires that operators have a Storm Water Management Plan (SWMP). The SWMP defines what erosion controls would be used during ground disturbing activities, explains how hazardous materials (such as oils and fuels) would be managed to prevent soil and water contamination, and specifies how reclamation and monitoring would occur. The major features of a SWMP include:

- Identification of site specific measures that would be used to control erosion and BMPs including silt fences, plant buffers, rock filter dikes, slope roughening, and mulch. The SWMP includes descriptions and drawings of the specific erosion control structures to be used.
- The SWMP should identify materials that will be stored and used on-site and procedures for preventing and managing spills. Spill prevention and management can be addressed separately in a Spill Prevention, Control, and Countermeasure (SPCC) Plan. SPCC Plans must be site specific, comply with applicable rules, and be certified by a professional engineer. The SWMP and SPCC plans must be kept on-site.
- The SWMP must describe the methods used for site stabilization of the site. Stabilization methods can include standards for dealing with compaction, seed mixtures, and seeding method (drill seeding, hydromulching, etc).
- Procedures for inspection and maintenance are described in the SWMP. Periodic inspections of erosion control devices and re-vegetation progress are required, and the SWMP must describe how inspection and maintenance is to take place and how it is to be documented. In addition to periodic inspections, inspections are required after strong precipitation events as defined by the permit.

Final stabilization of a site under the CDPHE storm water rules, "means that all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, paved, or a uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed. Re-seeding alone does not qualify." For oil and gas operations, if a site reverts to cropland after oil and gas activities, then permit coverage is no longer required.

Road Construction

The routes for the proposed access roads have been designed to minimize the amount of road construction and impacts to habitat, soils, and sensitive plants. BMPs as described above would be used to minimize runoff and erosion and facilitate reclamation. Access roads to the locations would branch off of the Lexam Road, a main north-south road through the Refuge (**Figure 1-2**). The Lexam Road is gravel and would not need to be upgraded to handle the equipment and traffic. An access road to the Baca #5 location would have to be built. The road

would be approximately 1.1 miles long with a running surface of approximately 15 feet. Total width of disturbance would be approximately 25 feet. The estimated fill required to construct this road is approximately 8,000 cubic yards. For access to location Baca #7, there already exists a two-track unimproved road that goes to this location. The existing two-track road would be upgraded to accommodate the equipment needed to transport the drilling rig and service the operation. The distance of the access road to the Baca # 7 location that will be upgraded would be approximately 1.4 miles.

Road construction may take from 1 week to 1 month to complete depending upon the terrain and soil conditions. The equipment would consist of haul trucks for transporting earth moving equipment and gravel, and earth moving equipment. Approximately 450 trips would be required to haul equipment and gravel for the roads. The number of trucks would depend upon the fleet and construction practices used by the contractor. Water trucks will be required to wet down the location for dust control.

Well Pad Construction

Disturbance for each well pad is expected to be approximately 2.1 acres, allowing for a 90,000 square foot well pad and soil stockpile areas (**Figure 1-3**). BMPs as described above will be used in pad construction as required by CDPHE and COGCC rules to control runoff and erosion. Bulldozers (two to three D7-sized Caterpillars) would be used to construct and level the drilling locations. Top soil and growth medium would be stockpiled for later reclamation. The pads and access roads would be graveled as necessary to support the rig and the ongoing operations. Road and well pad construction would take place during daylight hours. The estimated fill required to construct each well pad is approximately 10,000 cubic yards. Approximately 550 trips would be required to haul equipment and gravel for the roads. The number of trucks would depend upon the fleet and construction practices used by the contractor.

Drilling Operations

Location Preparation

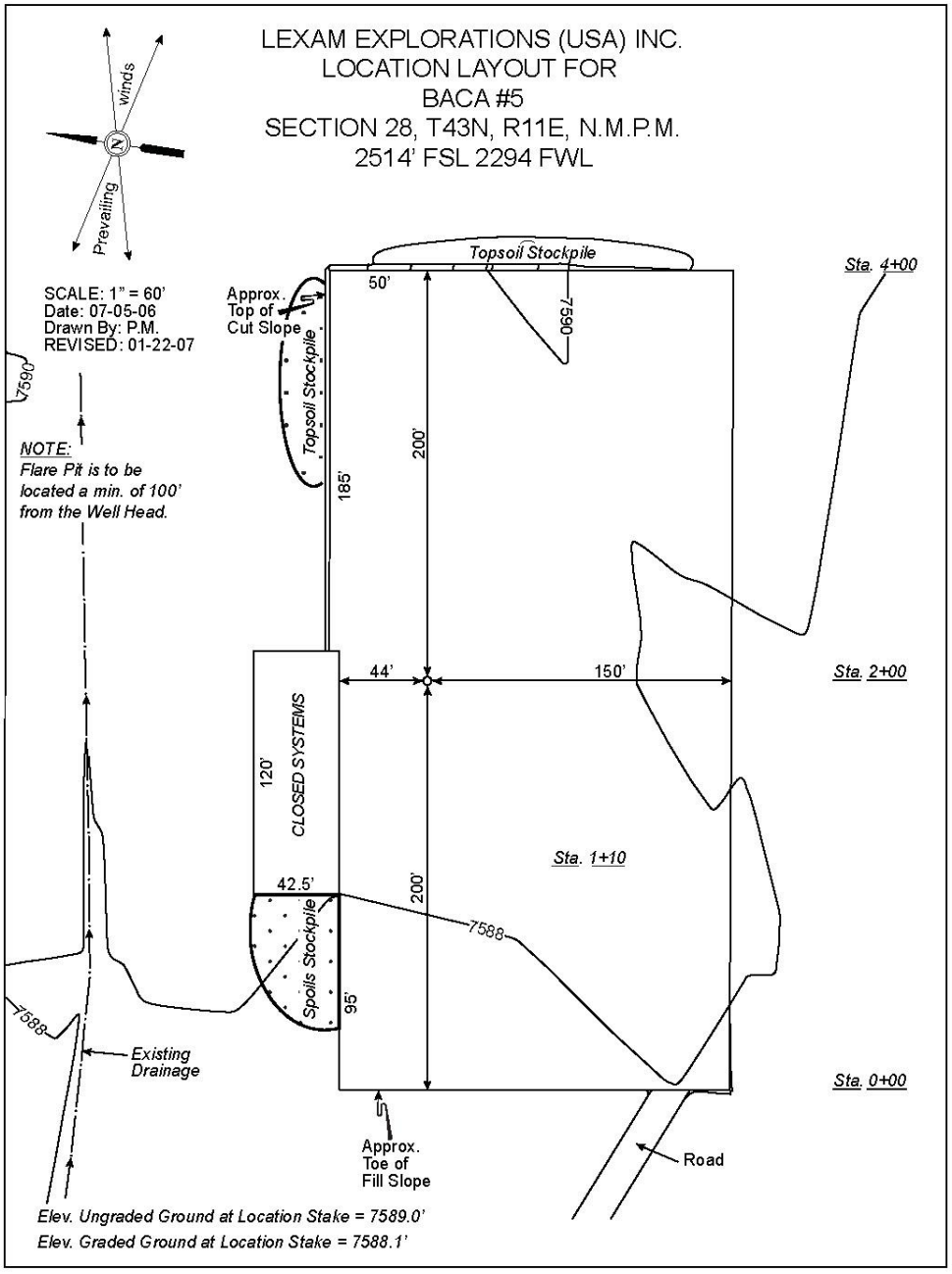
When the pad is completed, several operations would take place before the drilling rig moves on location. A small work-over rig would move in, drill a 24-inch hole and set approximately 80 to 150 feet of 20-inch conductor pipe. This small, diesel powered self-propelled rig would have an approximately 40 feet tall derrick. The conductor pipe would provide stability for the hole in the unconsolidated materials in the uppermost part of the subsurface. The conductor pipe would be cemented in place from a depth of approximately 80 to150 feet to the surface as required by the COGCC permit (**Figure 1-4**). The small rig also would drill the “rathole” and the “mousehole,” which are used to manipulate and store pipe and equipment used in the drilling process. The rathole and mousehole would nominally be 13 to 24 feet deep, cased with 8.63-inch pipe, and be sealed from contact with groundwater. Drill location preparation would take approximately 3 days. Equipment typically used consists of a water well-type rig, several vehicles and trailers. The work would take place during daylight hours.

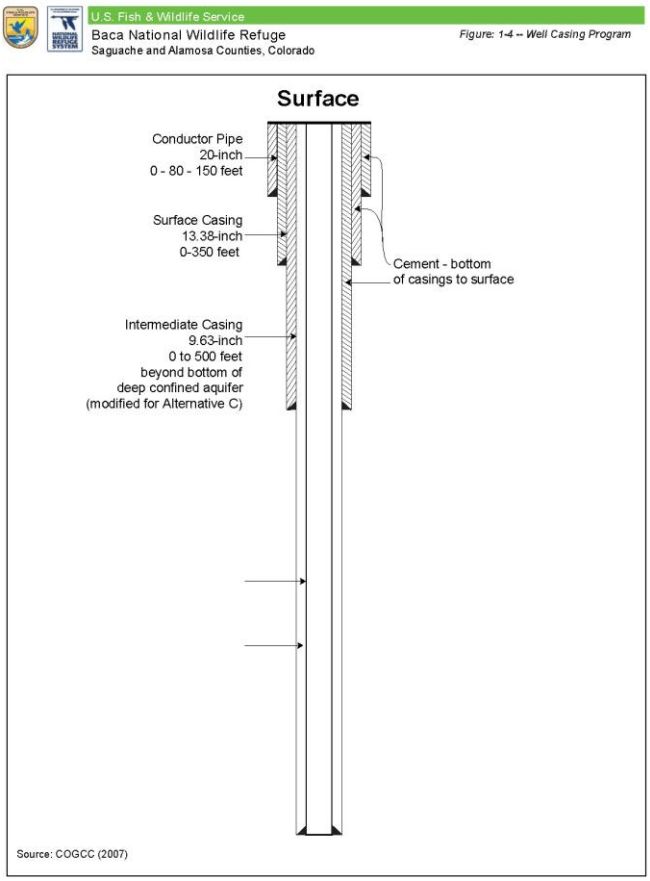
After location preparation, the drilling rig and associated equipment would be moved to the location and erected. Moving a drilling rig would require 30 to 60 truck-loads of equipment. After the pieces are assembled, the derrick would be raised to a height of approximately 135 feet. Derrick heights vary depending on the depth of the drill hole and weight capacity of the rig.

Drilling

Once the rig is ready, a 17.5-inch-diameter hole will be drilled to approximately 350 feet, at which point a string of 13.38-inch-diameter surface casing would be set and cemented from total depth to the surface (**Figure 1-4**). After the surface casing is set, a blowout preventer (BOP) will be attached to the top of the surface casing. A blowout is an uncontrolled release of subsurface fluids (oil, gas, water) to the surface, which if ignited could cause a dangerous or hazardous fire. Through a system of hydraulically activated valves and manifolds, the BOP is designed to shut the well in and also allow fluid to be pumped into the hole and stop the uncontrolled release of fluids (i.e., to “kill” the well). BOPs are required by COGCC rule, and conditions of the drilling permit approval specify the pressure rating of the BOP, which depends on potential subsurface conditions. COGCC rules also require testing of the BOP before drilling out from the surface casing.

Figure: 1-3 -- Typical Well Location Layout





Drilling fluid or mud would be circulated through the drill pipe to the bottom of the hole, through the bit, up the bore of the well, and finally to the surface. When the mud emerges from the hole, it would pass through a series of equipment used to screen and remove drill cuttings (rock chips) and sand-size solids. When the solids have been removed, the mud will be placed into holding tanks, and from the tank, pumped back into the well. The mud would be maintained at a specific weight and viscosity to cool the bit, seal off any porous zones (thereby protecting aquifers or preventing damage to producing zone productivity), control subsurface pressure, lubricate the drill string, clean the bottom of the hole, and bring the drill cuttings to the surface (Moore 1974). There are three common types of drilling fluids: water-based, oil-based, and synthetics. Water-based muds are the most common and are largely made up of water and bentonite, a naturally occurring clay that has special properties used to maintain proper viscosity and other properties over a wide range of drilling conditions. Lexam's drilling operations will use water-based drilling fluids.

Upon drilling out of the surface casing, the well would be deepened to a depth of approximately 3,000 feet. At that point, a 9.63-inch intermediate casing string (**Figure 1-4**) would be placed in the hole and cemented in from total depth to the surface in accordance with COGCC rules and the permits to drill. The intermediate casing would be used to protect the deep (confined) and shallow (unconfined) aquifers (actually all usable groundwater as it extends from below the deep aquifer to surface) and ensure stability of the hole as the well is deepened to its target depth. To provide additional protection for the aquifers, the 3,000-foot depth for the intermediate string is a permit condition irrespective of surface management issues. The COGCC has authority under Rule 317 to set casing and cementing requirements to protect aquifers. The 3,000-foot depth of the intermediate aquifer protection casing was added as a condition of the drilling permits by the COGCC at the specific request of the Service.

After the intermediate casing is set, the well would be deepened (hole size 8.75 inches to total depth), and prospective zones would be evaluated if encountered while drilling. Rock cores may be obtained depending on data derived during drilling. The expected total depth is approximately 14,000 feet, and once the total depth is reached, geophysical wireline well logs would be run. If warranted, formation productivity tests (drill stem tests or wireline formation tests) would be conducted on prospective zones. Data from logging and testing would support a determination as to the commercial potential of the zone(s) of interest. If the zones are deemed not to be commercially productive, the well would be plugged and abandoned according to COGCC regulations. If tests indicate commercial productivity, 5.5-inch production casing (**Figure 1-4**) would be run and set according to COGCC rules. The drilling rig would be rigged down and moved off to the next well or removed from the area. Rig down and move off should take an estimated 5 days subject to weather conditions and truck availability. The Service would perform another NEPA environmental review prior to any proposed oil and gas development in the Refuge.

A flow test that is conducted during well drilling is called a drill stem test (DST). A DST is a temporary completion of the well to test for oil and gas. A DST may be conducted when evidence of oil and gas or a porous zone(s) are encountered while drilling or indicated by down-hole logs. A DST can be highly diagnostic of producible oil and gas, particularly in frontier exploration areas where no well data exists to accurately assess the potential of a rock formation to produce oil and gas based solely on down-hole logs. At a minimum, running of a DST includes the expense of hiring a testing contractor to conduct the test and the cost of 24 to 48 hours of additional rig time.

The DST not only provides for formation fluids to flow, but also obtains samples of fluids and gas in sample chambers and records pressure data. Testing procedures commonly require one or two flow periods and one or two shut-in periods. The flow periods allow formation fluids to flow into the drill pipe and sample chambers, and the shut-in periods allow for measurement and calculation of accurate formation pressure. During a flow period (usually one to two hours in length), fluids consisting of varying combinations of oil, gas, water, and drilling mud may enter the drill pipe. Gas may come to the surface if it is present in sufficient quantities. The safest and most efficient way to handle gas during a DST is by flaring the gas during the short periods of fluid flow. Flaring would be done using a flare stack common to the industry. Flaring would occur for short durations, 2-4 hours, with limited emissions. All other fluids that reach the surface will be collected in tanks and disposed of off-site. A DST can take up to 6 hours, not counting time to trip in and out of the hole. DST's are usually run in daylight hours for safety reasons, since potential spark sources such as electrical equipment and lights must be shut down because of the potential for the presence of gas.

One or more DST's may be required to determine if potentially economic quantities of oil or gas are present in the event that favorable petroleum source and reservoir rocks are encountered during drilling. The decision to run DSTs and the number required would be based on what formations are encountered during drilling, the results of mud logging data and the results of down-hole logs. As many as 10 DST's could be conducted.

Waste streams potentially generated from a DST would be oil and gas, formation water, and drilling mud. These materials would be recovered into surface tanks and the materials disposed of offsite at approved third-party disposal facilities.

Any natural gas produced by the well during a DST would be flared. COGCC Rule 912 requires that local emergency dispatch or emergency authority be contacted at least two hours prior to flaring. The gas from the DST will be routed through a separator (for removal of the condensate and produced water) then to the flare, with a release point about 20 feet above the ground. Flaring rate is expected to be between 125 and 2,500 MCF of a methane/ethane mixture over this 3-hour period. Because the flaring follows separation, it should contain only trace amounts of the heavier hydrocarbon compounds, so there should be little if any visible plume.

Using the EPA generic emission factor of 0.068 lb/106 Btu for NOx (USEPA 2008a), the range of NOx emissions (at a gas heat content of 1050 Btu/SCF) is from 9 to 179 lb per three-hour flare event. With two potential DSTs, the total proposed project (and annual) flare emissions should range from 18 to 358 lbs of NOx. Emission factors for soot from a flare range from: 0 lb/106 Btu (non-smoking); 40 lb/106 Btu (lightly smoking); 177 lb/106 Btu (average smoking flares); and 274 lb/106 Btu (heavily smoking flares).

The flare will be operating only at a times when drilling will have ceased and the generators will be operating at a very low level, if at all, so there will be no additive effect with the generator plume while the generators are being run at load. For emissions estimation purposes, assuming full-time use of the generators instead of developing scenarios for DST flaring provides a conservatively high value for projected air pollution that will be produced by this project.

Well Abandonment and Reclamation

If the well is considered non-commercial, then the well would be plugged and abandoned following COGCC rules. Plugging and abandonment would consist of placing cement plugs as directed by the COGCC. It is anticipated that the COGCC would require placing multiple plugs in the open hole section, one plug at the base of the surface casing, and one plug from the surface down 100 feet. Heavy drilling mud would be placed between all plugs. For final abandonment, all casing would be cut off at least six feet below ground level.

With a non-commercial well, plugging is accomplished using the drilling rig that drilled the hole. Heavy drilling mud would be pumped into the open hole up to the lowest elevation required for a cement plug by the COGCC. Cement would then pumped on top of the heavy drilling mud up to the desired thickness, typically 100 feet of cement plug. Heavy drilling mud and cement would then be placed in sequence until the drill hole is filled.

Under COGCC reclamation rules, after a well is plugged, the drill site and access roads must be reclaimed. For final reclamation of well sites, the rules include the following requirements:

- Upon the plugging and abandonment of a well, all mouse and rat holes shall be backfilled.
- All access roads to plugged and abandoned wells shall be closed, graded, and recontoured. Culverts and any other obstructions that were part of the access road(s) shall be removed.
- Well locations, access roads, and associated facilities shall be reclaimed according to rules and including, as applicable, compaction alleviation, restoration, and revegetation of well sites and access roads.

COGCC rules allow the surface owner to waive reclamation requirements. If, for instance, the surface owner wants to retain roads, the operator and surface owner can make agreement to do so. However, it is intent of the Refuge management that roads (except for the Lexam Road) and pads be completely removed and the areas reclaimed to prior conditions in accordance with COGCC rules regarding reclamation. The operator must comply with the provisions of the CDPHE SWMP requirements concerning final site stabilization.

In addition, Service regulations 50 CFR 29.32, Mineral Rights Reserved and Excepted, require oil and gas companies to restore their sites as closely as possible to the original conditions that existed prior to site disturbance. Lexam's restoration efforts would be conducted under the direct supervision of the Service, using only endemic plants and seed mixtures approved by the Service. The Service will monitor restoration efforts from that point on to ensure that restoration efforts have been successful.

Water Requirements

Water would be piped to the well locations using temporary plastic pipe laid out on the surface from the supply well to the drilling locations. Water requirements for the project are estimated to be a maximum of 15 acre-feet. Water could be obtained from a nearby monitoring well (SW-5) that is owned by the Service. The well is cased to approximately 181 feet below the ground surface and is considered to be tributary to the stream system. The well would be temporarily permitted as an industrial well for the duration of the project, and a substitute water supply plan (SWSP) would be required from the State Engineer's Office (SEO) to replace water pumped from SW-5. Lexam has investigated nearby agriculture water rights and transferring the consumptive use portion of those water rights to Well SW-5 to offset depletions arising from the drilling program. Lexam would file for a SWSP pursuant to Colorado Revised Statutes (CRS) 37-92-308(5), which apply when the depletions will not exceed 5 years. The plan would be approved for 1 year and can be renewed annually, but not to exceed 5 years.

However, in the event that well water would not be available, water would have to be purchased from an off-site source and trucked to the drilling locations. Depending on daily water needs of the rig and the capacity of the tanker truck, as many as 250 truckloads per well could be required to supply water to the drilling operation.

Solid Waste and Hazardous Materials

Trash containers and portable toilets would be located on well sites during well pad construction, drilling operations, and site restoration. Toilet holding tanks would be pumped bi-weekly or as needed and their contents disposed of at a municipal sewage treatment facility in accordance with applicable rules and regulations regarding sewage treatment and disposal. Garbage, trash, and other non-hazardous waste material would be collected in a portable, self-contained, fully enclosed trash cage during operations. Trash would not be burned on location. The collected material would be hauled to an approved landfill.

According the U.S. Environmental Protection Agency (EPA) rule, certain wastes intrinsic to the drilling and production of oil and gas are exempt from regulation as hazardous wastes (USEPA 1988). Although exempted from regulation as hazardous wastes, it is still required that these wastes be disposed of according to applicable rules and in an environmentally acceptable manner. Drilling mud and drill cuttings are included in the exempt waste category.

Drilling mud would constitute the largest volume of solid waste generated by the drilling operation. At the request of the Service, a condition of the COGCC permit requires use of a mud system that does not use an excavated reserve pit. The drilling system would be a closed-loop type of system in which all fluids and drill cuttings are contained in tanks. Also at the request of the Service, the COGCC permit requires Lexam to transport all drilling

mud and drill cuttings to an off-site third-party commercial disposal facility permitted by CDPHE to handle such wastes.

Lexam would maintain a file, according to 29 CFR 1910.1200 (g), containing Material Safety Data Sheets for all chemicals, compounds, and/or substances that would be used during drilling and completion operations. A variety of chemicals and materials, including petroleum fuels, lubricants, paints, and additives, are used to drill and complete a well. Some of these chemicals and materials may be considered hazardous or contain constituents that are hazardous. The transportation, use, storage, and handling of hazardous materials would follow procedures specified by federal and state regulations. Transportation of the materials to the well locations would be regulated by the DOT under 49 CFR Parts 171–180. DOT regulations pertain to packaging, container handling, labeling, placards on vehicles, and other safety aspects.

A SPCC plan would be developed for the drill sites. A SPCC is site specific, describes how certain hazardous materials would be managed (oils and fuels), and provides information and procedures in case of a spill or release of those materials occurs. SPCC plans would be developed when a drilling contractor is chosen, since the SPCC has to be specific to the equipment and storage that would be on-site. A SPCC plan must be reviewed and certified by a professional engineer. Lexam would be responsible for providing the certification of the SPCC plan.

Workforce and Time Requirements

Construction of the access road and drill pad would be completed by local contractors and only during daylight hours. When drilling commences, the operation would become a continuous 24-hour operation until the well is drilled to total projected depth. Following road and pad construction, the following personnel would be on-site for any given shift (tour): six rig hands including the driller, one tool pusher (drilling contractor's supervisor), one company representative, one geologist, two mud loggers, one mud engineer, one water truck/equipment operator, and one gatekeeper. A rig crew would work one 12-hour tour per 24-hour day. Supervisory personnel, the geologist, mud loggers, mud engineer, water truck/equipment operator, and gatekeeper would be on-site 24 hours per day. Other personnel would be on-site on a regular basis, but they are not considered part of the drilling personnel: drilling contractor health and safety supervisor, delivery drivers, suppliers, and government inspectors. Service company personnel (for cementing, BOP testing, wireline, drill stem testing, and casing) would be present for the time needed to conduct given services (6- to 24-hour events). Therefore, at any given time there may be from 14 to 30 people on-site during drilling operations. It is estimated that each well would take approximately 60 to 90 days to drill and complete perhaps longer if unforeseen circumstances arise.

Health and Safety

Health and safety for drilling operations are governed by regulations of the COGCC, OSHA, and CDPHE. For more information, please consult:

- COGCC: http://cogcc.state.co.us Select Rules, select 600 Safety Regulations
- OSHA: www.osha.gov/SLTC/oilgaswelldrilling/index.html
- CDPHE: www.cdphe.state.co.us/ap/tankdocuments.html

Conditions of the COGCC permit include the following health and safety measures:

- Prior to commencing operations, an inventory of all chemicals and products that would be used or stored on site must be provided to the COGCC, the surface owner, and local emergency response personnel prior to bringing those substances on to the Refuge. If additional chemicals or products are required, then information about these substances must be provided to the COGCC, the surface owner, and local emergency response personnel prior to bringing them on to the Refuge.
- Prior to commencing operations, an emergency response plan would be completed by Lexam and approved by the Service and discussed with local governments responsible for emergency services. A meeting with the local emergency response personnel would be held to establish an adequate safety and response plan for drilling, completion, and production activities.

A copy of the emergency response plan and emergency contact numbers would be provided to Refuge staff and monitors before operations begin.

1.7 Scoping

Public scoping was an important component of the development of this Draft EA. During this phase of the project, the Service obtained input from the public, interested organizations and federal, state, and local agencies to help inform the Service of concerns related to the proposal by Lexam. Information obtained through public involvement was important to capture specific issues, concerns, and ideas related to the potential exploration activities proposed by Lexam.

The formal scoping period for the general public began on October 13, 2010 with the publication of a press release that was distributed through the Refuge website (http://fws.gov/alamosa/BacaNWR.html) and various newspapers and radio advertisements throughout the state of Colorado. The 30-day public comment period closed on November 10, 2010. A public scoping meeting was held on October 26, 2010 at the Colorado College Baca Conference Center in Crestone, Colorado and was attended by 19 people. Lexam's Plan of Operations and the Service's power-point presentation given during the public scoping meeting also are included on the Refuge's website for public review and comment. The purpose of this meeting was to solicit public comments and concerns that will be considered in the Draft EA.

Meeting Format

Following a brief welcome and introduction, Service staff made a 15-minute power-point presentation that outlined the following points:

- Description and purpose of the Service and the National Wildlife Refuge System
- Timeline of events associated with the proposed exploration activity by Lexam
- Issues identified through previous public involvement
- Overview of proposed exploration

Following the presentation, the remainder of the meeting was broken up into two components, questions and answers and public comments. During the question and answer session, questions from the attending audience were posted on flip charts. In turn, Service staff answered all questions. The majority of the meeting time was spent in the question and answer session. After all the questions were answered, the Service took formal comments from those who wanted to offer them. This format enabled participants to have their questions answered about the Draft EA process and also identified many of the important issues. Refer to **Appendix C** for a complete scoping report including the questions and scoping comments received during the public meeting and public comment period.

Major issues and concerns identified during the scoping process include:

- Acquisition of mineral rights from Lexam;
- Protection of aquifer;
- Exploration prior to completion of Comprehensive Conservation Plan (CCP);
- Number of exploration well pads;
- Potential contaminants;
- Degradation of air quality;
- Degradation of surface water and groundwater quality;
- Potential impacts to vegetation, habitats, and wildlife;
- Increased noise;
- Management of hazardous materials and solid wastes;
- Degradation of visual environment;
- Impacts to human quality of life and livelihoods; and
- Impacts to cultural resources.
- Traffic associated with exploration;
- Potential for future development;
- Impacts to public health.

2.0 Description of Alternatives

2.1 Introduction

This chapter describes the alternatives considered in the development of this Draft EA for the proposed oil and gas exploration by Lexam, including the drilling of two exploratory vertical wells (Baca #5, Baca #7) on the Refuge. Alternatives are different approaches for consideration of the proposed action that must be rigorously explored and objectively evaluated. A range of alternatives was considered regarding the proposed action during the development this Draft EA, including the No Additional Protective Measures Provided by the Service Alternative (no action), Acquisition of the Mineral Estate Alternative, and Maximum Protection of Refuge during Exploration Alternative (preferred alternative), as well as alternatives considered but not selected for further evaluation. These alternatives evaluate the different levels of protection that the Refuge and associated resources can expect if a mineral owner exercises their legal right to conduct exploration activities on the Refuge.

2.2 Alternative A - No Additional Protective Measures Provided by the Service (No Action Alternative)

The No Action Alternative is important to include in the range of alternatives because it allows decision-makers to compare the magnitude of environmental effects of the action alternatives (i.e., Alternatives B and C) against a benchmark. Further, NEPA regulations require the inclusion of a No Action Alternative. The No Action Alternative may be thought of in terms of continuing with the proposed exploration without the addition of protective measures and standards by the Service.

Under the No Additional Protective Measures Provided by the Service Alternative (Alternative A), the Service would accept the standard rules and regulations required by various federal, state, and local agencies as adequate to protect the Refuge. Thus, no additional Refuge specific protective measures for Lexam's proposed exploration activities would be required for inclusion in Lexam's Plan of Operations.

The Service policy (612 FW 2.7c; USFWS 2007a) mandates that Project Leaders:

- Administer all oil and gas activities;
- Comply with all applicable laws, policies, and guidance when administering oil and gas activities;
- Protect Service lands against all unnecessary damage resulting from oil and gas activities;
- Where reserved or excepted mineral rights exist, the project leader is responsible for ensuring that his/her actions do not result in an illegal taking of private property.

The Service would not require any additional protective measures to be implemented by Lexam as part of their Plan of Operations because the Project Leader would consider the standard rules and conditions of imposed by federal (e.g., OSHA, EPA), state (e.g., COGCC, CDPHE), and local (Saguache County) guidelines adequate to protect the surface and subsurface resources of the Refuge from unnecessary degradation during the proposed oil and gas exploration. Exploration of Baca #5 and Baca #7 also would be subject to the binding Surface Use Agreement that was signed in 1992 by the previous owner. Also, under this alternative, Lexam would not be required to follow any of the protective measures required by the Service required under the Maximum Protection of Refuge during Exploration Alternative (alternative C).

Under this alternative, drilling would occur from two vertical wells, one at Baca #5 and the other at Baca #7. The Service is uncertain which, if any additional conditions would be required by the COGCC as conditions of approval for a permit-to-drill in the absence of Service input. However, the COGCC has the authority to require certain conditions to prevent environmental degradation as determined through the permit review process.

2.3 Alternative B - Acquisition of the Mineral Estate

Under this alternative, three scenarios for acquiring the mineral estate could occur including: the purchase of the mineral estate by the federal government, purchase of the mineral estate by an outside party where the estate is then donated to the federal government or direct donation of the mineral estate to the federal government by the mineral owner. Acquisition of the mineral estate by the federal government would be pursuant to the authorization contained in Section 8(a)(1) of the Great Sand Dunes National Park and Preserve Act of 2000, 16 USC 410hhh-6(a)(1). Donation of the mineral estate to the federal government would be pursuant to Fish and Wildlife Act of 1956, as amended, 16 USC 742f(b), which authorizes the acceptance of gifts, devises, or bequests of real and personal property, or interests therein, for the benefit of the Service.

Acquisition or donation of the mineral estate would preclude proceeding with the proposed exploration, and the effects of exploration activities would not occur. Lexam has expressed to interested parties, the company's willingness to sell its mineral interests and share of oil and gas rights for the purchase price of $8,399,847. This figure is based on Lexam's total cost expended includes all costs associated with the acquisition of the property and past development and exploration related expenses, including the drilling and reclamation of two previous exploratory wells (Lexam #1 and Lexam #2); water quality baseline sampling; a cultural resource survey; geophysical evaluation including the recent 3D seismic survey; water rights planning and engineering; and air quality analysis. The cost does not include litigation costs associated with the Civil Action. This information was prepared by an independent audit firm and provided to the Service for analysis (Ernst and Young 2010). Lexam's cost estimate includes significant limitations due to lack of available records dating back to the inception of the project. Costs from inception through 2006 were tabulated using public filings and communications with current and past management of Lexam. Only costs incurred from January 1, 2007 to present are supported by actual receipts and invoices which total $1,887,760 or approximately 22% of the requested purchase price.

Although Service policy (342 FW 6) authorizes acquisition of land through condemnation in certain situations, the Service has never considered the use of eminent domain to secure the mineral estate under the Refuge as it is prohibited by the Refuge's authorizing legislation (The Great Sand Dunes National Park and Preserve Act of 2000) which only allows the purchase of lands and other interests from willing sellers.

The Service may only purchase mineral interests for the fair market value (FMV) as determined by a competent minerals specialist that is either employed by or contracted by the Department of the Interior's Office of Minerals Evaluation. The Office of Minerals Evaluation is used by Department of the Interior to perform mineral assessments and market analyses of potentially marketable minerals. The Federal government will not include so-called consequential costs incurred throughout the duration of the project in its valuation. The valuation process for reserved minerals beneath the Refuge is considered costly due to the size of the project and would be need to be funded using the Service's operating funds (Davidoff & Cornellisson 2011). To date, Lexam has not provided information on the valuation of the actual mineral estate and the Service has not contracted for an evaluation of the value of minerals under the Refuge.

The following documents were provided to the Refuge Manager by Lexam : a Special Warranty Deed With Reserved Net Profits Interest (Baca Minerals, Inc. to Aberford Minerals dated July 16, 1987); Articles of Amendment to the Articles of Incorporation (Aberford Minerals [U.S.] Inc. to Abermin Inc. dated September 3, 1987); Articles of Amendment to the Articles of Incorporation (Abermin Inc. to Challenger Gold Inc. dated December 10, 1990); Articles of Amendment to the Articles of Incorporation [Change of Name] (Challenger Gold Inc. to Lexam Explorations (U.S.A.) Inc. dated January 17, 1995); a Special Warranty Deed (Newhall Land and Farming Company to Lexam Explorations [U.S.A.] Inc. dated October 14, 1997); a Quit Claim Deed (James N. Donaldson to Lexam Explorations [U.S.A.] Inc. dated November 2, 1998); a Surface Agreement (American Water Development, Inc. to Challenger Gold, Inc. dated April 7, 1992, but effective April 1, 1992); and a Supplement to Surface Agreement (dated January 12, 1993, but also effective April 1, 1992). In addition, the Service reviewed public documents held by Saguache County which include a Notice of Claim to Severed Mineral Interests (ConocoPhillips dated October 4, 2007).

Once the mineral estate is properly valued, the Service has multiple legal authorities to purchase interests in lands to become a part of the federal estate. These legal authorities vary based on the source of their funding and

their intended purposes. The following legal authorities would be applicable to the purchase of the mineral estate beneath the Refuge:

- The Fish and Wildlife Act of 1956**,** as amended, 16 USC 742a, authorizes acquisition of additions to the National Wildlife Refuge System for the development, management, advancement, conservation, and protection of fish and wildlife resources by purchase or exchange of land and water or interests therein.
- The Great Sand Dunes National Park and Preserve Act of 2000, 16 USC 410hhh-6(a)(1), authorizes acquisition on lands and interests in lands within the acquisition boundary of the national wildlife refuge by purchase, donation, transfer, or exchange.
- The Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 460l, authorizes appropriations to the Service to acquire land for National Wildlife Refuges as otherwise authorized by law.

Each year, the Service develops a request for funding obtained through the Land and Water Conservation Fund. This request is based upon a Land Acquisition Priority System (LAPS) which ranks proposed acquisition projects using standardized, objective biological criteria. The LAPS quantifies the biological attributes of fisheries and aquatic resources, endangered species, migratory birds, and larger ecosystems at the refuge level. The Service's land acquisition program then achieves its conservation goals by prioritizing proposed acquisitions according to their potential to permanently protect habitats where biological communities will flourish within ecosystems. Funding is requested on a project-by-project basis. In addition, the Secretary of the Interior and the President's Office of Management and Budget provide input into the formulation of the Service land acquisition budget proposal. Once completed, this budget proposal is provided to Congress as a part of the annual federal appropriation process.

Table 2-1 U.S. Fish and Wildlife Service Land and Water Conservation Fund Enacted Appropriations – FY 2001 through FY 2010 (Land Acquisition Project Funding by Fiscal Year)

(thousands of dollars)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Region 6[1]	$5,650	$7,000	$6,750	$10,500	$3,994	$1,500	$1,980	$319	$2,000	$8,550
National	$50,700	$80,135	$65,870	$30,070	$29,494	$15,195	$12,402	$20,676	$29,315	$66,785
Region 6 Average (FY 2001 – FY 2010): $4,824 Region 6 Average (FY 2006 – FY 2010): $2,870										

[1] U.S. Fish and Wildlife Service, Mountain-Prairie Region 6 includes: Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming.

Over the past ten years (FY 2001 – FY2010), the Fish and Wildlife Service has received Land and Water Conservation Fund appropriations ranging from $12.4 to $80.1 million annually for land acquisition projects (Table 2-1). Funding has been distributed using a relatively equitable ratio across the organization's eight geographic regions. The Refuge falls within Region 6, which has also seen a wide range of appropriations. Region 6 has averaged approximately $4.8 million annually for the past ten years and approximately $2.9 million annually for the past five years. Project funding must be used to achieve a wide variety of habitat protections throughout the geographic region. The current budget process is focused on the agency's ability to deliver conservation outcomes through protection of additional acres of habitat. The system does not provide metrics to reflect public concern or other non-habitat related impacts associated with commercial development of outstanding mineral rights. The Service recognizes these concerns, but it is very unlikely that the purchase of a severed mineral estate will ever be scored high enough to be included in an annual budget request. However, the Service has been required to expend over $400,000 to date as a direct result of Lexam's intention to explore for oil and gas under the Refuge. As this figure grows, the federal government must be willing to consider an analysis where the cost of mineral acquisition becomes a reasonable expense.

The federal process begins eighteen months prior to the start of any fiscal year and there are currently no requests for funding to acquire the mineral estate on the Refuge in Fiscal Year 2011 or Fiscal Year 2012 federal

budgets. Without a proper valuation of the cost to purchase the minerals beneath the Refuge, it is extremely speculative to determine the relative priority of a project of this nature.

However, the Department of the Interior finished a complete appraisal in 2008, including surface and subsurface interests on over 51,000 acres and on approximately 6,000 acres of several mineral rights located in Alamosa and Saguache Counties. This report concludes that cost of severed minerals in Luis Maria Baca Grant No. 4 are of relatively low value due to the numerous attempts to locate significantly producible oil and gas and the lack of any significant discovery. This report is supported by an independent geologic evaluation of the Crestone Prospect with similar negative conclusions (USDOI 2008). Appraisals are site-specific and may not be used in the development of fair market value for alternate locations, but comparable data is always a valuable tool in supporting real estate transactions.

The Service has the legal authority and would accept the donation of reserved mineral interests directly from a mineral owner or as a donation from a third-party upon their acquisition. Donations would be handled in accordance with Department of the Interior donation guidelines for real property and would be recorded as property of the United States.

The Service can neither compensate Lexam for its cumulative costs of exploration and it can only consider acquisition of the entire mineral estate beneath the Refuge for the fair market value. Without discovery of significant recoverable oil and gas, such a figure would be significantly lower than the $8.4 million proposed by Lexam. In addition, the Service will only consider the acquisition of 100% of the hard mineral and oil and gas rights beneath its lands which would require additional compensation to any other parties holding a reserved mineral interest. If all outstanding mineral rights are purchased, 43 CFR 3101.5-1 states that federal minerals underlying a NWR are not leasable, except in the event of actual drainage. However, this alternative is not being rejected , because Lexam has not rejected a compete valuation necessary to determine the fair market value of the complete mineral estate beneath the Refuge nor have they rejected discussions related to full or partial donation of the mineral estate.

2.4 Alternative C - Maximum Protection of Refuge during Exploration (Preferred Alternative)

Under this alternative, the Service would require that specific protective measures and standards be followed during all phases of oil and gas exploration being proposed by Lexam, including the proposed drilling of two exploratory oil and gas wells on the Refuge, to ensure that the surface estate of the Refuge and associated resources are not unreasonably degraded or impacted. These measures shall be equally applicable to Lexam's employees, representatives, consultants, contractors and subcontractors. The Service also will require that Lexam resubmit a new Plan of Operations that addresses deficiencies identified in the current Plan of Operations and implements protective measures required by the Service.

Under this alternative, drilling would occur from a vertical well at Baca #5 and a vertical well at Baca #7. However, at the request of the Service, Lexam has agreed to conduct their exploration activities including construction of roads and pads in sequential order, beginning first at their primary target (Baca #5). After Baca #5 is drilled, Lexam will make a decision on whether sufficient information was obtained, or if proceeding with construction and drilling at Baca #7 is necessary. The Service's request for sequential exploration at Baca #5 then at Baca #7 does not affect the scope of the analyses in this Draft EA because the impacts of both wells (Baca #5 and Baca #7) have been assessed throughout Chapter 4.

Specific protective measures would be required by the Service to minimize and mitigate the potential effects of Lexam's Plan of Operations on the surface and subsurface resources of the Refuge. These protective measures were developed by the Service through information obtained during public scoping, from the Final Settlement Agreement dated September 23, 2010 involving the litigation of the proposal by Lexam (Operator), and by new evidence outlining the potential impacts to resources protected by the Refuge. Of these, protection measures #5, 8, 10, 12, 13, 14, and 32 included in the list below were modified or not included as conditions of approval for prior permits to drill on the Refuge. These protective measures also are listed in **Appendix D**.

Under this alternative, Lexam would be required to implement the following protective measures and conditions outlined below. Specific reference to federal and state laws and regulations are not intended to be all inclusive. Therefore, all applicable federal and state laws in addition to those highlighted below would still apply to the proposed exploration activities.

1) All vehicles and equipment from outside the Refuge will be decontaminated per Service procedures to prevent the introduction of noxious weeds to the Refuge. Decontamination will include removal of skid plates for inspection and cleaning if necessary. This measure is subject to the following rules:

   - COGCC rule 1004(e) – "All areas being reclaimed shall be kept as free as practicable of all undesirable plant species designated to be noxious weeds. Weed control measures shall be conducted in compliance with the Colorado Noxious Weed Act, C.R.S. §35-5.5-115 and the current rules pertaining to the administration and enforcement of the Colorado Noxious Weed Act. It is recommended that the operator consult with the local weed control agency or other weed control authority when weed infestation occurs. It is the responsibility of the operator to monitor affected and reclaimed lands for noxious weed infestations. If applicable, the Director may require a weed control plan."

   - Plants and animals or their parts taken elsewhere shall not be introduced, liberated, or placed on any national wildlife refuge except as authorized. (50 C.F.R. 27.52)

2) In order to protect cultural resources Lexam will provide on-site cultural resource monitoring during all ground disturbing activities. This measure is subject to the following rules:

   - No person shall search for or remove from national wildlife refuges objects of antiquity except as may be authorized by 43 CFR part 3. (50 C.F.R. 27.62)

   - No person shall search for buried treasure, treasure trove, valuable semi-precious rocks, stones, or mineral specimens on national wildlife refuges unless authorized by permit or by provision of this subchapter C; Permits are required for archeological studies on national wildlife refuges in accordance with the provisions of this subchapter C. (50 C.F.R. 27.63)

3) Lexam will provide trained natural resource advisors (NRAs), approved by Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts. NRAs have specific skills and duties when working on "sensitive lands," like a NWR, that enable them to identify deficiencies or negligent activities before issues arise that have the potential to cause unreasonable degradation of the surface and subsurface estate of the Refuge.

4) Impacts to sensitive habitat, wildlife, plants, other sensitive natural or historical resources will be avoided to the extent possible while constructing the access road and well pads. This measure is subject to the following rules:

   - COGCC rule 1002(e) – "Existing roads shall be used to the greatest extent practicable to avoid erosion and minimize the land area devoted to oil and gas operations. Roadbeds shall be engineered to avoid or minimize impacts to riparian areas or wetlands to the extent practicable. Unavoidable impacts shall be mitigated. Road crossings of streams shall be designed and constructed to allow fish passage, where practicable and appropriate."

5) Lexam will provide a resource monitoring plan which must be approved by Service. This plan should include a schedule for gathering data before, during, and after construction and/or drilling activities occur. It should include an assessment of baseline water quality of surface waters, the near-surface unconfined aquifer and the deeper confined aquifers in proximity to the proposed well locations (both up gradient and down gradient), as well as baseline information on soils, vegetation, air quality, sound (e.g., hourly sound pressure, ambient sound levels, etc.), and visual impacts. In addition, it should include provisions for re-sampling in the event of anomalous detections.

6) Pre- and post-drilling aerial photographs will be taken of the proposed drilling and road construction area. The photographs will be color and will provide complete coverage of the drilling and road construction area. The pre-survey documentation shall be submitted within 10 days of initiation of the drilling, the post-survey documentation shall be submitted within 110 days of completion along with a digitized version of the pre-survey photographs. These photographs will become the property of the Refuge. This measure is subject to the following rule:

- COGCC rule 303(d)(3) – "A minimum of four (4) color photographs, one (1) of the staked location from each cardinal direction. Each photograph shall be identified by: date taken, well or location name, and direction of view."

7) The soils at the location site will be tested using approved standards to determine levels of heavy metals, chemical pollutant, and other contaminants, prior to rig-up operations. Duplicate tests will be conducted before completion or at abandonment. If the exit test reveals levels above the background established by pre-drilling test, cleanup will be required. The most practical method of clean up is soil removal. Any quantity of soil removed will be replaced to the original contours. This measure is subject to the following rules:

- COGCC rule 1003(e)(2) – "**Revegetation of non-crop lands.** All segregated soil horizons removed from non-crop lands shall be replaced to their original relative positions and contour as near as practicable to achieve erosion control and long-term stability, and shall be tilled adequately in order to establish a proper seedbed. The disturbed area then shall be reseeded in the first favorable season following rig demobilization. Reseeding with species consistent with the adjacent plant community is encouraged. In the absence of an agreement between the operator and the affected surface owner as to what seed mix should be used, the operator shall consult with a representative of the local soil conservation district to determine the proper seed mix to use in revegetating the disturbed area. In an area where an operator has drilled or plans to drill multiple wells, in the absence of an agreement between the operator and the affected surface owner, the operator may rely upon previous advice given by the local soil conservation district in determining the proper seed mixes to be used in revegetating each type of terrain upon which operations are to be conducted."

  Interim reclamation of all disturbed areas no longer in use shall be considered complete when all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, compacted, covered, paved, or otherwise stabilized in such a way as to minimize erosion to the extent practicable, or a uniform vegetative cover has been established that reflects pre-disturbance or reference area forbs, shrubs, and grasses with total percent plant cover of at least eighty percent (80%) of pre-disturbance levels or reference areas, excluding noxious weeds. Re-seeding alone is not sufficient."

8) Lexam shall provide Service with a detailed wetland delineation, which shall be performed prior to any disturbance in the immediate Project Area vicinity. This determination should follow U.S. Army Corps of Engineers Hydrogeomorphic Method (Smith et al. 1995). Based on information gathered from the wetland delineation, well sites will be located as far from sensitive wet meadow wetlands as practicable. This measure is important to determine if the following rules apply:

- COGCC rule 303(f) – "**Oil and gas locations in wetlands.** In the event that an operator, otherwise required to file a Form 2A, acquires an Army Corps of Engineers permit pursuant to 33 U.S.C.A. §1342 and 1344 of the Water Pollution and Control Act (Section 404 of the federal "Clean Water Act") for construction of an oil and gas location, the operator shall so indicate on the Oil and Gas Location Assessment, Form 2A."

- COGCC rule 1002(e)(2) – "Operators shall avoid or minimize impacts to wetlands and riparian habitats to the degree practicable."

9) Summaries of all the results generated from the water quality sampling, cultural resource work and any other sampling or monitoring, including the results of Lexam's exploratory drilling, will be provided to the Refuge Manager upon completion and summation. This measure is subject to the following rule:

- COGCC rule 608(b)(5) – "Copies of all test results described above shall be provided to the Commission and the water well owner within three (3) months of collecting the samples. The analytical data and surveyed well locations shall also be submitted to the Director in an electronic data deliverable format."

10) Lexam will provide a detailed description of all best management practices that will be used during any aspect of the proposed exploration project. This measure is subject to the following rule:

- COGCC rule 1002(f)(2&3) – Stormwater management - best management practices.

11) All construction of roads and pads will occur in a way that best facilitates their subsequent complete removal and reclamation once Lexam activities have ceased at these sites. This includes separating and stockpiling and covering topsoil layers on-site to be replaced during reclamation. All disturbed areas will be reclaimed per the requirements imposed by the COGCC and with Service input. Only endemic plants and seed mixtures are to be used in reclamation. This measure is subject to the following rules:

- COGCC rule 1002(b)(2) – "The operator shall separate and store the topsoil horizon or the top six (6) inches, whichever is deeper, and mark or document stockpile locations to facilitate subsequent reclamation. When separating the soil horizons, the operator shall segregate the horizon based upon noted changes in physical characteristics such as organic content, color, texture, density, or consistency."

- COGCC rule 1002(c) – "All stockpiled soils shall be protected from degradation due to contamination, compaction and, to the extent practicable, from wind and water erosion during drilling and production operations. Best management practices to prevent weed establishment and to maintain soil microbial activity shall be implemented."

- COGCC rules 1003 & 1004 – "Final reclamation of all disturbed areas shall be considered complete when all activities disturbing the ground have been completed, and all disturbed areas have been either built upon, compacted, covered, paved, or otherwise stabilized in such a way as to minimize erosion, or a uniform vegetative cover has been established that reflects pre-disturbance or reference area forbs, shrubs, and grasses with total percent plant cover of at least eighty percent (80%) of pre-disturbance or reference area levels, excluding noxious weeds, or equivalent permanent, physical erosion reduction methods have been employed. Re-seeding alone is not sufficient."

12) To fully protect the aquifers from contamination through communication in the borehole. The intermediate casing shall extend 500 feet beyond the bottom of Layer #4 of the deep confined aquifer[1]. The bottom of Layer #4 must be determined by detailed logging of the lithology during drilling. Although, existing information suggests that the bottom of Layer #4 could be 3,500 feet below the surface, Lexam shall consult with an independent professional geologist (reference CRS-34-1-201) approved by the Service to confirm when the appropriate depth has been reached based on data collected from drill logs.

- COGCC rule 317(d) – "**Casing program to protect hydrocarbon horizons and groundwater.** The casing program adopted for each well must be so planned and maintained as to protect any potential oil or gas bearing horizons penetrated during drilling from infiltration of injurious waters from other sources, and to prevent the migration of oil, gas

[1] Lexam must case the entire deep confined aquifer (Aquifer Layer #4). The CDWR (2004) described five separate hydrogeological layers that comprise the aquifer in the San Luis Valley. Each layer is defined based on one or more lithologies with similar hydrogeologic characteristics. Layer #4 occurs within a Sante Fe formation that is predominantly sand and gravel and has up to 50% clay layers in most areas of the SLV. Approximate depth of Layer #4 is from 1,200 to 3,500 feet.

or water from one (1) horizon to another, that may result in the degradation of groundwater. A Sundry Notice, Form 4, including a detailed work plan and a wellbore diagram, shall be submitted and approved by the Director prior to any routine or planned casing repair operations. During well operations, prior verbal approval for unforeseen casing repairs followed by the filing of a Sundry Notice, Form 4, after completion of operations shall be acceptable."

- COGCC rule 317(e) **– "Casing where subsurface conditions are unknown.** In areas where pressure and formations are unknown, sufficient surface casing shall be run to reach a depth below all known or reasonably estimated utilizable domestic fresh water levels and to prevent blowouts or uncontrolled flows, and shall be of sufficient size to permit the use of an intermediate string or strings of casings. Surface casing shall be set in or through an impervious formation and shall be cemented by pump and plug or displacement or other approved method with sufficient cement to fill the annulus to the top of the hole, all in accordance with reasonable requirements of the Director."

13) Lexam shall provide a Storm Water Management Plan (SWMP) which must be approved by Service. This plan should be prepared according to *SWMP* guidelines prepared by the Colorado Department of Public Health and Environment (CDPHE). ***CDPHE guidelines for General Permit Application and Stormwater Management Plan Preparation Guidance*** and should include sufficient information and narrative descriptions regarding construction activities along the existing waterways, locations of all proposed potential discharges, identification of potential pollutant sources, maps detailing all ground disturbing activities at sites, and details and figures for proposed BMPs for these construction activities. An outline is available from CDPHE and should be followed.

- COGCC rule 1002(f)(2&3) - "Oil and gas operators shall implement and maintain Best Management Practices (BMPs) at all oil and gas locations to control stormwater runoff in a manner that minimizes erosion, transport of sediment offsite, and site degradation. BMPs shall be maintained until the facility is abandoned and final reclamation is achieved pursuant to Rule 1004. Operators shall employ BMPs, as necessary to comply with this rule, at all oil and gas locations, including, but not limited to, well pads, soil stock piles, access roads, tank batteries, compressor stations, and pipeline rights of way. BMPs shall be selected based on site-specific conditions, such as slope, vegetation cover, and proximity to water bodies, and may include maintaining in-place some or all of the BMPs installed during the construction phase of the facility. Where applicable based on site-specific conditions, operators shall implement BMPs in accordance with good engineering practices."

- The Water Quality Control Act (§25-8-501(1), C.R.S.) - Establishes a state water quality management program administered by the Water Quality Control Division (WQCD) which prohibits any person from "discharg[ing]…any pollutant into any state water from a point source without first having obtained a permit from the division for such discharge . . ." Stormwater management for construction activities at oil and gas related sites is currently regulated under two separate agencies within the State of Colorado, the WQCD and the COGCC.

14) Lexam shall provide a Spill Prevention and Countermeasures Plan (SPCC), which must be approved by Service. This plan shall include: a listing of secondary containment and/or diversionary structures or equipment for all oil handling containers, equipment, and transfer areas. It should also include a table identifying tanks and containers at the facility with the potential for an oil discharge; the mode of potential failure; the likely flow direction and potential quantity of the discharge; as well as, provide the secondary containment method and containment capacity. In addition, the plan should include the physical layout of the facility and a facility diagram, which must mark the location and contents of each container. The facility diagram must also include all transfer stations and connecting pipes.

15) A closed loop mud and drill cuttings system will be used to minimize impacts to surrounding habitats. In addition, drill cuttings will be isolated in an above-ground tank during drilling. Cuttings and drilling fluids

will be removed from the Refuge and disposed of off-site in accordance with state regulations (50 C.F.R. 27.94; 50 C.F.R. 29.32).

16) Drilling operations will be modified, as necessary, to reduce conflicts with regular Refuge management activities.

17) A gate guard will be provided by Lexam, and approved by the Service, to document traffic entering and exiting the Refuge and to eliminate potential illegal entry onto the Refuge.

18) Arrangements for additional Service law enforcement personnel will be made in the event it is deemed necessary to effectively enforce state, federal, refuge, and wildlife laws and regulations during drilling activities.

19) The Operator's construction and drilling activities will be restricted to the period of August 1 through April 30 to avoid conflicts with wildlife and limit ground disturbance activities to periods of low precipitation minimizing impacts to soil. Any field operations conducted during the Refuge's migratory bird closure period (May 1 through July 31) must be coordinated and pre-authorized by the Refuge Manager or his authorized representative. Service will consider allowing Lexam to continue work in early May if allowing access is necessary to complete activities and such activities would not impact the Refuge and resources greater than what is anticipated in the EA. Absolutely no activities will be permitted beyond May 15. Rig up and rig down operations can only be conducted during daylight hours. However, drilling operations can be conducted 24 hours per day. This measure is subject to the following rules:

- COGCC rule 306(a) – "**Consultation with surface owner**. In locating roads, production facilities, and well sites, or other oil and gas operations, and in preparation for reclamation and abandonment, the operator shall consult in good faith with the surface owner…Such good faith consultation shall allow the surface owner or appointed agent the opportunity to provide comments to the operator regarding preferences for the timing of oil and gas operations and preferred locations for wells and associated facilities."

- CDOW Actions to Minimize Adverse Impacts to Wildlife Resources - "Schedule construction, drilling, and completion activities to avoid particularly sensitive seasonal wildlife habitats."

20) Refuge Manager or his authorized representative may require drill pads to be fenced if necessary to prevent large ungulates from gaining access to the sites.

- CDOW Actions to Minimize Adverse Impacts to Wildlife Resources - "Fence livestock and/or wildlife out of newly reclaimed areas until reclamation standards have been met and plants are capable of sustaining herbivory."

21) To protect special status species such as the Rio Grande Sucker and Rio Grande Chub, the Service requires that Lexam:

− Establish a 0.25-mile buffer zone of no activity around potential and identified habitat.
− Limit vehicle crossings to existing or pre-approved crossings.
− Sample waterways for particulate matter, creating a baseline and regular monitoring during period of activity.
− Assess stability and suitability of road water crossings prior to road construction and drilling activities and perform upgrades, if needed. Conduct periodic monitoring of crossings during activities and documentation of any deficiencies that may occur that may be indicative of potential structural failure.
− Provide dust suppression in the vicinity of waterway crossings.

22) The Operator shall provide detailed maps or plats, as required by COGCC the Refuge Manager or his authorized representative of the proposed project layout, showing routes, staging areas, construction areas, and work locations. This measure is subject to the following rules:

- COGCC rule 303 (c) - “Attached to and part of the Permit-to-Drill, Form 2, as filed shall be a current 8½" by 11" scaled drawing of the entire section(s) containing the proposed well location with the following minimum information:

  (1) Dimensions on adjacent exterior section lines sufficient to completely describe the quarter section containing the proposed well shall be indicated. If dimensions are not field measured, state how the dimensions were determined.
  (2) The latitude and longitude of the proposed well location shall be provided on the drawing with a minimum of five (5) decimal places of accuracy and precision using the North American Datum (NAD) of 1983 (e.g.; latitude 37.12345 N, longitude 104.45632 W). If global positioning system (GPS) technology is utilized to determine the latitude and longitude, all GPS data shall meet the requirements set forth in Rule 215. a. through h.
  (3) For directional drilling into an adjacent section, that section shall also be shown on the location plat and dimensions on exterior section lines sufficient to completely describe the quarter section containing the proposed productive interval and bottom hole location shall be indicated. (Additional requirements related to directional drilling are found in Rule 321.)
  (4) For irregular, partial or truncated sections, dimensions will be furnished to completely describe the entire section containing the proposed well. (5) The field-measured distances from the nearer north/south and nearer east/west section lines shall be measured at ninety (90) degrees from said section lines to the well location and referenced on the plat. For unsurveyed land grants and other areas where an official public land survey system does not exist, the well locations shall be spotted as footages on a protracted section plat using GPS technology and reported as latitude and longitude in accordance with Rule 215.
  (6) A map legend.
  (7) A north arrow.
  (8) A scale expressed as an equivalent (e.g. - 1" = 1000').
  (9) A bar scale.
  (10) The ground elevation.
  (11) The basis of the elevation (how it was calculated or its source).
  (12) The basis of bearing or interior angles used.
  (13) Complete description of monuments and/or collateral evidence found; all aliquot corners used shall be described.
  (14) The legal land description by section, township, range, principal meridian, baseline and county.
  (15) Operator name.
  (16) Well name and well number.
  (17) Date of completion of scaled drawing.”

- COGCC rule 303 (d)(3)(D) - "A topographic map showing all surface waters and riparian areas within one thousand (1,000) feet of the proposed oil and gas location, with a horizontal distance and approximate bearing from the oil and gas location.”

- COGCC rule 303 (d)(3)(E) - "An 8 1/2” by 11” vicinity or U.S. Geological Survey topographic map showing the access road from the highway or county road providing access to the proposed oil and gas location.”

23) All materials brought into the Refuge to build up the location pad will be authorized by the Refuge Manager or his authorized representative. To minimize the spread of invasive species, no top soils will be brought in from off the Refuge. (50 C.F.R. 27.52; 50 C.F.R. 29.32)

24) The Operator shall have an on-site independent oil and gas consultant present during all phases of exploration and they shall be the sole representative of the Operator and subcontractors regarding all communications and decisions of the Refuge Manager or his authorized representative. The consultant’s sole responsibility is to ensure daily compliance with Refuge, ensure that all oil and gas laws and

regulations are followed, report all accidents and/or injuries and keep the Project Leader informed daily. The Operator shall keep the Refuge Manager or his authorized representative informed if there is any change of designated independent oil and gas consultant. (50 C.F.R. 25.72)

25) Refuge officials will conduct an on-site meeting before rig-up with representatives of the Operator, drilling contractor, subcontractors, suppliers and service companies. The purpose of the meeting is to go over regulations and conditions that apply to work crew conduct on the Refuge.

26) Prior to rig-up, an Emergency Preparedness Plan covering exploratory drilling, well control, materials hauling, spill response, and fire evacuation, will be provided to the Refuge Manager and discussed in a pre-operation meeting to be held with local governments. The plan shall contain a telephone list naming key contacts for emergency operations and activation. This measure is subject to the following rules:

- COGCC rule 306 - **Consultation.** The operator shall consult in good faith, as provided . . .[with] local governments that have appointed a local governmental designee and have indicated to the Director a desire for consultation shall be given an opportunity to engage in such consultation."

- COGCC rule 317(l) - "**Flaring of gas during drilling and notice to local emergency dispatch**. Any gas escaping from the well during drilling operations shall be, so far as practicable, conducted to a safe distance from the well site and burned. The operator shall notify the local emergency dispatch as provided by the local governmental designee of any such flaring. Such notice shall be given prior to the flaring if the flaring can be reasonably anticipated, and in all other cases as soon as possible but in no event more than two (2) hours after the flaring occurs."

- COGCC rule 317(B)(d)(6) - "An emergency spill response program that includes employee training, safety, and maintenance provisions and current contact information for downstream Public Water System(s) located within fifteen (15) stream miles of the DCPS Operation, as well as the ability to notify any such downstream Public Water System(s) with intake(s) within fifteen (15) stream miles downstream of the DCPS operations."

27) The Operator will upgrade and maintain all access routes, roads and bridges designated for its use across the Refuge in accordance with acceptable specifications and standards. The Operator shall have road maintenance equipment and operator(s) readily available to perform road repairs and maintenance as needed, or as directed by the Refuge Manager or his authorized representative.

28) Dust levels on regularly traveled access routes must be kept to a minimum. The Operator shall have a water truck and operator(s) readily available to perform dust abatement as needed, or as directed by the Refuge Manager or his authorized representative. Only water will be allowed for dust suppression efforts. Dust control measures shall be implemented throughout the traveled areas of the Project Area in addition to the dust abatement requirement in measure #15. This measure is subject to the following rule:

- COGCC rule 1002(e)(1) - In order to reasonably minimize land disturbances and facilitate future reclamation, well sites, production facilities, gathering pipelines, and access roads shall be located, adequately sized, constructed, and maintained so as to reasonably control dust and minimize erosion, alteration of natural features, removal of surface materials, and degradation due to contamination.

29) The drill site and immediate access roads shall be constructed of Refuge approved material for all drilling locations. Drill pads may not exceed 90,000 square feet in area. All existing drainage patterns within roads to be constructed shall be maintained uninterrupted by the use of culverts, bridges or other applicable techniques as specified and authorized by the Refuge Manager or his authorized representative. This measure is subject to the following rule:

- COGCC rule 1002(d) - The drilling location shall be designed and constructed to provide a safe working area while reasonably minimizing the total surface area disturbed. Consistent with applicable spacing orders and well location orders and regulations, in locating drill pads, steep

slopes shall be avoided when reasonably possible. The drill pad site shall be located on the most level location obtainable that will accommodate the intended use. If not avoidable, deep vertical cuts and steep long fill slopes shall be constructed to the least percent slope practical. Where feasible, operators shall use directional drilling to reduce cumulative impacts and adverse impacts on wildlife resources.

30) Upon completion of drilling operations, the Refuge Manager or his authorized representative must be advised within 120 days whether the well is to be retained or plugged. If the well site is to be abandoned, the well is to be plugged according to state law, all above ground structures removed and the site and road restored as directed by the Refuge Manager or his authorized representative. Any damage to existing surface vegetation, water channels, or other physical features shall be restored to original site conditions. All costs shall be born by the Operator. This measure is subject to the following rules:

- COGCC rule 1001(a) - The rules and regulations of this series establish the proper reclamation of the land and soil affected by oil and gas operations and ensure the protection of the topsoil of said land during such operations. The surface of the land shall be restored as nearly as practicable to its condition at the commencement of drilling operations.

- Upon the cessation of operations the area shall be restored as nearly as possible to its condition prior to the commencement of operations. (50 C.F.R. 29.32)

31) Pits, ponds and/or open tanks are prohibited. Fully enclosed portable tanks must be used in circulating operations for the temporary storage of all drilling fluids, cuttings, mud, and contaminants. All drilling fluids, cuttings, mud, contaminants, portable tanks, and other equipment must be transported off Refuge to a state approved facility upon cessation of drilling activity. On-site disposal of drilling fluids is prohibited. It is highly recommended that an auger tank be used for transferring drill cuttings and sand to a vehicle for off Refuge transport. This measure is subject to the following rule:

- COGCC rule 907(c)(2)(c) – Drilling Fluids. Treatment and Disposal. Drilling fluid may be disposed as follows:
  B. Disposal at a commercial solid waste disposal facility

32) Lexam must provide Service with a written description of how potential produced water and condensate resulting from drill stem testing will be handled and disposed of, in the event that the proposed exploratory wells intersect gas reserves. On-site disposal of produced water is prohibited. Produced water may only be disposed of at an off-site state approved facility following:

- COGCC rule 907(c)(2)(c) – **Produced water disposal.** Produced water may be disposed as follows:
  C. Disposal at permitted commercial facilities

33) All toxic construction and equipment supplies and refuse (oil, grease, gasoline, diesel, paint, and other petrochemical derivatives) shall be centrally stored. Wastes shall be disposed off Refuge immediately following completion of drilling operations. In the event of an accidental spill or discharge of oil, brine, or any other petrochemical substance, the Operator shall immediately notify the Refuge Manager or his authorized representative. The Operator shall remove contaminated soils for proper disposal off Refuge, and replace such soils with the same type soils or of a type specified and approved by the Refuge Manager or his authorized representative. A site reclamation plan may be required by the Refuge Manager or his authorized representative. (50 C.F.R. 29.32) This measure is subject to the following rules:

- CDPHE rule 6 C. C. R. 1007-2&3. Solid and Hazardous Waste Commission Regulations. Hazardous wastes require storage, treatment, and disposal practices in accordance with 6 C.C.R.

1007-3. All non-hazardous/non-E&P wastes are considered solid waste, which require storage, treatment, and disposal in accordance with 6 C.C.R. 1007-2.

34) Catch pans or other liner systems approved by the Refuge Manager are required for equipment and locations such as mud pumps, bulk mud additive tanks, fuel tanks, mixing shed, generators, accumulator and lines, and under the entire rig floor. The catch pans will cover the entire surface area under the equipment. The rig floor catch pan will be tied to allow for wash down and mud drainage from drill pipe. The catch pans will be kept free and clean from accumulated debris and spill materials. (50 C.F.R. 27.94; 50 C.F.R. 29.32)

35) The Operator will be responsible for providing all water needed for drilling operations. No waste water will be discharged onto Refuge lands, ditches, or water bodies. The Operator will provide a containerized or temporary septic system for domestic sewage disposal during drilling operations, which shall be removed upon completion of drilling. Use of portable toilets at drill site or the installation of a septic system, or similar treatment system or tanks will be required for any trailer or quarters on site. No surface discharge of septic system or portable toilet water is permitted. Septic tanks must be inspected weekly during operations and pumped as necessary. Upon completion of operations, the septic tanks must be pumped out and all material hauled away.

36) All disposable type materials and trash brought onto the Refuge or generated at the drill site shall be removed from the Refuge on a biweekly basis and upon completion of the drilling activities. The drill site and operational area shall be kept free of debris and trash at all times. Trash shall be contained securely at the drill site in such a manner (fully enclosed trash cages) as to prevent trash from being spread by wind or wildlife. No trash may be disposed of or buried on the Refuge. (50 C.F.R. 27.94)

37) Lexam must implement the recommendations contained in the report entitled “Existing Conditions Report for a Portion of the Lexam Road, Saguache County, Colorado,” prepared by Russell Surveyors and Associates, Inc., March 30, 2008, with input from the Service.

38) Lexam must implement the recommendations that were the basis for the air quality report analysis set forth in the “Lexam Baca Drilling Project Visibility Impact Evaluation,” Air Sciences Inc., April 30, 2008: (a) power generators will be Tier 2 engines; (b) diesel fuel used in generators and all other non-road engines will be ultra-low-sulfur (less than 0.05 percent sulfur); and (c) disturbed areas will be watered to control the fugitive dust.

39) Lexam must use mufflers on all internal combustion engines and certain compressor components that are designed to further attenuate noise emissions during all exploration activities.

- COGCC rule 802(b) - "Oil and gas operations at any well site, production facility, or gas facility shall comply with the following maximum permissible noise levels. Operations involving pipeline or gas facility installation or maintenance, the use of a drilling rig, completion rig, workover rig, or stimulation is subject to the maximum permissible noise levels for industrial zones. The type of land use of the surrounding area shall be determined by the Commission in consultation with the local governmental designee taking into consideration any applicable zoning or other local land use designation.”

40) Upon CDOW recommendation, Lexam has agreed, that in the event of a severe winter, to assist the CDOW with managing for the needs of any wintering big game temporarily displaced by Lexam’s activities within the designated areas, especially if the temporary displacement results in the potential for a decline in overall physiological health of the animals or in increased game damage claims by private landowners. This assistance could occur as a Lexam funded baiting program, feeding program or other form of distribution management as determined appropriate by CDOW within the severe winter range area.

41) A minimum of one up-gradient and two down-gradient monitoring wells will be installed around each drill pad. The wells will be completed in the shallow unconfined aquifer. The locations and elevations of

the wells will be surveyed and depth to water will be measured. Water samples will be collected for chemical analysis before the wells are spud and at predetermined intervals thereafter, which will agreed to by the Service and Lexam. If spills or releases of drilling related chemicals at sites occur, then the sampling frequency may be increased to a frequency agreed to by the Service, Baca Grande Water and Sanitation District, and Lexam.

42) General Refuge access conditions:

− Access is to allow Lexam and/or its contractor's access to portions of the Refuge for the purpose of carrying out drilling of oil and gas exploration wells Baca #5 and Baca #7. (50 C.F.R. 26.22)

− The Refuge Manager is the coordinating official having immediate jurisdiction and administrative responsibility for oil and gas operations on the Baca National Wildlife Refuge (Refuge) lands and property, all entry upon the Refuge must be coordinated with the Refuge Manager or his authorized representative The Refuge Manager must be advised at least 48 hours in advance of initial activity. (50 C.F.R. 26.22)

− The failure of the United States to require strict performance of the terms, conditions, covenants, agreements, or stipulations of this permit for access to conduct exploration activities on National Wildlife Refuge lands, shall not constitute a waiver or relinquishment of the right of the United States to strictly enforce thereafter such terms, conditions, covenants, agreements, or stipulations which shall, at all times, continue in full force and effect.

− Lexam and/or its contractors shall save, hold harmless, defend, and indemnify the United States, its agents and employees for loss, damages, or judgments and expenses on account of bodily injury, death or property damage, or claims for bodily injury, death or property damage of any nature whatsoever, and by whomever made, arising out of the Operator, his employees, subcontractors or agents with respect to the exploration of any and all mineral rights within the lands administered by the Refuge.

− All applicable federal and state regulations apply and will be in force. Operator shall be responsible for the actions of all exploration and support personnel. Violations of applicable laws or regulations will subject the operator and/or his employees to prosecution under state and/or federal laws. Individuals utilizing the Refuge under the Operator's authorization are subject to inspections of vehicles and their contents by federal and state law enforcement officers.

− Proof of general liability insurance in the amount of $1,000,000 must be furnished to repair/mitigate any damages. This does not limit the liability for damages to this amount.

- COGCC rule 708 - **General Liability Insurance.** All operators shall maintain general liability insurance coverage for property damage and bodily injury to third parties in the minimum amount of one million dollars ($1,000,000) per occurrence. Such policies shall include the Commission as a "certificate holder" so that the Commission may receive advance notice of cancellation.

− Operators will act in a manner that is respectful of Refuge habitats, wildlife, and property. Gates are to be locked or unlocked as they are found. (50 C.F.R. 27.21; 50 C.F.R 27.51)

− All vehicle access will be restricted to developed roads and two-tracks. All terrain vehicle use and deviations to vehicle use must be pre-approved by the Refuge Manager in writing prior to any action taken. (50 C.F.R. 27.31)

− Vehicle speed limits will be set at the discretion of Refuge Manager and limits will be strictly adhered to. (50 C.F.R. 27.31)

− No pets will be allowed on the Refuge. (50 C.F.R. 28.42; 50 C.F.R. 28.43)

− Possession of firearms, alcoholic beverages or drugs is strictly prohibited on the Refuge. (50 C.F.R. 27.41; 50 C.F.R. 27.42; 50 CFR 27.81; 50 C.F.R. 27.82)

− Fires are strictly prohibited in any areas of the Refuge. (50 C.F.R. 27.95)

− Operators are not to be considered agents of the Service and are not to represent the Service in any matters. (50 C.F.R. 27.84)

− Operators will perform all work in accordance with the highest standards of the industry and to the satisfaction of the Service.

− Operators will perform all work in accordance with all applicable laws and regulations and will obtain all necessary permits or licenses when required to do so. (50 C.F.R. 25.13; 50 C.F.R. 29.32)

− All personnel and activities shall be restricted to the immediate drilling area and the direct access road to the drill site. (50 C.F.R. 26.22)

− Feeding wildlife species is prohibited. Molesting or destroying the home or dens of wildlife is prohibited. If dens are found during the normal course of operations, distinctive flagging will be used to alert all personnel of the den location. Adverse impacts on fish, wildlife and the environment shall be kept to an absolute minimum. All road kills will be reported to the Refuge Manager or his authorized representative. (50 C.F.R. 27.51)

− Littering is prohibited. All cans, bottles, lunch papers, and operations trash must be removed. Cigarette butts are considered litter. All vehicles will be equipped with a container to carry out trash. (50 C.F.R. 27.94)

− All necessary permits, contacts and clearances must be completed or obtained by Lexam prior to the start of the activity. (50 C.F.R. 25.13)

− No overnight quarters will be permitted on the Refuge unless authorized by Refuge Manager. (50 C.F.R. 27.92)

− Re-route the access road to Baca #5 to avoid sensitive plant species and wet meadow habitat (**Figure 2-1**).

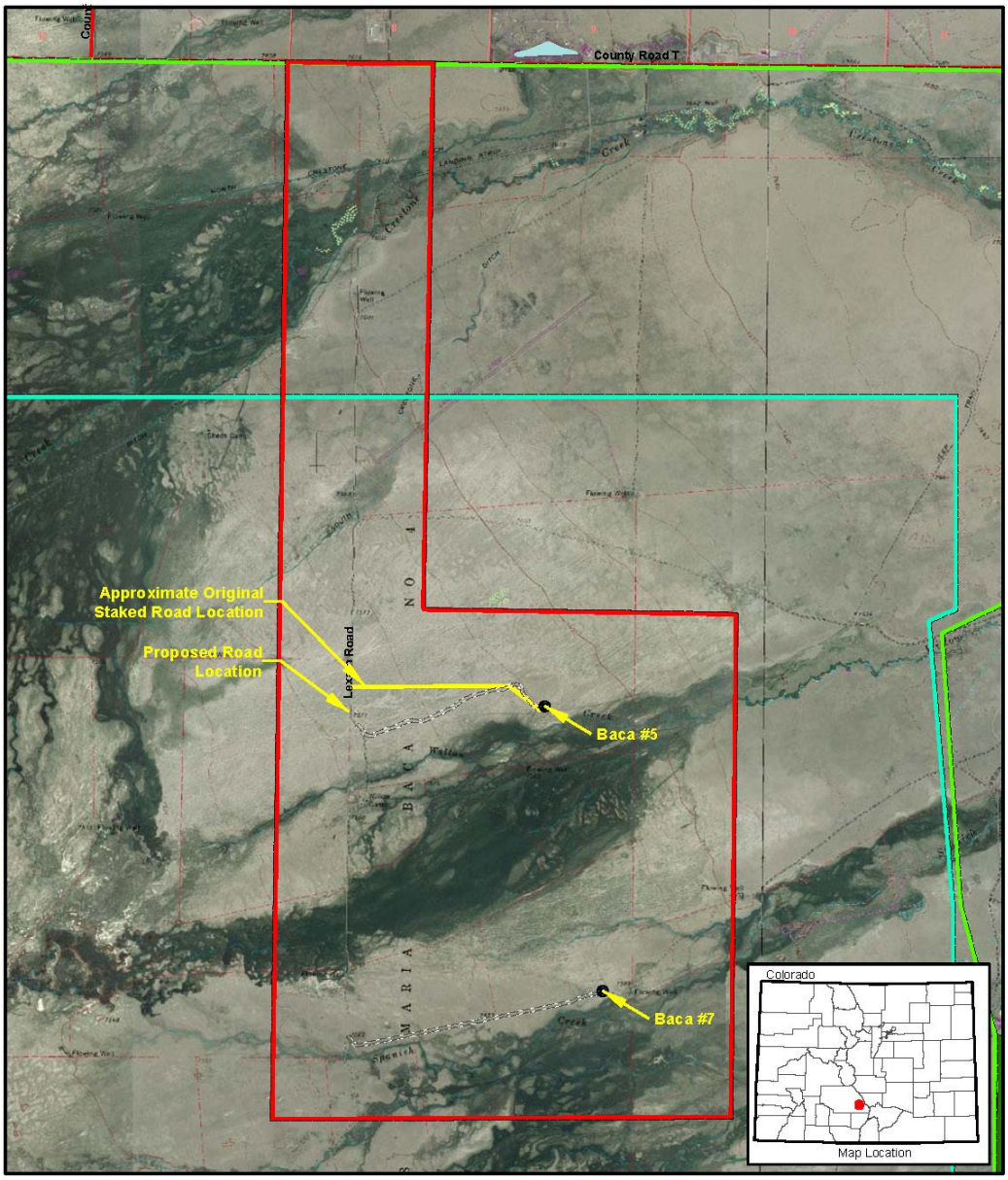
Under this alternative, if Lexam discontinues or fails to perform any of the preceding protective measures, and the Refuge Manager believes such failure will lead to unreasonable damages to Refuge resources, the Service may assess penalties pursuant to 50 CFR Part 28 or any of the aforementioned CFRs listed above. The Service may require Lexam to cease exploration activities until the risk of damage to Refuge resources has been removed or mitigated in the sole discretion of the Service.

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure 2-1 -- Baca #5 Access Road Reroute



2.5 Alternatives Considered but Eliminated from Further Analysis

No Drilling Alternative

Under the No Drilling Alternative, the Service would continue to manage the surface estate of the Refuge without exploration for oil and gas. Lexam would remain the owner of a mineral interest and have the right to explore for oil and gas on the Refuge and may retain an application for permitting exploratory wells (Baca #5 and Baca #7) by the COGCC. However, the mineral owner would not submit an application to permit Baca #5 and Baca #7 by the COGCC or implement their Plan of Operations to explore for oil and gas, including any survey or construction activities. As a result, there would be no new disturbance to the surface estate of the Refuge and associated resources (e.g., soil, air, surface and groundwater, vegetation, habitat, wildlife, fisheries, cultural resources, socioeconomic resources, and aesthetic resources) because drilling would not occur.

This alternative was deemed not to be feasible by the Service and eliminated from further analyses because of Lexam's investment to date since 1992. The Service determined that it was unlikely that Lexam would not pursue permitting Baca #5 and Baca #7 wells with the COGCC and explore for oil and gas beneath the Refuge, given their interest and activity to date including collecting 3D seismic data in 2007 and other data collected during the drilling of two test wells (Baca #1, Baca #2) in 1995 which provided useful information for exploration of the proposed oil and gas wells.

Deny Access Alternative

The Service does not have the right to deny a mineral owner of their mineral rights and party to a binding surface use agreement, and access to the Refuge to pursue recovery of minerals. This alternative was eliminated from additional detailed analyses because Colorado property law allows the subsurface mineral owner to make reasonable and necessary use of the surface to explore for, develop, and produce its mineral interest. Any action by the Service to deny Lexam the reasonable opportunity to explore for minerals would likely be considered by Lexam an unconstitutional "taking" of private property (oil and gas mineral interest) without just compensation.

Drilling Two Wells from One Pad Alternative

The Service considered the drilling of two wells (one vertically, one directionally) from a single well pad to limit disturbance during exploration to one site. This required the Service to first better understand the requirement for two exploratory wells and then to understand any limitations associated with directional drilling in providing the exploratory information needed by Lexam.

Lexam's plans for testing the oil and gas potential of the Refuge by drilling the proposed wells is driven primarily by the interpretation of the available 2D and 3D seismic data. Seismic exploration of what is now the Refuge began in 1984 by Chevron and has continued periodically until the most recent 25 square mile 3D seismic survey completed by Lexam in 2007. Seismic technology is used to interpret data and to map the structural configuration of traps that could potentially contain oil and gas. Seismic information is then refined and validated through the drilling and analysis of information obtained from exploratory wells.

Seismic data is recorded in the time domain. Reflections from geological strata are recorded and imaged by the amount of time it takes for waves to return to the surface after the seismic energy source has initiated a sound wave. The depth of any particular horizon is dependent upon the velocity at which the sound waves travel down through various rock types and back to the surface. Lacking data from previous drilling, significant uncertainty exists in estimating seismic velocities. As a result, the interpreted depth and geometry of targeted geologic formations are only approximate. The interpretation of 3D seismic data is also subject to significant uncertainties due to lateral and vertical changes in rock characteristics that affect seismic velocities. The interpretation of 3D seismic data is often an iterative process that includes initial interpretation, drilling and subsequent re-interpretation using velocity measurements obtained from geophysical logs of the well or wells that have been drilled.

Seismic exploration also cannot identify the age and types of geologic formations. It can provide useful information for exploration by identifying potential prospect areas based on the known geologic history and substrates that are likely to contain commercially recoverable hydrocarbons. The Dakota sandstone (an early Cretaceous formation of the Rocky Mountains) is interpreted to be one of the primary targets of exploration by Lexam **(see Appendix E – Lexam Explorations (U.S.A.) Inc. Letter from Consulting Geologist)**.

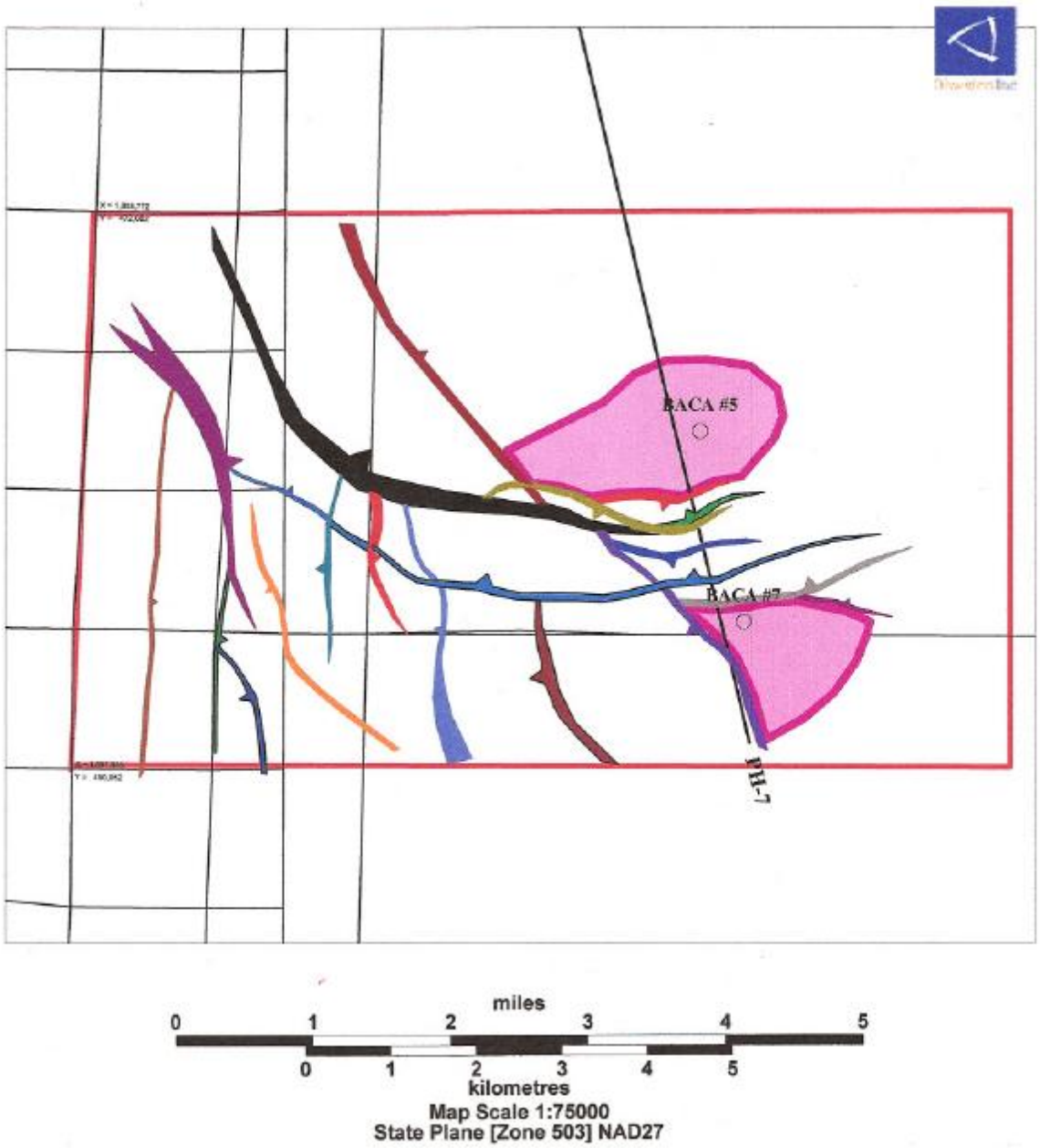
Current analysis of 2D and 3D seismic data reveals there are two distinct structural components beneath the project area. This data is the basis used by Lexam to describe the need to obtain additional well data from two distinct targets within the so-called Crestone East prospect. The targets fall directly beneath the Baca #5 and Baca #7 wells. These targets are on opposite sides of a significant and heavily faulted east-west geologic intrusion (**Figure 2-2**). Lexam's primary target, Baca #5, was selected for exploration because it had the highest image data quality and lies within a less complex series of fault lines compared to Baca #7. **Figure 2-2** also displays the two independent structural prospect traps located on opposite sides of the intersected fault lines that Lexam has identified as potential areas for oil and gas discovery. This target was first identified as having the appropriate qualities and structure by 2D seismic (Sonat in 1998 and Petro-Hunt between 2002-2004) and later validated by the 3D seismic analysis. The target beneath Baca #7 has not been as successfully imaged, but still shows similar characteristics. For these reasons, Lexam will begin drilling with the Baca #5 exploratory well and using acquired data will then move equipment to drill the Baca #7 exploratory well.

The need for two wells has been further described by Lexam due to the very limited oil and gas exploration in the San Luis Valley. Oil and gas companies rely on whatever information is available to inform exploration activities. Comparing previous seismic data to actual well data create analytical controls to further refine future prospects. Within the entire area of the Refuge and adjacent GSDNPP, well control is only available from Lexam's Baca #1 and #2 wells. As defined by the results of oil and gas exploration conducted from 1995 to the present, no wells have been drilled in areas currently judged to be prospective for oil and gas. Because of lateral variations in geologic formations within the area, the Baca #1 and #2 wells do not provide suitable well control for interpreting seismic data in the area of the proposed wells.

The requirements for two sequentially drilled exploratory wells appear to be well substantiated and necessary to limit surface disturbance while exploring for oil and gas. The Service reviewed the possibility of using directional drilling from one well pad to reach the two targets beneath Baca #5 and Baca #7. Directional drilling is generally defined as "drilling a non-vertical hole." There are a number of different designs of directional drilling including a simple slant hole, single bend, double bend, and extended reach (**Figure 2-3**). Directional drilling is conducted for a variety of reasons and includes multiple wells from one location, inaccessible surface locations, access to different productive zones from existing vertical bores and to enhance productivity. Generally, exploratory wells are vertically drilled because subsurface conditions cannot be predicted with certainty in unexplored areas, especially at greater depths and with a potential for over-pressurized zones. In addition, deviated wells have been rarely used during exploration in areas with extreme geologic formations like the Rocky Mountains.

Vertical wells minimize exploration risks associated with the uncertainty in estimating depth in an area with little or no well control and to minimize the number of wells needed to definitively test the target during the early stages of exploration. Generally, exploratory wells are vertically drilled because subsurface conditions cannot be predicted with certainty in unexplored areas, especially at greater depths and with a potential for over-pressurized zones. A vertical well bore will intersect the target geologic formation at its true depth below the surface, even though that may be significantly different than the original interpreted depth. Wells directionally drilled at a deviated angle (**Figure 2-3**) add the risk of not encountering the target at the preferred location, potentially increasing the exploration time because of the need to drill additional wells. More importantly, the velocity control gained from vertical wells is superior to data gained from drilling deviated wells in that a vertical well will provide a discrete velocity function from the surface directly through the total depth of the well. Drilling vertical wells at both of the proposed locations will provide unique velocity functions at two points which can be used to define lateral variations in seismic velocities directly over the target.

Figure 2-2. Lexam's Prospective Targets for Oil and Gas Exploration[2]



Observed lateral variations in seismic velocities can then be projected beyond the area of the two initial wells for the purpose of re-interpreting seismic data and generating new well plans. Inferior velocity control obtained during the early stages of exploration will continue to add uncertainty to subsequent drilling prognoses and well plans. Other concerns regarding directional drilling involve the simple fact that a deviated well will have a longer measured depth (MD) than the true vertical depth (TVD) of the target zone. Assuming the case of simple slant hole configuration, an additional 4000 feet would have to be drilled. The actual borehole configuration would be more complex and result in additional drilling distances of more than 4,000 feet and MDs in excess of 18,000 feet. The consequences of the increased distance include, but would not be limited to, a larger rig, a larger drill pad

[2] Source: John S. Belcher, 20/20 Exploration, LLC, Denver, Colorado 80202.

(greater disturbance), more time needed to drill the well, more drill cuttings, and higher potential for hole problems (sticking drill pipe and drilling tools, inadequate ability to test potential zones, losing the hole).

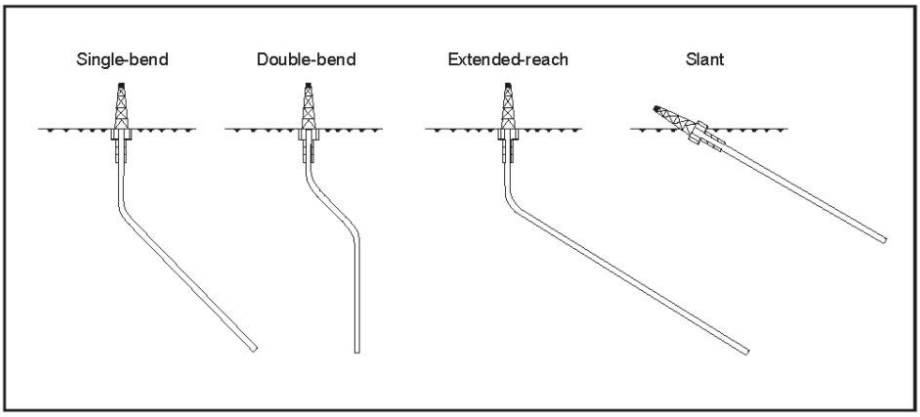
All of the preceding information provided by Lexam has provided sufficient evidence to the Service indicating that Lexam will not be able to acquire adequate information to definitively characterize and quantify the target resource potential without the need for further exploration, if vertical drilling is not allowed. Any further exploration will result in greater potential for environmental damage. Therefore, the Service has determined that requiring directional drilling is not a feasible alternative that would offer greater protection for the resources of the Refuge.

Suspend Drilling Until Completion of a Comprehensive Conservation Plan Alternative

Suspension of the proposed drilling until completion of a Comprehensive Conservation Plan (CCP) was eliminated from consideration because it is considered an unreasonable constraint on a mineral owner's rights to develop its oil and gas interests. The purpose of this EA is to analyze the Service's establishment of protective measures and standards to ensure protection of the surface estate on the Refuge from unreasonable damage from the proposed oil and gas exploration. Second, as noted above, the roads and drill pads affect approximately 11.7 acres of land on the Refuge. The CCP will apply to the entire Refuge, which is approximately 92,500 acres. The Service has determined that impact of this proposed drilling program on the resources of the Refuge can and should be thoroughly assessed and evaluated prior to the completion of the CCP. In addition, information obtained through Lexam's proposed exploratory drilling will be beneficial to Service's planning efforts by further defining the economic viability of the underlying oil and gas mineral estate and predicting potential development scenarios which could affect the remaining acreages of the Refuge. Therefore, any information gained from this effort would be incorporated into the development of the CCP.

Figure: 2-3- Directional Drilling Patterns

Directional Drilling Patterns



Source: Short (1993)

3.0 Affected Environment

3.1 Introduction

This Draft EA analyzes the Service's stipulations requiring protective measures and standards to be implemented by the mineral owner to ensure that their proposed exploration of the mineral estate underlying the Refuge does not unreasonably degrade or significantly impact the Refuge's surface estate and associated resources. As such, the sites of the exploration wells and existing and proposed access roads constitute the project area. The larger 16,246-acre area of the earlier seismic exploration by Lexam serves to provide the regional context for most of the "on the ground" resources (e.g., vegetation, wildlife, cultural resources, geology, etc.). This seismic survey area is referred to as the project vicinity. Larger regional contexts are used as appropriate for resources such as air, groundwater, and visual resources.

Baca National Wildlife Refuge

The Refuge was established in 2000 and comprises 78,670 acres in Saguache and Alamosa counties in the San Luis Valley of south-central Colorado. The Refuge is situated the San Luis Valley, which is considered a high mountain desert. However, abundant snowfall in the two 14,000 foot mountain ranges (San Juan Mountains to the west and Sangre de Cristo Mountains to the east) and the resulting annual spring snowmelt support the dynamic wetland complex within this intermountain basin. Runoff from snowmelt also supplies numerous streams with surface water that flows across the Refuge providing an abundance of life in an otherwise arid landscape. The Refuge contains numerous habitat types including desert shrublands, grasslands, wet meadows, playa wetlands, and riparian areas and is home to a large number of wildlife and plant species, many of which are endemic to the San Luis Valley.

Congress approved the Refuge boundary and authorized acquisition of lands within it with passage of Public Law 106-530, also known as the "Great Sand Dunes National Park and Preserve Act of 2000," as amended by Section 117 of the 2009 Omnibus Appropriations Bill (Public Law 111-8). This legislation focused not only on protecting the region's hydrology, which the unique sand dunes ecosystem depends upon, but also protecting the ecological, cultural, and wildlife resources of the area.

Project Area

The proposed access roads and two exploration wells would be located in the north east portions of the Refuge which is situated in the north central portion of the larger Luis Maria Baca Grant No. 4. This is generally in the southern portions of T43N, R11E NMPM. Lexam's proposed drilling is at an approximate surface elevation of 7,600 feet and is on a slight west-facing slope covered with shrubs. The Project Area is approximately 5,200 acres in size, compared to the project vicinity of 16,246 acres and the Refuge, which contains 78,670 acres. The Project Area provides a 0.50-mile buffer around key elements of Lexam's proposed drilling program.

3.2 Geology, Minerals, and Soils

Geology

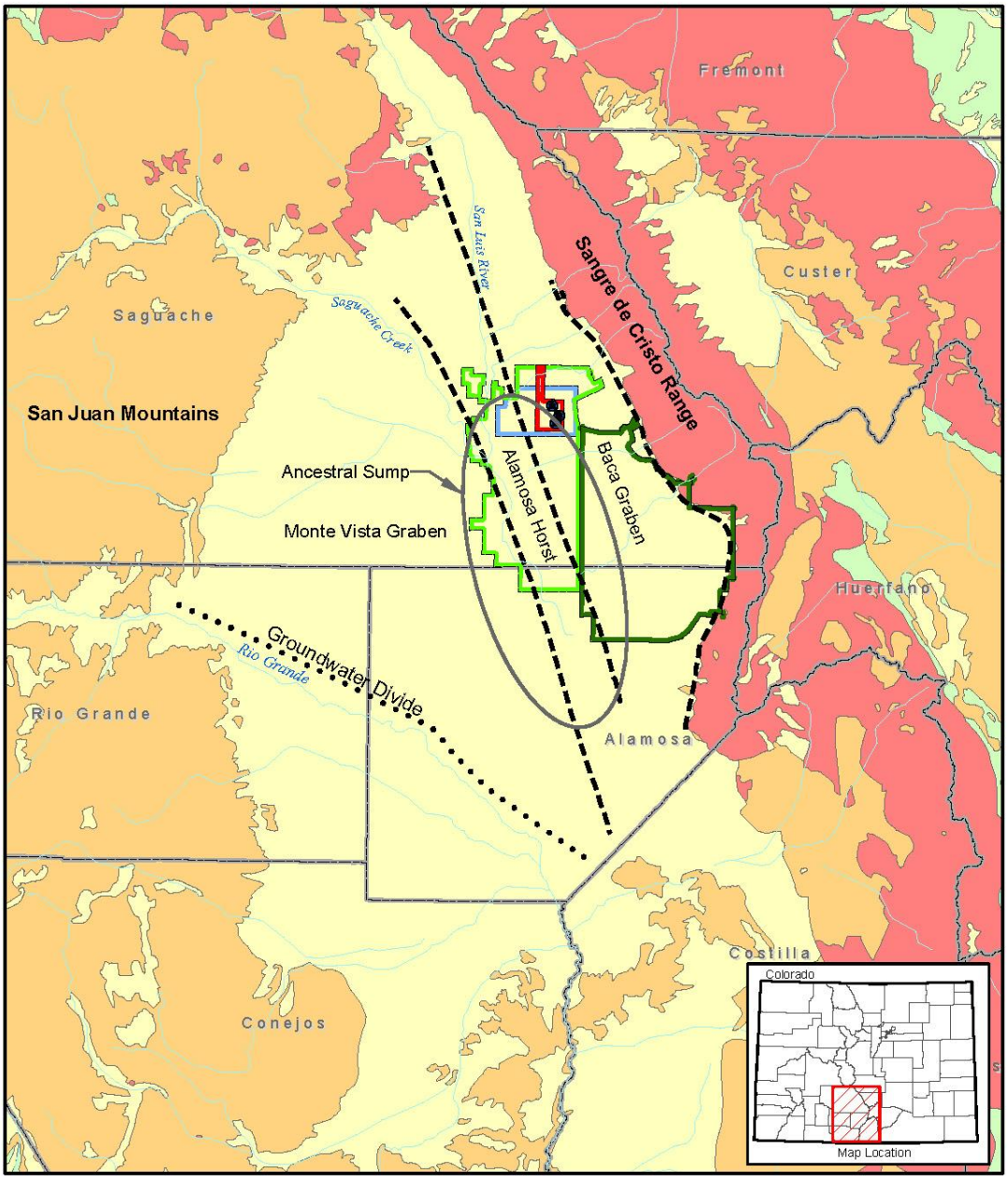
The San Luis Valley is part of the much larger Rio Grande Rift Zone, which extends from southern New Mexico northward through the San Luis and Upper Arkansas Valleys to its northern termination near Leadville, Colorado (McCalpin 1996). The San Luis Valley is bordered on the east by the linear Sangre de Cristo Mountains, which resulted from extensive block faulting during the Laramide Orogeny (**Figure 3-1**). The west side of the valley is flanked by the San Juan Mountains, the result of extensive Tertiary-aged volcanism. In sharp contrast with the steeply faulted eastern side of the valley floor, the Oligocene volcanic rocks of the San Juan Mountains gently dip eastward into the valley floor where they are interbedded with valley-fill deposits. Valley-fill deposits consist of sedimentary rocks that inter-finger with volcanic deposits (McCalpin 1996). Quaternary deposits include pediments along the mountain fronts, alluvium, and sand dunes.

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure: 3-1 -- Project Area General Geology



The Project Area is immediately underlain by Quaternary alluvium (Cappa and Wallace 2007). Below the alluvium are over 10,000 feet of sedimentary deposits of the Alamosa and Santa Fe Formations (Mayo et al. 2006) and generally consist of stream and lake deposits composed of sand, clay, and gravel. The Project Area lies within the Baca Graben adjacent to the Sangre de Cristo Mountains (**Figure 3-2**).

Minerals

The most recent modern-day mining activities to have occurred in the general vicinity of Crestone, Colorado have been operations conducted by Battle Mountain Gold Company at its San Luis Mine, located some 50-plus miles southeast of Crestone in Costilla County, which ceased operations in late 1996; and, the former Summitville Mine which is located some 60-plus miles southwest of Crestone in Rio Grande County. The Summitville Mine was operated by Galactic Resources, Inc. and ceased operations in late 1992. In the immediate vicinity of Crestone, the last recorded mining took place in the late 1800s. Prospecting for gold and silver occurred throughout the immediate area in the Sangre de Cristo's, and Crestone itself was founded at one of the locations where there was a small producing ore body. Production was sufficient to support the construction of a stamp mill at the location; however the mine soon played out.

The major mineral commodities that are mined in the San Luis Valley vicinity are sand and gravel (Guilinger and Keller 2000). The nearest sand and gravel pits are located a couple of miles north of the Refuge in T44N, R11E. Other sand and gravel operations are scattered around the San Luis valley, and concentrated around the towns of Alamosa and Del Norte. Other minerals that are mined in the area include gold, silver, peat, and limestone. In 2006, there were no active mine permits issued or pending mine permits in Saguache County (Cappa et al. 2007). Only 46 mining claims were recorded in the county compared with 5,693 for the entire state. At present, no minerals are produced from the Refuge.

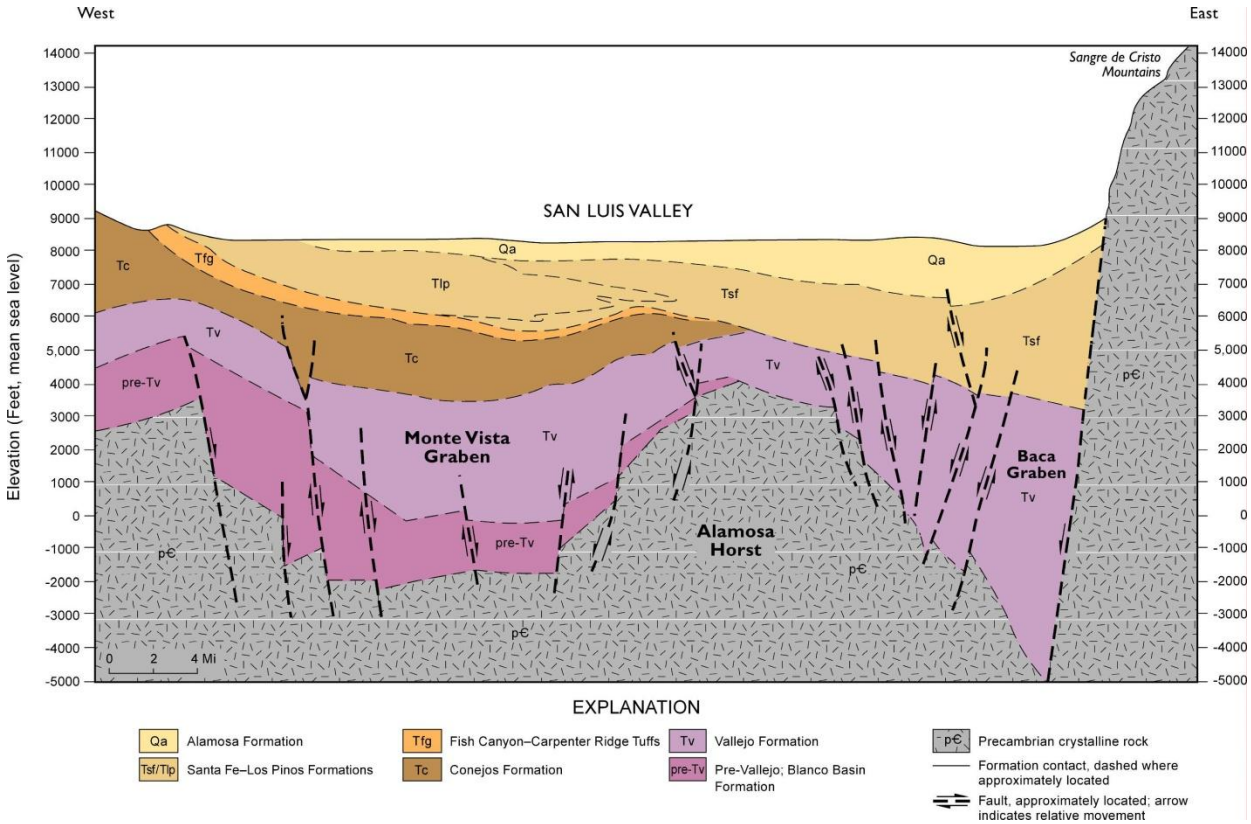


Figure 3-2. Geologic Cross-Section in Center of San Luis Valley (Topper et al. 2003)

Soils

Baca #5 Well Location and Baca #5 Access Road

The Baca #5 well location and access road would be constructed on Laney loam (Soil Map Unit #42) (U.S. Department of Agriculture-Natural Resources Conservation Service [USDA-NRCS] 2007) (**Figure 3-3**). The Laney loam has 0 to 3 percent slopes and consists of very friable A horizons and stratified very strongly alkaline C horizons. Depth of the calcareous material ranges from 9 to 10 inches below ground surface. Laney soils reside on gently sloping flood plains and alluvial fans with slopes of 0 to 3 percent. They are well-drained with slow-to-medium runoff and moderate permeability. The Laney soil is considered erodible by wind (USDA-NRCS 1984).

Baca #7 Well Location and Baca #7 Access Road

The Baca #7 location would be constructed on Mosca loamy sand, (Soil Map Unit #50) (USDA-NRCS 2007). The Mosca series has 0 to 3 percent slopes and consists of very deep, well drained soils that formed in mixed alluvium. They have low runoff and moderate permeability; Mosca loamy sand is highly erodible (USDA-NRCS 1984).

The access road to the Baca #7 well location crosses the Mosca loamy sand from the Lexam Road to approximately 1,000 feet north of the Baca #7 location (USDA-NRCS 2007). From there the road crosses the Laney loam (USDA-NRCS 2007) approximately 1,200 feet north of the Baca #7 location. The road then crosses onto the Laney loam for approximately 1,600 feet before it turns to the northeast and crosses onto Kerber loamy sand for a few hundred feet (Soil Map Unit #41). The Kerber loamy sand is highly erodible.

3.3 Air Resources

Special Air Quality Protection Area

Great Sand Dunes National Park and Preserve (GSDNPP) and the Refuge are areas designated for natural resource management and protection in the San Luis Valley. GSDNPP is located immediately east of the Refuge and includes an air quality protection area that requires specific attention in the analysis of the proposed project (**Figure 3-4**). From its designation as Great Sand Dunes National Monument in 1932 by Herbert Hoover, the protection of GSDNPP has been a priority to local citizens, including protection of its scenic value.

Consistent with the Wilderness Act of 1964, which defined wilderness as "untrammeled by man, where man himself is a visitor who does not remain," the over 33,000 acres of Great Sand Dunes National Monument was designated wilderness, and on November 22, 2000, Congress passed the Great Sand Dunes National Park and Preserve Act of 2000, which authorized the expansion of the national monument into a national park almost four times its original size. The legislation authorized the eventual purchase of privately held property from willing sellers for inclusion in Great Sand Dunes National Park.

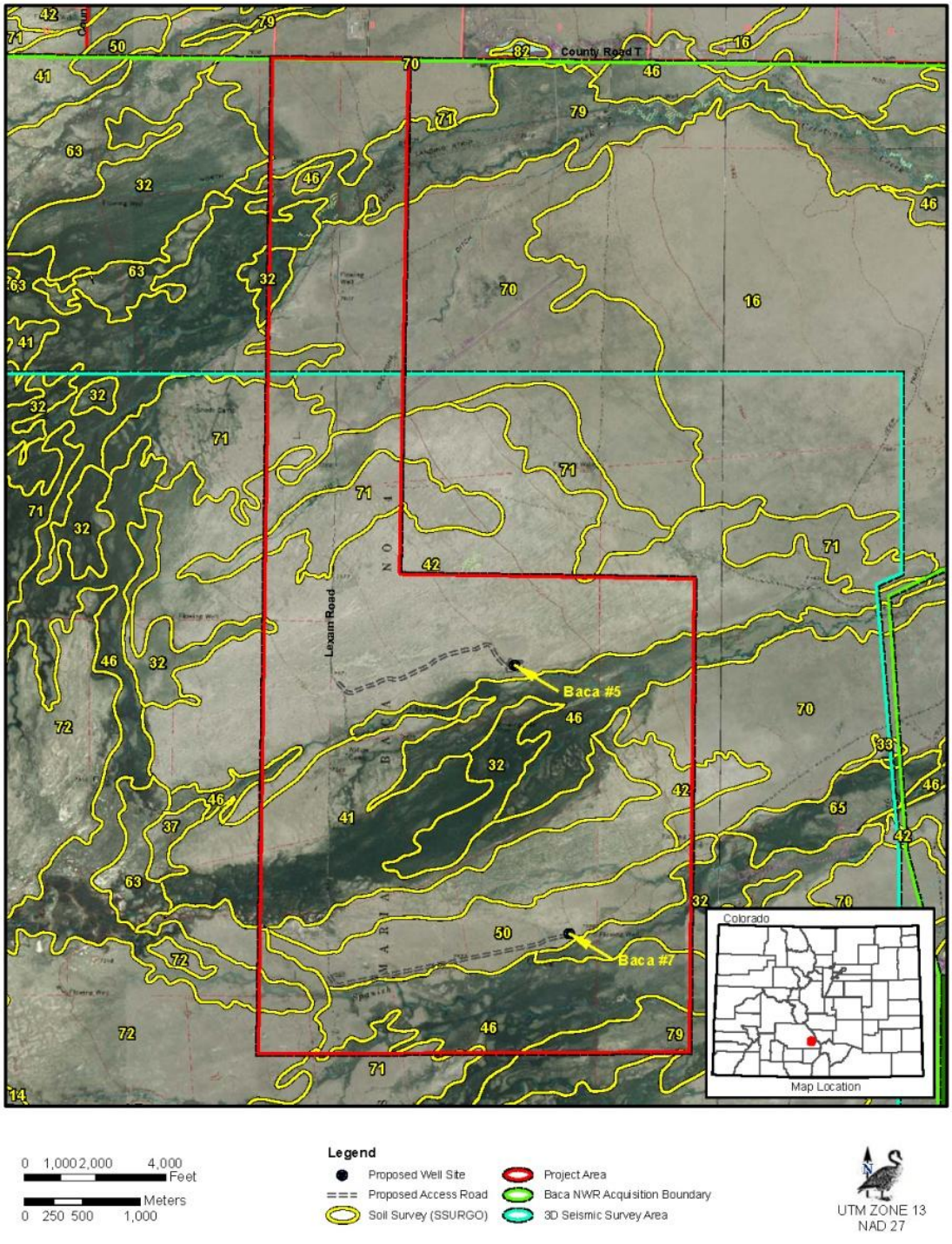
Of specific importance to the air quality analysis of this proposed project is the definition of mandatory Class I Federal areas in the 1977 Clean Air Act. These mandatory Class I lands are identified as national parks (over 6,000 acres), wilderness areas (over 5,000 acres), national memorial parks (over 5,000 acres) and international parks that were in existence as of August 1977. As such, the wilderness portion of the original Great Sand Dunes National Monument was designated Class I. As part of the Act, Federal Land Managers (FLM) were given an “affirmative responsibility” to protect AQRVs inside mandatory Class I lands.

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure 3-3 -- Project Area Soil Map Units



Climate

The climate in the San Luis Valley is typical of high mountains and valleys. As a result of cold air drainage from the surrounding mountains, winters are cold and summers are cool. Summers average about 62°F, compared with 27°F in winters. The proximity of the San Juan Mountains to the west results in decreased orographic precipitation because storms from the west unload moisture before moving over the mountains. This rain shadow effect results in annual precipitation within the Valley of approximately 11 inches.

- Orographic precipitation is rain, snow, or other precipitation produced when moist air is lifted as it moves over a mountain range. As the air rises and cools, orographic clouds form and serve as the source of the precipitation, most of which falls upwind of the mountain ridge. Some also falls a short distance downwind of the ridge and is sometimes called spillover. On the lee side of the mountain range, rainfall is usually low, and the area is said to be in a rain shadow. Very heavy precipitation typically occurs upwind of a prominent mountain range that is oriented across a prevailing wind from a warm ocean (Encyclopædia Britannica 2008).

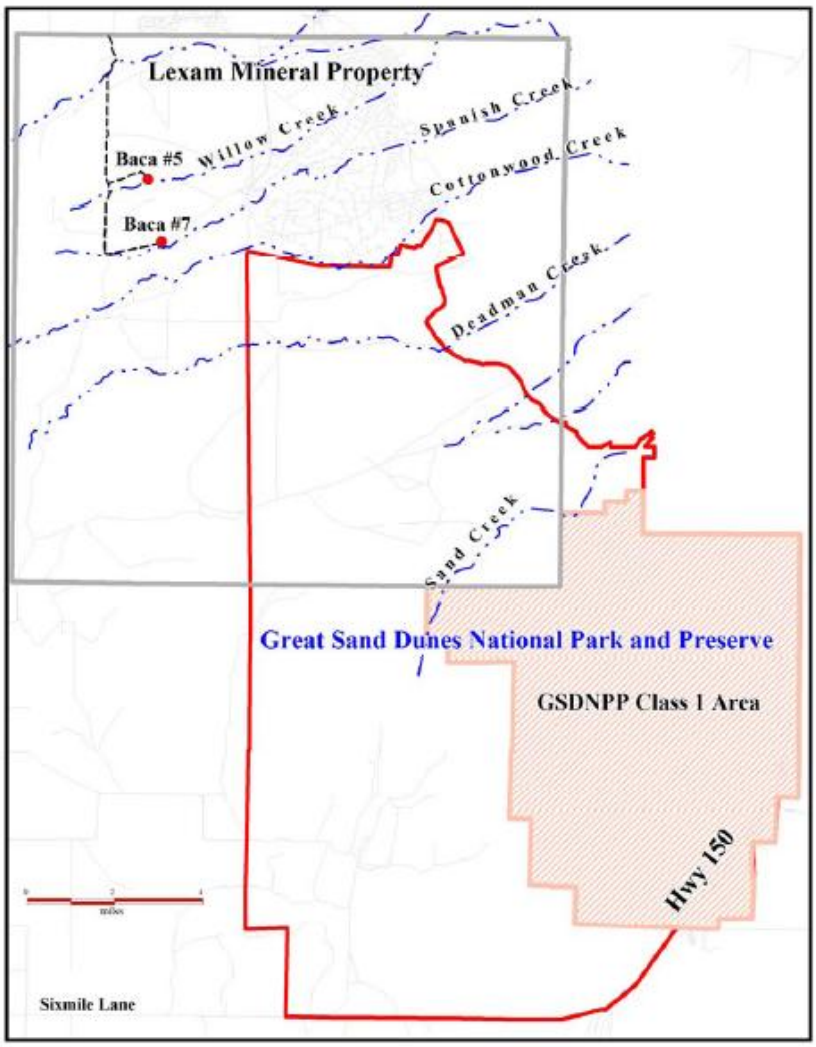


Figure 3-4. Proximity of Proposed Drilling to GSDNPP

A summary of monthly climatic data from GSDNPP, located immediately east of the Refuge, is provided in **Table 3-1** (WRCC 2010).

Table 3-1. Monthly Climate Summary for Great Sand Dunes National Park and Preserve, 1950 to 2010.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual*
Avg. Max. Temp (°F)	34.8	39	46.8	56.2	66.2	76.5	80.7	77.9	71.5	60.3	45.6	36.0	57.6
Avg. Min. Temp (°F)	9.7	14.0	21.1	28.1	37.0	45.3	50.6	48.7	41.8	31.7	20.3	11.2	30.0
Avg. Total Precip. (in.)	0.43	0.36	0.77	0.92	1.10	0.85	1.85	2.01	1.22	0.88	0.47	0.38	11.25
Avg. Total Snowfall (in.)	6.7	5.2	8.2	6.1	1.3	0.0	0.0	0.0	0.1	2.8	4.7	5.8	41.0
Avg. Snow Depth (in.)	3	2	1	0	0	0	0	0	0	0	0	2	1

Representative meteorological data for the San Luis Valley is available from both the GSDNPP and from the airport in Alamosa. Hourly meteorological data was collected at GSDNPP from March 24, 1988 through September 30, 1991 (3.5 years). Six years of data (2001-2006) are available from the National Weather Service (NWS) station at the Alamosa airport. These data are represented on annual, fall-winter, and quarter-of-year wind roses (**Figures 3-5, 3-6,** and **3-7).** Although the fall-winter (October through March) rose is not identical in time with the drilling season proposed for this project (August through April), it is similar and representative of it. Both the annual and fall-winter wind roses show a similar pattern where more frequent, faster winds blow from the southwest and less frequent, lighter winds blow from the northeast. During these seasons, winds are primarily from the southwest, with secondary components from the north and southeast. In the spring, the winds are strongest and blow mostly from the southwest. Winds in the summer blow from all directions but a stronger, easterly flow is evident, a result of down sloping winds from the nearby mountains to the east. On these wind rose diagrams, the length of the vectors shows the percentage of time that the wind blew from each direction. The frequency of occurrence of various wind speeds is represented by colors the length of color band within the vectors for each of the 16 compass directions, as listed in the legend accompanying each graph.

Air Quality

With the exception of ozone, the existing air pollutant concentrations in the local vicinity of the proposed Project Area are relatively low. This is because there are few air pollution emission sources (limited industrial facilities and few residential emissions, primarily from smaller communities and isolated ranches) in the region. There is some local, naturally-generated particulate matter, in part due to the dry climate (windblown dust).

Representative air quality monitoring data have been collected at GSDNPP from 1988 to 1992. Specifically, information is available from 1988-1991 for ozone concentrations and from 1988-1992 for SO_2 measurements. Data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring for visibility (particle sampling at Morris Gulch and camera near the landing strip adjacent to the south boundary of the Class I area) are available from 1988 to the present. The IMPROVE monitoring program was established in 1985 to aid the creation of Federal and State implementation plans for the protection of visibility in Class I areas (156 national parks and wilderness areas) as stipulated in the 1977 amendments to the Clean Air Act. [see also: http://vista.cira.colostate.edu/IMPROVE/]

Atmospheric deposition data from the National Atmospheric Deposition Program (NADP) monitoring in Alamosa, Colorado (approximately 30 km away) are available from 1980 to the present. The NADP is a nationwide network of government and private entities that collect data on the chemistry of precipitation (e.g., hydrogen [acidity as pH], sulfate, nitrate, ammonium, chloride, and base cations [calcium, magnesium, potassium, and sodium] for monitoring geographical and temporal long-term trends. [see also: http://nadp.sws.uiuc.edu]

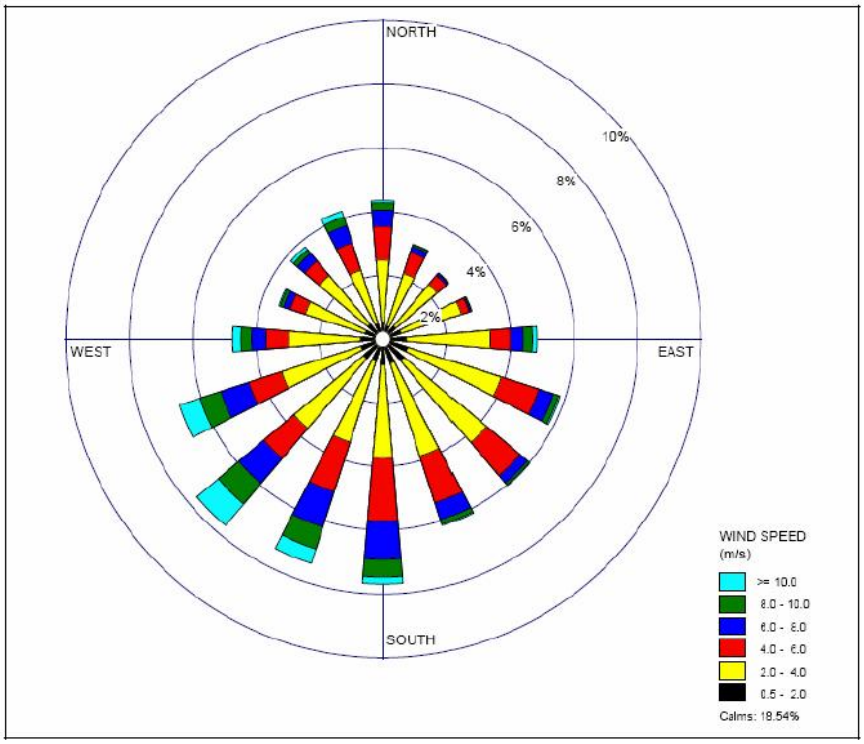


Figure 3-5. Annual Wind Rose for Alamosa, Colorado, Airport: 2001-2006

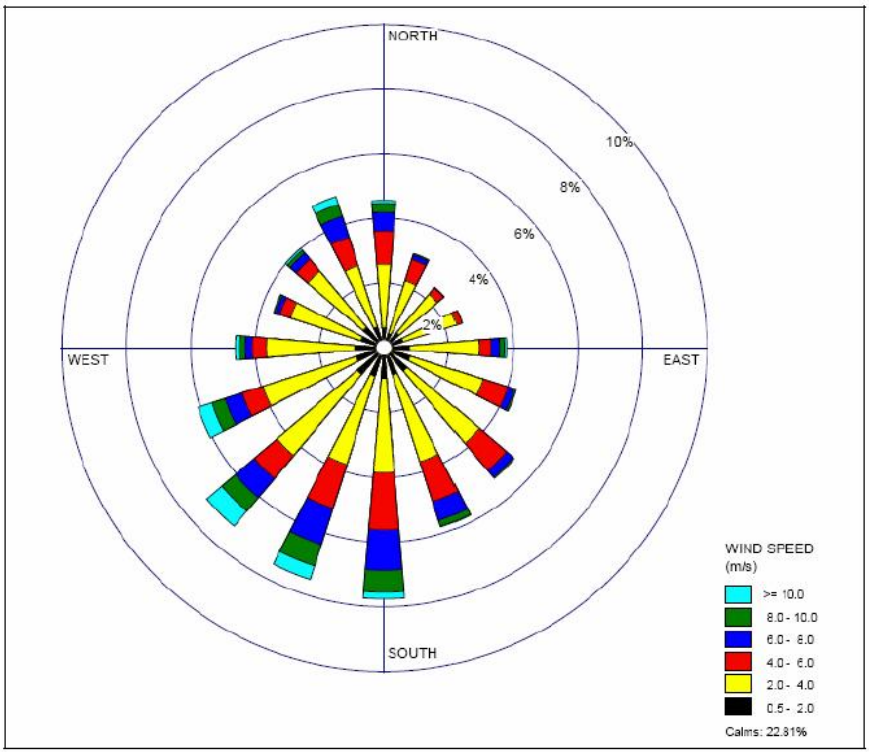


Figure 3-6. Wind Rose for Alamosa, Colorado, Airport: October through March, 2001-2006

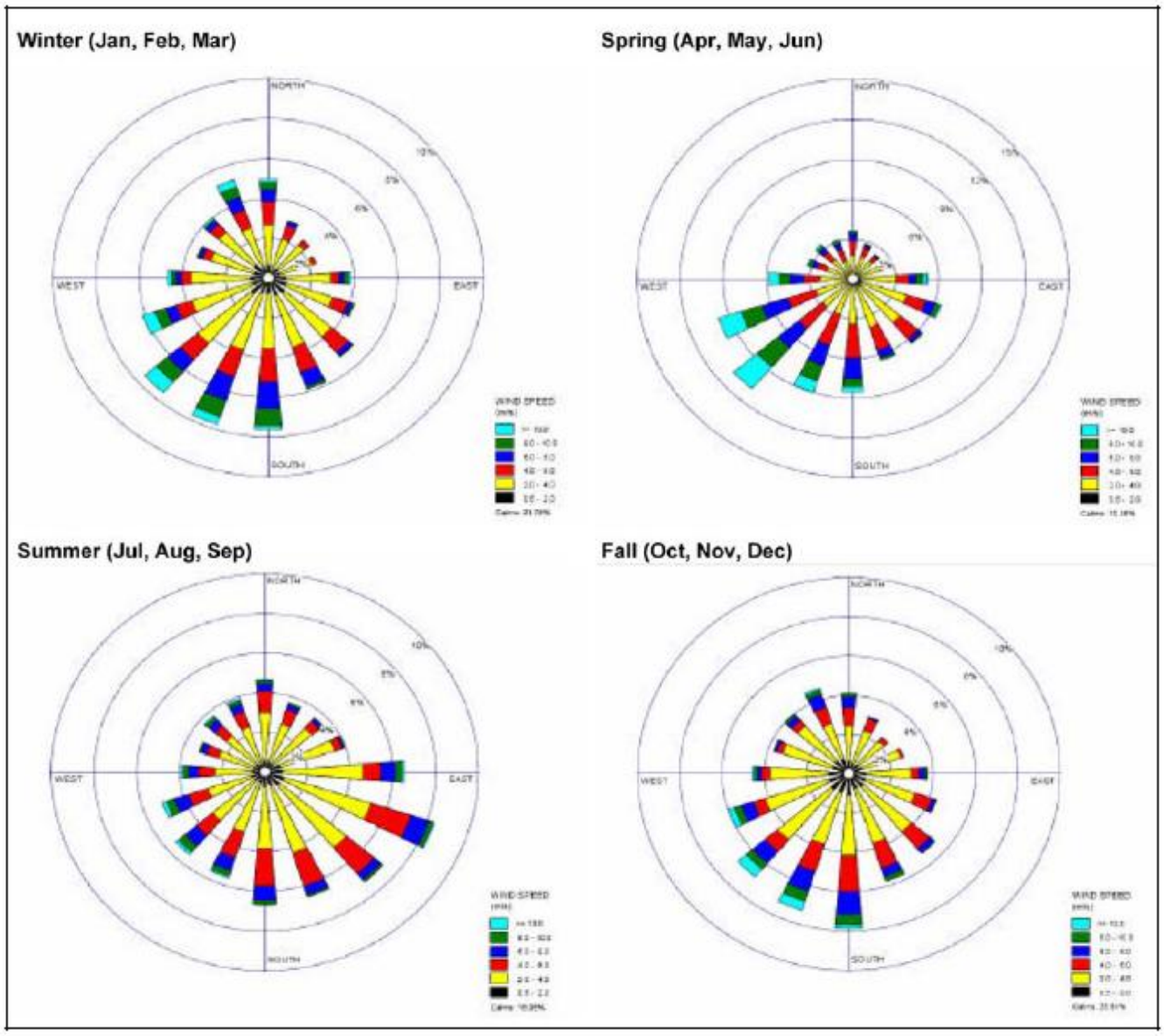


Figure 3-7. Comparison of Seasonal Wind Roses for Alamosa, Colorado, Airport: 2001-2006

The data presented in **Table 3-2** were used to define background air quality conditions in the area of the proposed project and include impacts from existing sources both inside and outside the proposed Project Area. The maximum pollutant concentrations are well below applicable Colorado and National Ambient Air Quality Standards (NAAQS) for most pollutants, although maximum concentrations of ozone (8-hour average) approaching the federal standard have been observed. Given the episodic nature of observed high ozone levels and limitations in photochemical modeling (which is required to simulate the complex mechanisms that govern ozone formation and fate in the lower atmosphere), the exact cause is uncertain, although it appears that regional transport plays a role in the level of ozone in the observed background concentrations (Western Regional Air Partnership 2008).

Table 3-2. Background Concentrations, Ambient Standards, and Significant Impact Levels of Regulated Air Pollutants

Pollutant	Averaging Time	Background Conc. (µg/m^3)	NAAQS[1] (µg/m^3)	CAAQS[2] (µg/m^3)	PSD Class I Increment (µg/m^3)	PSD Class II SILs (µg/m^3)	PSD Class I SILs (µg/m^3)
Carbon Monoxide[3]	1-hour	2,060	40,000	40,000	NA	2,000	500
	8-hour	1,831	10,000	10,000	NA	500	NA
Nitrogen Dioxide[3]	Annual	8	100	100	2.5	1	0.1
Ozone[4]	1-hour	151	235	235	NA	NA	NA
	8-hour	138	157	157	NA	NA	NA
	Annual	78	NA	NA	NA	NA	NA
	Max. Season[5]	80	NA	NA	NA	NA	NA
	Avg. Season[5]	78	NA	NA	NA	NA	NA
$PM_{2.5}$[6,4]	24-hour	21	35	35	NA	NA	NA
	Annual	4	15	15	NA	NA	NA
PM_{10}[6]	24-hour	50	150	150	8	5	0.3
	Annual	11	50	50	4	1	0.2
Sulfur Dioxide[7]	3-hour	---	1,300	700	25	25	1
	24-hour	3	365	365	5	5	0.2
	Annual	0.2	80	80	2	1	0.1

1 National Ambient Air Quality Standards
2.0 Colorado Ambient Air Quality Standards
3.0 Based on the most recent 3 years of data from EPA AIRS database for data collected near Ignacio, CO (rural location), 2005-2007. http://www.epa.gov/aqspub1/
4.0 EPA's current $PM_{2.5}$ implementation policy will be finalized 60 days after publication (Aug. 24, 2010) in the Federal Register.
5.0 From August through April
6.0 Based on the most recent 3-years of data available from the IMPROVE station at Great Sand Dunes NP, 2002-2004. Http://vista.cira.colostate.edu/improve/Data/IMPROVE/AsciiData.aspx
7.0 Based on historical data collected at Great Sand Dunes NP, 1988-1991.
SIL – Significant Impact Level, NA – Not Applicable

3.4 Water Resources

Surface Water

The Refuge lies within a topographic basin referred to as the "Closed Basin" (Mayo et al. 2006). The Closed Basin lies in the northern portion of the Rio Grande Watershed (**Figure 3-8**). The lowest portion of the Closed Basin is known locally as the "Sump," which occurs on part of the Refuge (USFWS 2005), but does not include the Project Area.

Figure 3-8. Rio Grande Watershed and San Luis Closed Basin (modified from Levings et al. 1998)

The Closed Basin or Sump may have occurred in middle Pleistocene when the lake that filled the valley began to dry up, resulting in an environment of swamps and organic-rich sediments. Mayo et al. (2006) refer to the Closed Basin of Pleistocene time as the "ancestral sump." Currently, the Closed Basin covers approximately 2,940 square miles in the northern part of the valley and is separated from the rest of the valley by a low alluvial fan.

The Closed Basin is composed of the San Luis and Saguache drainage basins (USEPA 2007a). Water enters the Closed Basin through precipitation and through snowmelt in the 4,700 square miles of watershed in the surrounding mountains. Water exits primarily through evapotranspiration. Approximately 7,000 miles of stream channels and ditches flow through the valley. The surface water in the basins generally flow into San Luis Creek, which flows generally to the south, and because there is no outlet, water is impounded in San Luis Lake and associated lakes in an area south of the Refuge.

Surface water flow data for several sites in the valley are available from the U.S. Geological Survey (USGS; USGS 2010) at the locations shown on **Figure 3-9**. These data also are summarized in **Table 3-3**. A plot of the monthly mean flows at the gaging stations is shown on **Figure 3-9**. The Saguache Creek site shows the highest flows, with maximum monthly average flows of 151 and 165 cubic feet per second (cfs) occurring in May and June. The two San Luis Creek sites are higher up in the drainage, and San Luis Creek flows further down valley would be comparable to Saguache Creek. All sites show a similar pattern of peak flows in May and June, with minimum flows occurring in the winter. Two of the sites, North Crestone Creek and Cottonwood Creek, lie near the Project Area.

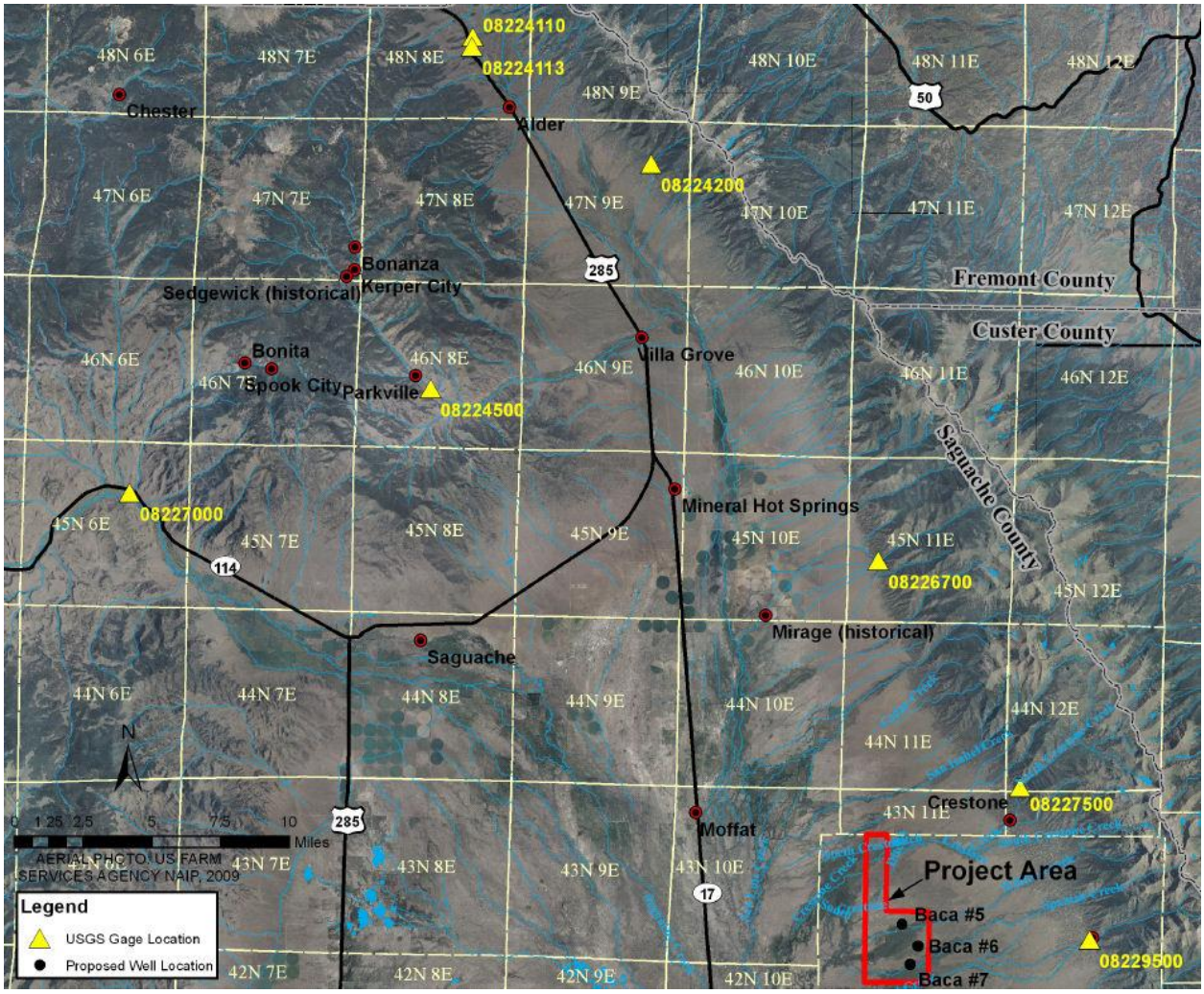


Figure 3-9. USGS Gage Locations[3]

Table 3-3. Summary of USGS Flow Data for San Luis Valley[4]

Station No.	Location	Data Period		Flow (cfs)		
		Begin	End	Max	Min	Avg
North Valley						
08224110	San Luis Creek near Poncha Pass	Jul-79	Sep-85	3.0 (May)	0.56 (Sep)	1.1
08224113	San Luis Creek above Villa Grove	Jul-79	Sep-85	3.1 (May)	0.57 (Sep)	1.2
West Valley						
08224500	Kerber Creek near Villa Grove	Jun-23	Sep-07	45 (May)	2.6 (Jan)	11.9
08227000	Saguache Creek near Saguache	Aug-10	Sep-07	165 (Jun)	23 (Jan)	65.3
East Valley						
08224200	Raspberry Creek near Villa Grove	Jan-67	Sep-70	1.1 (Jun)	0.32 (Jan)	0.6
08226700	Cotton Creek near Mineral Hot Springs	Jan-67	Sep-70	30 (Jun)	5.5 (Jan)	12.7
08227500	North Crestone Creek near Crestone	May-36	Sep-81	45 (Jun)	2.0 (Feb)	11.9
08229500	Cottonwood Creek near Crestone	Jan-67	Sep-70	19 (Jun)	1.2 (Feb)	6.7

[3] Figure 3-9 was created using data from the USGS (2010) by The PBS&J Corporation.
[4] Table 3-3 was created using data from the USGS (2010) by The PBS&J Corporation.

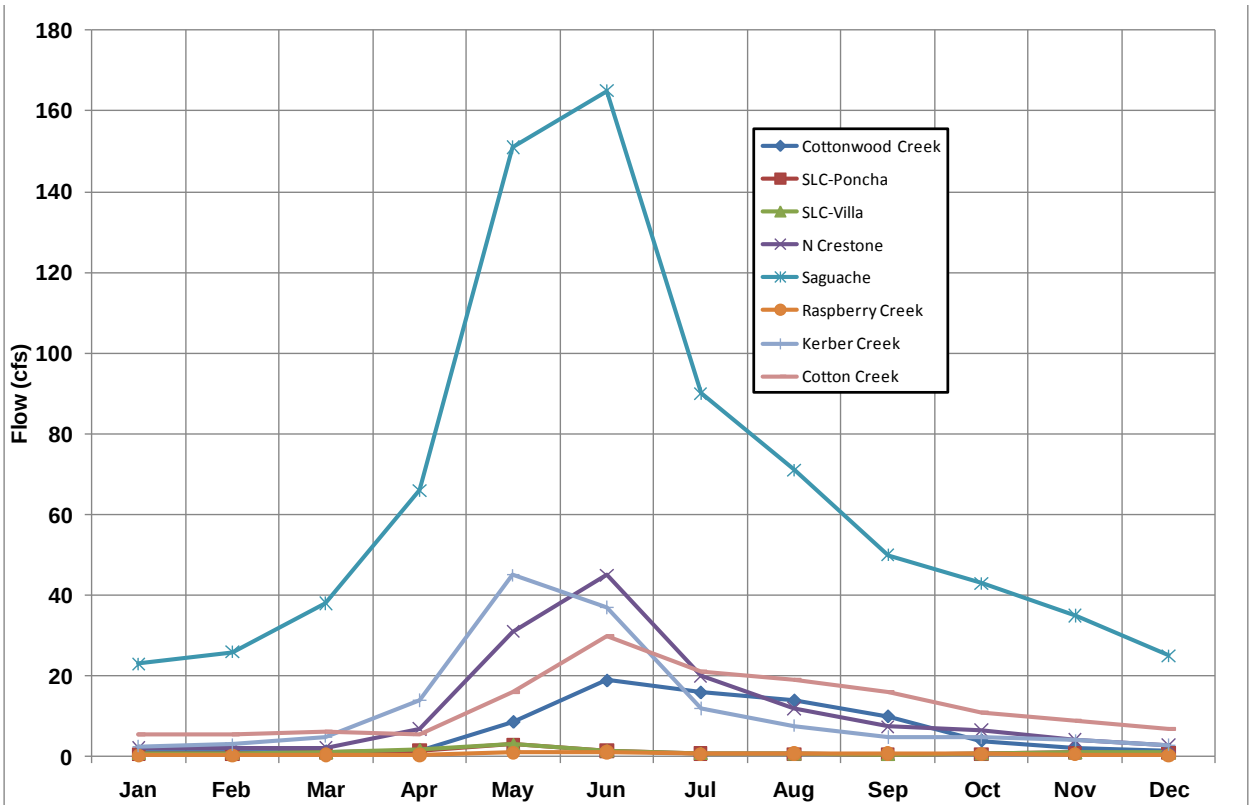


Figure 3-10. Annual Pattern of Surface Water Flow Data[5]

Project Area

San Luis Creek and Saguache Creek are the main surface water bodies in closed basin portion of the valley. San Luis Creek lies to the west of the Project Area. A number of drainages cross the Refuge, flowing generally from northeast to southwest, including Deadman Creek and Cottonwood Creek that lie to the south of the Project Area. GSDNPP lies to the south of Cottonwood Creek.

In the immediate vicinity of the Project Area are a number of named and unnamed drainages that flow from northeast to southwest. The named drainages (from north to south) include Crestone Creek, Willow Creek, and Spanish Creek. In the northern part of the Project Area are the Crestone Creek and Baca Grant Ditch # 9. Although the Project Area is in the San Luis Creek drainage, the surface water flows into ephemeral playa lakes on the western border of the Refuge (Anderson 2007).

Within the project area Crestone Creek and Baca Grant Fitch #9 have year round flow, but Willow Creek and Spanish Creek are intermittent streams that only flow in response to significant runoff and snowmelt events in their respective watersheds (Applegate Group, 2008). Average monthly flows for North Crestone Creek upstream of the Project Area are shown on **Figure 3-10**. A plot of the average annual flow by year for North Crestone Creek for the available data period is shown on Figure **3-11**, suggests that despite brief periods of higher and lower flows, on average flows in the creek did not change between 1948 and 1980. More current data are not available.

Baca Grant Ditch #9 is an irrigation supply canal that conveys water primarily during the irrigation season. In addition, several smaller ditches and additional simple diversion structures divert water from creeks within the Refuge to irrigate wet meadows, with any excess water diverted to the normally dry playa wetlands to the west.

[5] Figure 3-10 was created using data from the USGS (2010) by The PBS&J Corporation.

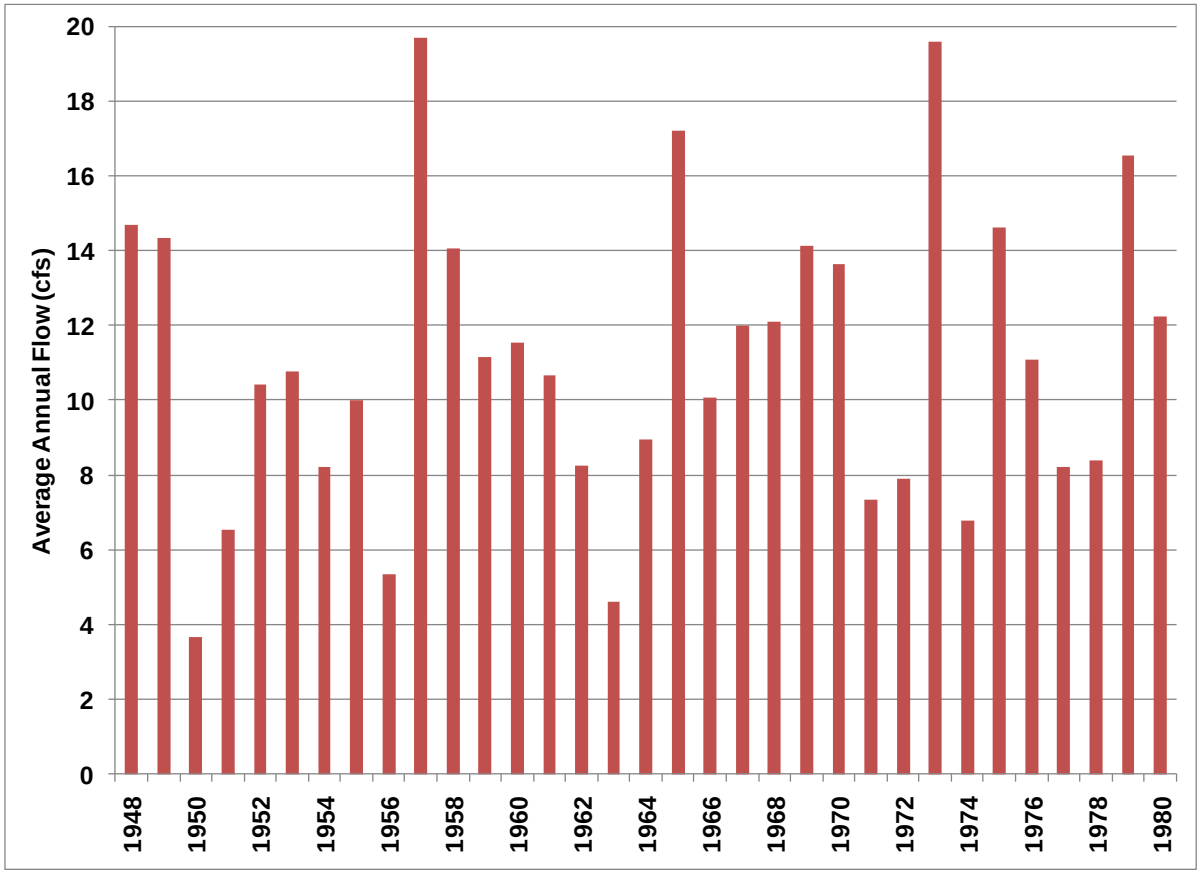


Figure 3-11. Average Annual Flow for North Crestone Creek: 1948–1980[6]

A plot of annual peak flow events (**Figure 3-12**) illustrates maximum flows above the Project Area. For the available period of data, peak flows exceed 100 cfs in 38 percent of the years, and exceeds 200 cfs on four occasions. South Crestone Creek likely behaves in a similar manner, so the combined flows crossing the Project Area would be even higher than shown on **Figure 3-12**.

[6] Figure 3-11 was created using data from the USGS (2010) by The PBS&J Corporation.

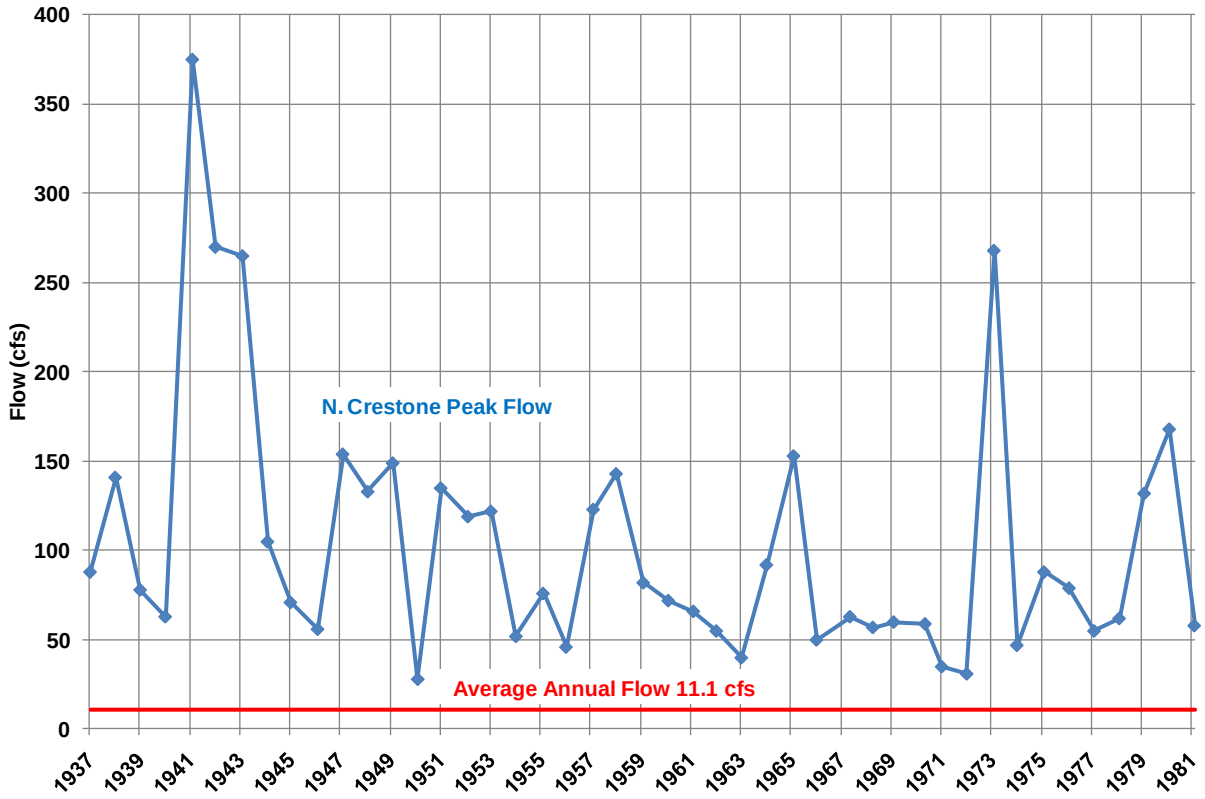


Figure 3-12. Peak Flow for North Crestone Creek: 1937–1981[7]

Surface Water Quality

Previous investigations into surface water quality in the San Luis Valley include both regional studies and work focused specifically on the San Luis Valley. A few of the previous water quality investigations include a study of the Rio Grande Watershed (Levings et al. 1998), an evaluation of surface water-groundwater interaction using stream and wetland water quality data (Kappen et al. 2004), and the use of geochemical and isotopic data to analyze surface water-groundwater interaction (Mayo et al. 2006). EPA water quality assessment data indicate that the surface water quality in the Project Area is fully supportive of the State Designated Use categories (agriculture, aquatic life warm water class 2, and recreation primary contact) (USEPA 2007b).

A search of the USGS database for water quality data found some analytical information available for the two main creeks in the valley (Saguache and San Luis) and also data for two creeks near the Project Area (North Crestone and Cottonwood). The most extensive and relevant data, summarized in **Table 3-4**, are not recent but can be used to illustrate seasonal patterns and to compare changes in conditions as more current data are gathered.

[7] Figure 3-12 was created using data from the USGS (2010) by The PBS&J Corporation.

Table 3-4. Summary of Relevant USGS Surface Water Quality Data[8]

Date	Disch (cfs)	Temp (C)	Spec Cond (µs/cm)	pH	Mg (mg/l)	Ca (mg/l)	Na (mg/l)	K (mg/l)	Cl (mg/l)	CO3 (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	TDS (mg/l)	HDN (mg/l)
Saguache Creek														
04/19/01	176	8.3	113	7.2	1.8	12	5.04	2.6	1.61		56	5.67	100	37.8
06/06/01	175	14	100	7.6	2.1	13	4.04	1.5	0.64		56	2.89	92	41.2
07/03/01	96	17.8	92	7.6	1.9	13	4.13	1.4	0.91		57	2.75	86	39.2
08/01/01	88	17.7	105	7.2	2	13	4.31	1.9	1.25		72	2.68	89	40.5
08/30/01	47	15.4	112	7.4	2.1	14	5.1	1.7	0.97		58	3.29	93	44.3
San Luis Creek														
10/03/72		19.5	275	8.1	8.4	29				0	120			110
12/09/72		0	270	7.5	8.4	32				0	120			110
02/10/73		0.5	280	6.9	8.4	37				0	127			130
06/05/73		9.5	320	7.5	8.6	38				0	74			130
11/01/73		5												
N Crestone Creek														
10/19/67	8.6	5	106	7.4	1	18	1.6		0.9	0	60	5	64	
01/02/68	3.1	0	113	7.4	1.5	20	1.7		0.8	0	66	5.2	64	
04/03/68	6	1	114	7.2	2.4	18	1.9		1	0	65	5.5	68	
06/14/68	36		61	7.1	1.5	10	0.7		1.1	0	36	4.2	42	
07/02/68	20	7	75	7.1	1.5	13	1		0.8	0	46	3.8	43	
09/03/68	14	7	94	7.1	1.5	16	1.2		0.9	0	55	4	55	
Cottonwood Creek														
10/16/67	3.1	2	72	7.4	1	11	1.1		0.4	0	38	5.5	72	
01/26/68	1.5	0	90	7.3	1.2	13	2.3		1.4	0	44	5	58	
04/03/68	1.3	2	85	7.4	1.7	13	2.1		1.5	0	41	5.2	52	
06/14/68	21	4	42	7.2	0.5	7.2	0.7		0.6	0	22	3.8	22	
07/02/68	9.3	6	49	7.2	1.2	7.6	0.8		1.7	0	28	3.2	29	
09/19/68	3.8	5	70	7.4	1.9	9.6	1		1.1	0	36	5	54	

When these data were collected for the two creeks near the Project Area, the data revealed seasonal variations in most of the parameters. Total dissolved solids (TDS) were lower during June and July, as was sulfate, bicarbonate, sodium, calcium, and magnesium. Peak concentrations generally occurred during the January and April sampling events, although some parameters for Cottonwood Creek had peak values during September and October.

More recently, surface water quality data in and around the Project Area have been collected as part of a baseline sampling program. The surface water component of the baseline sampling program includes eight locations (**Figure 3-13**).

Analytical results of the baseline sampling conducted in 2008 are in **Appendix G**. The major ions and metals reported for the Cottonwood Creek sample were part of a December 2006 sampling event. In addition to field parameters and major ions and metals, the samples were also analyzed for oil and gas and volatile organic compounds (VOC).

Neither diesel nor gasoline were detected in any of the samples. Methane was detected in all of the Spanish Creek and Willow Creek samples at ranges of 1 to 35 parts per billion. The highest levels of methane were in the Spanish Creek samples. VOCs were not detected in any of the samples except for bis(2-Ethylhexyl)phthalate, at concentrations of 0.6 and 3.3 parts per billion in the samples from Willow Creek-West and Willow Creek-Baca 5, respectively.

[8] Table 3-4 was created using data from the USGS (2010) by The PBS&J Corporation.

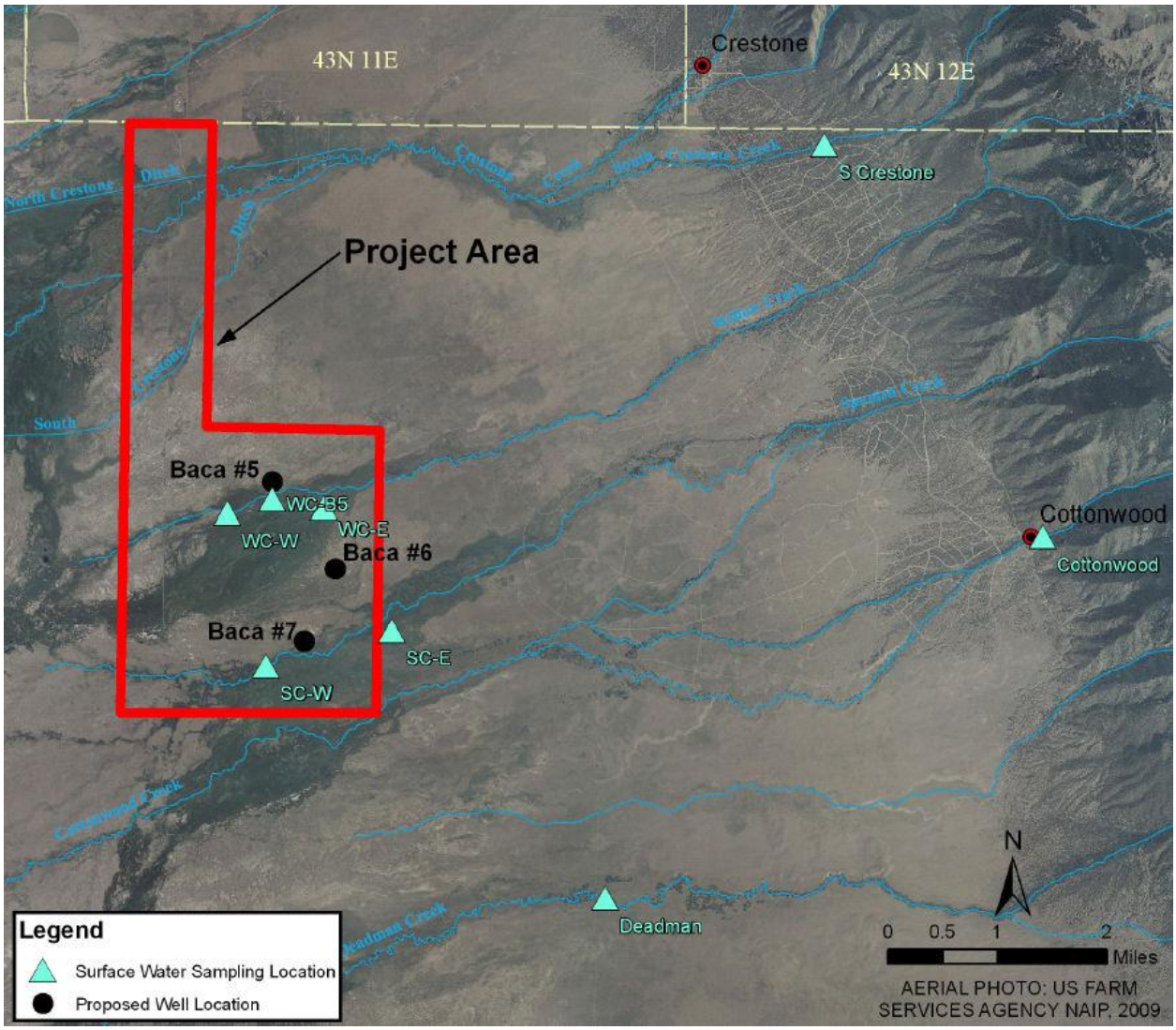


Figure 3-13. Baseline Surface Water Sampling Locations[9]

The eight baseline surface water sampling locations are:

- S. Crestone: South Crestone Creek, northeast (upstream) of Project Area
- Deadman: Deadman Creek, southeast (upstream) of Project Area
- Cottonwood: Cottonwood Creek, east (upstream) of Project Area
- SC-E: Spanish Creek-East, east (upstream) of Project Area
- SC-W: Spanish Creek-West, in Project Area
- WC-E: Willow Creek-East in Project Area
- WC-W: Willow Creek-West in Project Area
- WC-B5: Willow Creek-Baca 5 in Project Area

[9] Figure 3-13 was created by The PBS&J Corporation.

In terms of major ions, a plot of the sample data is shown on a piper diagram (**Figure 3-14**). Piper diagrams are useful to illustrate general water types and to compare samples. The piper diagram indicates that general water quality conditions change moving from the sites upstream of (diamonds) to those within (triangles) the Project Area. The Project Area samples tend to be higher in the major ions as well as TDS, and pH and conductivity are higher as well.

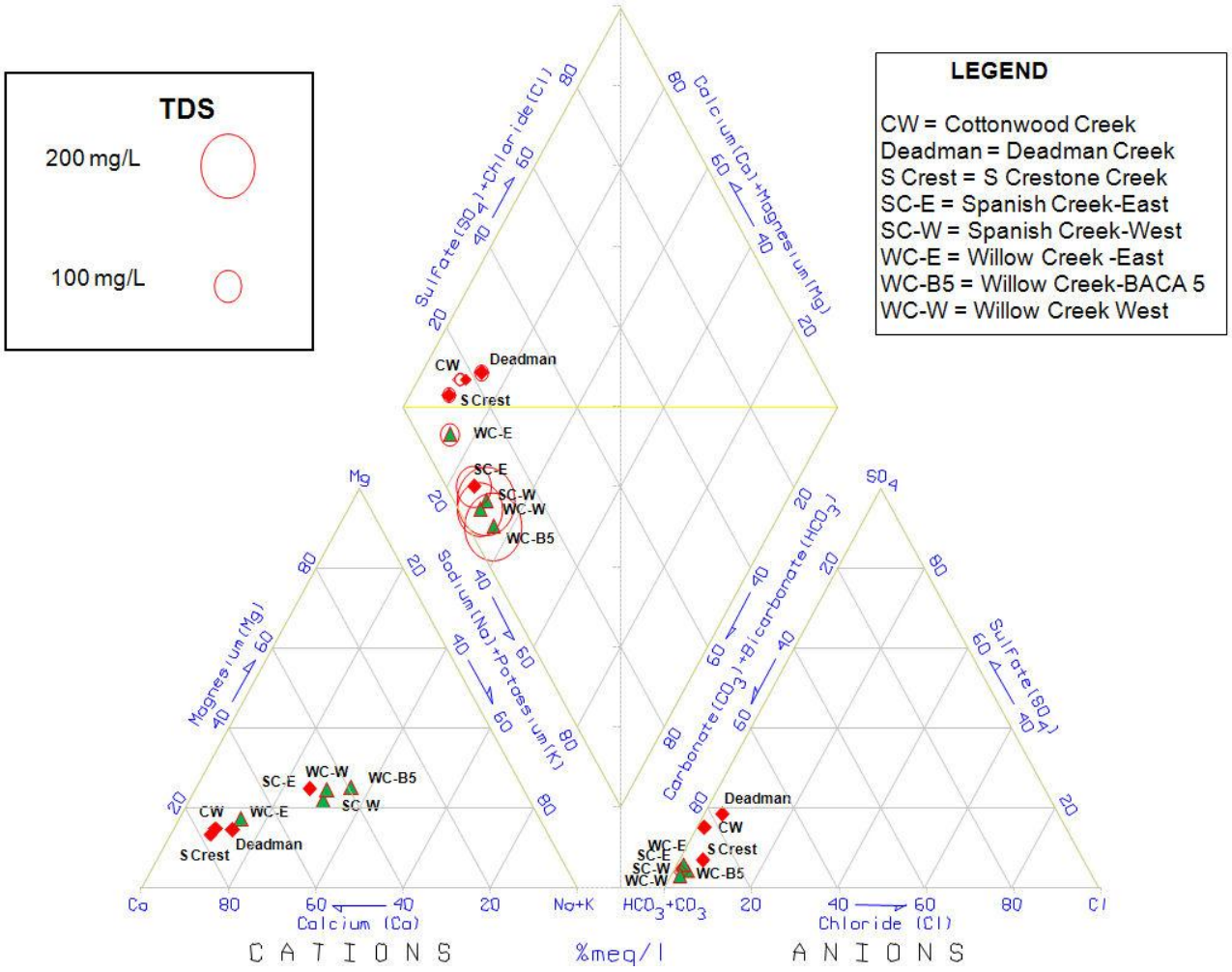


Figure 3-14. Baseline Surface Water Samples[10]

[10] Figure 3-14 was created by The PBS&J Corporation based on data gathered during the 2008 surface water sampling by Lexam.

Table 3-5 compares the older USGS water quality data (1967-1968) with the baseline sampling (2008); the table shows values in grey where baseline sampling differs from previous sampling. Although the Crestone Creek samples are for two different branches, they can be used for comparison. The comparison indicates that conditions generally do not appear to have changed appreciably in the two creeks.

Table 3-5. Comparison of USGS and Baseline Surface Water Quality Data[11]

Location	Date	pH	Mg (mg/l)	Ca (mg/l)	Na (mg/l)	Cl (mg/l)	HCO3 (mg/l)	SO4 (mg/l)	TDS (mg/l)
N Crestone Creek	1967-1968	7.1-7.4	1.0-2.4	10-20	0.7-1.9	0.8-1.1	36-66	3.8-5.5	42-68
S Crestone Creek	2008	7.28	0.84	8.13	0.96	0.95	25.8	1.62	46
Cottonwood Creek	1967-1968	7.2-7.4	1.0-1.9	7.2-13	0.7-2.3	0.4-1.7	22-44	3.2-5.5	22-72
Cottonwood Creek	2008	6.7	1.4	11.8	1.61	0.41	32.3	4.67	39

Groundwater

The Project Area is in the San Luis Valley portion of the Rio Grande Aquifer System (**Figure 3-15**). The San Luis Valley is the northernmost portion of the aquifer system that stretches from Saguache County, Colorado, to West Texas (Robson and Banta 1995). The San Luis Valley is estimated to contain more than 2 billion acre-feet of groundwater in storage, with more than 140 million acre-feet estimated to be recoverable, and the principal use of groundwater is agricultural (Topper et al. 2003).

The Project Area is underlain by two relatively distinct aquifers, the unconfined or shallow aquifer and the confined or deep aquifer. The confined aquifer, which ranges from 60 to more than 4,500 feet below the surface (Mayo et al. 2006) has been further subdivided into separate units.

The Rio Grande Decision Support System (RGDSS) ground water model was developed by the State of Colorado and Principia Mathematica Inc. for the Rio Grande Water Conservation District. This ground water model is considered to be the most rigorous, detailed and peer-reviewed modeling application in Colorado and contains the most accurate information on the hydrogeologic characteristics of the Rio Grande Aquifer System. The model is based on five layers that represent the major geologic formations in the San Luis Valley (**Figure 3-16,** CDWR 2004).

[11] Table 3-5 was created by The PBS&J Corporation based on data from the USGS (2010) and surface water samples collected by Lexam.

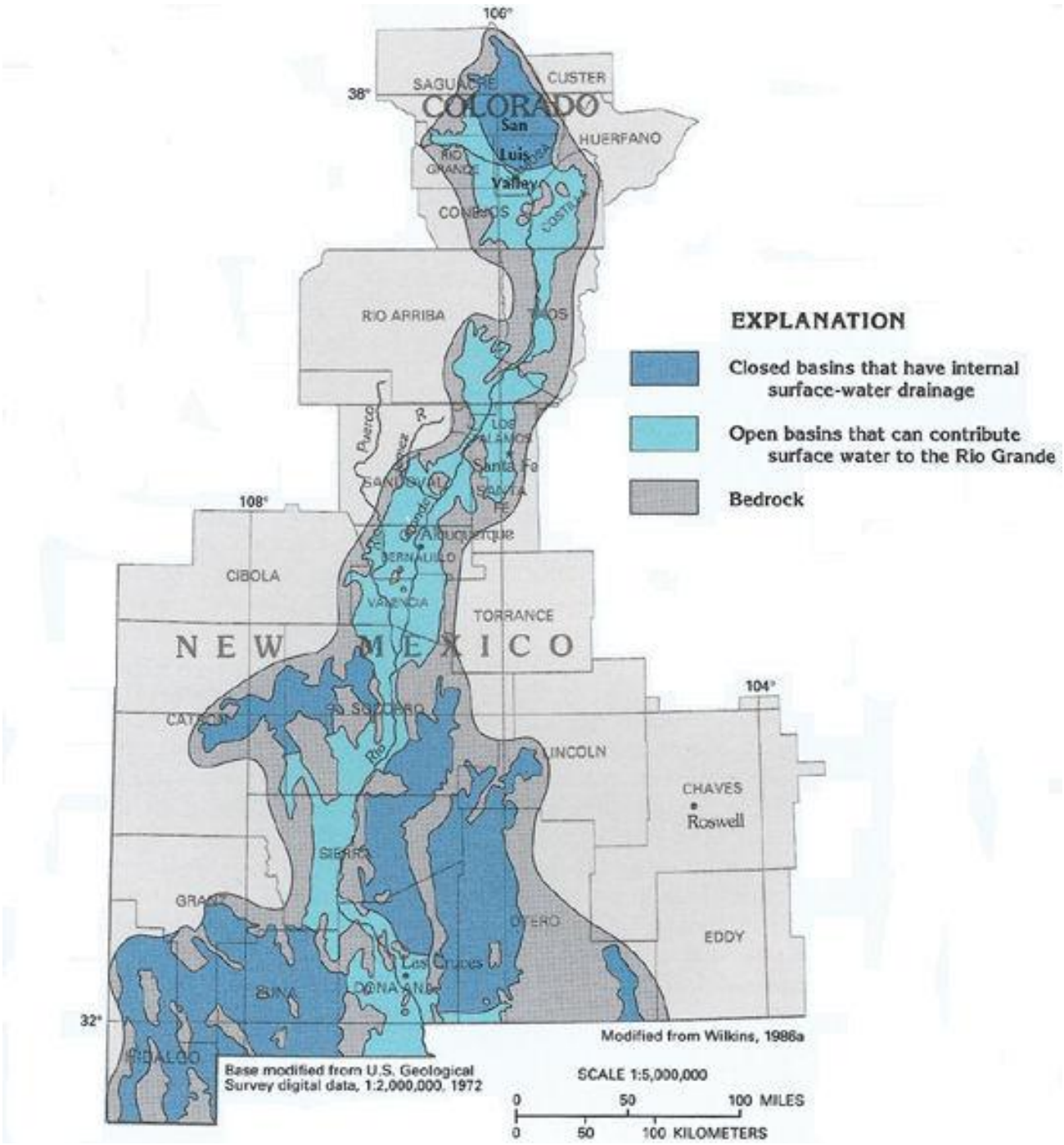


Figure 3-15. Rio Grande Aquifer System (from Robson and Banta 1995)

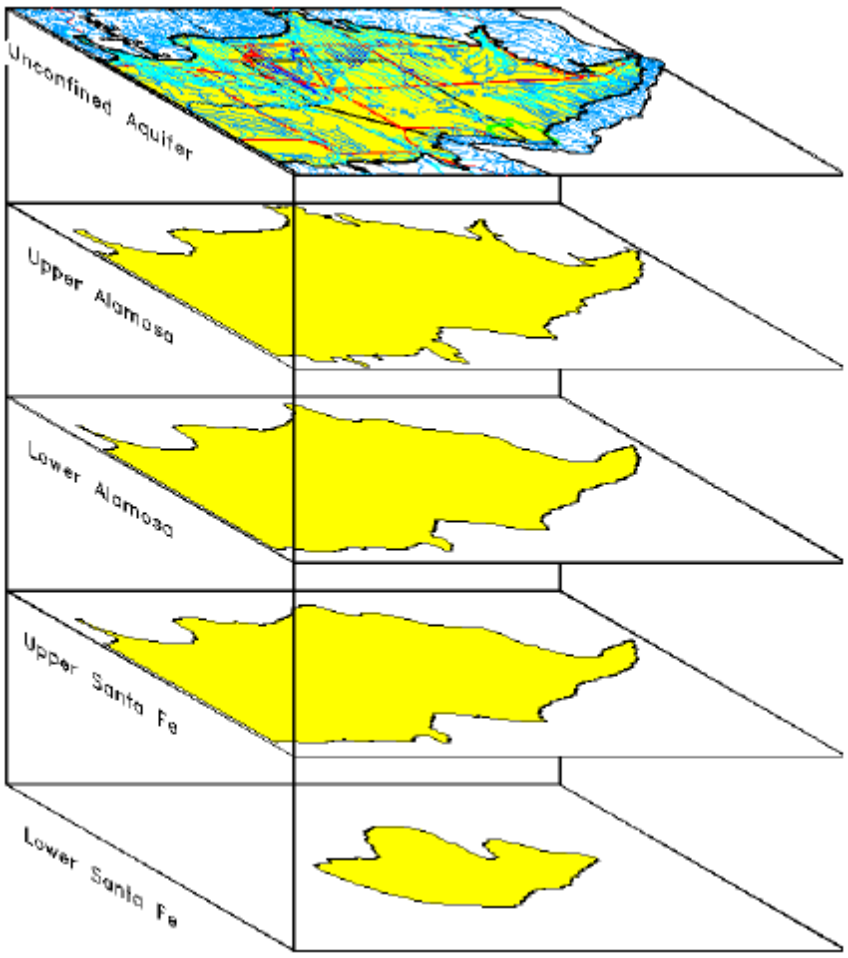


Figure 3-16. Conceptual Representation of the Five Major Hydrogeologic Formations in the San Luis Valley (CDWR 2004)

Because of the complex interlaying of sand, clay, and volcanic rocks in the San Luis Valley, the layers are defined in a broader context based on one or more lithologies containing similar hydrogeologic characteristics within each layer (**Figure 3-17**; CDWR 2004). The Project Area for exploration occurs in the Northern San Luis Valley portion of **Figure 3-17**.

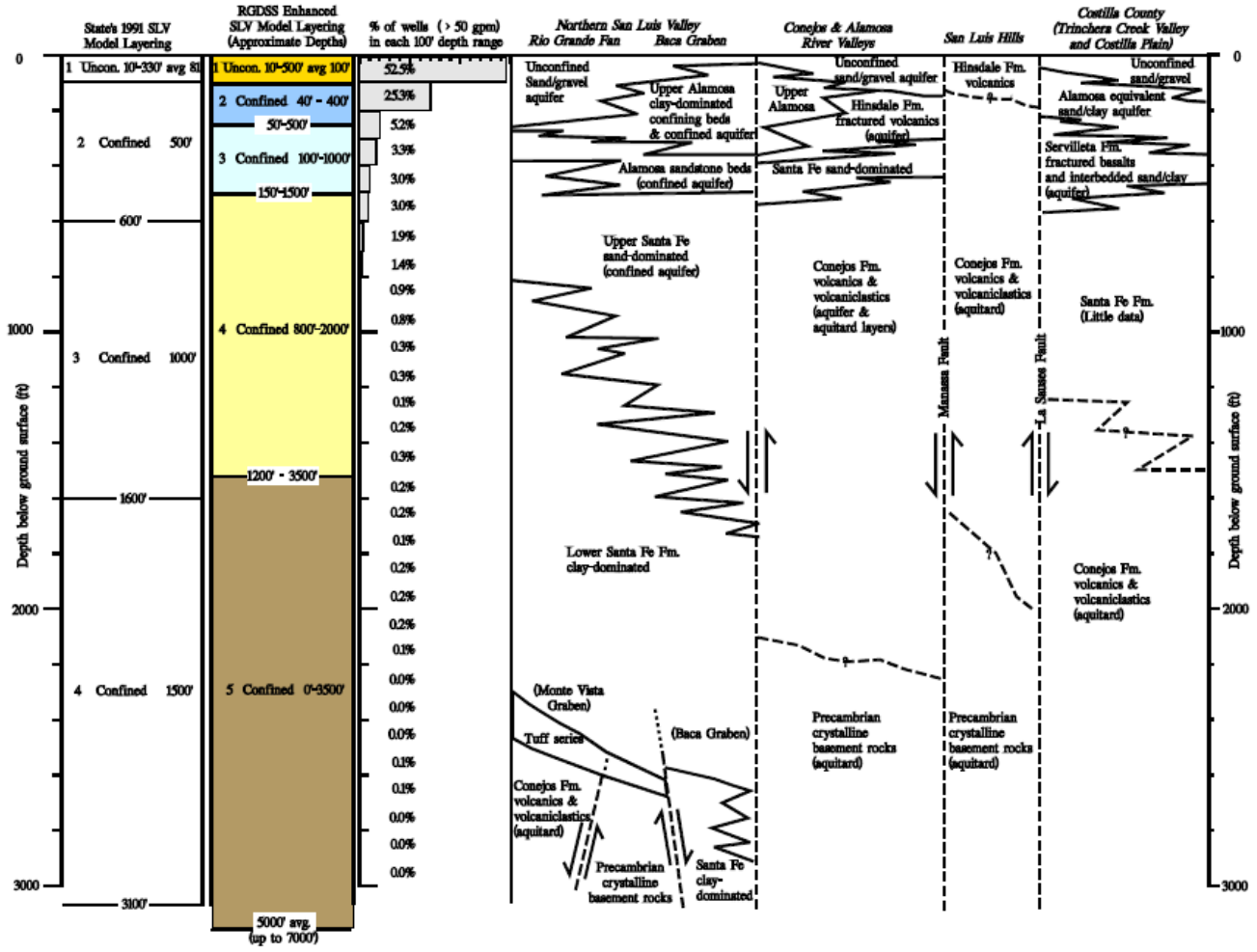


Figure 3-17. Hydrogeological Characteristics of Layers 1 through 5 in the San Luis Valley (CDWR 2004)

The five stratigraphic layers in the San Luis Valley are defined by the RGDSS (CDWR 2004) as follows:

- "Layer 1: Unconfined aquifer - from ground level to the first regionally extensive, greater than 10 ft. thick clay layer. Mainly sand, gravels, and cobbles, with minor thin (10-ft.) clay layers." Approximate depth of Layer 1 is 100 feet on average.

- "Layer 2: Alamosa- Clay dominated – predominantly clay with generally less than 25% sand or gravel content (however, the sand layers within this clay-dominated series do constitute an aquifer in some parts of the SLV. Even though the clay series that forms the upper confining layer (layer 2) does not physically extend to the edge of the modeled area, it does within the model. However these extensions of the upper confining layer have appropriate hydraulic conductivity values assigned to represent the higher conductive sands and gravels that dominate the alluvial fans along the edge of the valley." Approximate depth of Layer 2 is 50-500 feet.

- "Layer 3: (Northern portion of model) Alamosa – Clay and Sand – sandier section of the Alamosa formation. Sand layers make up greater than approximately 25% of the interval. This is generally interpreted to be the most productive portion of the confined aquifer. The Southern portion of model – Volcanics – includes Hinsdale and Servilleta basalts." Approximate depth of Layer 3 is 150-1,500 feet.

- "Layer 4: Sante Fe – predominantly sand and gravel with up to 50% clay layers in most areas of the SLV. Also includes interlayered Conejos Formation volcanics and volcaniclastic units, particularly in the western portion of the modeled area." Approximate depth of Layer 4 is 1,200-3,500 feet.

- "Layer 5: Lower Sante Fe – more clay rich, generally of low hydraulic conductivity. This layer only occurs in the Baca Graben area. Due to its depth and low hydraulic conductivity it is not generally considered a feasible aquifer. However, it was included in the layering sequence to include all Santa Fe formation deposits in the valley, to allow ground water movement to and from Layer 4, and to allow simulation of pumping stresses in this layer, should that simulation be desired in the future." Approximate depth of Layer 5 is 5,000 feet on average.

Groundwater flow and aquifer characteristics are affected by the presence of major structural elements of the valley including the Monte Vista Graben, the Alamosa Horst, and the Baca Graben. These structures represent vertical displacement that results in variable thicknesses of the aquifer units as well as changes in vertical groundwater flow conditions. The Project Area lies in the area of the Baca Graben (**Figure 3-2**).

Unconfined Aquifer

Recharge

The unconfined aquifer is recharged by infiltration of irrigation waters, canal leakage, seepage from mountain streams that flow across permeable alluvial fans, and infiltration from precipitation. Below the unconfined aquifer are a number of clay-based layers that serve to separate, although not disconnect entirely, the unconfined aquifer from the deeper layers of sands and gravels containing water in the confined aquifer. The clay layers reduce upward movement of water from the confined aquifer creating water pressure.

Aquifer Properties and Groundwater Flow

Transmissivity of the unconfined aquifer has been estimated to range from 5,000 to 225,000 gallons per day per foot throughout the entire valley (Alamosa River Watershed rest plan). Ongoing RGDSS modeling (CDWR 2004) has specified hydraulic conductivity (transmissivity divided by thickness) of the aquifer in the Project Area to range between about 300 and 1,000 feet per day, consistent with coarse sand and gravel.

Flow of groundwater in the unconfined aquifer is from northeast to southwest beneath the Project Area (Rupert and Plummer, 2004; Topper et al. 2003). Where the unconfined aquifer comes to the surface, natural seeps, wet meadows, and inter-dune wetlands typically result (USFWS 2005).

Groundwater contours for the unconfined aquifer were previously developed by Topper et al. (2003) for the period 1996–1997 (**Figure 3-18**). Using water level data from the USGS website (USGS 2010), water table contours of more recent data were developed (**Figure 3-19**). The contours were developed by identifying water levels for wells in the area shown that were measured in early 2004 or early 2005. The water levels were separated into those for the unconfined and those for the confined aquifer. Information on the wells used for the contouring is in **Appendix G**.

The unconfined contours for 2004–2005 match favorably with those from 1996–1997. Both maps show groundwater in the unconfined aquifer flowing into the valley center from uplands to the west, north, and east. In the Project Area, groundwater in the unconfined aquifer flows to the southwest at a gradient of roughly 0.0042. Depth to groundwater in the unconfined aquifer is roughly 4 to 9 feet for wells in the Project Area.

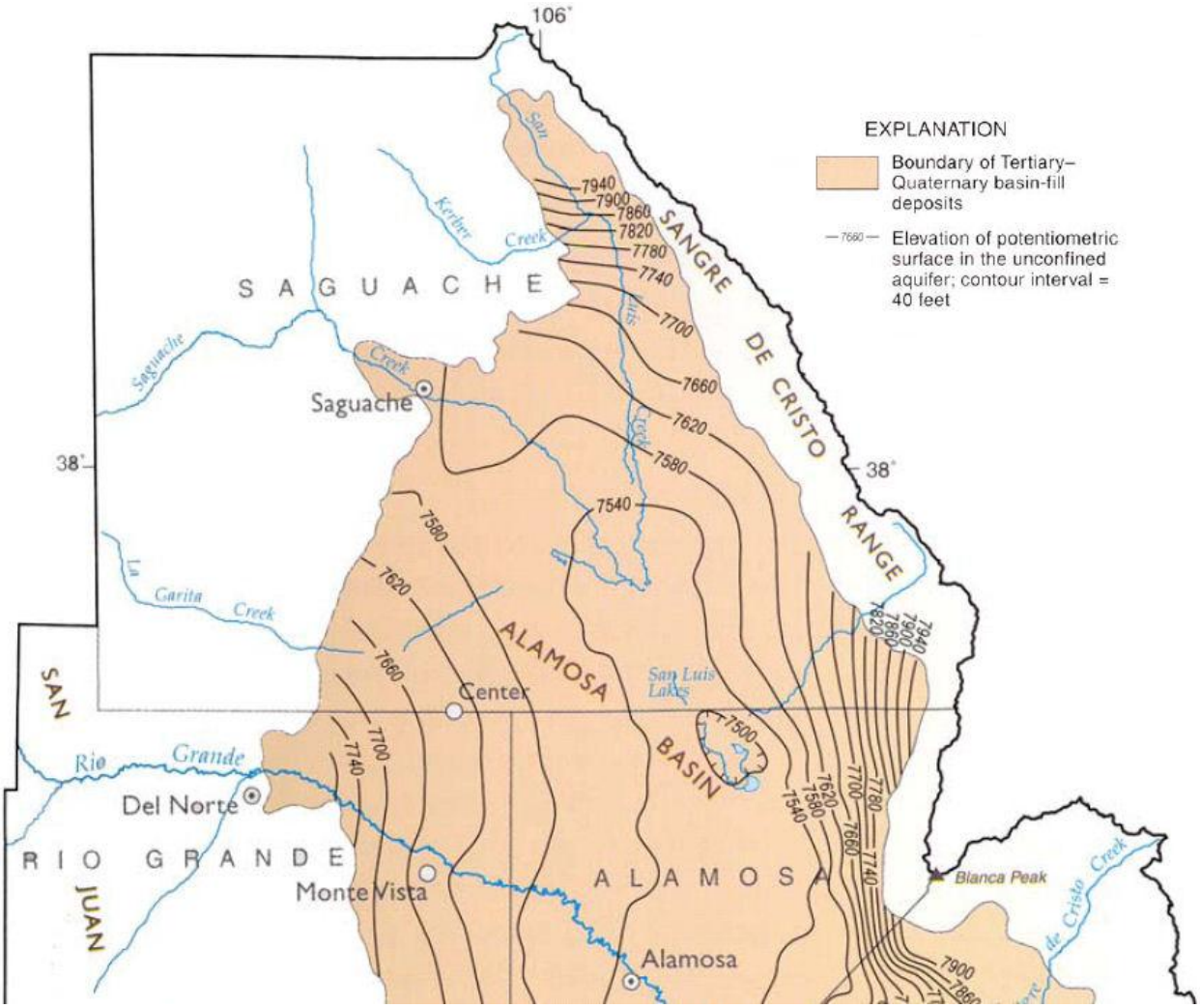


Figure 3-18. San Luis Valley Water Table Contours: 1996-1997 (from Topper et al. 2003)

Confined Aquifer

Recharge

The confined aquifer is recharged from precipitation in the mountains and enters the aquifer at higher elevations in the mountains. Recharge from the Sangre de Cristos to the east of the valley appears to occur within a relatively narrow fault zone. To the west, recharge in the San Juans is greater due to a larger recharge area and occurs more commonly through bedding planes (HRS 1987).

Aquifer Properties and Groundwater Flow

Transmissivity of the shallow confined aquifer was estimated to be 132,000 gallons per day per foot from testing of the Hooper Pool well (HRS 1987). The deep confined aquifer transmissivity was estimated to be roughly 10,000 gallons per day per foot based on comparison of geophysical well logs with logs of similar lithology where testing data were available (HRS 1987). Ongoing groundwater modeling has established a hydraulic conductivity (transmissivity divided by thickness) for the confined aquifer at roughly 10 to 30 feet per day (CDWR 2004).

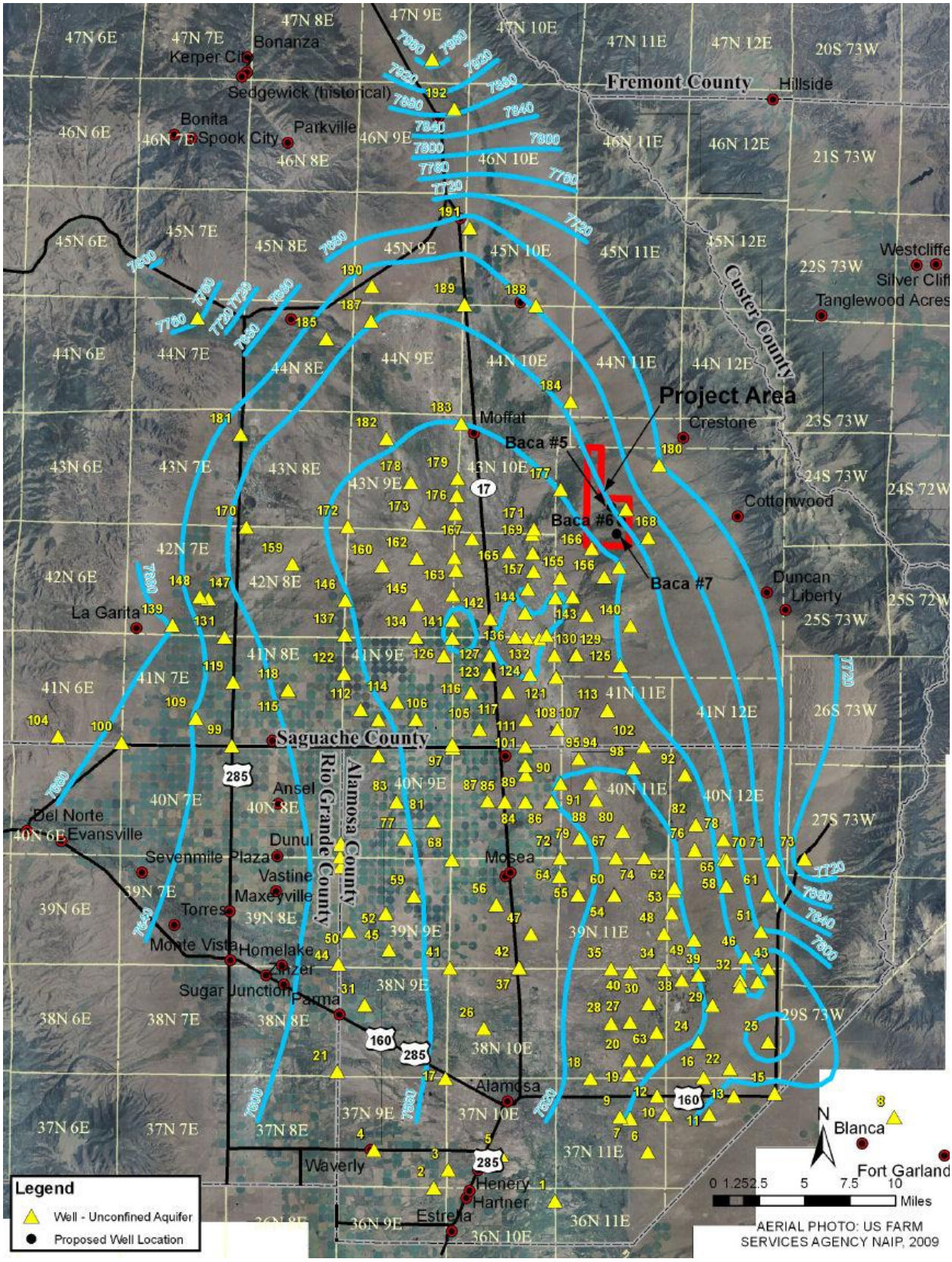


Figure 3-19. San Luis Valley Water Table Contours: 2004–2005

Groundwater flow in the shallow confined aquifer is from the recharge source in the surrounding mountains toward the valley center, with a component of flow to the south in the southern portion of the valley, south of the closed basin. As noted, there is an upward gradient in the confined aquifer forcing some groundwater to flow into the unconfined aquifer. Isotope data indicate the confined aquifers slowly discharge to the surface, but the amount of contribution of the confined aquifer to the unconfined aquifer does not exceed 20 percent based on isotope data analysis (Mayo et al. 2006).

Water level data from the USGS website (USGS 2010) were used to develop a potentiometric surface map for both the shallow and deep confined aquifers. Wells with water levels for the period of early 2004 or early 2005 were separated into the three aquifers present and the data were contoured. The potentiometric surface elevation contours for the shallow confined aquifer are shown on **Figure 3-20**, along with the wells used. Information on the wells used for the contouring is in **Appendix G**. Note that the depth to potentiometric surface does not imply depth to aquifer because the groundwater is under pressure and rises above the aquifer top in wells.

The potentiometric map suggests that flow in the shallow confined aquifer mimics the unconfined aquifer, with flow toward the center of the valley. This is consistent with isotope analyses that suggest groundwater systems in the Closed Basin are not in active communication with groundwater systems in the southern portion of the valley (Mayo et al. 2006). Within the Project Area, flow is to the west-southwest at a gradient of roughly 0.0038. Depth to the potentiometric surface in the vicinity of the Project Area ranges from about 35 feet above ground (flowing well) to 24 feet below ground.

Groundwater flow in the deep confined aquifer consists of downward movement in the upland recharge zones and upward movement in the area near the extensional horst-graben features. The vertical flow is a function of the high elevation of the recharge zones and the lower elevation of the aquifer. In addition, as groundwater in the lower confined aquifer flows basinward, it encounters less permeable material and is forced upward into the shallow confined aquifer. Vertical flow is enhanced along the structural fracture openings and in cooling-related jointing in the lava flows. Enhanced horizontal flow occurs along bedding planes and in thin horizons of the lava-flow and welded ash-flow units (HRS 1987).

South of the closed basin, groundwater flow in the deep confined aquifer is also to the south and out of the valley, as evidenced by a decline in the potentiometric surface to the south (HRS 1987). Estimates of flow out of the valley range from 71,000 afy (HRS 1987) to 89,000 afy (Coons and Kelly 1984). In terms of relative contributions of the outflow, HRS (1987) break it down into 7,000 afy from the deep confined aquifer and 64,000 afy from the unconfined and shallow confined aquifer. HRS (1987) estimated the groundwater flow rate to the south in the shallow confined aquifer is 10 to 12 feet per year, while in the deep confined aquifer it is 1.2 feet per year.

A potentiometric surface elevation contour map developed from USGS data (USGS 2010) for the deep confined aquifer is shown on **Figure 3-21**, along with the wells used. Information on the wells used for the contouring is in **Appendix G**. Note that the depth to potentiometric surface does not imply depth to aquifer because the groundwater is under pressure and rises above the aquifer top in wells.

The potentiometric map suggests that flow in the deep confined aquifer is to the southeast. Immediately south of the Project Area, flow is to the south-southwest at a gradient of roughly 0.001. Depth to the potentiometric surface in a single well near the Project Area is 83 feet above ground (flowing well).

Groundwater Use

Important uses for water in the San Luis Valley include domestic, recreation, wildlife, agriculture, and mining. Most mining operations closed by the end of the 20th century. Agriculture is the primary use of water in the valley, with more than 97 percent reportedly being used for that purpose (Saguache County 2001).

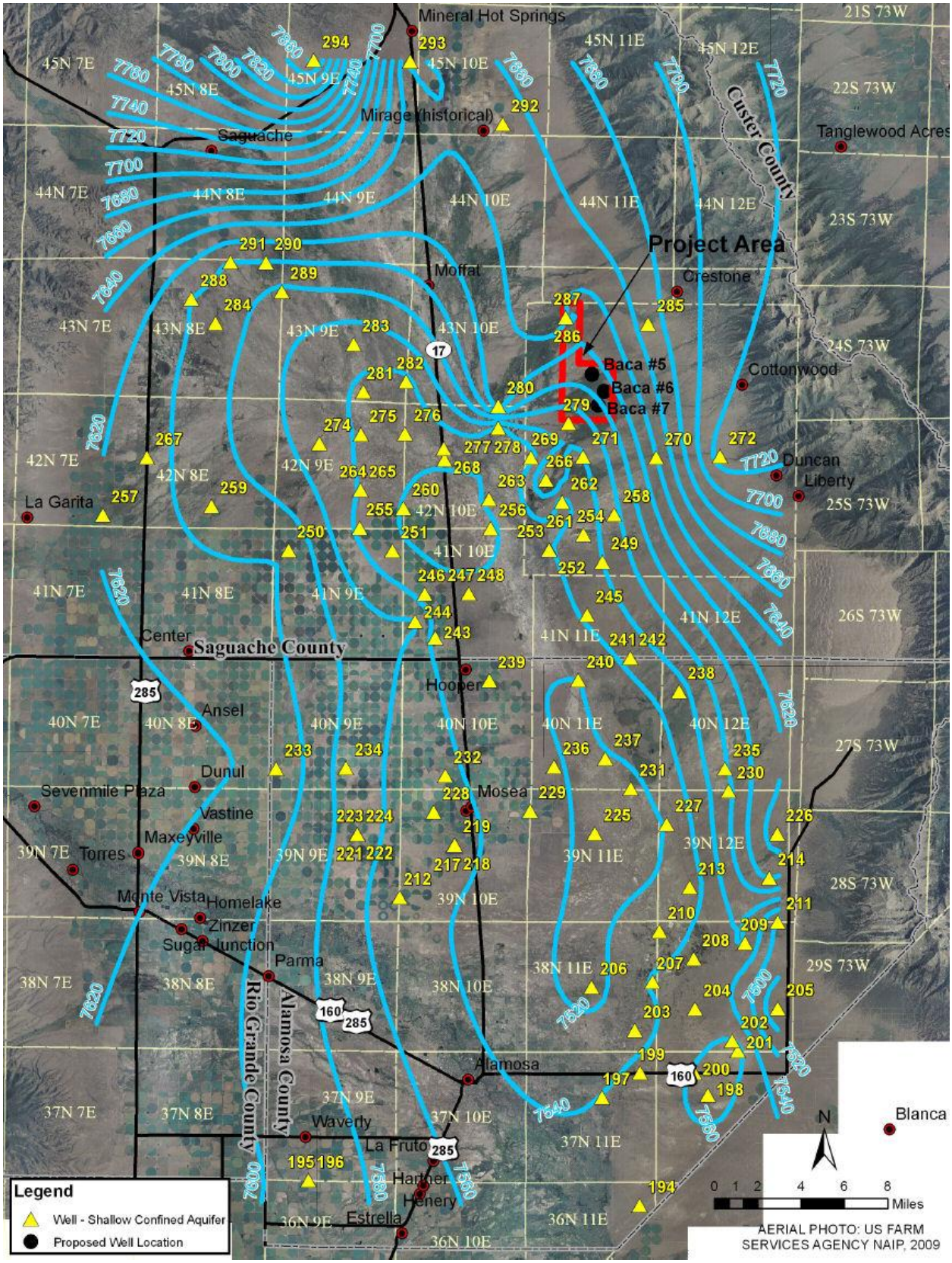


Figure 3-20. San Luis Valley Water Shallow Confined Aquifer Potentiometric Surface: 2004–2005

Data evaluations for ongoing groundwater modeling (CDWR 2004) indicate that as of 1978 a total of 7,688 wells with pumping rates greater than 50 gallons per minute existed in the San Luis Valley. In a 2007 publication (Martin 2007), it was noted that the Ground Water Atlas of Colorado specifies that as of February 2001 water well permit records indicate that nearly 10,000 wells have been completed in the San Luis Valley, 90 percent of which are used for irrigation of commercial crops. Although groundwater use in the San Luis Valley is primarily for agriculture, more than 95 percent of domestic water use for the San Luis Valley's 45,000 residents is dependent on groundwater (Saguache County 2001). Groundwater is also used for public water supply in most of the municipalities within the San Luis Valley. As of 2000, there were 76 permitted municipal wells in the valley, with a total permitted pumping rate of 32,552 gallons per minute (Topper et al. 2003).

Pumping represented in the RGDSS groundwater flow model (CDWR 2004) includes both agricultural and municipal and industrial wells. Municipal and industrial represents less than 5 percent of the water pumped, consistent with the 90 percent agricultural use noted above. For the steady state modeling period of 1990–1998, the model uses a total of 604,349 afy for agriculture and 36,865 afy for municipal and industrial.

Most available publications do not differentiate on the amount of groundwater use from aquifers in the valley. It is clear that based on the number of wells, the primary sources are the unconfined and shallow confined aquifer. The RGDSS model assigns 47 percent of the pumping to model layer 1 (unconfined aquifer), 21 percent to model layer 2 (upper Alamosa), and 32 percent to the other model layers (CDWR 2004). The extensive use of the unconfined aquifer is borne out by the Ground Water Atlas of Colorado, which states that "historically, depth to water in the unconfined aquifer has been generally less than 12 feet below ground surface. Extensive irrigation in the valley using groundwater wells has resulted in depletion of the aquifer. In the period 1969 to 1980, water level declines of up to 40 feet were documented in the unconfined aquifer. Since 1976, the Water Division engineer estimates that the unconfined aquifer has lost 1 million acre-feet of storage."

One other use of groundwater worthy of note is the Closed Basin Project. The Closed Basin Project was developed from 1985 through 1993 and was designed to reduce non-beneficial evapotranspiration and convey the resulting water to the Rio Grande. A series of wells in the unconfined aquifer pumps water into pipeline laterals connected to a 42-mile conveyance channel that delivers the water to the Rio Grande. Direct benefits of the project include supplying additional water to help Colorado satisfy its obligations under the Rio Grande Compact and providing water supplies for fish and wildlife habitat. As originally envisioned, the project would supply approximately 100,000 acre-feet, thereby reducing the need to curtail water users on the Rio Grande and Conejos River to meet Compact obligations. To date (1985 to 1997), the project has supplied an average of 35,000 acre-feet for this purpose (CDWR 2004).

Groundwater Level Patterns

Seasonal and long-term trends of groundwater levels in the three aquifers in the San Luis Valley were evaluated by obtaining and plotting water level data from the USGS website (USGS 2010). The database was searched for wells with water level data in Alamosa County and Saguache County, and was further reduced to include only those with a long period of record that is either still ongoing or ended relatively recently. The wells were then differentiated as to whether they are in the unconfined, shallow confined, or deep confined aquifer. The well locations used for this evaluation are shown on **Figure 3-22**.

The wells used to evaluate groundwater level patterns are summarized in **Table 3-6**. Well data were analyzed to determine the change in water levels, with the period of focus being 1990–2005, although some wells had slightly different periods. The period of data used for evaluating water level change, along with the net change in water levels is shown in **Table 3-6**.

All wells showed a decline in water levels for the period evaluated. Unconfined aquifer wells had declines ranging from 0.7 to 9.2 feet, with a mean value of 3.4 feet. Shallow confined aquifer wells exhibit a decline of 0.6 to 5.4 feet, with a mean value of 3.3 feet. Only two wells in the deep confined aquifer had enough data to evaluate trends, and they showed declines of 10.2 and 14.7 feet.

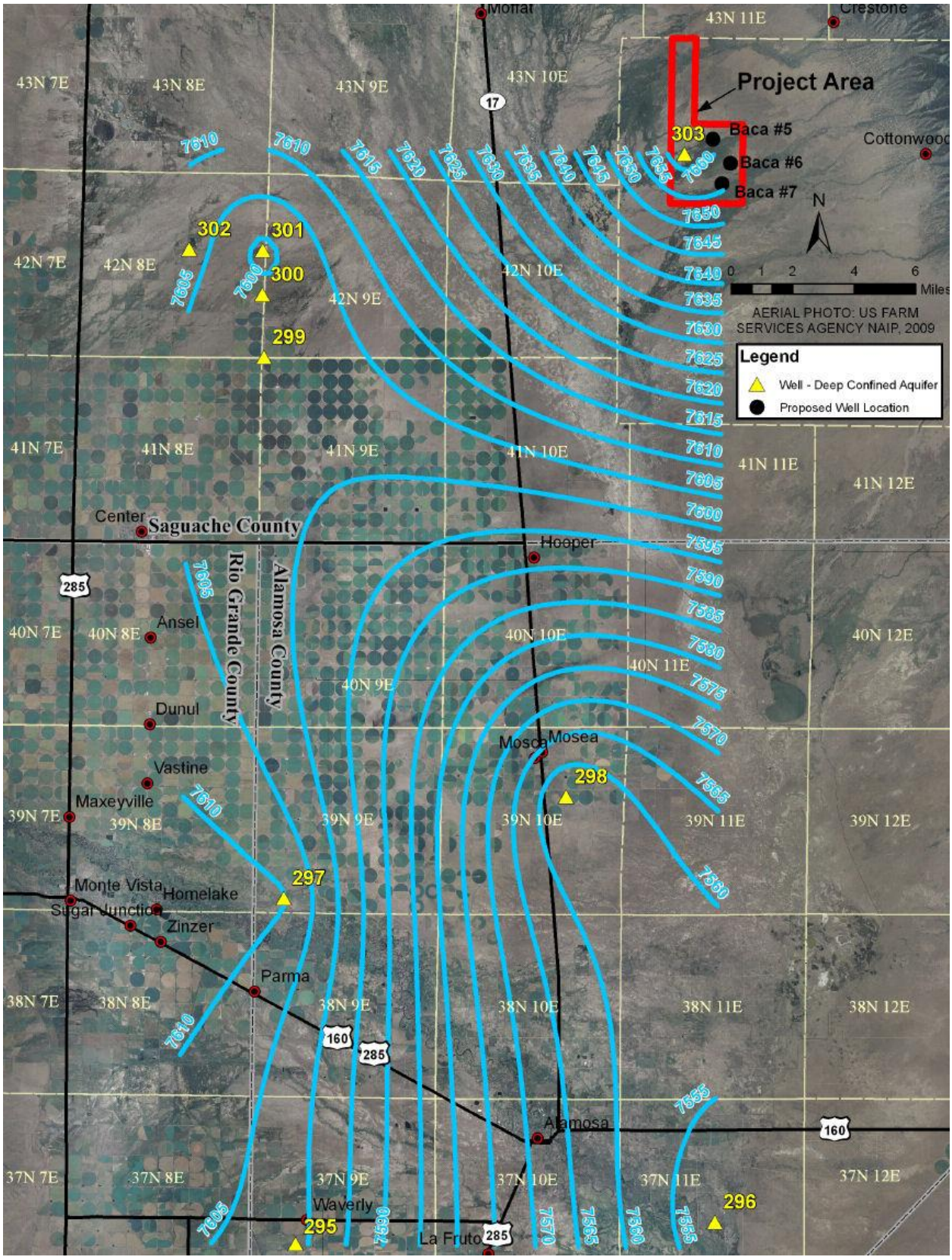


Figure 3-21. San Luis Valley Water Deep Confined Aquifer Potentiometric Surface: 2004–2005

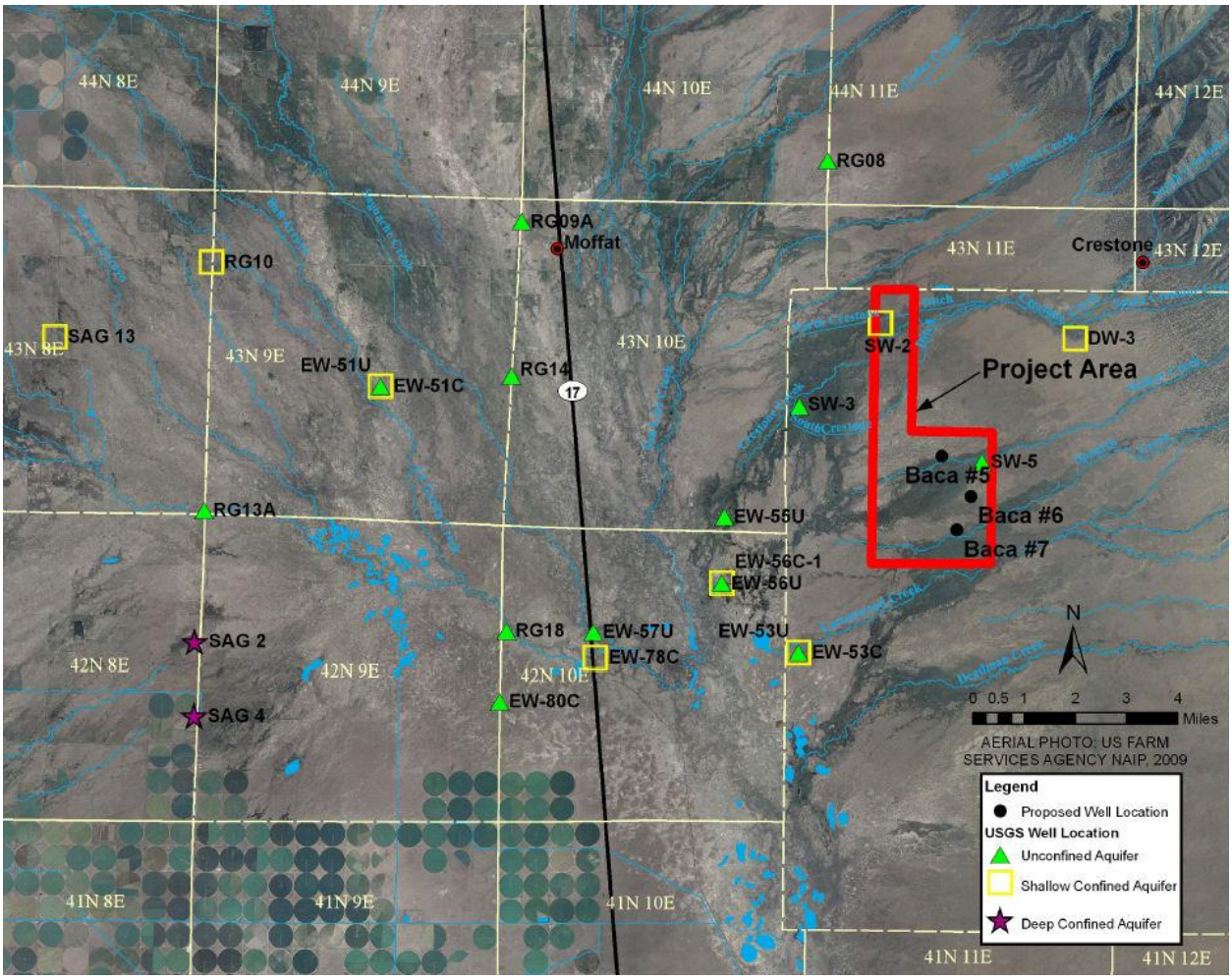


Figure 3-22. Wells Used to Evaluate Seasonal and Long-Term Trends[12]

Hydrographs of some of these data were developed and are presented below. Wells near the Project Area are shown on **Figure 3-23**. Well RG-08 to the north of the Project Area has the longest record of data, showing a rise of 2 to 3 feet from 1974 to 1994, and then a decline of about the same amount through 2010, for a net rise of about 1 foot since 1974. Small seasonal fluctuations of about 1 to 2 feet are evident at RG-08, with peaks in the spring and lows in late summer.

To the south, wells EW-55U and EW-56C-1 both show a decline of about 5 feet for the period 1984 to 2006 and demonstrate a similar pattern for the unconfined and shallow confined aquifer. Both wells show highly variable seasonal fluctuations ranging from less than 1 foot to about 4 feet.

Near the Project Area, wells have a very short period of record, with the longest being 5 years. Shallow confined wells DW-1 and DW-3 both exhibit a water level rise of about 2 feet for the period 2005 to 2010, while unconfined aquifer well SW-3 shows no net change for the same period.

The two deep confined aquifer wells are shown on **Figure 3-24**. These two deep wells show a decline in potentiometric head of about 30 feet for the period 1988 to 2005, followed by a rise in water levels of about 6 to 8 feet through 2010. The wells also exhibit significant seasonal fluctuations of about 10 feet, with peaks occurring in spring and lows in summer.

[12] Figure 3-22 was created by The PBS&J Corporation using data from the USGS (2010).

Table 3-6. Summary of USGS Flow Data for San Luis Valley[13]

Map ID	Site No.	Site Name	Well Depth	Measurements			Period		Change (ft)
				Begin	End	No.	Dates	Years	
Unconfined									
151	375212105554301	NA04200924DAD EW-80C	105	3/5/1980	8/24/2005	316	1994-2005	11	-5.04
155	375305105491601	NA04201013ADB1 EW-53U	41.8	9/14/1984	1/15/2006	378	1990-2005	15	-3.74
158	375324105553301	NA04201007CCC RG18	57	1/5/1967	10/7/2010	416	1990-2005	15	-8.43
164	375415105505601	NA04201002CCD1 EW-56U	42	9/14/1984	7/11/2006	189	1990-2005	15	-4.04
171	375523105505301	NA04301035CAC1 EW-55U	38	9/14/1984	1/4/2006	239	1990-2005	15	-2.46
172	375524106020501	NA04300931CCC RG13A	30	9/5/1974	10/5/2010	418	1990-2005	15	-1.52
175	375621105452301	BACA LAND GRANT NO. 4 SW-5	181	4/21/2005	6/7/2006	11			
177	375717105492001	BACA SW-3	221	4/19/2005	10/13/2010	32			
178	375733105581901	NA04300922BDD1 EW-51U	42.5	6/28/1984	4/21/2005	223	1994-2005	11	-0.7
179	375745105553001	NA04301019BBB RG14	25	9/5/1974	10/7/2010	396	1990-2005	15	-1.19
183	380023105551901	NA04301006BCC1 RG09A	35	6/2/1986	10/7/2010	286	1990-2005	15	-0.16
184	380128105484401	NA04401131BBC RG08	27	9/5/1974	10/7/2010	424	1990-2005	15	-0.83
NA	375324105534101	NA04201017AAC1 EW-57U	NA	10/19/1983	4/10/2006	191	1991-2005	14	-9.21
Shallow Confined									
268	375258105533801	NA04201017ADC EW-78C	107	5/3/1979	5/26/2005	235	1995-2005	10	-5.43
269	375305105491602	NA04201013ADB2 EW-53C	129	12/17/1984	7/28/2005	167	1994-2005	11	-3.15
277	375415105505602	NA04201002CCD2 EW-56C-1	108	9/14/1984	7/11/2006	150	1991-2005	14	-5.03
283	375733105581902	NA04300922BDD2 EW-51C	135	10/16/1984	4/21/2005	66	1994-2005	11	-0.55
284	375820106052001	NA04300815CBB SAG 13	830	1/20/1969	9/28/2010	99	1998-2005	7	-5.1
285	375828105432501	BACA DW-3	993	4/20/2005	10/12/2010	32			
286	375842105473601	BACA LAND GRANT NO. 4 SW-2	302	3/1/2005	8/30/2006	15			
287	375842105473701	BACA DW-1	994	6/10/2005	4/5/2010	33			
289	375938106015901	NA04300907BBB2 RG10	27	9/5/1974	10/5/2010	417	1990-2005	15	-0.82
Deep Confined									
300	375155106021501	NA04200919CCC1 SAG 4	2301	1/20/1969	9/30/2010	150	1994-2005	11	-14.7
301	375310106021501	NA04200907CCC SAG 2	1987	1/20/1969	9/30/2010	187	1991-2005	14	-10.2

Three sets of paired wells (unconfined and shallow confined wells at the same location) are shown on **Figure 3-25**. Each well pair shows a similar pattern for the unconfined and shallow confined aquifers, indicating a similar response to variations in recharge and discharge (pumping). Head in the shallow confined aquifer is greater than that in the unconfined aquifer at each well pair, indicating an upward gradient, except for brief periods at well pair EW-56U/56-C1 when seasonal highs create a downward gradient. For the data period 1984 to 2006, the well pair EW-51U/C shows no net change in water levels, while declines of about 5 feet occur at EW-53U/C and 8 feet at EW-56U/C1.

[13] Table 3-6 was created using data from the USGS (2010) by The PBS&J Corporation.

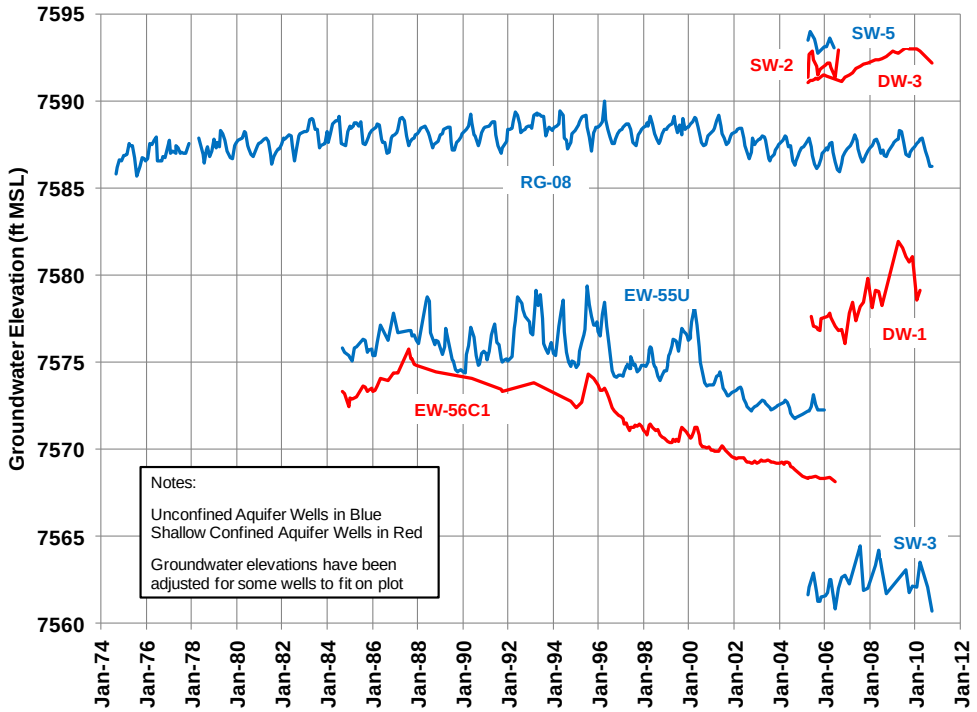


Figure 3-23. Hydrograph: Wells Near Project Area[14]

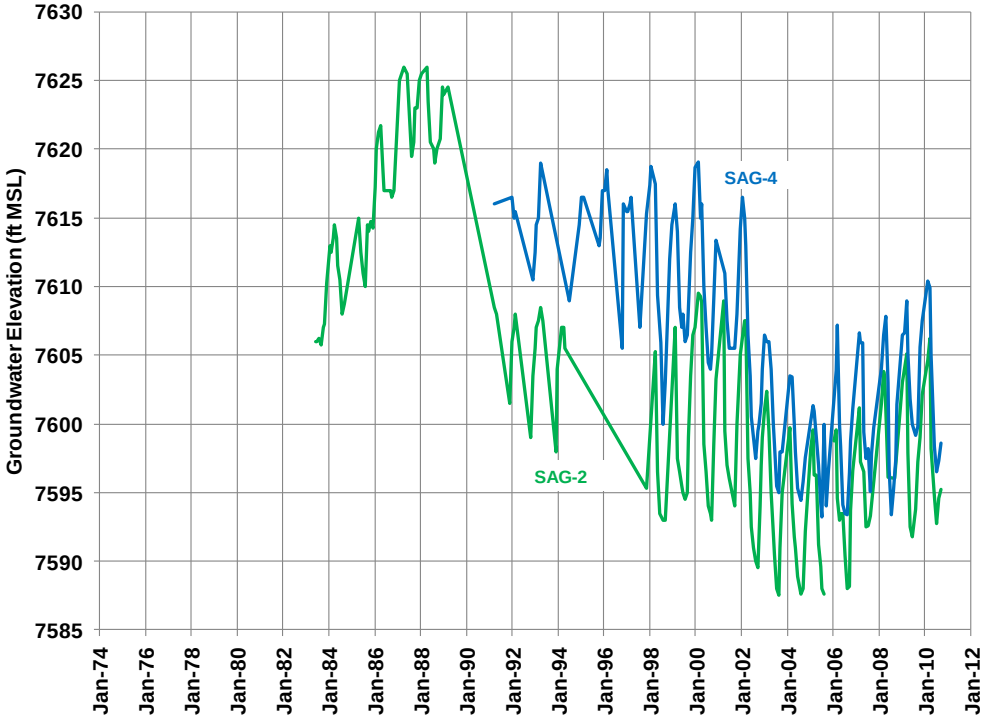


Figure 3-24. Hydrograph: Deep Confined Aquifer Wells[15]

[14] Figure 3-23 was created using data from the USGS (2010) by The PBS&J Corporation.
[15] Figure 3-24 was created using data from the USGS (2010) by The PBS&J Corporation.

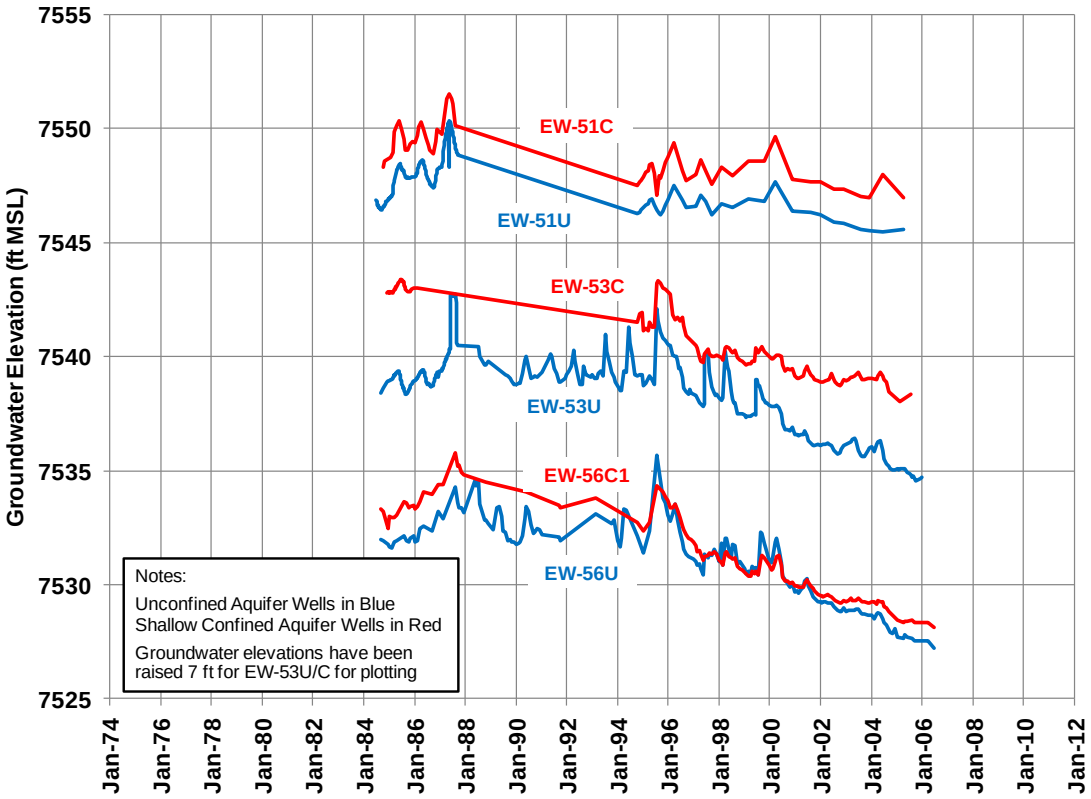


Figure 3-25. Hydrograph: Select Well Pairs[16]

Groundwater Quality

The water quality in the San Luis Valley varies by location and among the different layers of the aquifer. Water quality in the unconfined aquifer of the San Luis Valley ranges from very good along the periphery of the valley to very poor in the sump area in the vicinity of San Luis Lakes, northeast of Alamosa (Topper et al. 2003).

TDS in the San Luis Valley can be variable, ranging from less than 500 milligrams per liter (mg/L) along the fringes to more than 3,000 mg/L in the center of the basin (Robson and Banta 1995). Topper et al. (2003) indicate that TDS concentrations in the sump area around San Luis Lakes range from 2,000 to more than 10,000 mg/L. However, reported TDS values in the unconfined aquifer in the northern valley have been reported as high as 35,000 mg/L according to Mayo et al. (2006), who concluded that "the elevated TDS of northern valley unconfined and upper active confined systems result from mineral dissolution, ion exchange and methanogenesis of organic and evaporate lake sediments deposited in an ancient lake." The highest values of TDS in the unconfined aquifer are found in the San Luis Lakes area at the lowest portion of the Closed Basin, approximately 20 miles south of the Project Area. The waters of the confined aquifer are generally lower in TDS and nitrogen, and thus are of higher quality.

Groundwater quality impairment issues in the San Luis Valley include the presence of bacteria, toxic metals, and nitrate that have been detected in private domestic drinking water wells (USEPA 2007c). A study by the USGS covering the period 1992 to 1995 found that in the San Luis Valley agricultural land use study, water from 11 of the 35 wells sampled contained nitrate concentrations greater than the EPA maximum concentration level; the largest concentration was 58 mg/L (Levings et al. 1998). In addition, the salinity hazard in the unconfined aquifer is medium to very high (Topper et al. 2003). In response, the San Luis Valley Drinking Water Well Project was initiated in April 2007 and includes free testing of water from private wells and provides information on various water treatment techniques.

[16] Figure 3-25 was created using data from the USGS (2010) by The PBS&J Corporation.

Sources of available groundwater quality data, in addition to those in the references cited above, include the USGS online database (USGS 2010) and the recent baseline sampling program. The USGS database was searched for water quality data from wells in the valley, but the search found analytical data for only a handful of wells in the vicinity of the Project Area and these were from 1980 or before. Unlike the surface water data, the locations typically contained single samples; therefore, seasonal variations could not be analyzed. The most recent data on groundwater quality is from the baseline sampling being conducted in and around the Project Area.

The baseline groundwater sampling included 21 wells, 8 of which are in the unconfined aquifer and 13 in the confined aquifer. The baseline study well locations are shown on **Figure 3-26**. **Table 3-7** summarizes the baseline groundwater sampling sites.

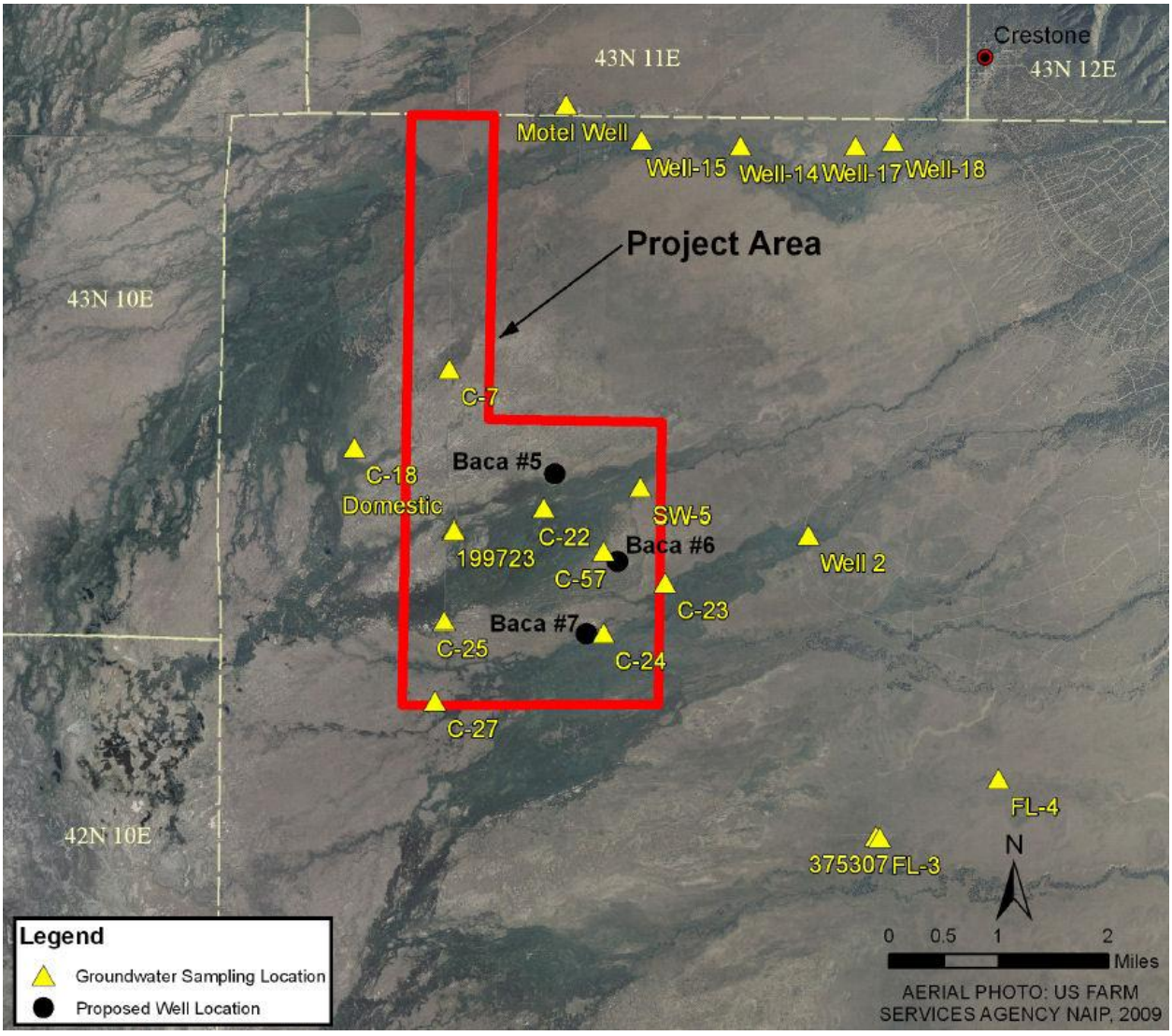


Figure 3-26. Baseline Groundwater Sampling Locations[17]

[17] Figure 3-26 was created by The PBS&J Corporation using baseline groundwater sampling data gathered by Lexam.

Table 3-7. Summary of Baseline Groundwater Sampling Sites[18]

Name	Location Type	Aquifer	Location
199723	Flowing Well	Confined	In Project Area
C-20	Flowing Well	Confined	
C-22	Flowing Well	Confined	
C-24	Flowing Well	Confined	
C-25	Flowing Well	Confined	
C-27	Flowing Well	Confined	
C-57	Flowing Well	Confined	
C-7	Flowing Well	Confined	
Domestic Well	Pumped Well	Unconfined	
SW-5	Pumped Well	Unconfined	
Motel Well	Pumped Well	Unconfined	Northeast of Project Area
Well-14	Pumped Well	Unconfined	
Well-15	Pumped Well	Unconfined	
Well-17	Pumped Well	Unconfined	
Well-18	Pumped Well	Unconfined	
C-23	Flowing Well	Confined	East of Project Area
Well-2	Pumped Well	Unconfined	
375307	Pumped Well	Confined	Southeast of Project Area
FL-3	Flowing Well	Confined	
FL-4	Flowing Well	Confined	
C-18	Flowing Well	Confined	West of Project Area

Analytical results of the baseline sampling conducted in 2008 are in **Appendix G**. The baseline sampling analysis detected neither gasoline nor diesel fuel; however, the lighter hydrocarbon gases methane and ethane were present. Methane was detected in 17 out of 20 wells that were sampled, and ethane was detected in 10 wells. Moreover, methane was detected in five of seven surface water samples. No ethane was detected in the surface water samples. The hydrocarbon gases likely originated from the decomposition of organic matter that accumulated in the “ancient sump” (Mayo et al. 2006).

Organic parameters also were measured in the samples obtained for baseline analysis and included VOCs, semi-volatile organic compounds (SVOC), and hydrocarbon compounds (gasoline, diesel, methane, and ethane). No VOCs were detected in the baseline samples; however, an SVOC, bis(2-Ethylhexyl) phthalate, was found in several samples, but no other SVOCs were detected. The origin of bis(2-Ethylhexyl)phthalate in the samples is likely from sample contamination from plastic containers used for sample collection (Telesto 2007). Bis(2-Ethylhexyl)phthalate is commonly associated with plastics, but it is not very persistent in an aquatic environment (Howard, 1989).

TDS values in the Project Area are generally less than 500 mg/L based on the groundwater baseline sampling analytical results; however, TDS in the deeper wells in the area may exceed 500 mg/L. A number of metals were analyzed in the samples, but no unusual concentrations of metals were detected. Concentrations of analyzed metals that are on the Colorado groundwater standards list did not exceed the standards (CDPHE 2007b).

Half of the baseline groundwater analytical results were plotted on a piper diagram (**Figure 3-27**). Groundwater in the San Luis Valley was characterized as calcium bicarbonate or magnesium bicarbonate by Robson and Banta (1995). The piper diagram shows a separation of the unconfined and confined aquifer samples, with the unconfined samples plotting as calcium bicarbonate and the confined samples plotting as magnesium bicarbonate.

[18] Table 3-7 was created by The PBS&J Corporation using the groundwater sampling locations for in and around the Project Area for Lexam’s proposed oil and gas exploration.

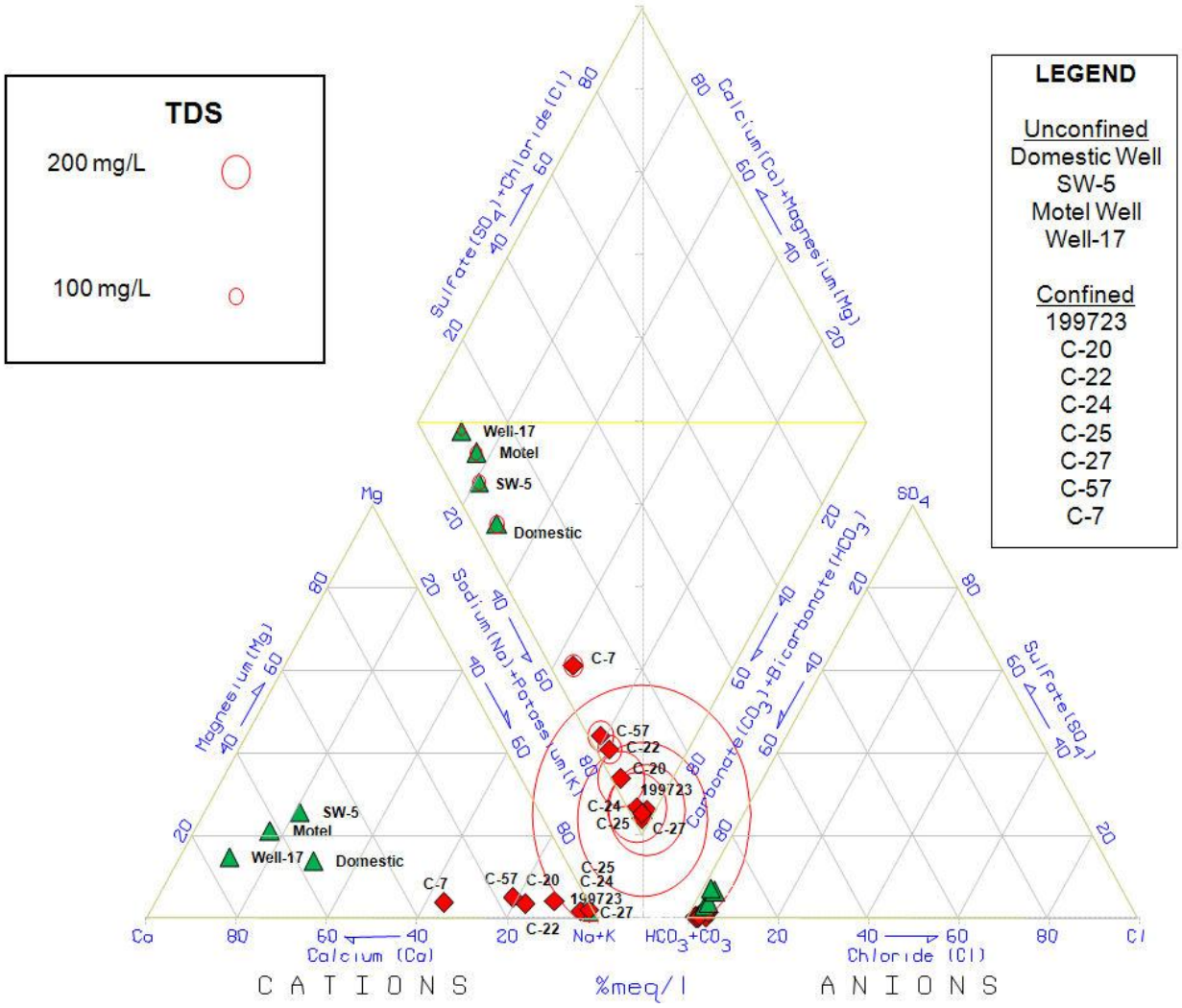


Figure 3-27. Baseline Groundwater Samples[19]

Water quality in the deep confined aquifer diminishes below 2,500 to 3,000 feet because of TDS concentrations of greater than 3,000 mg/L as compared to 300 to 500 mg/L above the 2,500-foot to 3,000-foot depth range. The decrease in water quality limits the potential use of water from depths greater than 3,000 feet. Also, decreasing hydraulic conductivity at depth would adversely affect well productivity. A TDS concentration limit of 500 mg/L is a secondary maximum contaminant level for drinking water (CDPHE 2007c). Concentrations above that level are acceptable but not optimal for human consumption mainly due to taste and palatability. Water with a TDS concentration greater than 2,000 mg/L is generally unsuitable for irrigation (Fipps 2003). TDS concentrations of between 3,000 and 5,000 mg/L are satisfactory for use for most livestock, but can cause problems for sensitive animals such as poultry. Concentrations between 7,000 and 10,000 mg/L are risky for several types of livestock (Soltanpour and Raley 1993).

Groundwater quality in the San Luis Valley can be variable ranging from less than 500 milligrams per liter (mg/L) total dissolved solids (TDS) along the fringes to over 3,000 mg/L in the center of the basin (Robson and Banta 1995). However, reported TDS values in the unconfined aquifer in the northern valley have been reported as high as 35,000 mg/L according to Mayo et al. (2006), who concluded that “the elevated TDS of northern valley unconfined and upper active confined systems result from mineral dissolution, ion exchange and methanogenesis

[19] Figure 3-27 was created by The PBS&J Corporation using data from groundwater samples collected in and around the Project Area for Lexam’s proposed oil and gas exploration.

of organic and evaporate lake sediments deposited in an ancient lake." The highest values of TDS in the unconfined aquifer are found in the San Luis Lakes area at the lowest portion of the Closed Basin, approximately 20 miles south of the proposed Project Area.

Groundwater quality impairment issues in the San Luis Valley include the presence of bacteria, toxic metals, and nitrate that have been detected in private domestic drinking water wells (USEPA 2007c). In response, the San Luis Valley Drinking Water Well Project was initiated in April 2007 and includes free testing of water from private wells and provides information on various water treatment techniques.

TDS values in the proposed Project Area are generally less than 500 mg/L based on groundwater baseline sampling analytical results (**Figure 3-27**) (**Appendix G**). However, TDS in the deeper wells in the area may exceed 500 mg/L. Groundwater in the San Luis Valley is characterized as calcium bicarbonate or magnesium bicarbonate (Robson and Banta 1995). A number of metals were analyzed in the samples, but no unusual concentrations of metals were detected (**Appendix G**). Concentrations of analyzed metals that are on the Colorado groundwater standards list did not exceed the standards (CDPHE 2007b).

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Water Balance

A water balance is a summary of flows into and out of a system and is useful to identify relative contributions of various components. A number of water balances for the San Luis Valley have been developed by researchers over the years. The water balances developed to date show a range in values for the various components, largely because the flows cannot be directly measured and need to be calculated using certain assumptions. The different water balances that have been developed to date were summarized and evaluated in 2001 in support of the RGDSS groundwater modeling effort being developed for the area (RGDSS 2001).

The 2001 effort reviewed and critiqued the previous water balances and developed a best estimate of the water budget components. The study also included the water budget resulting from the groundwater model for comparison. Results of that effort are in **Table 3-8**. Differences between the best estimate and model results were partly attributable to different study periods, although significant differences were discussed.

Table 3-8. Comparison of Groundwater Area Average Annual Results (from RGDSS 2001)

Water Budget Component	Best Estimate (kaf/yr)	RGDSS Results (kaf/yr)
Inflows		
Precipitation	1,220	1,284
San Juan SW Inflow [1]	1,200	1,249
San Juan GW Inflow [2]	130 – 890	100
Sangre de Cristo SW Inflow [1]	320	174
Sangre de Cristo GW Inflow [2]	0	0
Total Inflows	2,870 - 3,630	2,807
Outflows		
Beneficial CU [3]	1,470	1,018
Non-Beneficial CU [4]	1,000 - 1,650	1,370
SW Outflow	330	305
GW Outflow	70	114
Total Outflows	2,870 - 3,520	2,807
Change in Storage		
GW Change	-60	0
SW Change	---	0
Total Change in Storage	-60	0

Notes:
[1] Total San Juan and Sangre de Cristo gaged and ungaged surface water inflows.
[2] Total San Juan ground water inflow (Sangre de Cristo considered negligible).
[3] Beneficial CU includes agriculture use from both precipitation and irrigation water, livestock use, M/I use, and reservoir evaporation.
[4] Non-beneficial CU includes consumptive use by native vegetation and sublimation of winter precipitation.

In general, the water budget supports the contention that precipitation and surface water inflow from the surrounding mountains are the primary sources of recharge, each providing roughly the same amount. The San Juan Mountains provide almost four times as much water as the Sangre de Cristo Mountains. The major outflow is consumptive use, which is an equal split between beneficial use and non-beneficial use.

3.5 Vegetation and Habitats

Vegetation Communities

The Refuge is characterized by a diverse range of habitats including desert shrublands, grasslands, wet meadows, playa wetlands, and riparian areas (USFWS 2005). Specific vegetation communities (**Figure 3-28**) within these habitats were classified based on review of aerial photography and ground-truthing surveys conducted by Service. Within the project vicinity, there are five general vegetation types: grasslands, shrublands, wet meadows/non-woody riparian areas, woody riparian areas, and playas. The wet meadows are wet during active runoff periods when native grasses and rushes are irrigated and grown primarily for water bid production. Open water, barren areas, sand flats, and developed areas accounts for less than 1 percent of the Project Area and do not display vegetation characteristics; consequently they are not discussed in this section of the Draft EA. **Table 3-9** summarizes the number of acres of each vegetation type and the sub-communities present in this area.

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure: 3-28 -- Vegetation Classification for the 3D Seismic Region Survey Area

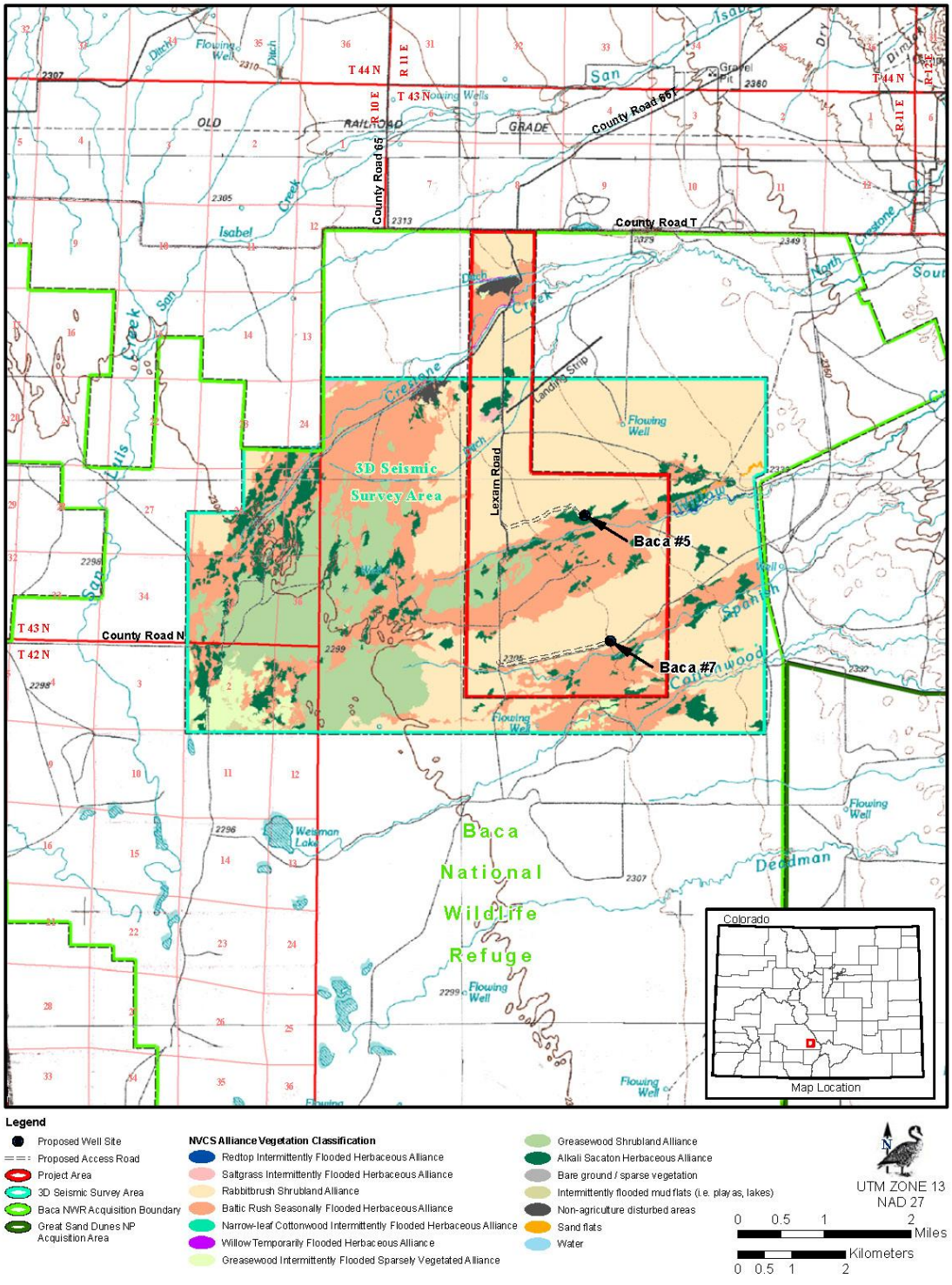


Table 3-9. Vegetation Types and Sub-communities Present in the Project Area

Vegetation Type	Sub-community[1]	Common Species	Acres[2]
Grassland	Alkali Sacaton Herbaceous Alliance	Alkali sacaton, western wheatgrass, buffalograss, tansyaster, fourwing saltbush, scarlet globemallow, prairie coneflower, James; galleta, bush muhly, little barley, Indian ricegrass, blue grama, seepweed, cholla cactus, and pricklypear cactus	292
Shrubland	Rabbitbrush Shrubland Alliance; Greasewood Shrubland Alliance	Rubber rabbitbrush, greasewood, four-wing saltbush, shadscale, winterfat, Indian ricegrass, Alkali sacaton, western wheat grass, blue grama, silver sagebrush, big sagebrush, broom snakeweed, yucca, pricklypear cactus, bluebunch wheatgrass, James' galleta, spike dropseed, fewflower buckwheat, and clasping pepperweed	3,254
Wet meadow/non-woody riparian areas	Baltic Rush Seasonally Flooded Herbaceous Alliance; Saltgrass Intermittently Flooded Herbaceous Alliance; Redtop Intermittently Flooded Herbaceous Alliance	Baltic rush, redtop, foxtail barley, greasewood, alkali sacaton, Nuttail's alkaligrass, sedges, tufted hairgrass, fleabane, bluebell, lupine, goldenrod, Junegrass, shrubby cinquefoil, and western wheatgrass	1,585
Woody riparian areas	Willow Temporarily Flooded Shrubland Alliance	Narrowleaf cottonwood, willows, red osier dogwood, and greasewood	9
Playas	Greasewood Intermittently Flooded Sparsely Vegetated Alliance	Greasewood, four-wing saltbush, saltgrass, alkali sacaton, spike-rush, and foxtail barley	19
Total[2]			**5,159**

1 Source: Grossman et al. 1998; vegetation mapping was conducted by Service personnel.
2 Total acres for each vegetation type in the Project Area.

Wetland, Riparian, and Aquatic Habitats

The type and locations of wetlands and riparian areas were mapped using remotely sensed data from the National Wetland Inventory (NWI) for the Project Area. Riparian/wetland areas can generally be identified in the Project Area during the summer months by the green belt of vegetation adjacent to streams. They also occur as seeps, sloughs, or wet meadows in areas where groundwater is close to the soil surface or in areas being actively irrigated. Drought conditions can make identification of riparian/wetland areas problematic.

Existing Conditions

Riparian/wetland areas can be distinguished from other plant community types by the unique combination of hydrology, soils, and vegetation. A site's hydrology is the overriding characteristic that distinguishes riparian/wetland areas from adjacent uplands. The hydrology of any site or region is ultimately linked to precipitation, but the development of riparian/wetland areas are dependent on the longer-term presence of available water. In much of the western United States, annual precipitation is less than 20 inches, and annual evapotranspiration is more than 30 inches (WRCC 2009), indicating a water deficit and that precipitation alone is insufficient to support the establishment or persistence of riparian/wetland areas. These conditions hold true for the Project Area. Because of this water deficit, the hydrology of riparian/wetland areas in the Project Area originates primarily from surface water, groundwater, or both.

Soils in riparian/wetland areas differ from upland soils by their formation and the prolonged presence of water. Riparian/wetland soils form under conditions characterized as flowing (lotic) or standing water (lentic) environments (Lewis et al. 2003). Soils in lotic environments, such as floodplains, typically exhibit a high level of stratification developed by successive depositional events during floods. Organic matter in these areas can often be found as deposits derived from offsite sources. Soils in lentic environments, such as in depressional areas or lakes, frequently have higher levels of organic matter accumulation than either lotic environments or uplands (Lewis et al. 2003). The amount of organic matter accumulation in lentic areas is affected by the type of vegetation and the amount of wave action the site receives, among other factors (Lewis et al. 2003).

When a soil becomes saturated with water, the bio-geochemical processes change because of the lack of oxygen (the environment is anaerobic). These changes in soil chemistry are unique to saturated soils and have been termed "hydric." Hydric soil is defined as "a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (NRCS 2007). Hydric soils are most commonly found in wetland areas and can be identified by field indicators such as mottling, gleying, and darker color (i.e., chroma), among others (USDA-NRCS 2006). According to the NRCS (2010), hydric soils within the Project Area are Hagga loam, dry; Medano fine sandy loam; Schrader sandy loam, 0 to 3 percent slopes; and Vastine loam. Partially hydric soils in the Project Area include Laney loam, 0 to 3 percent slopes and Space City loamy sand, saline, 0 to 3 percent slopes. Within the Project Area hydric soils are found on active floodplains and stream terraces on valley floors (NRCS 2010). Hydric soils can also be found as inclusions in other, non-hydric, soil types.

The Refuge contains a diversity of riparian/wetland types. According to the NWI map, approximately 32 percent (1,309 acres) of the Project Area is classified as wetlands (**Table 3-10** and **Figure 3-29**). Four types of riparian/wetland areas potentially occur:

- Freshwater (palustrine) emergent
- Unconsolidated shore
- Aquatic bed
- Lacustrine

Table 3-10. Wetland Types Present in the Project Area

Wetland Type	Acres	%
Freshwater Emergent, temporarily flooded	956	73.0
Freshwater Emergent, Unconsolidated Shore, seasonally flooded	352	26.8
Freshwater Emergent, semi-permanently flooded	1	<1
Freshwater Aquatic Bed, Lacustrine Littoral Unconsolidated Shore, seasonally flooded	<1	<1
Total	1,309	100

Source: USFWS 1990. Based on Service consultation and Service field surveys, the PSS NWI classification has been reclassified as shrubland habitat for this analysis.

These wetland and waters of the U.S. types are concentrated along the streams and playa areas located within the Project Area. The palustrine emergent and unconsolidated shore temporary and seasonal wetlands are referred to locally as wet meadows and non-woody riparian areas.

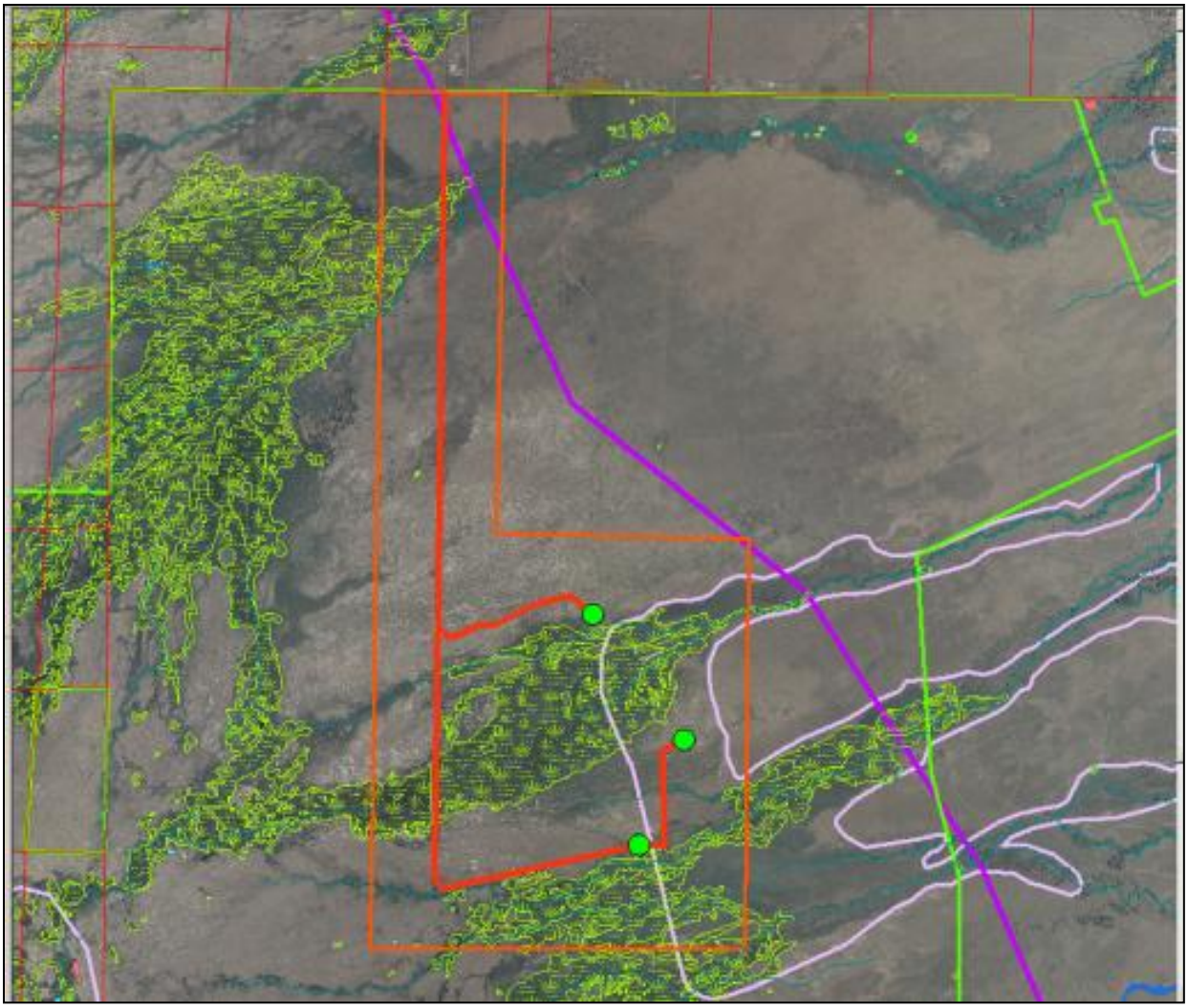


Figure 3-29. Project Area National Wetland Inventory Map[20]

Wet Meadows/Non-woody Riparian Areas

Wet meadows and non-woody riparian areas comprise the largest wetland type in the Project Area. Where the water table just reaches the soil surface during the early part of the growing season or inundates the surface for short periods is usually where this vegetation type is found.

The majority of this vegetation type is found in the north, central, and western portions of the Project Area along Crestone, Spanish, and Willow creeks. Historically, the Refuge was managed as a working ranch under which creation and maintenance of this habitat type was perfected for utilization as high quality cattle forage. Current management of the wet meadows by the Service involves similar management and maintenance for use as migratory bird nesting, foraging, and cover by actively flooding the meadows and haying in the fall in an attempt to promote the native plant communities.

The dominant sub-community in this vegetation type is the Baltic Rush (*Juncus balticus*) Seasonally Flooded Herbaceous alliance. The Baltic Rush Seasonally Flooded Herbaceous Alliance occupies seasonally flooded

[20] Figure 3-29 was created by The PBS&J Corporation using data from the national wetlands inventory.

swales and wet, low- to mid-elevation sites, where habitats are often alkaline. The graminoid layer is dense with up to 98 percent cover, dominated by Baltic rush, and found throughout the Project Area.

The two other communities that compose the wet meadows/non-woody riparian areas are the Saltgrass Intermittently Flooded Herbaceous Alliance and the Redtop (*Agrostis gigantean*) Intermittently Flooded Herbaceous Alliance. In the Project Area, the Saltgrass Intermittently Flooded Herbaceous Alliance occurs south of North Crestone Creek, while the Redtop Intermittently Flooded Herbaceous Alliance sub-community is found along Willow Creek on the eastern edge.

Woody Riparian Areas

The Project Area has less than 1 percent of woody riparian habitat; this habitat is location along North Crestone Creek (USFWS 2005). There are no woody riparian vegetation communities near the proposed well sites. This habitat type is composed of one sub-community, Willow (*Salix* spp.) Temporarily Flooded Shrubland Alliance is found north of Crestone Creek. This community is usually found in the floodplains of the creeks, located on islands, sand or cobble bars, and immediate streambanks. It is tree-dominated with a diverse shrub component and is dependent on the natural hydrological regime, especially annual to episodic flooding. Narrowleaf cottonwood is the dominant tree species with understory vegetation of willows, red osier dogwood (*Cornus stolonifera*), and greasewood (USFWS 2005).

Playas

Playas can experience weeks, months, or even years between periods of inundation. This vegetation type is found in small patches in the south-and north-central portions of the Project Area. This vegetation type is characterized by sparsely vegetated areas (<10 percent canopy cover), with typical species including greasewood and four-wing saltbrush (*Altriplex canescens*). Surrounding the playas is usually greasewood and rubber rabbitbrush (*Ericameria nauseosa*) with an understory of saltgrass and western wheat grass (*Pascopyrum smithii*). Barren salt flats also are a component of playa wetland systems. The only sub-community in this vegetation type is Greasewood Intermittently Flooded Sparsely Vegetated Alliance. It often occurs along flat to gently sloping stream terraces, where soils are alkaline and may be moderately saline.

Wetland Functions

As noted, riparian/wetland areas are transition zones between aquatic and terrestrial systems. As such, they frequently occupy important positions in the landscape for providing a variety of physical, chemical, and biological functions important to society. These functions are linked not only to processes occurring within the riparian/wetland area, but also are directly linked to watershed-scale processes. Functions commonly associated with freshwater riparian/wetland areas typically fall into the following categories:

- Flood flow attenuation
- Food chain support
- Nutrient cycling
- Water quality improvement
- Water storage
- Wildlife/bird habitat

The USACE has developed a system for the classification and evaluation of riparian/wetland functions called the hydrogeomorphic (HGM) method. The HGM classification system is based on a riparian/wetland area's topographic position (i.e., geomorphic setting), its dominant water source, and the hydrodynamics of the site (i.e., dominant direction of flow) (Smith et al., 1995). The HGM riparian/wetland classes applicable to the Project Area are primarily riverine and slope, though mineral flats and depressional classes may also occur. Each HGM class has certain associated functions (**Table 3-11**) that are performed at varying capacity levels depending on their HGM class as well as site-specific conditions and characteristics.

Table 3-11.Typical Characteristics and Primary Functions of Hydrogeomorphic Riparian/Wetland Classes Found in the Project Area

HGM Class	Examples	Characteristics*	Primary Functions
Depressional	Potholes	Occurs in a topographic depression (e.g., shallow pond). Dominant water sources are precipitation, overland flow, and/or groundwater. Water levels fluctuate vertically.	Water storage, nutrient cycling, food chain support, wildlife/bird habitat.
Mineral Flats	Large playas	Dominant water source is precipitation. Water levels fluctuate vertically. Poor vertical drainage usually due to hardpans or spodic horizons.	Water storage, nutrient cycling, food chain support, wildlife/bird habitat.
Riverine	Perennial and intermittent creeks	Occurs along streams and rivers. Dominant water source is from overbank flow from channel or alluvial aquifer. Flow is downstream and lateral away from channel.	Water storage, flood flow attenuation, water quality improvement, nutrient cycling, food chain support, wildlife/bird habitat.
Slope	Wet meadows on slopes with seeps/springs	Occurs on a slope. Dominant water source is groundwater. Flow is down-gradient.	Water storage, nutrient cycling, food chain support, wildlife/bird habitat.

*Source: Smith et al., 1995.

Wetland Conservation Areas

The Colorado Natural Heritage Program (CNHP) defines a Network of Conservation Areas (NCA) as a collection of Potential Conservation Areas (PCA) that contains similar species or natural communities and ecological processes. An NCA may also be identified as large, relatively undisturbed (e.g., lightly fragmented) landscapes that support wide-ranging species and large disturbances (CNHP 2005a). PCAs include the ecological processes that are necessary to support the continued existence of a particular element of natural heritage significance. PCAs may include a single occurrence of a rare element, or a suite of rare elements or significant features (CNHP 2005b).

The Project Area occurs within a portion of the San Luis Valley Playa Lake Megasite. This NCA includes several playa lake PCAs. According to Rondeau et al. (1998):

> The playa lake ecosystems of the San Luis Valley floor depend upon a complex interaction of surface and groundwater sources which undergo characteristic seasonal and inter-annual fluctuations. Water uses which perturb the timing or magnitude of surface flows, or affect the valley bottom water table, are likely to affect these wetlands detrimentally.

The Project Area also occurs within the western extent of the Baca Grande and Reserve PCA. According to the CNHP (2006) this PCA supports a “fair” occurrence of a globally vulnerable subspecies of the northern pocket gopher. In addition, the three creeks included in the PCA (Willow, Spanish, and Cottonwood) are important water sources for wetlands on the Baca MWR (CNHP 2006).

Upland Habitats

Grasslands

Grasslands occur throughout the Project Area. This vegetation type is typically found in lowland and upland areas on swales, playas, mesa tops, plateau parks, alluvial flats, and plains. The only sub-community in this vegetation type is Alkali Sacaton (*Sporobolus airoides*) Herbaceous Alliance, which is widespread on the valley floor. A sparse to moderately dense graminoid layer of medium-tall bunch grasses with smaller densities of short grasses and forbs characterize this sub-community, with alkali sacaton being the dominant grass. The access road to the Baca #5 location, and the location itself, are located within this vegetation type.

Shrublands

Shrubland is the most dominant vegetation type in the Project Area, and is widespread on the valley floor. Many of the plants within this type are drought resistant and tolerant to a range of soil salinity, conditions common to the valley floor. The most dominant sub-community is the Rubber Rabbitbrush Shrubland Alliance, usually characterized by open to moderately dense, short-shrub layer dominated by rubber rabbitbrush, big sagebrush, broom snakeweed (*Gutierrezia sarothrae*), sand sagebrush (*Artemisia filifolia*) pricklypear cactus (*Opuntia* spp.), yucca (*Yucca* spp.), Indian ricegrass, and blue grama. It is typically found on alluvial fans and flats with moderate to deep soils. This sub-community is dominant throughout the Project Area. The two access roads and Baca #7 well sites are located within this vegetation sub-community.

The Greasewood Shrubland Alliance is found mostly on the west side of the Project Area, with the dominant species being greasewood, four-wing saltbush, alkali sacaton, saltgrass, and spike-rush (*Eleocharis palustris*). This sub-community typically has saline soils, a shallow water table, and floods intermittently, but remains dry for most of the growing season. In both sub-communities, exotic species also are common including cheat grass (*Bromus tectorum*) and crested wheatgrass (*Agropyron cristatum*).

Special Status Plant Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed and federally proposed species that are protected under the Endangered Species Act or are considered as candidates for such listing by the Service, and those species that are state-listed as threatened or endangered.

Within the Project Area, the globally rare Slender spiderflower (*Cleome multicaulis*) is the only rare plant species found. Slender spiderflower is an annual that inhabits saline or alkaline soils at the edge of wetlands or moist meadows, especially where the water table nears the surface. A member of the caper family, population size fluctuates considerably from year-to-year. The species was once found in suitable habitats in south-central Colorado, and from southeastern Arizona to western Texas and to northern New Mexico, and one distinct population in central Wyoming (CNHP 2005a). Drainage of wetlands throughout its range is thought to have decreased the amount of habitat available. This species now occurs almost exclusively in the San Luis Valley, commonly found in the transition area between the Seasonally Flooded Herbaceous Alliance and the Rabbitbrush Shrubland Alliance, where it thrives in moist, slightly saline conditions (USFWS 2005). Sizeable populations of this rare plant are known to occur in the Project Area.

Invasive and Noxious Weeds

Subsequent to disturbance, vegetation communities may be susceptible to infestations of noxious species. These species are most prevalent in areas of prior surface disturbance, such as agricultural areas, roadsides, existing utility rights-of-way, and wildlife concentration area. The prevention of the introduction or spread of noxious and invasive weeds is a high priority to federal, state and county agencies. Under Executive Order (EO) 13112 of February 3, 1999 – Invasive Species, federal agencies shall not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless it has been

determined that the benefits of such actions outweigh the potential harm caused by invasive species and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions.

The terms “noxious weed” and “invasive weed” are often used interchangeably to describe any plant that is unwanted and grows or spreads aggressively. The term “noxious weed” is legally defined under both federal and state laws. Under the Federal Plant Protection Act of 2000 (formally the Noxious Weed Act of 1974 [7 USC SS 2801-2814]), a noxious weed is defined as “any plant or plant product that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment” (Animal and Plant Health Inspection Service 2000; Institute of Public Law 1994). The Federal Plant Protection Act contains a list of 137 federally restricted and regulated federal noxious weeds, as per CFR Title 7, Chapter III, Part 360, including 19 aquatic and wetland weeds, 62 parasitic weeds, and 56 terrestrial weeds. Each state is federally mandated to uphold the rules and regulations set forth by this Act and manage their lands accordingly.

In addition to federal noxious weed lists, Colorado regulates noxious and invasive species through the Colorado Noxious Weed Act, which classifies noxious weeds into three lists, A, B, and C (§§35 5.5-101 through 119, CRS [2003]). Each list has specific control requirements, with the most stringent requirements for those species found on List A. Only List A species are required by law to be controlled (Colorado Department of Agriculture [CDA] 2010). The species that are managed and regulated by the State of Colorado are included in **Table 3-5.**

Noxious weeds of primary concern in the Project Area include:

- Canada thistle (*Cirsium arvense*);
- Perennial pepperweed (*Lepidium latifolium*);
- Russian knapweed (*Acroptilon repens*);
- Salt cedar (*Tamarisk* spp.)

Salt cedar is found primarily along the west side of the playa wetlands in disturbed areas (e.g., roads) in the project vicinity. Russian knapweed is primarily found in the northwest portion of the Project Area, while perennial pepperweed is found farther south and is often found in conjunction with Baltic rush communities. Yellow toadflax (*Linaria vulgaris*) has been reported in the Refuge.

3.6 Wildlife and Fisheries

Recreationally and Economically Important Species and Nongame Wildlife

As discussed in Section 3.5, Vegetation and Habitats, wildlife habitat within the project vicinity consists primarily of semi-desert shrubland, semi-desert grassland, wet meadows, and non-woody riparian habitats. Semi-desert shrubland and semi-desert grassland are the most common wildlife habitats within the Project Area. The project vicinity is characterized by flat to low rolling terrain with intermittent streams, wet meadows, and wetlands. Baseline descriptions of both resident and migratory wildlife include species that have either been documented or that may occur in the Project Area based on habitat associations. Wildlife species are typical of the high mountain semi-desert shrublands of the San Luis Valley. Riparian/wetland habitats found along the drainages and ponds within the project vicinity support a greater diversity and population density of wildlife species than habitat types occurring in the Project Area. However, both Baca #5 and Baca #7 are considered to be in important areas for wintering concentrations of pronghorn, mule deer, and elk by the Colorado Division of Wildlife (CDOW). The COGCC also uses this information on sensitive wildlife habitat (see Appendix VIII at http://cogcc.state.co.us/) to assist in regulating oil and gas activities in Colorado.

Information regarding wildlife species and habitat within the Project Area was obtained from a review of existing published sources, USFWS, CDOW, COGCC, CNHP database information, and a site-specific biological assessment on the Baca Grande property 2 miles east of the proposed Project Area (CNHP 2006). The biological assessment is relevant due to its close proximity to the Project Area and information on special status wildlife species in the San Luis Valley. The survey was conducted by the CNHP in the summer of 2005 and examined the existing use of the Baca Grande by terrestrial and aquatic vertebrates and special status species.

Table 3-12. Noxious Weeds Potentially Occurring within the Project Area

Common Name	Scientific Name	Federal List[1]	Colorado Noxious Weed List[2,3]	Primary Concern for the Refuge
Velvetleaf	*Abutilon theophrasti*		C	
Russian knapweed	*Acroptilon repens*		B	X
Jointed goatgrass	*Aegilops cylindrical*		B	
Camelthorn	*Alhagi pseudalhagi*		A	
Spurred anoda	*Anoda cristata*		B	
Corn chamomile	*Anthemis arvensis*		B	
Mayweed chamomile	*Anthemis cotula*		B	
Common burdock	*Arctium minus*		C	
Absinth wormwood	*Artemisia absinthium*		B	
Downy brome	*Bromus tectorum*		C	
Hoary cress	*Cardaria draba*		B	X
Plumeless thistle	*Carduus acanthoides*		B	
Musk thistle	*Carduus nutans*		B	
Wild caraway	*Carum carvi*		B	
Diffuse knapweed	*Centaurea diffusa*		B	
Spotted knapweed	*Centaurea maculosa*		B	
Meadow knapweed	*Centaurea pratensis*		A	
Yellow starthistle	*Centaurea solstitialis*		A	
Squarrose knapweed	*Centaurea virgata*		A	
Rush skeleton weed	*Chondrilla juncea*		A	
Oxeye daisy	*Chrysanthemum leucanthemum*		B	
Chicory	*Cichorium intybus*		C	
Canada thistle	*Cirsium arvense*		B	X
Bull thistle	*Cirsium vulgare*		B	
Chinese clematis	*Clematis orientalis*		B	
Poison hemlock	*Conium maculatum*		C	
Field bindweed	*Convolvulus arvensis*		C	
Common crupina	*Crupina vulgaris*	X	A	
Houndstongue	*Cynoglossum officinale*		B	
Yellow nutsedge	*Cyperus esculentus*		B	
Common teasel	*Dipsacus fullonum*		B	
Russian-olive	*Elaeagnus angustifolia*		B	
Quackgrass	*Elytrigia repens*		B	
Redstem filaree	*Erodium cicutarium*		C	
Cypress spurge	*Euphorbia cyparissias*		A	
Leafy spurge	*Euphorbia esula*		B	
Myrtle spurge	*Euphorbia myrsinites*		A	
Halogeton	*Halogeton glomeratus*		C	
Dame's rocket	*Hesperis matronalis*		B	
Venice mallow	*Hibiscus trionum*		B	
Orange hawkweed	*Hieracium aurantiacum*		A	
Hydrilla	*Hydrilla verticillata*	X	A	
Black henbane	*Hyoscyamus niger*		B	
Common St. Johnswort	*Hypericum perforatum*		C	
Dyer's woad	*Isatis tinctoria*		A	
Perennial pepperweed	*Lepidium latifolium*		B	X
Sericiea lespedeza	*Lespedeza cuneata*		A	

Table 3-12. Noxious Weeds Potentially Occurring within the Project Area (continued)

Common Name	Scientific Name	Federal List[1]	Colorado Noxious Weed List[2,3]	Primary Concern for the Refuge
Dalmatian toadflax, broad-leaved	*Linaria dalmatica*		B	
Dalmatian toadflax, narrow-leaved	*Linaria genistifolia*		B	
Yellow toadflax	*Linaria vulgaris*		B	
Purple loosestrife	*Lythrum salicaria*		A	
Scentless chamomile	*Matricaria perforate*		B	
Eurasian watermilfoil	*Myriophyllum spicatum*		B	
Scotch cottonthistle	*Onopordum acanthium*		B	
Bull cottonthistle	*Onopordum tauricum*		B	
Wild proso millet	*Panicum miliaceum*		C	
African rue	*Peganum harmala*		A	
Sulfur cinquefoil	*Potentiall recta*		B	
Mediterranean sage	*Salvia aethiopis*		A	
Giant salvinia	*Salvinia molesta*	X	A	
Bouncingbet	*Saponaria officinalis*		B	
Tansy ragwort	*Senecio jacobaea*		A	
Perennial sowthistle	*Sonchus arvensis*		C	
Johnsongrass	*Sorghum halepense*		C	
Medusahead	*Taeniatherum caputmedusae*		A	
Salt Cedar	*Tamarisk* spp.		B	X
Common tansy	*Tanacetum vulgare*		B	
Puncturevine	*Tribulus terrestris*		C	
Moth mullein	*Verbascum blattaria*		B	
Common mullein	*Verbascum Thapsus*		C	

[1] Each state is federally mandated to uphold the rules and regulations set forth by the Federal Plant Protection Act of 2000 (formerly the Noxious Weed Act of 1974 [7 USC SS 2801-2814]).

[2] In the Colorado Noxious Weed Act (§ 35 5.5-101 through 119, CRS [2003]), noxious weeds are classified into three lists, A, B, and C. Each list has specific control requirements, with the most stringent requirements for those species found on List A. List A includes noxious weeds targeted for eradication and for which management plans have been developed for their control. Control of these species is required by law. If these species were found within the Project Area, Lexam will be required to follow the prescribed management techniques stipulated by Colorado's Noxious Weed Act. These techniques must be applied for the duration of the seed longevity for the particular species. List B species are recommended for control, but management plans have not yet been developed for these species and control is not required by law. List C species are generally considered too widespread to effectively control, and control of List C species is not required (CDA 2010).

[3] Saguache County follows the Colorado Noxious weed list..

Source: USDA-APHIS 2010; CDA 2010.

Big Game

Elk, mule deer, and pronghorn are the primary big game species within the Project Area (CDOW 2007a). The Project Area occurs in game management unit 82. In 2009, a total of 449 elk, 125 mule deer, and 88 pronghorn were harvested in unit 82 (CDOW 2010a). Details on each big game species are presented below.

A large herd of resident elk occurs within the vicinity of the Project Area. Elk use a variety of habitat types within the Project Area but primarily occur in wet meadows and shrub-dominated habitats (USFWS 2005). Elk

populations within the Project Area usually peak during winter months (November-March), with populations highest during severe winters (USFWS 2005). The entire Project Area is considered summer range, while the eastern portion of the Project Area is considered severe winter range (CDOW 2007c). Two small areas located in the eastern portion of the Project Area are considered winter concentration areas by CDOW. These areas occur along Crestone, Cottonwood, Spanish, and Willow creeks (CDOW 2007c). **Figure 3-30** presents the designated elk winter range located within the Project Area.

Mule deer are typically found in riparian areas and abandoned agricultural fields (USFWS 2005). The eastern portion of the Project Area is considered winter range (CDOW 2007c). **Figure 3-31** presents the designated mule deer winter range located within the Project Area.

Pronghorn occur throughout the Project Area year-round. Use of the Project Area by pronghorn is highly dependent on water and forage availability. The entire Project Area is considered pronghorn winter range (CDOW 2007c). A small area located in the northern portion of the Project Area is considered a winter concentration area by CDOW (CDOW 2007c). **Figure 3-32** presents the designated pronghorn winter range located within the Project Area.

Big game population numbers fluctuate slightly from year-to-year based on weather and habitat conditions. Water availability and the amount of quality winter habitat are the limiting factors within the Project Area. Water availability, forage quality, cover, and weather patterns typically determine the level of use and movement of big game species through the Project Area.

Mountain lion and black bear also are classified as big game species in Colorado (CDOW 2007a). Both of these species are fairly common in south-central Colorado and occupy the higher elevations of the Sangre de Cristo mountain range east of the Project Area (Fitzgerald et al. 1994). Due to the lack of preferred habitat (i.e., canyons, mesas, brushy hillsides), occurrence within the Project Area by these species would be limited to dispersing individuals.

Small Game and Furbearers

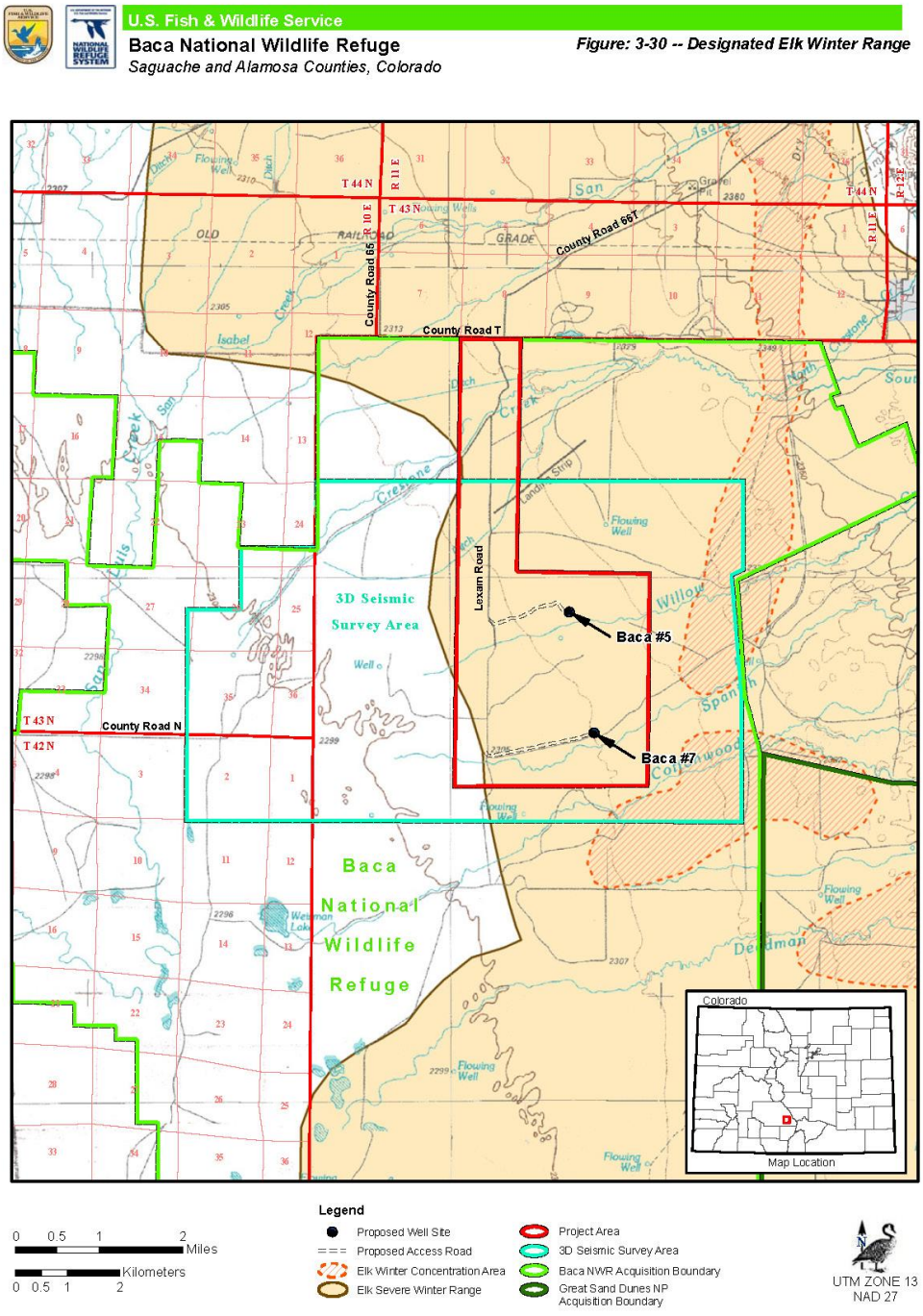
Small game species that occur within the Project Area are mourning dove, cottontail, and white-tailed jackrabbit (USFWS 2005). Currently, there are no upland game birds other than mourning dove found within the project area due to the absence of suitable habitat. Mourning doves are found in a wide range of habitats in close proximity to water and are most likely to occur within the Project Area during spring, summer, and early fall. Furbearers that may occur within the Project Area include the coyote, badger, red fox, bobcat, beaver, muskrat, skunk, and raccoon (Fitzgerald et al. 1994).

The Project Area contains important nesting habitat for waterfowl as well as important staging habitats that are utilized during migration (USFWS 2005). Common species found within the Project Area include Canada goose, mallard, Northern pintail, gadwall, American wigeon, cinnamon, green-winged and blue-winged teal (USFWS 2005). Waterfowl are found throughout the project vicinity in appropriate habitats such as wetlands, ponds, wet meadows, and riparian areas.

Nongame Species

A diversity of nongame species (e.g., small mammals, passerines, raptors, and reptiles) occupy a wide range of trophic levels and habitat types within the Project Area. Habitats (e.g., semi-desert shrublands, wet meadows) support a variety of resident and seasonal nongame species. Nongame mammals include such species as deer mouse, silky pocket mouse, meadow vole, Ord's kangaroo rat, thirteen-lined ground squirrel, Gunnison's prairie dog, and northern pocket gopher (USFWS 2005). The Gunnison's prairie dog is uncommon and is only found in small colonies in the San Luis Valley and south-central Colorado (Fitzgerald et al. 1994). The Gunnison's prairie dog is currently considered a candidate species for protection under the Endangered Species Act of 1973. The northern pocket gopher is a Colorado species of concern, Special Status Wildlife Species. Small mammals provide a substantial prey base for the areas predators including mammals (e.g., coyote, badger, skunk), raptors (eagles, hawks, falcons, owls), and reptile species. Migratory birds potentially occurring in the Project Area are discussed below.

Several bat species may occur within the Project Area including Brazilian free-tailed bat, western small-footed myotis, long-eared myotis, long-legged myotis, hoary bat, and Townsend's big-eared bat (Fitzgerald et al. 1994). The Townsend's big-eared bat is a Colorado species of concern and is discussed below under Special Status Species.

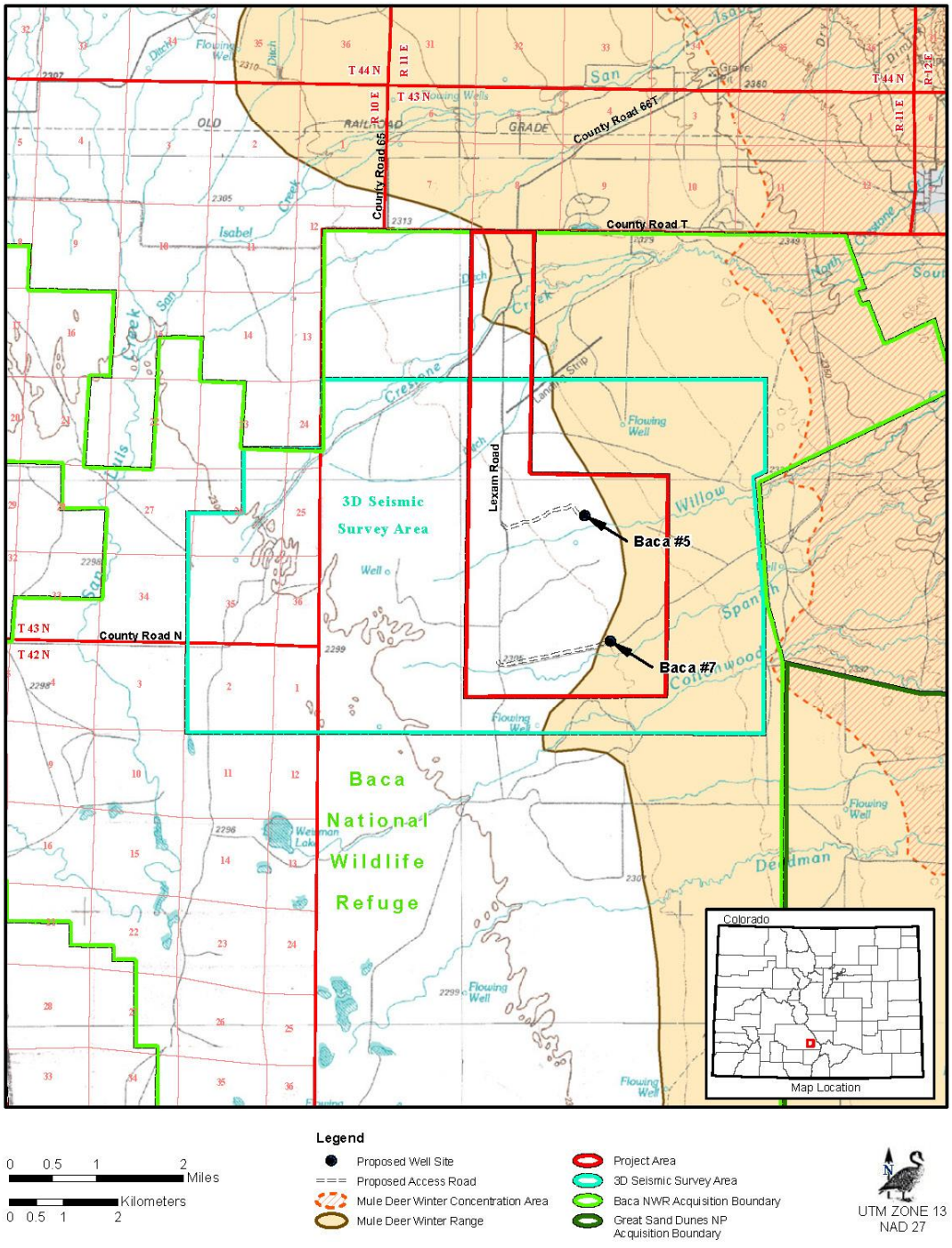


U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure: 3-31 -- Designated Mule Deer Winter Range



0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

Legend

- Proposed Well Site
- Proposed Access Road
- Mule Deer Winter Concentration Area
- Mule Deer Winter Range
- Project Area
- 3D Seismic Survey Area
- Baca NWR Acquisition Boundary
- Great Sand Dunes NP Acquisition Boundary

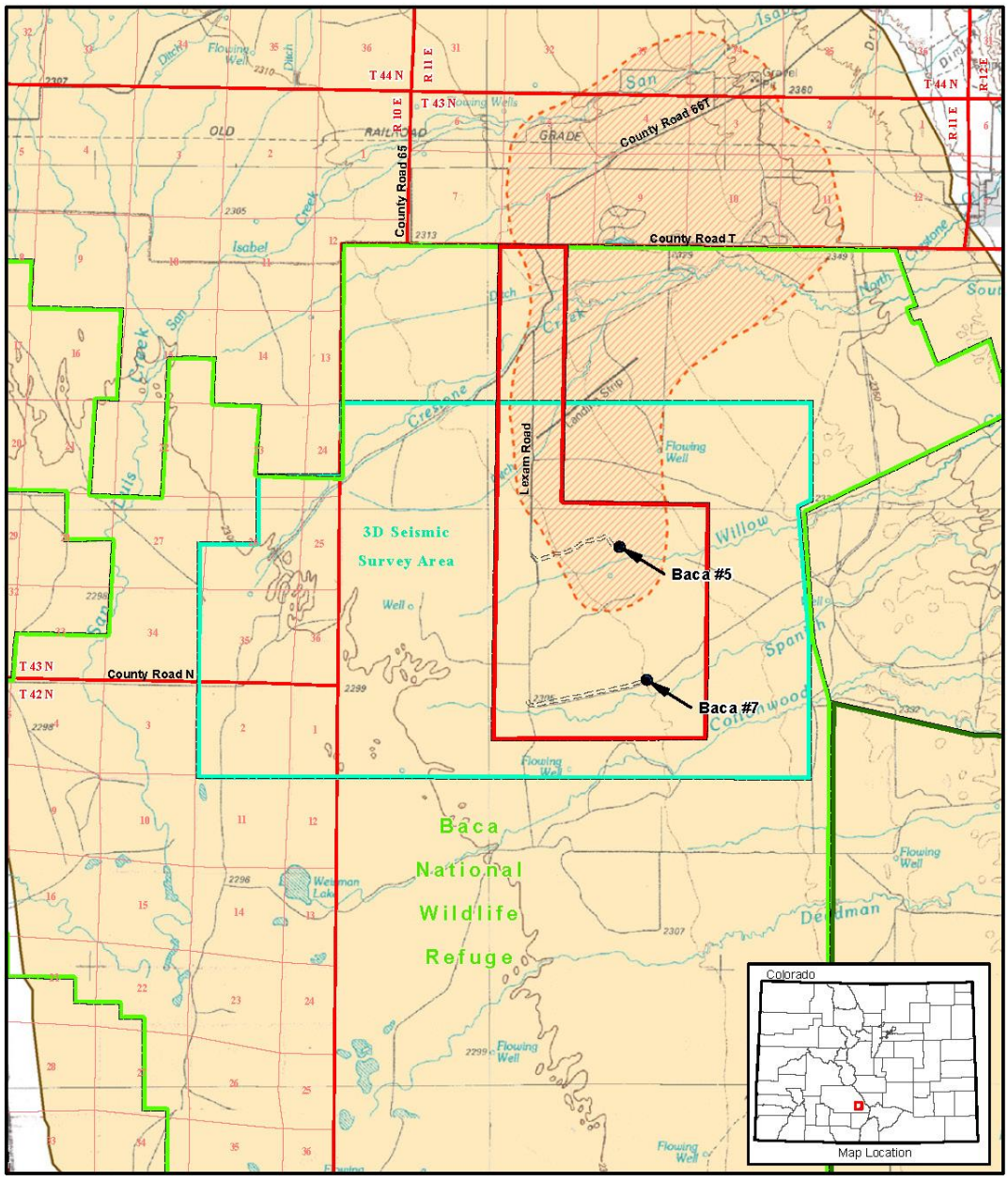
UTM ZONE 13
NAD 27

U.S. Fish & Wildlife Service

Baca National Wildlife Refuge

Saguache and Alamosa Counties, Colorado

Figure: 3-32 -- Designated Pronghorn Winter Range



The Project Area contains important nesting habitat for shorebirds and waterbirds as well as important staging habitats that are utilized during migration (USFWS 2005). Common species found within the Project Area include greater sandhill crane, greater and lesser yellowlegs, American avocet, white-faced ibis, Wilson's phalarope, snipe, sora, and Virginia rail. Shorebirds and waterbirds are found throughout the Project Area in appropriate habitats such as wetlands, ponds, wet meadows, and riparian areas.

Other important nongame species that are found within the Project Area include several species of reptiles and amphibians. These species include the short-horned lizard, bull snake, western garter snake, tiger salamander, chorus frog, Great Plains toad, Woodhouse's toad, Plains spadefoot toad, and northern leopard frog (CDOW 2007c; CNHP 2006; Service and Lexam Explorations 2007; USFWS 2005). The northern leopard frog is a Colorado species of concern and as discussed under Special Status Species.

Migratory Birds

Nongame birds within the project region include a wide range of migratory bird species including neotropical migrants - birds that breed in North America and winter in the neotropical region of South America. These birds are considered integral to natural communities and act as environmental indicators based on their sensitivity to environmental changes caused by human activities. Representative bird species breeding in the project region include yellow warbler, song sparrow, western wood pewee, black-billed magpie, American crow, western meadowlark, and a number of raptor species (see below) [; USFWS 2005; Garcia 2007; USFWS and Lexam Explorations 2007]. Migratory birds are protected under the MBTA (16 USC 703 711) and EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (66 Federal Register 3853).

The San Luis Valley hosts an array of hawks, falcons, owls, and eagles throughout the year. Abundant food sources (e.g., rodents, waterfowl) are found throughout the numerous wetlands, wet meadows, ponds, lakes, and streams that occur in the San Luis Valley (Service and Lexam Explorations 2007). Details on raptor species found within the project vicinity are presented below.

Prairie falcons are common year-round residents within the Project Area and use various habitats extensively for feeding and resting. Red-tailed hawks, Swainson's hawks, and American kestrels nest in the vicinity of the Project Area, primarily in trees and snags scattered along creeks and water delivery canals (Garcia 2007; USFWS and Lexam Explorations 2007).

Northern harriers and short-eared owls likely nest in dense vegetation found in wet meadows and marshes (Garcia 2007; USFWS and Lexam Explorations 2007). Great horned and long-eared owls likely nest in the project vicinity in deciduous trees found along riparian areas and are likely to occur in the banks of incised creeks and water delivery ditches (USFWS and Lexam Explorations 2007).

Species such as ferruginous hawk, rough-legged hawk, northern harrier, short-eared owl, and golden and bald eagles are common winter residents within the Project Area (Service and Lexam Explorations 2007). The hawks, owls, and golden eagles forage for rodents, small mammals, and other prey in riparian areas, uplands, and short-emergent wetlands where cover is abundant. Details on the bald eagle, peregrine falcon, and ferruginous hawk are discussed below under Special Status Species.

Passerine or songbird species occupy the entire range of habitats found within the Project Area. However, due to the higher level of plant diversity and structure, more abundant potential nest sites, and greater food base, the riparian areas and wetlands support the highest diversity of bird species within the seismic survey area. Information on sensitive species such as southwestern willow flycatcher, western yellow-billed cuckoo, mountain plover, and long-billed curlew, as discussed under the Special Status Species section below.

Fisheries

Crestone Creek is inhabited by four native fish species: Rio Grande sucker (*Catostomus plebeius*), Rio Grande chub (*Gila pandora*), fathead minnow (*Pimephales promelas*), and longnose dace (*Rhinichthys cataractae*) (Service and Lexam Explorations 2007). The Rio Grande sucker and Rio Grande chub are discussed in detail under Special Status Species section below.

Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed species that are protected under the ESA, species designated as state endangered or threatened by CDOW, and state species of concern identified by CDOW.

A total of 28 special status species (21 terrestrial and 7 aquatic) were identified as potentially occurring within the Project Area (CDOW 2010b; CNHP 2007; USFWS 2007b, USFWS 2007c). These species, their associated habitats, and their potential for occurrence within the Project Area are summarized in **Table 3-13**. Occurrence potential within the Project Area and cumulative effects area was evaluated for each species based on their habitat requirements and/or known distribution. Based on these evaluations, 10 special status species have been eliminated from detailed analyses based on their habitat requirements and/or known distributions (**Table 3-13**). These species include wolverine, Canada lynx, Gunnison's sage grouse, Mexican spotted owl, boreal toad (2007f), Uncompahgre fritillary butterfly, bonytail chub, razorback sucker, humpback chub, and Colorado pikeminnow. The 18 special status species identified as potentially occurring within the Project Area are described below.

Table 3-13. Special Status Species Identified for the Environmental Assessment of Lexam's Proposed Oil and Gas Exploration

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Mammals				
Townsend's big-eared bat (*Corynorhinus townsendii*)	SC	Range: Occurs throughout the western U.S. Habitat: Highly associated with caves and mines. Very susceptible to disturbance at roost sites. Periodically moves to alternate roosts and actively forages and drinks throughout the winter. Foraging associations include edge habitats along streams, adjacent to and within a variety of wooded habitats.	Moderate. Suitable foraging habitat exists within the Project Area.	No.
Northern pocket gopher (*Thomomys talpoides agrestis*)	SC	Range: This subspecies occurs in the San Luis Valley north and east of the Rio Grande River. Habitat: A wide variety of vegetation communities including semidesert shrublands, grasslands, forests, and alpine tundra.	High. This species has been documented approximately 2 miles east of the Project Area on the Baca Grande.	No.
Black-footed ferret (*Mustela nigripes*)	FE, SE	Range: Isolated locations in South Dakota, Wyoming, Utah, and Colorado. Habitat: Prairie dog colonies. Uses the burrows as living quarters and nurseries.	Low. Suitable habitat occurs within Gunnison's prairie dog colonies within the Project Area. However, the nearest known population is located in northwest Colorado.	Yes.
Wolverine (*Gulo gulo*)	SE	Range: Throughout boreal forest and tundra regions of North America. Several historical records exist for Colorado, although their status is currently unknown. Habitat: Boreal forests, bogs, lowlands, and tundra. Dens are typically in log jams, under rocks and boulders, or under tree roots.	None.	Yes. Lack of suitable habitat occurs within the Project Area.

Table 3-13. Special Status Species Identified for the Environmental Assessment of Lexam's Proposed Oil and Gas Exploration (Continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Canada lynx (*Lynx Canadensis*)	FT, SE	Range: Found throughout Canada and Alaska as well as the high elevation forests of Colorado, Utah, Wyoming, Montana, and Idaho. Habitat: Coniferous forests such as spruce-fir with well-developed understories. Uneven aged stands of spruce-fir with rock outcrops and large boulders are the preferred habitat. Dens are typically under ledges, trees, deadfalls, or occasionally in caves.	None.	Yes. Lack of suitable habitat occurs within the Project Area.
Gunnison's prairie dog (*Cynomys gunnsoni*)	FC	Range: Found in central and south-central Colorado to north-central New Mexico. Habitat: Gently sloping grasslands and semi-desert and montane shrublands at elevations of 6,000 to 12,000 feet.	High. The only colony within the exploration Project Area is approximately three miles north-northwest of Baca #5. This small colony is approximately two acres in size and is on either side of the main access or "Lexam" road that is used by Refuge staff, Refuge permittees and by Lexam.	No.
Birds				
Bald eagle (*Haliaeetus leucocephalus*)	SC	Range: Throughout Colorado, however most breeding occurs along the front range and western parts of the state. Habitat: Generally nests and roosts in close proximity to large water bodies including rivers, lakes, and reservoirs. Nests in large trees such as cottonwood and ponderosa pine. Breeding season is February 15-July 15.	Moderate. Occurrence is limited migrating and wintering individuals. Most of the bald eagle use is along Crestone Creek northeast of the Project Area.	No.

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (Continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Ferruginous hawk (*Buteo regalisi*)	SC	Range: Throughout the Great Plains and grassland/shrub-steppe areas of western North America. Habitat: Open grassland and shrub-steppe habitats. Nests on the ground, usually on a hill or rock outcrop. Forages over open country. Breeding season is March 15-July 15.	High. This species has been documented foraging around wetlands and marshes within the Project Area. However, no known nesting habitat occurs within the vicinity of the Project Area.	No.
American Peregrine Falcon (*Falco peregrinus anatum*)	SC	Range: Primarily found in western Colorado but breeding pairs also are found along the front range. Habitat: Foothill and mountain cliffs surrounded by pinyon-juniper or ponderosa pine woodlands. Nest sites consist of a small depression on a cliff ledge. Breeding season is March 15-July 15.	High. This species has been documented foraging around wetlands and marshes within the Project Area. However, no known nesting habitat occurs within the vicinity of the Project Area.	No.
Gunnison sage-grouse (*Centrocercus minimus*)	FC, SC	Range: In Colorado, this species is found primarily in Gunnison county with small scattered populations in Montrose, San Miguel, Mesa and Saguache counties. Habitat: Sagebrush grasslands. Leks are located in open areas in close proximity to escape cover. Nests are located in sagebrush habitat, typically within 2 miles of the lek. Broods are raised in wet, grassy areas near sagebrush. Winter habitat consists of south and east facing slopes with minimal snow cover. Breeding season is March 15-July 1.	None.	Yes. The nearest population is a small introduced population restricted to an area approximately 25 miles northwest of the Project Area.
Greater sandhill crane (*Grus canadensis tabida*)	SC	Range: In Colorado, this species breeds in the northwest portion of the state and migrates through the San Luis Valley in the fall and spring. Habitat: Flooded fields, wetlands, marshes, meadows, and agricultural fields. Breeding season is April 1-July 15.	High. A large number of greater sandhill cranes, part of the Rocky Mountain population, migrate through the San Luis Valley in the fall and spring.	No.

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (Continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Western snowy plover (*Charadrius alexandrinus*)	FT, SC	Range: Found along manmade reservoirs in southeast Colorado and alkali-covered playas in the San Luis Valley. Habitat: sandy beaches, dry salt flats, river bars, and alkali covered playas. Breeding season is April 1 – July 15.	High. This species has been documented approximately 15 miles south of the Project Area near San Luis Lake. .	No.
Mountain plover (*Charadrius montanus)*	FP, SC	Range: Western North America with the largest breeding populations found in Colorado and eastern Montana. Habitat: Native short-grass prairie, stunted shrublands, agricultural fields, and overgrazed pastures. Breeding season is April 1-July 15.	High. Very few records exist for the San Luis Valley although this species was observed east of the Project Area on the Baca Grande in 2005. Suitable habitat occurs within the Project Area.	No.
Long-billed curlew (*Numenius americanus*)	SC	Range: Found primarily in southeastern Colorado with isolated populations in the northeast and northwest Colorado. Habitat: Short-grass prairie with scattered playas. Feeds along lake and reservoir edges during migration. Breeding season is April 1-July 15.	Moderate. This species has been documented migrating through the Project Area. Suitable nesting habitat occurs within the Project Area.	No.
Western yellow-billed cuckoo (*Coccyzus americanus*)	FC, SC	Range: In Colorado, this species is primarily found west of the continental divide along riparian areas. Habitat: Old growth riparian woodlands with dense understory. Nests are typically located high in trees with closed canopies. Breeding season is April 15-July 15.	Low. This species has been documented in dense, old- growth cottonwood forests on McIntire Springs approximately 35 miles south of the Project Area. Suitable habitat occurs in the vicinity of the Project Area.	No.

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Mexican spotted owl (*Strix occidentalis lucida*)	FT, ST	Range: In Colorado, this species is found in the south-central and southwest portions of the state. Habitat: In south-central Colorado, this species prefers deep rocky canyons with tall old growth conifers such as white pine and Douglas fir. In southwest Colorado, this species is found in narrow slick-rock canyons that cut through pinyon-juniper woodlands. Breeding season is March 15-July 15.	None.	Yes. Lack of suitable habitat (i.e., deep rocky canyons with tall conifers) occurs within the Project Area.
Burrowing owl (*Athene cunicularia*)	ST	Range: Found primarily in eastern Colorado as a summer resident although small populations occur in the western Colorado and the San Luis Valley. Habitat: Open country from desert scrub to grasslands. Often found in or around prairie dog colonies. Nests in burrows. Breeding season is March 15-August 15.	High. This species has been documented nesting at several locations in the vicinity of the Project Area.	No.
Southwestern willow flycatcher (*Empidonax traillii extimus*)	FE, SE	Range: Southwestern U.S. and Mexico. In Colorado, this species has been found in the southwest corner of the state and the San Luis Valley. Habitat: Riparian areas with a well developed willow component. Breeding season is April 15-July 15.	Low. This species has been documented at Rio Grande and Higel State Wildlife Areas approximately 25 miles southwest of the Project Area. Suitable habitat occurs in the vicinity of the Project Area.	No.
Amphibians				
Boreal toad (*Bufo boreas boreas*)	SE	Range: In Colorado, this species is restricted to the Rocky Mountains and is found at elevations between 7,000 and 12,000 feet. Habitat: Restricted to areas with suitable breeding habitat in spruce-fir forests and alpine meadows. Breeding habitat includes lakes, marshes, ponds, and bogs with sunny exposures and quiet, shallow water. Breeding season is April 15-August 15.	None.	Yes. Lack of suitable habitat (e.g., high elevation spruce-fir forests, alpine meadows) occurs within the Project Area.

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Northern leopard frog (*Rana pipiens*)	SC	Range: Once the most widespread frog species in North America, this species has been drastically declining in the last 50 years. In Colorado, this species is found statewide except for the southeast and east-central portion of the state. Habitat: Typical habitats include wet meadows and the banks and shallows of marshes, ponds, glacial kettle ponds, beaver ponds, lakes, reservoirs, streams, and irrigation ditches. Breeding season is April 15-August 15.	High. Suitable habitat exists within the Project Area.	No.
Invertebrates				
Uncompahgre fritillary butterfly (*Boloria Acrocnema)*	FE	Range: This butterfly is endemic to the high alpine meadows of the San Juan Mountains in southwestern Colorado. Habitat: This species of butterfly lives in patches of snow willow (*Salix* spp.) at high elevations as well as moist tundra with dwarf willows above 13,000 feet.	None.	Yes. Project area is outside of species range and a lack of suitable habitat occurs within the Project Area.
Fish				
Bonytail chub (*Gila elegans*)	FE, SE	Range: Historically, bonytail chub were present in the Colorado River system, which includes the Yampa, Green, Colorado and Gunnison rivers. Today, there are no known populations in Colorado. They can be found in the Green River drainage in Utah and Mohave Reservoir on the Arizona-Nevada border. Habitat: This fish typically lives in large, fast-flowing waterways of the Colorado River system.	None.	Yes. The Project Area does not occur within the known range of this species.

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (Continued)

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Razorback sucker (*Xyrauchen Texanus*)	FE, SE	Range: Originally widespread in the Colorado River system, wild populations were reduced to a small number of individuals in the Yampa, Colorado and Gunnison rivers in Colorado. Reproducing populations remain only in the middle Green River in Utah and in an off-channel pond in the Colorado River near Grand Junction. Habitat: This species is found in deep, clear to turbid waters of large rivers and some reservoirs over mud, sand or gravel.	None.	Yes. The Project Area does not occur within the known range of this species.
Humpback chub (*Gila cypha*)	FE, ST	Range: The historic range of the humpback is similar to the Colorado pikeminnow, occurring in great numbers throughout the Colorado River system from Green River in Wyoming to the Gulf of California in Mexico. Today, they can be found in deep, canyon-bound portions of the Colorado River system such as Black Rocks and Westwater canyons on the Colorado River and Yampa Canyon inside Dinosaur National Monument. Habitat: This species prefers deep, fast moving, turbid waters often associated with large boulders and steep cliffs.	None.	Yes. The Project Area does not occur within the known range of this species.
Colorado pikeminnow (*Ptychocheilus lucius*)	FE, ST	Range: Historically, the Colorado pikeminnow occurred in great numbers throughout the Colorado River system from Green River in Wyoming to the Gulf of California in Mexico. In Colorado, they are currently found in the Green, Yampa, White, Colorado, Gunnison, San Juan and Dolores rivers. Habitat: This species thrives in swift flowing muddy rivers with quiet, warm backwaters.	None.	Yes. The Project Area does not occur within the known range of this species.

Table 3-13. Special Status Species Identified for this Draft Environmental Assessment (continued)

Common Name/ Scientific Name	Status	Range/ Habitat Requirements	Potential for Occurrence on or Near the Project Area	Eliminated from Detailed Analysis
Rio Grande sucker (*Catostomus Plebeius*)	SE	Range: Historically, this species was found throughout the Rio Grande river system. In Colorado, this species is now limited to several small tributaries of the Rio Grande River. Habitat: This species prefers small streams with clear water, pools, and riffles.	High. This species was documented near the Project Area in Crestone Creek by CDOW in 2005.	No.
Rio Grande chub (*Gila Pandora*)	SC	Range: In Colorado, this species range is restricted to the Rio Grande Basin. Habitat: This species prefers pools of small to moderate streams near areas of current.	High. This species was documented near the Project Area in Crestone Creek by CDOW in 2005. It also has been documented 1.5 miles north of Weisman Lake.	No.
Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*)	FC, SC	Range: In Colorado, this species range is confined to the headwaters of the Rio Grande surrounding the San Luis Valley. Habitat: This species like other cutthroat trout species prefers clear, cold streams and lakes.	Moderate. This species is known to occur in the Saguache Creek drainage west of the Project Area and in the San Luis Creek drainage northwest of the Project Area.	No. This species occurs in perennial streams, but has never been documented in Crestone Creek, the only perennial stream in the Project Area.

[1] Status:
- FE - Federally Endangered
- FT - Federally Threatened
- FC - Federal Candidate
- FP - Federally Proposed
- SE - State Endangered
- ST - State Threatened
- SC - State Species of Concern

Source: Butterfly Conservation Initiative 2007; Black-footed Ferret Recovery Program 2007; CDOW 2010b, 2007a,b,c,e,f, 2003, 2002; CNHP 2007, 2006; Ellison et al. 2003; Fitzgerald et al. 1994; Garcia 2007; Gray 1998; Gunnison's Sage-grouse Rangewide Steering Committee 2005; Johnsgard 1990; Kingery 1998; USFWS and Lexam Explorations 2007; USFWS 2007b,c; USFWS 2005; Woodling 1985).

Mammals

Townsend's big-eared Bat (SC). The Townsend's big-eared bat (*Plecotus townsendii*) occurs throughout Colorado but is largely absent for the eastern plains (Fitzgerald et al. 1994). This species is most commonly found in desert shrublands, pinyon-juniper woodlands, and open montane forests (Fitzgerald et al. 1994).This species is highly associated with caves and mines. The Townsend's big-eared bat is very susceptible to disturbance at roost sites (Fitzgerald et al. 1994). This species periodically moves to alternate roosts and actively forages and drinks throughout the winter. Common foraging associations include edge habitats along streams, adjacent to and within a variety of wooded habitats (Fitzgerald et al. 1994). Although this species has not been documented within the Project Area (Garcia 2007), suitable foraging habitat occurs within the Project Area. The potential for this species to occur within the Project Area is considered moderate.

Northern Pocket Gopher (SC). The northern pocket gopher (*Thomomys talpoides agrestis*) occurs in the San Luis Valley north and east of the Rio Grande River (Fitzgerald et al. 1994). This species inhabits a wide variety of habitats including desert shrublands, grasslands, forests, and alpine tundra. This species was documented in 2005 by CNHP on the Baca Grande 1 mile east of the Project Area (CNHP 2006). The potential for this species to occur within the Project Area is considered high.

Black-footed Ferret (FE, SE). The black-footed ferret (*Mustela nigripes*) is known only from a reintroduced population in northwestern Colorado (CDOW 2007d). Black-footed ferrets are considered obligate associates to prairie dogs, which constitute their primary food source and provide burrows for shelter (Black-footed Ferret Recovery Program 2007; CDOW 2007d; Fitzgerald et al. 1994). Although the Refuge occurs within the historic range of the black-footed ferret, this species is presently restricted to reintroduced populations in Arizona, northwestern Colorado, Montana, South Dakota, north-central Utah, and Wyoming; however, remnant ferret populations may exist in portions of its former range (Black-footed Ferret Recovery Program 2007). Potentially suitable habitat within Gunnison's prairie dog colonies occurs within the Project Area. No designated critical habitat has been established for the ferret. Based on the current distribution of this species, the potential for this species to occur within the Project Area is considered low.

Gunnison's prairie dog (FC). The Gunnison's prairie dog (*Cynomys gunnisoni*) in the montane portion of its range is considered a candidate for listing under the federal Endangered Species Act. The montane portion of the range is generally described as the San Luis Valley, Gunnison Basin and South Park in Colorado, extending south into north-central New Mexico, (Seglund, A.E. and P.M Schnurr. 2010). Sylvatic plague has been identified as the only significant factor affecting the future conservation of the species (Federal Register. 2008*b*.) The Baca National Wildlife Refuge is the site of a number of Gunnison's prairie dog colonies and therefore the potential for this species to occur within the Project Area is considered high. The only colony within the exploration Project Area is approximately three miles to the north-northwest of Lexam's of the proposed Baca #5 exploration well. This small colony of approximately two acres in size is on either side of the Lexam road that is used by Refuge staff, Refuge permittees and by Lexam.

Birds

Bald Eagle (SC). The bald eagle (*Haliaeetus leucocephalus*) is primarily a winter migrant throughout Colorado, although bald eagle nests have been documented throughout Colorado, primarily along river, lakes and reservoirs. Primary wintering areas for this species in Colorado include the South Platte, Arkansas, White, Colorado, and Yampa rivers (Gray 1998). Bald eagles typically select very large, open canopy trees such as cottonwood and ponderosa pine for nesting (Johnsgard 1990; Kingery 1998). Within the Project Area, bald eagles primarily feed on waterfowl and carrion. Most of the bald eagle use near the Project Area occurs along Crestone Creek (Service and Lexam Explorations 2007). CDOW considers the entire Project Area winter range and a small area northeast of the Project Area along Crestone Creek as roosting habitat. No known nest sites occur within the vicinity of the Project Area (CDOW 2007e). The potential for this species to occur within the Project Area is considered moderate.

Ferruginous Hawk (SC). Ferruginous hawks (*Buteo regalis*) are found throughout the Great Plains and shrubsteppe areas of western North America (Johnsgard 1990; Kingery 1998). In Colorado, this species is typically found in arid to semiarid regions, as well as grasslands and agricultural areas. Most breeding records

occur on the eastern plains, northwest Colorado, and San Luis Valley (Kingery 1998). This species forages over open country and typically nests on cliff faces, rock outcrops, and grassy knolls but may also nest in pinyon-juniper woodlands (Johnsgard 1990; Kingery 1998). In Colorado, nesting can begin as early as mid-March and last through July (Kingery 1998). This species has been documented nesting in the vicinity of the Project Area (Garcia 2007; USFWS and Lexam Explorations 2007). The potential for this species to occur within the project area is considered high.

American Peregrine Falcon (SC). The peregrine falcon (*Falco peregrinus*) is found throughout western Colorado in areas of suitable habitat. This species prefers areas with suitable nesting habitat (i.e., ledges on tall cliffs) with pinyon-juniper or ponderosa pine woodlands nearby (Johnsgard 1990; Kingery 1998). In Colorado, peregrine falcons arrive at their nesting areas in March and typically begin nesting by April (Kingery1998). This species hunts for shorebirds and other small water birds in the wetlands and short-emergent vegetation wetlands within the Project Area during spring and fall migration (Service and Lexam Explorations 2007). There are no known nesting areas in the immediate vicinity of the Project Area (CDOW 2007e). Suitable foraging habitat occurs within the Project Area. The potential of this species to occur within the Project Area is considered moderate.

Greater Sandhill Crane (SC). In Colorado, the greater sandhill crane (*Grus canadensis*) breeds in northwest Colorado and migrates through the San Luis Valley in the spring and fall in route to wintering grounds in New Mexico (Kingery 1998). This species inhabits a wide variety of habitats including wetlands, flooded fields, beaver ponds, marshes, wet meadows. Greater sandhill cranes arrive in the San Luis Valley in late February and begin courtship in March (Kingery 1998). This species has been documented using flooded meadows and wetlands within the Project Area (USFWS 2005). The potential for this species to occur within the Project Area is considered high.

Western Snowy Plover (FT, SC). The western snowy plover (*Charadrius alexandrinus*) is considered a rare migrant and rare breeder in Colorado. This species utilizes broad, alkali beaches of manmade reservoirs and typically nests within a shallow depression (Kingery 1998). This species has successfully adapted to nesting on the shores of irrigation storage reservoirs. Western snowy plovers arrive in Colorado in early April and typically nests in late April and May. Nests have been documented at several southeastern Colorado reservoirs along the Arkansas River and in the San Luis Valley (Kingery 1998). This species has been documented nesting at San Luis Lake approximately 15 miles south of the Project Area (Kingery 1998). The potential for this species to occur within the Project Area is considered low as habitat for this species is not present in Project Area.

Mountain Plover (FP, SC). In Colorado, mountain plovers (*Charadrius montanus*) are found on the eastern plains and intermountain parks and valleys including North Park, South Park, and the San Luis Valley (Kingery 1998). Breeding habitat for the mountain plover in the San Luis Valley is characterized as semi-desert shrublands (Kingery 1998). In the San Luis Valley, mountain plovers use flat, sparsely vegetated areas with stunted shrubs and widely spaced dwarf rabbitbrush (Kingery 1998). This species generally arrive on their breeding grounds from mid-March through mid April. Nests are typically built in a slight depression on bare or open ground (Kingery 1998). Eggs are typically laid in May, averaging three per clutch. Mountain plovers typically migrate from their breeding grounds in early August to late September to wintering grounds located from Texas to southern California (Kingery 1998). This species was documented in 2005 by CNHP on the Baca Grande east of the Project Area (CNHP 2006). The potential for this species to occur within the Project Area is considered high.

Long-billed Curlew (SC). The long-billed curlew (*Numenius americanus*) is found mainly in southeastern Colorado with additional small populations found in northeastern and northwestern Colorado (Kingery 1998). This species prefers open, sparsely vegetated habitats such as short-grass prairie with scattered wetlands and playas. Adults typically arrive on breeding grounds in April and lay eggs by May. Very few breeding records exist for the San Luis Valley, although suitable nesting habitat occurs within the Project Area (USFWS 2005). This species has been documented migrating through the Project Area (Garcia 2007). The potential for this species to occur within the Project Area is considered to be high in the Project Area.

Western Yellow-billed Cuckoo (FC, SC). The western yellow-billed cuckoo (*Coccyzus americanus*) is limited to west of the Continental Divide in Colorado although small scattered populations occur in the San Luis Valley (USFWS 2005). Typical habitat of the western yellow-billed cuckoo consists of old growth riparian woodlands with dense understory (Kingery 1998). Nests are typically located high in trees with closed canopies. Nesting peaks

later (mid-June through August) than in most co-occurring bird species, and may be triggered by an abundance of the cicadas, katydids, caterpillars, or other large prey that form the bulk of their diet. The species is inconspicuous on its breeding range, except when calling to attract or to contact mates (Kingery 1998).This species has been documented in the San Luis Valley in dense, old-growth cottonwoods on McIntire Springs approximately 35 miles south of the Project Area (USFWS 2005). Suitable habitat occurs in the vicinity of the Project Area for this species along riparian areas (USFWS 2005). The potential for this species to occur within the Project Area is considered low.

Burrowing Owl (ST). The burrowing owl (*Athene cunicularia*) is typically associated with prairie dog colonies and heavily grazed tracts of mixed-grass prairie. In Colorado, this species is found on the eastern plains, intermountain parks and valleys, and western portions of the state including areas around Cortez and Grand Junction (Kingery 1998). Habitat typically consists of desert-shrublands and grasslands with sparse vegetation and abundant burrows (Kingery 1998). This species arrives in Colorado in late March or early April and begins nesting by late April (Kingery 1998). The breeding season is typically March 15-August 15. Burrowing owls nest in rodent burrows in areas with sparse vegetation and several nesting records have been recorded in the San Luis Valley (Kingery 1998). This species has been documented nesting in the vicinity of the Project Area (Garcia 2007; USFWS and Lexam Explorations 2007). The potential for this species to occur within the Project Area is considered high.

Southwestern Willow Flycatcher (FE, SE). The Service (1995a) listed the southwestern willow flycatcher (*Empidonax trailli extimus*) as an endangered species on February 27, 1995. The breeding range of the southwestern willow flycatcher includes southern California, Arizona, New Mexico, extreme southern portions of Nevada and Utah, far western Texas, southwestern Colorado, and extreme northwestern Mexico (Service 2007b). The southwestern willow flycatcher historically nested primarily in willows, buttonbush, and coyote brush, with a scattered overstory of cottonwood (USFWS 2005). This species nests in dense riparian habitats from sea level to approximately 8,500 feet in Arizona and southwestern Colorado. This species still nests in native vegetation where available, but has been known to nest in thickets dominated by *Tamarisk* spp. (Service 2007b). The southwestern willow flycatcher typically builds a nest near surface water or the damp soil of intermittent streams that support the riparian vegetation. Nests are cup-shaped made constructed of plant material usually 3 to 15 feet aboveground in a fork or on a horizontal branch of a medium-sized bush or small tree with dense vegetation above and around the nest (USFWS 2005). The southwestern willow flycatcher arrives on breeding grounds in late April and May, nesting typically begins in May and June and young usually fledge from late June into mid-August (USFWS 2007b). Surveys to document the presence of southwestern willow flycatcher within the Project Area have not been conducted to date. Suitable habitat occurs in the vicinity of the Project Area for this species along riparian areas (USFWS 2005). This species has been documented by CDOW at Rio Grande and Higel State Wildlife Areas approximately 25 miles southwest of the Project Area and Alamosa NWR approximately 30 miles south of the Project Area (CDOW 2003, 2002). The potential for this species to occur within the Project Area is considered low.

Amphibians

Northern Leopard Frog (SC). The northern leopard frog (*Rana pipiens*) was once considered the most widespread frog species in North America. In Colorado, this species is found throughout the state except for the southeast and east-central portions of the state (CDOW 2007c). This species prefers wet meadows and the banks and shallows of marshes, ponds, glacial kettle ponds, lakes, reservoirs, streams, and irrigation ditches (CDOW 2007c). The breeding season for this species is April 15-August 15. The potential for this species to occur within the Project Area is considered high.

Fish

Rio Grande Sucker (SE). The Rio Grande sucker (*Catostomus plebeius*) occurs exclusively in the Rio Grande basin from Colorado to Mexico (CDOW 2007e; Woodling 1985). In Colorado, this species is limited to small creeks and springs within the San Luis Valley such as Hot Creek and McIntyre Springs (CDOW 2007e; Woodling 1985). This species prefers backwaters and pools near rapidly flowing water (Woodling 1985). The Rio Grande sucker typically spawns from February to April and may spawn a second time in late summer (Woodling 1985).

This species was documented near the Project Area in 2005 by CDOW in Crestone Creek and laterals in the Project Area (CNHP 2006). The potential for this species to occur within the Project Area is considered high.

Rio Grande Chub (SC). The Rio Grande chub (*Gila pandora*) occurs in a single area in Texas, and north through the Rio Grande and Pecos River drainages of New Mexico into southern Colorado (Woodling 1985). In Colorado, this species is found exclusively in the Rio Grande basin in pools of small streams and creeks. The Rio Grande chub prefers streams with undercut banks, overhanging bank vegetation, and aquatic vegetation (CDOW 2007e; Woodling 1985). The spawning period for this species is largely unknown although it most likely mimics that of the Rio Grande sucker. This species was documented near the Project Area in 2005 by CDOW in a ditch associated with Crestone Creek and at a spring 1.5 miles north of Weisman Lake (CNHP 2007, 2006). The potential for this species to occur within the Project Area is considered high.

Rio Grande Cutthroat Trout (FC, SC). The Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) occurs in the headwaters of the Rio Grande River surrounding the San Luis Valley. This species prefers clear, cold streams and lakes, and shallow riffles and runs for spawning (CDOW 2007e). The spawning period for this species is roughly March-July depending on water temperature (CDOW 2007e). The Rio Grande cutthroat trout is known to occur in the Saguache Creek drainage west of the Project Area and in the San Luis Creek drainage northwest of the Project Area (CDOW 2007c). The potential for this species to occur within the Project Area is considered moderate. The Rio Grande Cutthroat trout was determined by the Service to be warranted for listing under the Endangered Species Act but precluded from listing due to higher priorities. Consequently it is considered a "Candidate" for listing and a proposed listing rule will be developed when priorities allow (Federal Register 2008).

3.7 Cultural Resources

Regulatory Framework

Cultural resources on all federal lands are regulated by a series of federal laws enacted to protect these resources from damage or loss due to federally funded activities or private undertakings on federally managed lands. The public's recognition that these non-renewable resources are important and should be protected began very early in the 20th century and continues to the present. Three of the most important laws are the National Historic Preservation Act (NHPA) of 1966, as amended; the American Indian Religious Freedom Act (AIRFA) of 1978; and the Archaeological Resource Protection Act (ARPA) of 1979. EO 11593 also provides necessary guidance on protection and enhancement of cultural resources. New legislation and emphases that have come to the forefront over the past 20 years include the Native American Graves Protection and Repatriation Act NAGPRA) of 1990, EO 13007, the consideration of historic and traditional landscapes, and the increased awareness of and consultation for traditional cultural properties.

Section 106 of NHPA, outlining the process for identifying, evaluating, conducting consultation, determining effects, and resolving impacts to historic properties, was followed during Lexam activities on the Refuge and will continue to be followed for future activities. This was accomplished by inventorying proposed disturbance areas or area of potential effect (APE), evaluating site importance and eligibility to the National Register of Historic Places (NRHP), assessing the effect of the Preferred Alternative on NRHP-eligible sites, and consulting with appropriate historic preservation agencies. The APE for the Lexam project includes the proposed well pads, plus a 100-foot buffer, and the proposed access roads, plus a 50-foot buffer on either side of each road. .

Cultural Resources Investigations

Cultural studies were conducted on the Refuge in 2006 and 2007 and the results of those studies are discussed below.

In the fall of 2006, TRC Mariah Associates Inc. (TRC Mariah) conducted cultural resource investigations on portions of the Refuge on behalf of the Service, Region 6, and Lexam (TRC Mariah 2006). These investigations included Class I and Class III inventories. Class I inventories are a review of reports containing the results of previously conducted surveys in the proposed Project Area, as well as library and archival sources for regional

prehistory and history. Class III inventories are intensive field surveys of areas in which potential impacts are anticipated or are likely to occur.

On September 20, 2006, TRC Mariah conducted a Class I file search using the Compass on-line cultural resources database of the Colorado Historical Society. The file search indicated that no cultural resource inventories were previously conducted, and no sites have been previously documented within the APE.

From September 29 through October 1, 2006, TRC Mariah conducted a Class III cultural resource inventory of the proposed Baca #5 well pad and access road within the Refuge. The survey boundary consisted of a 10-acre block centered on the proposed well pad location and a 100-foot-wide corridor centered on the access road centerline. A total of 37.6 acres was inventoried on federal land administered by the Service.

As a result of the Class III inventory, a total of two sites (5SH3146 and 5SH3147.1) and four isolates (5SH3148, 5SH3149, 5SH3150, and 5SH3151) were recorded. The sites included a prehistoric lithic scatter and historic canal. All of the isolates are prehistoric.

Site 5SH3146 consists of a sparse disperse lithic scatter that included one basalt and four obsidian flakes. No features, diagnostic artifacts, or other unique artifacts were located during the inventory. Intensive inspection of the sand sheet in and around the site boundary did not reveal any evidence of buried cultural deposits or soils. two shovel tests were dug within the site boundary to a depth of approximately 20 inches. Neither shovel test encountered any buried cultural deposits or soils. As a result of the inventory and shovel testing, the site was recommended by the Service as not eligible for the NRHP, and in a letter dated December 7, 2006, the Colorado State Historic Preservation Office (SHPO) concurred with the eligibility determination (Contiguglia 2006).

Site 5SH3147.1 is a canal that measures approximately 3 to 4 feet wide and 1 foot deep and will be crossed by a proposed access road. The canal is a named, adjudicated canal listed in the 1901 Decree Book, Water District No. 25, Saguache County, Colorado, and is part of the irrigation system associated with the post-Spanish period settlement and homesteading of the San Luis Valley. The canal was recommended by the Service as eligible for the NRHP, and the SHPO concurred with the eligibility determination (Contiguglia 2006).

Four isolates were located during the Class III inventory. Isolate 5SH3148 consists of a single piece of limestone heat-altered rock. Isolate 5SH3149 consists of a basalt projectile point base. The remaining two isolates, SH3150 and 5SH3151, consist of a white chert projectile point and a brown chert modified flake, respectively. All four of the isolates are not eligible for the NRHP (Contiguglia 2006).

Subsequent to the Class III inventory conducted for the proposed Baca #5 well pad and access road, TRC Mariah conducted a Class III inventory for Lexam's Baca 3D Seismic Project, which encompasses the currently proposed well pads and access roads (TRC Mariah 2007). A total of 325.9 miles (2,607 acres) of proposed seismic lines, access roads, and fence lines were inventoried within the Refuge. The inventory was conducted from mid-October to mid-November 2006.

A total of 61 sites and 96 isolated finds were recorded during the Baca 3D Seismic Project Class III inventory. A total of 39 of the sites are prehistoric open camps, 5 are historic sites (cow camp, bridge, and artifact scatters), 3 sites are multi-component sites containing both prehistoric and historic components, and 14 are segments of historic canal systems. The isolated finds primarily are prehistoric lithic, groundstone, or heat-altered rock remains, and a few are historic trash.

All of the canals segments were recommended by the Service as eligible for the NRHP. A total of 37 of the remaining 47 sites were unevaluated prehistoric sites and 1 was an unevaluated historic site. Additional data were recommended for these 38 sites in order to determine their NRHP eligibility. A total of 9 sites and the 96 isolated finds were recommended as not eligible for the NRHP. In a letter dated January 29, 2007, the Colorado SHPO concurred with the NRHP eligibility determination for the 9 sites and 96 isolated finds and that additional data were necessary to determine the eligibility of the 38 sites (Contiguglia 2007).

The 38 sites that were either eligible for the NRHP or needed additional data were avoided during seismic activities by rerouting those activities around the sites. To avoid impact to the NRHP-eligible canals by seismic

vehicles, the vehicles were driven over the canals when the ground was frozen. This protection measure was reviewed by the Service and submitted to the SHPO for review and concurrence prior to initiation of seismic activities. In a letter dated January 29, 2007, the Colorado SHPO concurred that no adverse effects will occur to the canals since vehicular traffic would take place when the ground was frozen (Contiguglia 2007).

From September 24 through September 27 2007, Western Cultural Resource Management, Inc. (WCRM) conducted a Class III cultural resource study of the Baca #7 drill pad, associated access road and a water line route (Mehls and Lennon. 2007). The survey boundaries consisted of a 10-acre block centered on the proposed well pad and a 100-foot-wide corridor centered on the access roads center line.

As a result of the Class III inventory, eight new sites and five previously recorded site segments were documented. The newly recorded sites are laterals associated with three previously recorded irrigation ditches: the Willow Creek Ditch Lateral (5SH3336), the Baca Grant No. 4, Ditch 17 (5SH3341), and the Baca Grant No. 4, Ditch 18 (5SH3342). These sites (5SH3336.2, 5SH3336.3, 5SH3341.2, 5SH3341.3, 5SH3341.4, 5SH 3341.5, 5SH3341.6, and 5SH3342.4) are recommended eligible to the NRHP as contributing elements in the overall ditch systems. These ditches are part of an active irrigation system.

The five re-evaluated segments had not been previously recorded as segments; the entire ditch had been noted (Byers 2006; Lowe and Schneider 2007). Where these ditches crossed the previous Project Area surveyed by TRC Mariah, they were not given official segment numbers. Rather, the entire ditches were identified; the ditches consisted of the Baca Grant No. 4, Ditches 15, 16, and 17. Subsequently, the entire ditches have been officially determined eligible for inclusion in the NRHP. The segments of the previously noted ditches located in the WCRM study area include: one segment of the Baca Grant No. 4 Ditch 15 (5SH3339.10), three segments of the Baca Grant No. 4, Ditch 16 (5SH3340.2, 5SH3340.3, and 5SH3340.4), and one segment of the Baca Grant, Ditch 17 (5SH3341.7). The re-evaluated segments have been recommended not eligible for inclusion in the NRHP; they no longer have a physical presence in the locations where they were originally recorded and, as a result, do not contribute to the significance of their affiliated ditch systems.

3.8 Native American Traditional Values

Federal law and agency guidance require federal agencies to consult with Native American tribes concerning the identification of cultural values, religious beliefs, and traditional practices of Native American people that may be affected by actions on federal lands. This consultation includes the identification of places (i.e., physical locations) of traditional cultural importance to Native American tribes. Places that may be of traditional cultural importance to Native American people include, but are not limited to, locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world; locations where religious practitioners go, either in the past or the present, to perform ceremonial activities based on traditional cultural rules or practice; ancestral habitation sites; trails; burial sites; and places from which plants, animals, minerals, and waters possessing healing powers or used for other subsistence purposes, may be taken. Additionally, some of these locations may be considered sacred to particular Native American individuals or tribes.

The Service will consult with 16 Native American tribes upon the release of the Draft EA on Jan. 7, 2011 to identify any cultural values, religious beliefs, and traditional practices of Native American people that may be affected by the proposed action on the Refuge.

In 1992, the NHPA was amended to explicitly allow that “properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization may be determined to be eligible for inclusion on the NRHP.” If a resource has been identified as having importance in traditional cultural practices and the continuing cultural identity of a community, it may be considered a traditional cultural property (TCP). The term “traditional cultural property” first came into use within the federal legal framework for historic preservation and cultural resource management in an attempt to categorize historic properties containing traditional cultural significance. National Register Bulletin 38: Guidelines for Evaluating and Documenting Traditional Cultural Properties (Parker and King 1989) defines a TCP as “one that is eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community’s history, and (b) are important in maintaining the continuing cultural identity of the community.” To qualify for nomination to the NRHP, a TCP must

be more than 50 years old, must be a place with definable boundaries, must retain integrity, and must meet certain criteria as outlined for cultural resources in the NHPA.

In addition to the NRHP eligibility, some places of cultural and religious importance also must be evaluated to determine if they should be considered under other federal laws, regulations, directives, or policies which include, but are not limited to, EO 13007 of 1996, the AIRFA of 1978, and the NAGPRA of 1990.

In compliance with the NHPA, as amended, the Service will initiate government-to-government consultation for Lexam's proposed oil and gas exploration by sending letters and a copy of the Draft EA on January 7, 2011, to several Native American tribal groups. The letters will be sent to inform the tribal groups of the proposed exploration on the Refuge and to solicit any comments the tribes may have concerning TCPs or places of cultural and religious importance to the tribes in the Project Area. **Table 3-14** lists the Native American groups that are planned to be contacted upon release of the Draft EA to solicit any concerns they have regarding the proposed oil and gas exploration on the Refuge.

Table 3-14 List of Native American Tribes to be consulted upon release of the Draft Environmental Assessment.

Name of Tribe	
Southern Ute Indian Tribe	San IIdefonso Pueblo
Ute Mountain Ute Tribe	Pueblo of Nambe
Jicarilla Apache Tribe	Ohkay Owingeh Pueblo
The Hopi Tribe	Pueblo of Santa Clara
Uintah & Ouray Tribe	Pueblo of Jemez
Navajo Nation	Pueblo of Picuris
Pueblo of Santa Ana	Pueblo of Taos
Pueblo of Santo Domingo	Pueblo of Zuni
Pueblo of Acoma	Pueblo of Cochiti
Pueblo of Isleta	Pueblo of Laguna
Pueblo of Pojoaque	Pueblo of Sandia
Pueblo of Santa Ana	Pueblo of Zia
San Juan Southern Paiute Tribe	

3.9 Recreation

The Refuge, pending the development of a CCP, is currently closed to all public uses, unless prescribed for management reasons. As such, there are no recreational opportunities at the Refuge or in the Project Area.

Recreational opportunities are available in areas near the Refuge at GSDNPP, Zapata Falls Recreation Area, San Luis Lakes State Park and Wildlife Area, The Zapata Ranch, and San Isabel National Forest. Common recreational activities at some, but not all of these areas include: camping, hiking, backpacking, horseback riding, observation, fishing, and hunting.

3.10 Social and Economic Environment

Because the Refuge is federal land currently not accessible to the public, there are limited direct economic or social considerations associated with the Project Area. Because the Refuge is owned by the federal government, there is revenue sharing with Saguache County since Saguache County doesn't generate tax money off the land as required by the Refuge Revenue Sharing Act (16 U.S.C. 715s). According to FY2008 info which was paid in 2009, the Refuge paid $43,503 to Saguache County. While the potential project would not affect this, the Refuge itself does provide economic benefits even with no recreational opportunities. Therefore, the influence area for economic and social considerations associated with the proposed exploration by Lexam is viewed within a regional context and includes a portion of southern Saguache County in south-central Colorado and the City of Alamosa in Alamosa County. Alamosa was included in the region of influence as it is the most likely location for the drill rig crews and other project personnel to be stationed during the project. The region is predominately rural with several small communities (i.e., Crestone, Moffat, Hooper, and Center) nearby.

Population

Saguache County had a population of 7,097 residents in 2009. The U.S. Census Bureau estimated a 19.9 percent increase in population between April 1, 2000 and July 1, 2009 (U.S. Census Bureau 2010). Center and Saguache are the county's two largest communities, an estimated 2,339 and 592 residents, respectively, in 2009 (Colorado State Demography Office 2010). The majority of Saguache County residents (3,676 est.) lived in unincorporated areas, including the Baca Grande subdivision. Other communities in the region include Bonanza City, Crestone, and Moffat (U.S. Census Bureau 2005).

Population growth in Saguache County has primarily occurred from lifestyle migration into the Baca Grande and Crestone communities, and the settlement in Center of agricultural households employed across the San Luis Valley.

The City of Alamosa is located approximately 32 miles southwest of the Refuge and has a current estimated population of 8,972, up from 7,960 recorded in the 2000 census (Colorado State Demography Office 2010).

Demographic Characteristics

Race and ethnicity percent for Saguache County differ from the state in many ways. Most notable is the higher percentage of persons of Hispanic or Latino origin – 47.8 percent in 2009 in Saguache County, whereas the state was 20.3 percent, also in 2009 (U.S. Census Bureau 2010). Additionally in 2009, the percent of American Indian persons was 2.3% higher in Saguache County than the state, respectively (U.S. Census Bureau, 2010). Apaches, Navajos, and Utes were the most commonly reported Native American tribal affiliations in 2000. No established American Indian reservations are located in Saguache County.

Over 14 percent of Saguache County residents in 2000 were foreign born and 36.5 percent of the county's residents had another language other than English spoken at home (U.S. Census Bureau 2010). This is likely a result of the high percentage of Hispanic/Latino origin residents.

Economic Overview

Total employment, including full- and part-time, in Saguache County continued to increase from 2001 to 2008, from 2,619 jobs in 2001 to 2,893 jobs in 2008, a 10.5 percent increase (Bureau of Economic Analysis [BEA] 2010). Employers in Saguache County include the federal and local government (NPS, USFWS, USFS, U.S. Postal Service, NRCS, and others), farmers and ranchers, recreational and tourism outlets and sites, and the service industry. In 2008, 570 jobs were government employees, with 505 of those being state and local government positions (BEA 2010). Farm employment has seen a downward trend from 620 jobs in 2001 to 430 in 2008, a decrease of 190 jobs (BEA 2010). Between 2002 and 2007, the number of farms in Saguache County decreased by 4 percent, from 252 farms in 2002 to 242 farms in 2007, but market value of products sold increased 12 percent, from $81,852,000 to $91,456,000, with 86 percent of market value coming from crop sales (NASS 2010). Overall, average earnings per job have increased between 2001 and 2008, from $21,183 to $26,703 respectively (BEA 2010).

Recreation and tourism also have a substantial role in the regional economy, and attractions in the San Luis Valley include: the Great Sand Dunes National Park; portions of the Rio Grande National Forest; the Cumbres and Toltec Scenic Railway (a steam-powered excursion railroad); Monte Vista, and Alamosa Refuges; San Luis Lakes State Park and multiple state wildlife management areas; Los Caminos Antiguos Scenic Byway; Fort Garland Historic Fort and Museum; multiple spiritual, new age, and retreat centers in Crestone and the Baca Grande subdivision; Shrine of the Stations of the Cross in San Luis; numerous local museums and historical sites; and the annual Sandhill crane migration and festival. Visitors and travelers support numerous jobs in the region's retail trade, accommodations and dining, and entertainment and other affiliated industries.

The City of Alamosa bills itself as the lodging hub of the San Luis Valley and offers many lodging and dining establishments that cater to the tourists who visit San Luis Valley attractions.

Income, Poverty, and Unemployment

Total personal income in Saguache County was $136.8 million in 2008 (BEA 2010). This amount is quite lower than other counties in Colorado, ranking 51st in the state. Per capita income (PCPI) in the county also is behind many other counties, with Saguache County ranked 63rd with a PCPI of $19,496 (BEA 2010). The percent of persons below the poverty limit in 2008 for Saguache County was higher than for Colorado as a whole, 29.8 percent for the county and 11.2 percent for the state (U.S. Census Bureau 2010). This is an increase from 1999, which saw Saguache County 22.6 percent of persons below the poverty limit (U.S. Census Bureau 2000).

In 2009, the unemployment number was 288, a 90 percent increase from 2000 which was 151 (Bureau of Labor Statistics [BLS] 2010). Over the 9 year period of 2000 to 2009, unemployment numbers tend to start rising in June with highest rates usually occurring in July and August (BLS 2010). December and January also tend to see an increase in numbers (BLS 2010). The unemployment rate has risen from 2000, with a rate of 8.8 percent in 2009, up from 5.6 percent in 2000 (BLS 2010). The unemployment rate follows a similar trend to the unemployment numbers in terms of monthly rates.

Environmental Justice

On February 11, 1994, President Clinton issued EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." This EO is designed to focus the attention of federal agencies on the human health and environmental conditions in minority communities and low-income communities. It requires federal agencies to adopt strategies to address environmental justice concerns within the context of agency operations. In an accompanying Presidential memorandum, the President emphasized that existing laws, including NEPA, should provide opportunities for federal agencies to address environmental hazards in minority and low-income communities.

The Crestone/Baca Grande subdivision area does not comprise a minority or low-income community.

Housing

At the time of the 2000 census, more than 25 percent of all units were reported vacant in Saguache County. However, 46 percent of the vacant units (361 units) were reported as being for seasonal, recreational, or occasional use. The latter includes about 75 units located in Crestone, the Baca Grande subdivision, and nearby areas. Recent population growth and migration are reflected in levels of new residential construction. An estimated 454 new homes were reported in Saguache County (nearly a 15 percent increase in 5 years). Many of these units are located in the Baca Grande subdivision, a proposed community consisting of 15,000 acres divided into approximately 4,200 lots. The community includes parks, a recreational vehicle park, tennis courts, ballfields, and greenbelts. Baca Grande is accessed via County Road T.

Traffic

The primary highway access through the region to the Project Area is via State Highway (SH) 17, a key north-south regional highway in the San Luis Valley, to Saguache County Road (CR) T to Lexam Road on the Refuge.

Saguache CR T is a paved road that extends east from SH 17 and terminates at two destinations — Crestone and the Baca Grande subdivision; therefore, traffic on CR T is related primarily to these destinations. The Crestone destination includes the Town of Crestone (population 83 in 2007) and three USFS trailheads. The Baca Grande destination includes a small Colorado College satellite facility, a restaurant and several other small businesses, over 600 residences, and many spiritual retreat centers.

The City of Alamosa is reached by Highways 285 and 160 and by SH 17. Commuters from Alamosa to the project site would take SH 17 to CR T, a commute of over 50 miles each way.

Emergency Services

In Saguache County, the County Sheriff responds to accidents and incidents on CRs. Troop 5B of the Colorado State Patrol, headquartered in Alamosa, handles incidents on SHs 150 and 17.

The San Luis Valley Regional Emergency Medical Services/Trauma Advisory Council (SLV RETAC) encompasses six counties located in the south-central portion of Colorado; these counties include Alamosa, Conejos, Costilla, Rio Grande, Mineral, and Saguache. There are 10 Emergency Medical Service transport services in the San Luis Valley. The SLV RETAC includes a fully trained Hazmat team that has dealt with incidents that have involved explosives, fuel spills, unknown white powders, methamphetamine labs, school chemicals, and numerous other incidents.

Emergency medical service for Saguache County and Alamosa, including ambulance transport, is dispatched from the San Luis Valley Regional Medical Center. The San Luis Valley Regional Medical Center is the major trauma center in the San Luis Valley and includes a Level III trauma center, a six-bed intensive care unit, 24-hour lab and imaging services, and an in- and out-patient surgery unit. Other area hospitals include the Conejos County Hospital in La Jara and the Rio Grande Hospital in Del Norte, both Level IV trauma centers.

The Crestone and Baca Grande Volunteer Fire Departments (6 and 30 volunteers, respectively) provide primary structural fire protection for their communities. The Kundalini Fire Management (a 20-member department) also serves the Baca Grande subdivision and surrounding area.

In 2007, the Town of Crestone applied for and received $638,210 in Energy and Mineral Impact Assistance program money from the Colorado Department of Local Affairs (DOLA), specifically mentioning Lexam's proposed exploration in the application. The money (of which $500,000 is an outright grant and the remaining $138,210 is a loan) is intended to provide for a water system to deliver potable drinking water and for fire fighting. The program, founded by the state legislature in 1977, was designed provide assistance to local communities that are impacted by boom and bust cycles in the energy and mineral extraction industries (DOLA 2007). A water system in nearby Crestone would increase the preparedness to deal with fire emergencies.

Land Use and Ownership

The land use and ownership in the Project Area is a NWR, administered by the Service. Regional land uses include agriculture, forested areas, and areas supporting wildlife, rural residential, residential, commercial, and industrial land uses. The Baca Grande subdivision and Crestone are included in the rural residential development category. The majority of Saguache County has been zoned as agricultural, with residential uses allowed "by right." Other uses on private lands in unincorporated areas require approvals from the respective zoning administrators and commissions. Federal lands account for approximately 69 percent of the lands in Saguache County. Another 4 percent of the land in the county is managed by the state, and 27 percent is privately owned. The latter includes a small amount of land managed by local public entities such as municipalities or school districts.

3.11 Aesthetics

Visual Resources

Regional Physical Setting

The proposed exploration by Lexam would be conducted in the Refuge, which is located in Saguache County, in the northern San Luis Valley, approximately 15 miles northwest of Great Sand Dunes National Park, approximately 19 miles east of U.S. Highway 285, approximately 6 miles southwest of Crestone, approximately 8 miles southeast of Moffat, and approximately 32 miles north of Alamosa, Colorado. The San Luis Valley is located within the Southern Rocky Mountain Physiographic Province, which is characterized by long, north-south-trending mountain ranges separated by broad valleys.

Project Area Physical Setting

The Project Area is located along Spanish and Willow Creeks approximately 1 to 3 miles west of Camino del Rey on the Baca Grande subdivision. The site contains scenic resources comparable to other areas of the region with similar habitats and features, and its overall level of scenic quality is considered moderate to high.

The Project Area is situated at an elevation of approximately 7,600 feet above mean sea level. The immediate area is dominated by a single large cottonwood tree (*Populus deltoides*), and a variety of vegetation communities including desert shrublands, grasslands, wet meadows, and playa wetlands. Please see Section 3.5, Vegetation and Habitats, for detailed descriptions of communities.

The Project Area has distant views to and from trails and recreation areas of the Rio Grande National Forest in the Sangre de Cristo mountain range (approximately 8.0 miles to the east), Kit Carson peak (approximately 10.5 miles to the east), and trails and recreation areas of the Rio Grande National Forest (approximately 30.0 miles to the west).

The greatest potential for public views of the proposed project is from the gate at Lexam Road and CR T which is to the north of the proposed project and from Camino del Rey Road on the Baca Grande subdivision to the east. Other viewing opportunities are from residences, religious sites, recreation areas, and roads in the San Luis Valley and higher elevations to the east, north, and west of the well sites and at substantial distances (3 to 30 miles away).

The nearest residences with views to the project site are located approximately 3 miles to the east, along Camino del Rey Road. Residences in the Baca Grande subdivision along the base of the Sangre de Cristo Mountains would have views at a distance of 4.5 or more miles.

Noise

Acoustical Environment

The acoustical environment is a measure of all the physical sound sources in a given area. At any location, both the magnitude and frequency of environmental sound may vary considerably over the course of the day. Variation is caused both by changes in the sound source, and by changes in weather conditions. The magnitude of a change in sound level is measured in decibels. A three-decibel change is a 100 percent increase or decrease in the sound level, and a ten-decibel change is a 1,000 percent increase or decrease in the sound level. Sound levels in decibels are measured in dBA, a-weighted decibel, which is a-weighted sum of sound energy across the range of human hearing. The A-weighted dB scale (dBA) is the most widely used for environmental noise assessments. **Table 3-15** lists some common sources of sound and their associated dBA.

Table 3-15. Common A-weighted (dBa) outdoor sound sources (USFWS 2006b)

Sound Source	Sound Level Pressure (dBA)	Typical Response
Carrier deck – jet operation	140	Painfully loud
Auto horn at 3 feet	120	Threshold of feeling and pain
Jet takeoff at 2,000 feet	110	Very annoying
Pneumatic Drill at 50 feet	90	Hearing damage (8-hour duration)
Helicopter at 500 feet	80	Annoying
Freeway traffic at 50 feet	70	Intrusive
Normal Speech at 15 feet	50	Quiet
Soft whisper at 15 feet	30	Very Quiet
	10	Just audible
	0	Threshold of hearing

Sound sources in rural areas are predominantly natural and include insects, birds, wind, weather, and livestock. Existing human-caused noise sources that occur in and around the proposed Project Area include, but are not limited to residents, visitors, vehicles, motorized and mechanical equipment, overhead aircraft, and surrounding residential and agricultural noise influences (NPS 2007). Noise is defined as unwanted, intrusive, or unpleasant sound.

Typical noise-sensitive receptors include residences, schools and day care facilities, hospitals, long-term care facilities, places of worship, libraries, and parks and recreational areas specifically known for their solitude and tranquility such as wilderness areas. Noise sensitive receptors near the proposed Project Area include rural residences, low-density residential clusters, schools, places of worship, libraries, and areas specifically valued for solitude and tranquility.

The Project Area occurs in a rural area. Background sound levels in rural areas typically range between 35 and 45 dBA (EPA 1974). Background sound levels are approximately 40 dBA in rural residential areas and 45 dBA in agricultural cropland with equipment operating.

Two studies have been conducted by the National Park Service (NPS) on Great Sand Dunes National Park and Preserve near the Refuge:

> The first NPS study was conducted July 1993 and October 1994 found background ambient noise levels averaged less than 45 dBA for 99 percent of the study, less than 40 dBA for 90 percent of the duration, and less than 35 dBA for 50 percent of the study. These findings are compatible with the EPA data described above for rural residential and agricultural areas (EPA 1974).
>
> The second study was conducted from September 24 to October 10, 2008. The NPS deployed an acoustic monitoring system in the northwest corner of Great Sand Dunes National Park and Preserve adjacent to Baca National Wildlife Refuge. Data were collected on both existing and natural ambient sound levels. All sounds measured from natural and extrinsic sources were considered the existing

ambient (L_{50}) level. All sounds excluding those caused by humans were considered the natural ambient sound level (NPS 2008b). Natural ambient sound level (L_{nat}) provides a reliable baseline condition for evaluating the actual soundscape (NPS 2006). Results from short-term monitoring indicate that the day and night sound existing ambient levels (20.5 dBA, 15.0 dBA) and natural ambient levels (17.3 dBA, 14.7 dBA) are low during autumn near Refuge. However, the report did not provide natural ambient sound level information that allowed for comparison of temporal variation (e.g., seasonal, annual), which is influenced by climatic conditions (e.g., wind speed, precipitation, storm events), topography, human activity, fluctuations animal abundance and activity (e.g., presence and signing-rates of migratory birds [Alldredge 2007]) and vegetation density and structure.

Data from these studies (EPA 1974, NPS 2008b) indicate that existing mean ambient sound levels near the Refuge likely range from 15 to 35 dBA.

Loud noises do have the potential to influence wildlife activity patterns. Wildlife may temporarily avoid otherwise suitable habitat in response to noise or have reduced breeding success if a species relies on sound to secure a mate.

Sound resulting from anthropogenic disturbance also can affect a persons' perception of their environment. The disruption of natural sounds can affect an individual's ability to enjoy the solitude a protected area (e.g., wilderness, National Wildlife Refuge) and varies depending upon the individual's attitude towards the source of the noise, magnitude and duration of the noise, time of day, and activities they pursue.

Regulatory Framework

Federal Regulations

The Noise Control Act of 1972 required the EPA to established noise emission criteria and testing methods that applied mainly to transportation effects of noise. In 1974, the EPA issued guidance levels for the protection of public health and welfare in residential land use areas. The guidance levels specified an outdoor L_{dn} of 55 dBA and an indoor L_{dn} of 45 dBA. The 55 dBA threshold for outdoor environmental noise is considered to be an acceptable level to be used for evaluating noise effects when data is lacking for a particular area (EPA 1974).

The Federal Energy Regulatory Commission (FERC) also determined that 55 dBA is the maximum noise level to be heard from an established sensitive receptor (e.g., residences, schools) from a new compressor station at the well pad site. Sound levels below 55 dBA are not suspected to have negative effects to public health and welfare from any identified noise source

OSHA regulations are designed to protect workers from occupational noise exposure. OSHA's regulations provide for permissible noise level exposures as a function of the amount of time during which the worker is exposed.

State Regulations

Colorado Statute 25-12-103 provides for maximum permissible noise levels for applicable activities that will be conducted in a manner so that any noise produced is not objectionable due to intermittence, beat frequency, or shrillness. The statute provides limits for sound levels of noise radiating from a property line (Refuge boundary) at a distance of 25 feet or more for certain time periods. Those limits are provided below in **Table 3-16**.

Table 3-16. Maximum Permissible Noise Levels (COGCC 2009)

Zone	**7:00 a.m. to next 7:00 p.m.**	**7:00 p.m. to next 7:00 a.m.**
Residential	**55 dBA**	**50 dBA**
Commercial	**60 dBA**	**55 dBA**
Light Industrial	**70 dBA**	**65 dBA**
Industrial	**80 dBA**	**75 dBA**

4.0 Environmental Consequences

4.1 Introduction

This chapter summarizes and compares the potential effects of implementing the three alternatives listed in Chapter 2–Description of Alternatives. The environment that would be affected by the alternatives is described in Chapter 3–Affected Environment. For the purposes of this Draft EA, the Service will analyze the potential effects of implementing each alternative to all resources protected by the Refuge, including the following:

- **Alternative A** – No Additional Protective Measures Provided by the Service Alternative (no action alternative) – under this alternative, the Service would not request any additional protective measures be included in Lexam's Plan of Operations. The Service would decide that protective measures that are standard to the oil and gas industry for exploration, as regulated by federal, state, and local agencies, would be adequate to protect the surface and subsurface resources on the Refuge. Drilling would occur from two vertical wells, one at Baca #5 and one at Baca #7.

- **Alternative B** – Acquisition of the Mineral Estate Alternative – under this alternative, the Service would acquire the mineral estate as a result of three possible scenarios, 1) through purchase of the mineral estate by an outside party where the estate is then donated to the federal government, 2) direct donation of the mineral estate to the federal government, and 3) direct purchase of the mineral estate by the federal government.

- **Alternative C** – Maximum Protection of Refuge during Exploration Alternative (preferred alternative) – under this alternative, the Service would require that specific protective measures and standards be followed during all phases of oil and gas exploration being proposed by Lexam, including the intended drilling of two exploratory gas wells on the Refuge, to ensure that the surface estate of the Refuge and associated resources are not unreasonably degraded or impacted. Drilling would occur sequentially from two vertical wells, first at Baca #5 and then at Baca #7.

The scope of this Draft EA does not address potential future production of oil and gas from any of the wells described above. If Lexam determines that production is viable as a result of exploration, then a separate analysis pursuant to NEPA would be required

Since the Service has not developed specific management plans for the Project Area, no reasonably foreseeable future actions (RFFAs) have been identified. However, the Service could enforce any oil and gas exploration activity that causes disturbance to the Refuge in an unreasonable manner. Such ground disturbing activities would be subject to all regular Refuge management strategies in future plans (e.g., Comprehensive Conservation Plan [CCP]) and all applicable rules and regulations whereby the Service would have the right to enforce under the designating authorization, Public Law 106-530, also known as the Great Sand Dunes National Park and Preserve Act of 2000, which provides permanent protection of the Refuge.

4.2 Analysis Method

Under each topic (resource) the actions or things that could affect that resource are discussed for each Alternative A, B, and C. Then, alternatives A, B, and C are compared to evaluate potential outcomes for each topic (**Table 4-3**). This includes determining if the potential environmental effects are negative or beneficial and whether the effects are direct, indirect, or cumulative with other independent actions. The evaluation of environmental consequences also uses the duration of an effect, whether it is long-term or short-term.

Direct effects are those where the impact on the resource is immediate and is a direct result of a specific action or activity. Examples of a direct effect might include the short-term increased traffic associated with construction of the access road and well pad to Baca #5.

Indirect, or secondary, effects are those that are induced by implementation action, but occur later in time or farther removed from the place of action through a series of interconnected effects. An example of an indirect effect might be that plant communities on the improved access road and well pad to Baca #5 could take several years to return to their original state following the initiation of reclamation of the site.
A cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes the actions" (40 CFR 1508.7). Following the discussion of direct and indirect effects, the anticipated cumulative impacts of each alternative are discussed.

Effects also are described in terms of their context intensity, and duration:

- Negligible – The effect would be at the lower levels of detection (less than 5-percent change compared to existing conditions);
- Minor – The effect would be detectable (a change of 5-24%);
- Moderate – The effect would be readily apparent, and it would have the potential to become major (a change of 25-50%);
- Major – The effect would be severe, or if beneficial, it would have exceptional beneficial effects (a change of more than 50 percent).

The duration of effects also are described as short-term or long-term. Short-term effects have the potential to persist for up to two years. However, activities directly associated with drilling (e.g., road traffic, construction of well site infrastructure) would occur over a period not to exceed 180 days. Long-term effects would last more than 2 years after the initiation of exploration.

The cumulative impact study area for resources discussed in this Draft EA includes the Project Area, the northern portion of the Refuge from the Project Area to CR T, the town of Crestone, the Baca Grande Subdivision, and areas immediately adjacent to the Refuge north of CR T, unless stated otherwise for a particular resource. No reasonably foreseeable projects were determined for this area (mines, oil and gas drilling, major construction projects).

In compliance with the provisions of NEPA and department and bureau policies, the Service has made a thorough assessment of the environmental effects using available science to quantify the degree of effect. Wherever possible, the degree of effect was quantified based on empirical information, modeled estimates, or research findings. Where sufficient numeric information was not available, qualitative or relative assessments were made using scientific literature or professional field experience.

4.3 Geology, Mineral Resources, and Soils

Effects on Geology

The major geologic structure below the proposed exploration wells is complex and characterized by intersecting vertical fault lines that primarily occur in the Baca Graben and the Alamosa Horst, to a lesser degree. These structural elements along with the Monte Vista Graben influence groundwater flow and the thickness of each aquifer unit within the multi-tiered aquifer. Effects of the two proposed exploration wells proposed by Lexam are expected to be negligible and are not expected to change the physical structure of the Baca Graben, Alamosa Horst, or Monte Vista Graben.

Effects on Mineral Resources

There is not definitive scientific evidence to indicate to the Service that there are significant oil and gas reserves beneath the Refuge, therefore there are no effects on mineral resources from the proposed exploration by Lexam. If Lexam discovers that commercially producible hydrocarbons do exist beneath the Refuge, a new NEPA analysis would be required to evaluate the potential effect of production on all resources protected by the Refuge and the human environment.

Effects on Soils

Construction of roads and drill pads is expected to cause minimal long-term impacts to soils; the maximum amount of disturbance for Lexam's proposed exploration program is 11.7 acres of soils that would be disturbed from construction of Lexam's access roads and drill pads. Potential impacts to soils from proposed exploration activities include the removal of vegetation, soil compaction, increased susceptibility of the soils to wind and water erosion, loss of topsoil productivity, and contamination of soils with hazardous materials. Disturbance is expected to be short-term since reclamation would commence as soon as drilling activities are concluded. At minimum, roads and well pad sites would be reclaimed if production of oil and gas is not viable following COGCC and CDPHE rules and regulations.

As discussed in Chapter 1, the COGCC Series 1000 Rules and the CDPHE storm water permit rules provide for specific soil handling and reclamation procedures. The stormwater permit requires revegetation goals that must be followed in order to terminate coverage under the permit. Because of the erosive nature of the soils and the semi-arid climate, complete revegetation and reclamation outlined in the CDPHE SWMP (70 percent of original vegetation) may be a long-term undertaking.

In addition to the impact of road and drill pad construction, soils could be impacted by any spills of hazardous materials (petroleum fuels, lubricants, paints, and additives). The SPCC requires immediate containment of spills or releases. Because of the temporary nature of the operations, the quantity of materials (oils and fuels) on-site would be relatively small. Impacts from spills would be short-term and limited to the immediate vicinity of the spill and impacted soil would have to be removed and disposed off-site in accordance with applicable rules.

Alternative A

Under this alternative, the Service would not require any additional protective measures to be followed during oil and gas exploration activities. Lexam would follow all applicable federal, state (e.g., COGCC and CDPHE) and local regulations that regulate surface disturbance and site reclamation. Because there would be no NRAs or input from Service into the site reclamation process and no restrictions on off-road vehicle use, there is a potential for greater impacts to the Refuge's soils under alternative A than alternative C. Soil contamination and erosion would be regulated by the SWMP and SPCC plans. The potential for soils to be eroded or contaminated by hazardous material spills is greater than Alternative C because no additional protective measures (e.g., NRAs) would be required by the Service.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

The Service would require that specific protective measures be followed by Lexam during exploration to ensure that the proposed activities do not unreasonably degrade resources protected by the Refuge. Any impacts would be reduced to negligible short-term levels because of the implementation of protective measures required by the Service, in addition to COGCC and CDPHE rules. Protective measure #5 and #7 would require that soils are monitored before, during, and after construction to establish baseline conditions and reduce potential pollutants or contaminants impact to negligible short-term impacts. Protective measure #11 (construction to facilitate revegetation in accordance with COGCC rules with input from Service), #23 (requirement that no off-Refuge top soils are brought onto the Refuge), and #30 (restoration to original site conditions) reinforces COGCC's site reclamation requirements and the Service would add Refuge-specific conditions including, but not limited to control of noxious weeds and usage of native plant seed endemic to the San Luis Valley, #34 (requirement of catch pans or other liner systems), and #42 (restriction of vehicles to existing and proposed access roads) would reduce soil erosion in the Project Area. The provision for NRAs required by protective measure #3 (trained NRAs) would help ensure that protective measures required by the Service, COGCC, and CDPHE are adhered to and

that operations are conducted in a manner that reduces potential issues associated with erosion, sedimentation, and stability of creek crossings. Spills of hazardous materials would be contained and remediated according to applicable rules and regulations of the COGCC and CDPHE; NRAs required by the Service protective measure #3 would further ensure that hazardous material spills are adequately contained and remediated.

Cumulative Impacts

Alternative A

No cumulative impacts have been identified for geology, minerals, or soils. The proposed project would add 11.7 acres of roads and two well pads to existing infrastructure of the Refuge. In addition to the Lexam Road, there are various existing gravel and unpaved roads used to access Refuge offices, pastures, water wells, and irrigation equipment. These roads would continue to be used for Refuge administration, maintenance and management. The proposed exploration wells would be the only oil and gas wells drilled on the Refuge to date. A total of 18 exploratory oil and gas wells have been drilled in all of Saguache County, only a few of which had hydrocarbon shows and there is no hydrocarbon production in the county (Cappa and Wallace 2007). There are no other reasonably foreseeable future activities (RFFA) regarding oil and gas in the cumulative effects study area as there are no other permitted oil or gas wells in Saguache County (COGCC 2010). There are no RFFAs regarding road building or construction activities in the cumulative effects study area. Any additional proposals for oil and gas activities, including the production of the two proposed wells, will be subject to additional NEPA.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons discussed in alternative A.

4.4 Air Quality

Effects on Air Quality

The CDPHE Air Pollution Control Division (APCD) regulates sources of air pollutant emissions in Colorado. The method of registering air pollutant emission sources occurs through the filing of an Air Pollution Emission Notice form (APEN), and/or through a construction permit application. There are several exemptions from the requirement to file an (APEN) and a construction permit application. The exemptions from APEN requirements are outlined in Regulation No. 3, Part A, II.D (CDPHE 2008). Sources are exempted because either individually, or cumulatively as a category, they are deemed to have a negligible impact on air quality.

Reg. 3, Part A.II.D.1.lll states: “Oil and gas exploration and production operations (well site and associated equipment) shall provide written notice to the COGCC of proposed drilling locations prior to commencement of such operations. Air Pollutant Emission Notices are not required until after exploration and/or production drilling, workovers, completions, and testing are finished.”

The exemptions from construction permit requirements are outlined in Regulation No. 3, Part B, II.D. Reg. 3, Part B.II.D.1.a, which states that sources exempted from APEN filing requirements in Section II.D. of Part A of the regulation are exempt from having to obtain an air quality construction permit. Once the well is drilled and if production does not occur, the owner or operator shall submit written notice to the APCD indicating that the well was plugged, or that emissions are otherwise not reportable.

COGCC and CDPHE rules direct oil and gas operators to take appropriate actions to reduce dust emissions from their activities. Dust emissions may result from traffic on unpaved roads and locations. CDPHE rules specifically exempt reporting of dust emissions for developments that total less than 25 contiguous acres of disturbance and

less than 6 months in duration. However, operators are required to implement a fugitive dust control plan, which can include but are not limited to watering roads, graveling roads, and controlling vehicle speeds.

Control measures to suppress dust emissions should minimize impacts. If water has to be hauled to the Project Area, there is increased likelihood of higher dust emissions from the additional road traffic. However, even under this scenario, the fugitive dust control plan would help limit these emissions to short-term, minimal impacts.

State and Local regulatory programs work in conjunction with federal review. In order to address the federal responsibility to protect Class I areas, the Federal Land Managers' Air Quality Related Values Work Group (FLAG) guidance document was published in December of 2000 (NPS 2005). The FLAG work group, consisting of representatives from the USFWS, NPS, and USFS, set a goal for FLAG to provide consistent policies and processes both for identifying air quality related values (resources sensitive to changes in air quality, including visibility), and for evaluating the effects of air pollution on AQRVs in Federal Class I air quality areas. The Federal Land Managers (FLM) also share concern about resources in Class II parks and wilderness areas because they have other mandates to protect those areas as well. The information and procedures outlined in the FLAG document are generally applicable to evaluating the effect of air pollution sources on the AQRVs in both Class I and Class II areas, including the evaluation of effects as part of the review of Environmental Assessments and Environmental Impact Statements under the NEPA. FLAG guidance was therefore used as much as possible in evaluating impacts in and around the Refuge with added emphasis on the Class I area inside GSDNPP.

Due to the extensive and detailed analysis associated with Class I impact and to ensure that potential impacts to the GSDNPP Class I area are minimized, control measures proposed by Lexam (**Appendix B**) were included in source description and modeling analysis.

Source Characterization

Lexam is proposing to drill two exploratory wells within the Refuge. Drilling will last for up to 90 days per well, so the proposed exploration would be temporary, lasting less than 180 days. Drilling will be performed with electric rigs, powered by portable diesel-fuelled generators. The combined disturbed areas needed for the two well pads and access roads would be approximately 11.7 acres. Location of the proposed drilling in relationship to the mandatory Class I area is depicted in **Figure 4-1**. Specifically, the two wells are to be located at least 16 km (10 miles) to the northwest of the closest mandatory Class I area boundary. Since the impact analyses are primarily short-term (daily) and impacts from ground level sources generally decrease with distance from the source, worst-case impacts on GSDNPP are estimated using the drill site #7 location for the source (the closer of the two drill holes to the Class I area).

Sources of air emissions from Lexam’s proposed exploration of two wells would include tailpipe exhaust from the diesel generators and trucks; fugitive dust from the drilling process; and wind and tire-generated fugitive dust from the exposed surfaces of the drill pads and access roads. More specifically, the emission units at each well location will consist of:

- A pair of non-road engines (separate from the drilling rig) comprising the power generators;
- An electrical-drive drilling rig with a potential for fugitive dust emissions from the drilling mechanical action;
- Mobile service and maintenance trucks with (tailpipe) combustion emissions;
- Mobile supervisory pickup trucks with (tailpipe) combustion emissions; and
- Mobile source vehicle activity on the access road and site resulting in fugitive dust emissions from exposed surfaces.

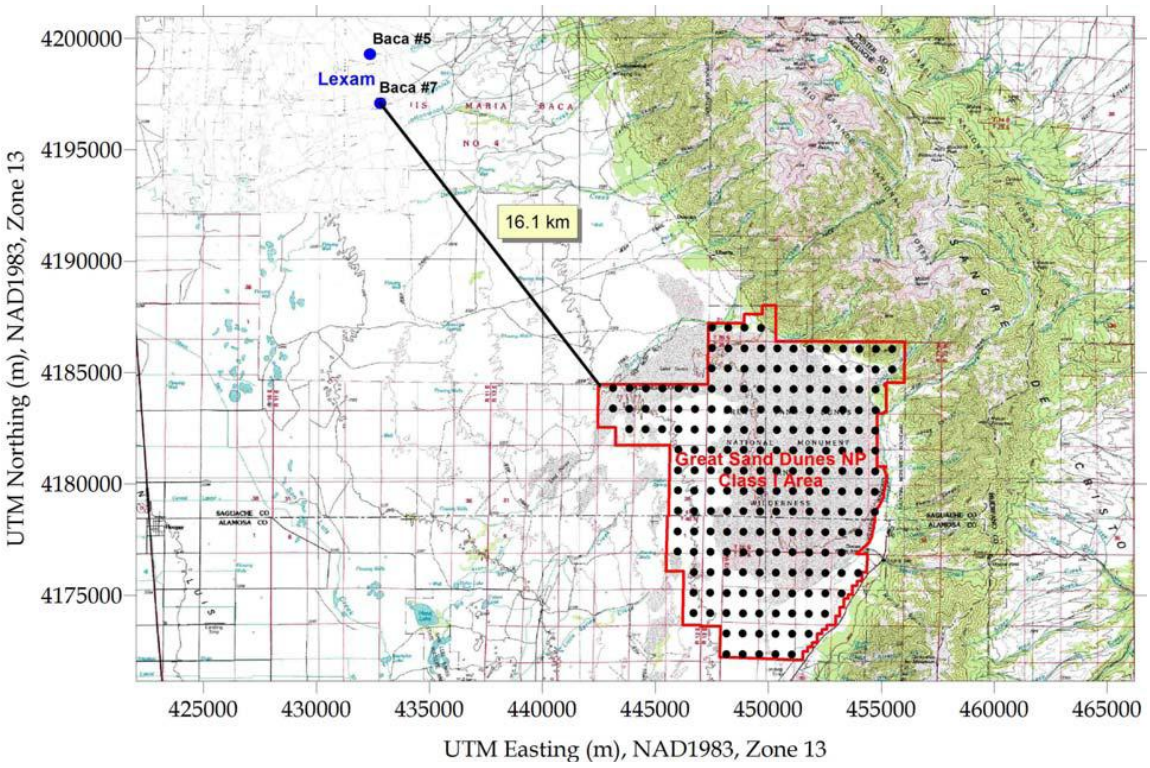


Figure 4-1. Map of Proposed Project Relative to GSDNPP Class I Area

The following are mitigation activities that will minimize emissions from the sources described above:

- The power generators will be Tier 2 engines;
- The diesel fuel used in the generators and all other locally fuelled non-road engines will be ultra-lowsulfur (15 ppm or less sulfur; i.e., ultra-low sulfur diesel available in Colorado);
- The disturbed areas will be watered to control the fugitive dust; and
- The drilling will be a wet process and negligible fugitive dust will be generated from the mechanical drilling action.

The emissions from Lexam's proposed exploration, including the above-listed controls, are estimated using maximum expected usage rates and EPA-provided emission factors (USEPA 2008a). The calculations and references for all assumptions are provided in **Appendix H**. Emissions calculations of several HAPs also are provided in **Appendix H**.

The generator engines are expected to be operated at about 40 percent of capacity, on an average day, according to the drilling supervisor's experience. For this analysis, to ensure a high-side estimate of daily generator emissions, the average operating rate is assumed to be half way between this expectation (i.e., 40 percent capacity) and 100 percent capacity, which is equal to an average of 70 percent of capacity. With this high-side estimate, the pair of generators is estimated to emit 24 tons of nitrogen oxides (NO_x) per drill hole over a maximum of a 90-day drilling program.

There may be a startup engine used to start the larger generator engines. If this is the case, it will be used for less than 1 hour per startup. Additionally, it will be exercised about once per week, for less than 1 hour. The startup engine will be sized at 500 hp or less and will be a Tier 2 engine.

Mobile source activity is estimated from similar previous drilling projects. The fleet is expected to consist of about six service vehicles, including a watering truck, a lube and fuel truck, drill mud removal and miscellaneous other trucks. There are expected to be about six supervisory transport trucks used for each of the two 10-hour shifts each day. The trucks will be parked much of the time. These vehicles will have diesel engines manufactured after

1996 and will be equipped with, at least, Tier-1 grade engines and emissions. Dust from travel across the exposed road and other surfaces (i.e., drill pads) are estimated in the following way: the exposed surfaces are principally the roadway from the north and west to the site and around the drilling activities, which will be graveled for an improved surface. Fugitive emissions will be reduced by approximately 75 percent using water as a control at times of dust generation. The roadways will be approximately 4 miles in length, and there are expected to be

about 15 round-trips to and from the site per day for all vehicles combined. Surface dust generated is estimated using a simplified and generic dust generating equation provided by the USEPA AP-42, as provided in **Appendix H**.

Fugitive dust from drilling itself will be minimal because the drilling is a wet process, and drill cuttings will come to the surface in the form of mud.

The emissions of the pollutants of greatest interest are summarized in **Table 4-1**. The total proposed project emissions of NO_x are 51 tons, emitted over about a 180-day period, while carbon monoxide (CO) emissions will amount to about 30 tons. The remaining constituents are emitted in much lower quantities. Emissions of hazardous air pollutants of interest from internal combustion engines are provided in **Appendix F**.

Table 4-1. Lexam's Proposed Exploration Program Emissions (estimated from USEPA 2008a)

Pollutant	Drill Generators (tons/180-day duration)	Mobile Sources (tons/180-day duration)	Un-paved Roads (tons/180-day duration)	Drilling (tons/180-day duration)	Total Emissions (tons/180-day duration)	Total Emissions (lbs/day)
NO_x	47.3	3.7	-	-	51.0	566.9
VOC	9.6	0.5	-	-	10.1	112.6
CO	25.9	4.6	-	-	30.5	338.7
PM_{10}	1.5	0.2	1.29	0.0001	3.0	33.2
$PM_{2.5}$	1.5	0.2	0.129	0.0000	1.8	20.3
SO_2	0.05	0.003	-		0.1	0.6

If Lexam's two proposed vertical wells intersect gas reserves of interest, it is likely that a drill stem test (DST) would be performed on each well. The DST will involve the flaring of the field gas, which is a test that normally lasts about 3 hours. The gas from the DST will be routed through a separator (for removal of the condensate and produced water) then to the flare, with a release point about 20 feet above the ground. Flaring rate is expected to be between 125 and 2,500 MCF of a methane / ethane mixture over this 3-hour period. Because flaring follows separation, it should contain only trace amounts of the heavier hydrocarbon compounds, so there should be little if any visible plume.

Using the EPA generic emission factor of 0.068 lb/106 Btu for NO_x (USEPA 2008a), the range of NO_x emissions (at a gas heat content of 1050 Btu/SCF, AP-42, page A-5) is from 9 to 179 lb per three-hour flare event. With two potential DSTs, the total proposed project (and annual) flare emissions should range from 18 to 358 lbs of NO_x. Emission factors for soot from a flare range from: 0 lb/106 Btu (non-smoking); 40 lb/106 Btu (lightly smoking); 177 lb/106 Btu (average smoking flares); and 274 lb/106 Btu (heavily smoking flares).

The flare will be operating only at times when drilling will have ceased and the generators will be operating at a very low level, if at all, so there will be no additive effect with the generator plume while the generators are being run at load. For emissions estimation purposes, assuming full-time use of the generators instead of developing scenarios for DST flaring provides a conservatively high value for projected air pollution that will be produced by this project. **Table 4-1**, below, reflects this conservative estimation, and therefore does not list the DST flares separately. Impacts of the remaining hazardous air pollutants are not estimated because their emissions are extremely low.

Impact Analysis

Impacts from potential AQRV impairing pollutants will take into consideration ambient air concentrations, atmospheric deposition, and visibility degradation resulting from the proposed project. The criteria for determining the significance of the potential air quality impacts is provided by absolute and relative measures. These criteria include the CAAQS and the NAAQS, which set maximum limits for pollutant concentrations; the Class I PSD increments, which limit the incremental increase of specific air pollutants (including NO_2, PM_{10}, and SO_2) above legally defined baseline concentration levels; and for atmospheric deposition and visibility (and other AQRVs), FLAG identifies single source contribution significance for potential impacts.

Concentration

Air pollution concentration impacts from the proposed project have been evaluated using EPA's AERMOD model (American Meteorological Society/EPA Regulatory Model), pursuant to the USEPA's recommendations in the AERMOD Implementation Guide (USEPA 2008b). The construction of the model inputs for the AERMOD analysis is provided in this section.

For the concentration impact analysis, the most recent version (07026) of the AERMOD was used. AERMOD is an advanced modeling system that incorporates the boundary layer theory, turbulence, and effects of terrain features into air dispersion simulations. It is the USEPA-recommended guideline model to be used for this type of application.

The modeled emissions and source characteristics for the AERMOD modeling are provided in **Appendix H**. Two point sources (the electric generators) and one volume source (representing the fugitive sources) were considered in the analysis. The two generators are modeled with the exhaust characteristics typical of these engines within a typical structure representing the physical size of the engines with cooling fans and generators. The fugitive sources include emissions from the mobile sources, unpaved roads, and drilling activities and are emitted over 14 acres of disturbance, which includes two drill sites and 4 miles of access road. For modeling purposes, these fugitives are characterized as being released from a 7-acre volume source surrounding the location of the generators on the drill pad, even though a substantial portion of the emissions will be released from portions of the access road located in areas relatively distant from the drill pad(s) and where the plumes would not be additive. The proposed project is assumed to occur for 180 days and sometime between August and April. For modeling, it is assumed that the emissions from both holes occur at the drill hole location which is nearest to the Class I area.

Building downwash from the generator structures was incorporated into the AERMOD runs. The 06341 version of AERMOD contains PRIME (Plume Rise Model Enhancements) algorithms for downwash calculations. The most recent version of the Building Profile Input Program (BPIP) with PRIME (BPIPPRM, version 04274) was used to calculate building downwash parameters for input to AERMOD. **Appendix H** includes detailed information on source and structure layouts for the proposed project.

Specific receptors are placed inside the GSDNPP Class I area for the modeling analysis (see **Figure 4-1**). These receptors are the standard Class I receptors provided by the NPS for GSDNPP (NPS 2008a).

All coordinates for modeling are characterized in the UTM, North American Datum 1983, Zone 13 coordinate system.

AERMOD requires receptor terrain processing with the AERMAP pre-processor to extract receptor elevations and estimate hill height scale values. AERMAP uses U.S. Geological Survey (USGS) 7.5-minute digital elevation model files for this purpose. The elevations provided in the NPS coordinate files where retained and AERMAP was then run to generate the necessary hill heights for AERMOD.

EPA recommends that a minimum of five years of representative meteorological data be used when estimating pollutant concentrations with an air quality model. Consecutive years from the most recent and readily available 5-year period are preferred. Meteorological conditions from the airport in Alamosa (WMO ID: 72462, WBAN ID: 23061) are representative of the San Luis Valley and the proposed project locations. Since the proposed project

would occur between August and April, 6-years of representative Alamosa surface meteorological data (fall and winter for 2001-2006) was utilized in the modeling analyses. The data format of the surface data is the integrated surface hourly format from the National Climatic Data Center.

For upper air data, concurrent data from the Albuquerque, New Mexico station (WMO ID: 72365, WBAN ID: 23050) were obtained from the National Oceanic and Atmospheric Administration's (NOAA's) Forecast System Laboratory (FSL) web site (roab.fsl.noaa.gov). This station is the nearest upper air station to Alamosa with data available during the same time period as the surface meteorological data (2001-2006). The Denver and Albuquerque upper air stations are equidistant from Alamosa and are located at similar elevations to each other (~5,300 feet above sea level). However, Albuquerque was chosen as the upper air station, rather than Denver, because Albuquerque, like Alamosa, also has large mountains to its east while Denver is located on the leeward side of the Rocky Mountains. The upper air station in Albuquerque also has better data capture rates than Denver.

The hourly Alamosa surface data and Albuquerque upper air data were processed using the AERMET Meteorological Preprocessor (version 06341) to generate AERMOD-compatible hourly surface and profile meteorological files. AERMET requires the input of three surface boundary layer parameters: albedo, Bowen ratio, and surface roughness length. These parameters are dependent on the land use and vegetative cover of the area. USEPA's AERSURFACE tool was developed to help obtain realistic and reproducible surface characteristic values for input to AERMET. The tool uses publicly-available national land cover datasets and look-up tables of surface characteristics that vary by land cover type and season.

The modeling results predict impacts for the proposed project's emissions to ambient air pollutant concentrations to be below Class I Significant Levels for all pollutants. Thus, no violations of applicable state, tribal, or federal air quality regulations or standards are expected to occur. **Table 4-2** provides a summary of concentration impacts from the proposed project on the GSDNPP Class I area.

Table 4-2. Summary of Maximum Estimated Concentrations at GSDNPP Class I Area and Applicable Standards (adapted from USEPA 2008b)

Pollutant	Ave. Time	Max. Modeled Conc.[1] ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)	Total Conc.[2] ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	CAAQS ($\mu g/m^3$)	PSD Class I	
							SILs ($\mu g/m^3$)	Increments ($\mu g/m^3$)
Nitrogen Dioxide (NO_2)[3]	Annual	0.05	8	8.0	100	100	0.1	2.5
$PM_{2.5}$	24-hour	0.09	21	21.1	35	35	---	---
	Annual	0.002	4	4.0	15	15	---	---
PM_{10}	24-hour	0.16	50	50.2	150	150	0.3	8
	Annual	0.003	11	11.0	50	50	0.2	4
Sulfur Dioxide (SO_2)	3-hour	0.02	---	0.02	1300	700	1	25
	24-hour	0.002	3	3.0	365	365	0.2	5
	Annual	0.00005	0.2	0.2	80	80	0.1	2

[1] The modeled concentration (no background included) compared to the PSD Class I Significant Levels and the PSD Class I Increment Levels.l
[2] The total concentration (background included) compared the NAAQS and CAAQS.
[3] To be conservative, assume that 100% of the modeled NO_x impact equals NO_2.
SILs = Significant Impact Levels

Deposition and HAPs

Atmospheric deposition occurs when air pollutants are transferred from the air to terrestrial and/or water resources. While deposition can be significant source of pollutants, it is also typically recognized to result from activities of long duration. In this case, the proposed project is relatively small is size and will take place over a maximum period of six months (180 days) and, therefore, it should not have a significant contribution to long-term depositional effects.

HAPs also are typically recognized to result in impacts when exposure is long term. Of more concern would be short term or acute air quality impact in and around the drill rig. In this case, due to the relatively small duration and size of the drilling activity and because of the need to protect against local exposure, no significant impacts are expected.

Visibility

FLAG prescribes procedures for visibility impact evaluation of emissions from proposed major stationary sources and major modifications to stationary sources. Because of the proximity of the Project to the GSDNPP, the concern regards "plume blight," which occurs when a visible plume could be perceptible against a viewing background (e.g., the sky or a terrain feature such as a mountain) to a casual observer. EPA's VISCREEN model (USEPA 2008c) is designed to assess the visual effects of a plume (from NO_x, primary SO_4, and PM emissions) as observed from a given vantage point (in this case the GSDNPP).

As described in the Workbook for Plume Visual Impact Screening and Analysis (Revised) (USEPA 1992), there are two levels of analysis in VISCREEN, Level 1 and Level 2. Level 1 screening is designed to provide a conservative estimate of the plume's visual impacts. Level 1 screening assumes a default particle size and density, as well as worst-case meteorological conditions (1.0 m/sec wind speed and F stability) which are assumed to persist for 12 hours with a wind direction that would transport the plume directly adjacent to the observer. If the Level 1 results exceed the visibility threshold values, then a Level 2 analysis is typically required. Level 2 screening uses a more probable representation of actual meteorological conditions associated with the plume, observer, and receptors.

For the proposed exploration, mobile tailpipe emissions and dust emissions (e.g., drilling emissions, emissions from unpaved roads, etc.) are fugitive in nature and would be spread over large areas. The plumes from the generators are the only likely coherent plumes from the proposed project. However, to be conservative, the emissions from all project sources, including mobile sources and fugitive emissions, were considered as a coherent plume in the model. The maximum daily emissions (adjusted to hourly values) were used in the VISCREEN analysis as they are most representative of the short-term operations and emissions from the proposed exploration program. The annual natural background visual range for GSDNPP of 249 km was used for ISCREEN input (NPS 2005).

The Level 2 VISCREEN analysis showed that the maximum calculated absolute contrast (|C|) for both a sky and terrain background is 0.018 which is less than the FLAG threshold value of 0.05. The maximum calculated difference in color contrast (ΔE) for both a sky and terrain background is 1.191 which is less than the FLAG threshold value of 2.0. A Level 2 analysis was necessary due to slightly elevated Level 1 values. The final VISCREEN analysis employed the 2nd most conservative conditions of 1.0 m/s wind speed and E stability and showed that the proposed project was within FLAG screening thresholds for visual impacts inside the GSDNPP Class I area.

Again, since emissions from the DST operation are not concurrent with drill operations and are at significantly lower emission rates, it is assumed that these emissions would also not produce an impact above threshold values.

Alternative A

Lexam's proposed exploration program would be conducted under applicable federal, state (e.g., COGCC and CDPHE), and local rules and regulations. Since the proposed exploration activities would be conducted in

compliance with applicable COGCC and CDPHE rules as described above, it's assumed that the impacts would be greater than alternative C because it would not include the Service protective measures #21, #28, or #38 that would reduce impacts to air quality. Also, emissions would be approximately twice that of alternative C because alternative A proposes two vertical wells compared to one vertical well under alternative C.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

The Service would require that specific protective measures be followed by Lexam during exploration to ensure that the proposed activities do not unreasonably degrade resources protected by the Refuge. The Service's protection measures specifically address dust emissions, engine standards, and specific fuel requirements. As shown by the impacts analysis associated with implementation of two vertical wells, air quality impacts would be minimized with emission impacts on the GSDNPP Class I area below levels of adverse impacts. Specific protective measures that would be required by the Service under this alternative include:

- Protective measure #3 - Lexam will provide trained NRAs, approved by the Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts.

  NRAs required by protective measure #3 would help ensure that protective measures required by the Service, EPA, COGCC, and CDPHE are adhered to and that operations are conducted in a manner that reduces emissions and any potential impacts to air quality.

- Protective measure #21 – To protect special status species such as the Rio Grande Sucker and Rio Grande Chub, USFWS and Lexam would:
  - Establish a 0.25-mile buffer zone of no activity around potential and identified habitat;
  - Limit vehicle crossings to existing or pre-approved crossings;
  - Sample waterways for particulate matter creating a baseline and regular monitoring during period of activity;
  - Assess stability and suitability of road water crossings prior to road construction and drilling activities and perform upgrades, if needed. Conduct periodic monitoring of crossings during activities and documentation of any deficiencies that may occur that may be indicative of potential structural failure.
  - Provide dust suppression in the vicinity of waterway crossings.

- Protective measure #28 – Dust levels on regularly traveled access routes must be kept to a minimum. The Operator shall have a water truck and operator(s) readily available to perform dust abatement as needed, or as directed by the Refuge Manager or his authorized representative. Only water will be allowed for dust suppression efforts. Dust control measures shall be implemented throughout the traveled areas of the Project Area in addition to the dust abatement requirement in measure #15.

- Protective measure #38 – Lexam must implement the recommendations that were the basis for the air quality report analysis set forth in the "Lexam Baca Drilling Project Visibility Impact Evaluation," Air Sciences Inc., April 30, 2008: (a) power generators will be Tier 2 engines; (b) diesel fuel used in generators and all other non-road engines will be ultra-low-sulfur (less than 0.05 percent sulfur); and (c) disturbed areas will be watered to control the fugitive dust.

Cumulative Impacts

Alternative A

In this case, there are no known or expected past or present activities other than the proposed project that are not represented in the current air quality monitoring data presented in Section 3.3. There have been no nearby petroleum exploration or production activities within the past 7 years. The dominant existing and forecast land cover types in the San Luis Valley are grasslands and shrublands, with agricultural uses in the southern and western portions of the Valley. While a low density of mobile source emissions (and fugitive dust) are present, there are relatively few other emission sources (i.e., industrial facilities and residential emission sources are limited, and typically related to, respectively, small communities and towns, and isolated ranches and farms). As a result, potential air quality impacts from the proposed drilling activity added to the existing background monitoring should not be significant.

If future production activities result from information gained by drilling the proposed exploratory wells, the possible impacts (whether direct, indirect, or cumulative) from that production will be addressed in a separate and comprehensive NEPA process.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.5 Water Resources

Effects on Surface Water

Three types of potential impacts to surface water resources could occur as a result of Lexam's proposed activities:

- Increased sedimentation and turbidity of surface water as a result of ground disturbance and increased erosion into surface waters via runoff;
- Effects on water quality (i.e., potential contamination of surface water resources with drilling fluids, petroleum, or other chemicals used for natural gas drilling);
- Disruption of normal flow patterns of surface water from the presence of roads and drill pads;

The potential for adverse impacts would be greatest in the short-term after the start of construction activities and would likely decrease in time due to natural stabilization, reclamation, and revegetation. The magnitude of these potential impacts to surface water resources depends on slope aspect and gradient, soil type, the duration and timing of the activities, and the success or failure of reclamation and protection measures.

Alternative A

Under this alternative, Lexam's proposed exploration program would be conducted under applicable federal (e.g., EPA), state (e.g., COGCC, and CDPHE) and local (Saguache County) rules and regulations. Potential impacts to surface water would be minimized through the implementation of the SWMP and SPCC Plan. COGCC permit conditions regarding protection of water resources would not include any additional protective measures required by the Service. Although the Project Leader of the Refuge would decide that federal and state rules and regulations would provide an adequate level of protection, impacts to surface water could be greater than alternative C because no NRAs would be on-site to identify potential spill or erosion events.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Under the Maximum Protection of Refuge during Exploration Alternative, the Service would require specific protective measures be followed by Lexam during exploration to reduce impacts to surface waters to negligible levels. Potential impacts from the proposed exploration to surface water quality include sedimentation due to runoff and erosion and contamination of surface water from spills. The SWMP and SPCC Plan for the activities would provide a moderate level of protection for reducing the likelihood negative impacts. For example, the COGCC and CDPHE rules concerning erosion control and sedimentation, when fully incorporated in the SWMP and SPCC, would minimize impacts to surface water quality. However, specific protective measures required by the Service are intended to eliminate or minimize potential short- and long-term impacts to surface water.

Surface water would be protected from contamination by establishing protective measures such as buffers between surface water and surface activities. Proper handling of hazardous materials in accordance with applicable rules and regulations also would minimize potential impacts. The primary hazardous materials to be used are fuels (diesel and gasoline), drilling mud additives, and cement.

In the event the protective measures are not fully followed, impacts to surface water have the potential to degrade surface water quality both within the Project Area and downstream, depending upon the nature of the spill or erosion event. Negative impacts may occur in the immediate Project Area, in surface water and in nearby wetland/riparian areas. In addition, because stream flow through the Project Area is to the east toward San Luis Creek and the valley center, these uncontrolled events have the potential to impact areas far beyond the Project Area. Although surface water in the Project Area does not flow year round, deposition of additional sediment or contaminants from uncontrolled spills could be washed downstream when the intermittent streams are flowing and especially during peak flow events.

The following protective measures would be required by the Service to be followed by Lexam during their exploration activities to ensure that the risks of hazardous spills or erosion events are minimized to negligible levels:

- Protective measure #3 – Lexam will provide trained NRAs, approved by the Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts.

- Protective measure #5 – Lexam will provide a resource monitoring plan which must be approved by USFWS. This plan should include a schedule for gathering data before, during, and after construction and/or drilling activities occur. It should include an assessment of baseline water quality of surface waters, the near-surface unconfined aquifer and the deeper confined aquifers in proximity to the proposed well locations (both up-gradient and down-gradient). In addition, it should include provisions for re-sampling in the event of anomalous detections.

- Protective measures #13 & 14 – Lexam shall provide a Storm Water Management Plan (SWMP) and a Spill Prevention and Countermeasures Plan (SPCC) approved by Service to ensure protection of surface and groundwater on the Refuge.

- Protective measure #21 - Sample waterways for particulate matter, creating a baseline and establish a regular monitoring regimen during all periods of activity. Also, assess road water crossing stability throughout exploration to minimize potential impacts of erosion and sedimentation.

- Protective measures #32, 33, 34, 35, and 36 – These measures will require Lexam to identify and contain all potential hazardous materials, construction equipment supplies, refuse and other produced waste products in a safe manner and transport all waste products used for drilling away off the Refuge to a state-approved facility.

Cumulative Impacts

Alternative A

If proper procedures are followed as identified in the CDPHE SWMP and SPCC Plan, no cumulative impacts to water resources would occur. In addition, other than annual irrigation practices, no water projects have been identified in the cumulative effects study area that would create water-related cumulative impacts. COGCC permit conditions regarding protection of water resources would not include any additional protective measures required by the Service. Although the Project Leader of the Refuge would decide that federal, state, and local rules and regulations would provide an adequate level of protection, impacts to surface water could be greater than alternative C because of potential erosion or spill events which would be minimized by protective measures in alternative C.

If SWMP and SPCC procedures are not followed, there is the potential that cumulative impacts could occur through repetitive erosion or spill events. These repetitive events, if they were to occur, would result in cumulative deposition and seasonal flushing of sediment or contaminants that would negatively impact surface water quality both in the Project Area and downstream to the valley center.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

Effects on Ground Water

The nature of the deep confined aquifer has been studied, but because of the limited number of wells it is not fully understood. The primary use of groundwater in the San Luis Valley is from agriculture in the unconfined and shallow confined aquifers. The deep confined aquifer is not used extensively and no wells were found near the Project Area when the USGS database was searched for wells with water level data.

Studies indicate that the recharge areas along the Sangre de Cristo mountain front provide sufficient head to drive water to the surface and that this zone of active vertical upward flow may be up to 3,000 feet below the surface. The upward vertical movement may be enhanced by fault zones, although at depths below 3,000 feet this effect may be diminished by decreasing transmissibility of the aquifer and subsurface discharge to the south and out of the valley (HRS 1987). However, isotopic data analysis indicates that water in the deep confined aquifer is very old and travel times are slow, suggesting water traveling from the deep confined aquifer to shallower units takes thousands of years (HRS 1987).

Potential impacts to groundwater resources could include the four following scenarios:

- Contamination of aquifers during drilling through the introduction of drilling fluids;
- Cross-contamination of aquifers from the introduction of drilling fluids into one aquifer that travels upward into shallower units due to improperly sealed well casings;
- Localized depletion of unconfined groundwater availability from pumping at SW-5;
- Progressive contamination of the deep confined, shallow confined and unconfined aquifers if the deep confined aquifer is not completely cased off from deeper units.

Impacts to groundwater from drilling would be short-term until protective casing is run and stops the fluid infiltration from the drilling mud. Provided that initial drilling terminates in the confining unit separating the unconfined and confined aquifers, and that proper procedures are followed for cementing casing, cross-contamination of aquifers will not occur. The 350 feet of drilling specified for the initial drilling should be considered an approximate depth, with the exact depth determined from logging of geologic materials.

Failure to completely seal off the deep confined aquifer from deeper units could result in hydrocarbon contamination of the deep confined aquifer. Because of groundwater flow from the deep confined units to successively shallower units, it is critical that the aquifer be cased to the bottom of RGDSS (2002) Layer #4 to prevent contamination. The bottom of the deep confined aquifer can be identified with detailed logging of lithological characteristics during drilling.

Figure 4-2 provides a visual reference of the bottom elevation of Layer #4 the deep confined aquifer. This modeled estimate was conducted by the Colorado Division of Water Resources (CDWR) as a decision support system for the Rio Grande Basin. The elevations displayed on the map are the estimate at the bottom of Layer #4 of the confined aquifer. For example, the surface elevation at Baca #7 is 7,581 feet and on **Figure 4-2** the elevation at the bottom of the deep confined aquifer at Baca #7 is approximately 3,750 feet. Therefore, an approximate casing depth for Baca #7 under alternative C would equal 3,831 feet plus 500 feet of extended casing and the total intermediate casing needed of 4,331 feet. With 4,331 feet of intermediate casing at Baca #7, the Service would decrease the risk of contamination of aquifer to negligible levels under alternative C.

Alternative A

Lexam's proposed exploration activities would be conducted under applicable COGCC and CDPHE rules and regulations. Potential impacts to groundwater would be minimized through the implementation of the SWMP and SPCC Plan. Lexam's SWMP specifies a depth of 3,000 feet for the intermediate casing, which would not fully protect the deep confined aquifer that could extend to a depth of 4,500 feet. Although the Project Leader of the Refuge would decide that Federal and State rules and regulations would provide an adequate level of protection, impacts to groundwater could be greater than alternative C because the intermediate casing would not extend 500 feet beyond the bottom of the deep confined acquired as required by alternative C.

Lexam's SWMP specifies that about 3,000 feet of casing would be run to protect the confined aquifer. The casing string will be fixed in place with cement pumped into the annular space between the casings and the borehole and nested inside the larger-diameter casing set in the unconfined aquifer. The cement will fill the annular space from the depth where the casing is set to the surface to ensure that the aquifers are not only protected during drilling, but also are isolated from each other. However, alternative A does not protect an estimated additional 789 feet of the deep confined aquifer at Baca #5 and 831 feet at Baca #7, plus an additional 500 feet of protective casing extending below the identified bottom depth of the deep confined aquifer (Layer #4) that would be protected under alternative C,.

The 3,000-foot depth specified does not appear to be based upon specific lithologies, but instead on information from previous studies suggests that with depth, water quality becomes poor and well yields decrease. This is supported by the fact that the depth of wells in the USGS database that penetrate the deep confined aquifer range are 2,300 feet deep or less.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Groundwater Quality

To protect groundwater quality in the unconfined and confined aquifers, several protective measures would be required by the Service. Primary concerns for potential impacts to groundwater include the use of drilling mud and sealing off the aquifers as they are drilled through. The use of drilling mud is designed to lessen the impact to porous and permeable formations. The use of drilling mud is an accepted practice for drilling all types of wells including water wells, environmental monitoring wells, and utility borings. Drilling mud is designed to seal the sides of the borehole and minimize the infiltration of the fluid component of the mud into porous and permeable layers. Impacts are expected to be limited to less than a few feet from the borehole.

After drilling, the use of cement to case the borehole would seal porous zones from further infiltration of drilling fluids. If the well is plugged and abandoned, COGCC rules require that cement plugs be placed over porous and permeable zones to protect aquifers. Over a period of time, the filtrate would disperse into the formation by movement of groundwater. The impact of the mud filtrate is expected to be negligible. Impacts to water quality would be less than significant because of compliance with COGCC rules and protective measures required by the Service (e.g., #12 – extending intermediate casing 500 feet beyond bottom of aquifer).

Unconfined Aquifer

Potential impacts to the unconfined aquifer would be minimized through implementation of the SWMP and SPCC Plan in addition to the additional protective measures required by the Service. For example, a closed-loop mud system would be used to eliminate the need for a drilling reserve pit, and drilling fluids and drill cuttings would be disposed of off-site.

About 350 feet of surface casing would be run to protect the unconfined aquifer. Although not clearly specified, this depth should be verified by review of drilling cuttings to assure the appropriate depths are used for sealing off the aquifer units. The casing string will be fixed in place with cement pumped into in the annular space between the casing and the borehole. The cement will fill the annular space from the depth where the casing is set to the surface.

Upward gradients have been documented throughout the San Luis Valley and also in the vicinity of the Project Area. As a result of these gradients, the movement of potential contaminants could be accelerated if the wells are not properly sealed at the appropriate depth, which is in the confining unit separating the unconfined and confined aquifers. If contaminants are introduced into the unconfined aquifer, they would migrate towards the center of the valley and upward into surface water and wetlands. However, alternative C requires that the entire aquifer be cased, which should negate potential movement of contaminants within the aquifer and to the center of the valley.

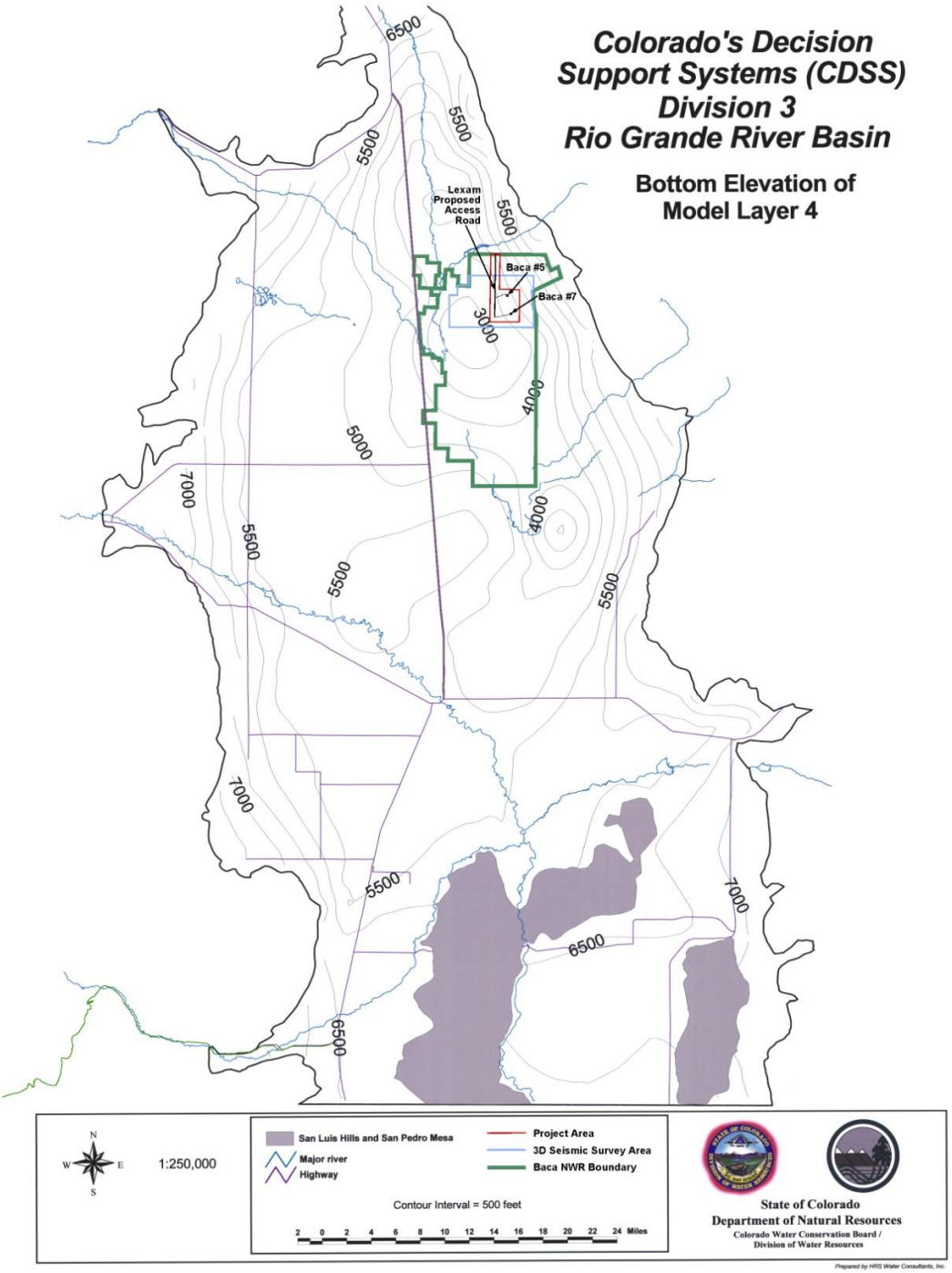
Confined Aquifer

Potential impacts to the confined aquifer include impacts from drilling mud and from the potential introduction of oil and gas from the proposed exploration production zone. The use of drilling mud was addressed above and is considered to be a localized, minor, and temporary impact.

Water quality in the deep confined aquifer diminishes below 2,500 to 3,000 feet because of TDS concentrations of greater than 3,000 mg/L as compared to 300 to 500 mg/L above the 2,500- to 3,000-foot depth range. The decrease in water quality limits the potential use of water from depths greater than 3,000 feet (HRS 1987).

To put these water quality data into perspective, a TDS concentration limit of 500 mg/L is a secondary maximum contaminant level for drinking water (CDPHE 2007d). Concentrations above that level are acceptable but not optimal for human consumption mainly due to taste and palatability. Water with a TDS concentration greater than 2,000 mg/L is generally unsuitable for irrigation (Fipps 2003). TDS concentrations of between 3,000 and 5,000 mg/L are satisfactory for use for most livestock but can cause problems for sensitive animals such as poultry. However, concentrations between 7,000 and 10,000 mg/L are risky for several types of livestock (Soltanpour and Raley 1993).

Figure 4-2. Colorado Division of Water Resources Decision Support System Modeled Elevation Estimate of Aquifer Layer #4[21]



[21] Figure 4-2 contains resource grade information that was geographically superimposed on the map produced by the CDWR by the Service. Interpretation of the map is intended only as an approximate visual reference and not for absolute accuracy.

The information on the deep confined aquifer indicates that it is not and will not likely be used for water supply because of its degraded water quality and low well yields. Further, groundwater flow from that layer into shallower and more commonly used aquifers is likely to be very slow, except along vertical fractures where groundwater flow would increase between layers. However, there is evidence that the bottom of Layer #4 of the deep confined aquifer extends beyond a depth of 3,500 feet in the Baca Graben area (CDWR 2004). If the entire deep aquifer is not cased off, the potential for contaminants to enter the aquifer and migrate into shallower units becomes much higher.

All of this information on the deep confined aquifer suggests that the 3,000-foot intermediate casing, implemented by alternative A, cannot definitively provide protection to the deep confined aquifer. Information on the deep confined aquifer indicates water does flow upward into shallower units. The upward flow is very slow in most places, but can be accelerated where faulting is present; therefore, potential contamination of the deep confined aquifer would present a threat to shallower units sooner or later. In addition, if contamination does make it into the unconfined and shallower aquifer Layers #2 and #3, the impact would spread down-gradient toward the valley center based on groundwater flow directions beneath the Project Area.

The Service will require that the aquifer is cased to the bottom of the Layer #4 of the deep confined aquifer under protective measure #12, to reduce any risk of contamination to the aquifer from the proposed exploration to negligible levels. An independent professional geologist that is approved by the Service will be required to be present to confirm when the appropriate depth has been reached based on lithographic data collected from drilling logs.

Water Use

There are two options for Lexam to acquire the approximately 15 acre-feet of water they need for drilling: 1) water could be withdrawn from a well (SW-5) owned by the Service if Lexam can provide an in-kind match of an equivalent amount of water to another portion of the Refuge (**Figure 4-3**), or 2) Lexam could haul the required truckloads of water from an off-Refuge site to the Refuge to be used during drilling operations.

Under alternative A and C, withdrawal of the 15 acre-feet of water from a well owned by the Service (SW-5) would result in no net impact to water supply on the Refuge because Lexam would be required to offset the depletion of water it uses. However, pumping water from SW-5 could result in a short-term minor impact from any localized depletion of the unconfined aquifer and surface water. If water is brought in from an outside source, there would be no impacts to surface water or groundwater on the Refuge under alternative A or C.

Protection Measures

The following protective measures would be required by the Service to be followed by Lexam during their exploration activities to ensure protection of groundwater underneath the Refuge:

- Protective measure #3 – Lexam will provide trained NRAs, approved by the Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts.

- Protective measure #5 – Lexam will provide a resource monitoring plan which must be approved by USFWS. The plan should also include a schedule for gathering data before, during, and after construction and/or drilling activities occur. It should include an assessment of baseline water quality of surface waters, the near-surface unconfined aquifer and the deeper confined aquifers in proximity to the proposed well locations (both up-gradient and down-gradient). In addition, it should include provisions for re-sampling in the event of anomalous detections.

- Protective measures #13 & 14 – Lexam shall provide a Storm Water Management Plan (SWMP) and a Spill Prevention and Countermeasures Plan (SPCC) approved by Service to ensure protection of surface and groundwater on the Refuge.

- Protective measures #32, 33, 34, 35, and 36 – These measures will require Lexam to identify and maintain all potential toxic construction equipment supplies and refuse and other produced waste products in a safe manner and transport all waste products used for drilling away off the Refuge to a state-approved facility. Proper storage and handling of hazardous substances would ensure that no contaminants be spilled onto the soil or into surface waters. These protective measures, along with # 14, and #14, would minimize the risk of hazardous substances moving from surface waters to the lower unconfined and confined layers of the aquifer.

- Protective measure #41 – A minimum of one up-gradient and two down-gradient monitoring wells will be installed around each drill pad. The wells will be completed in the shallow unconfined aquifer. The locations and elevations of the wells will be surveyed and depth to water will be measured. Water samples will be collected for chemical analysis before the wells are spud and at predetermined intervals thereafter, which will agreed to by the Service and Lexam. If spills or releases of drilling related chemicals at sites occur, then the sampling frequency may be increased to a frequency agreed to by the Service, Baca Grande Water and Sanitation District, and Lexam.

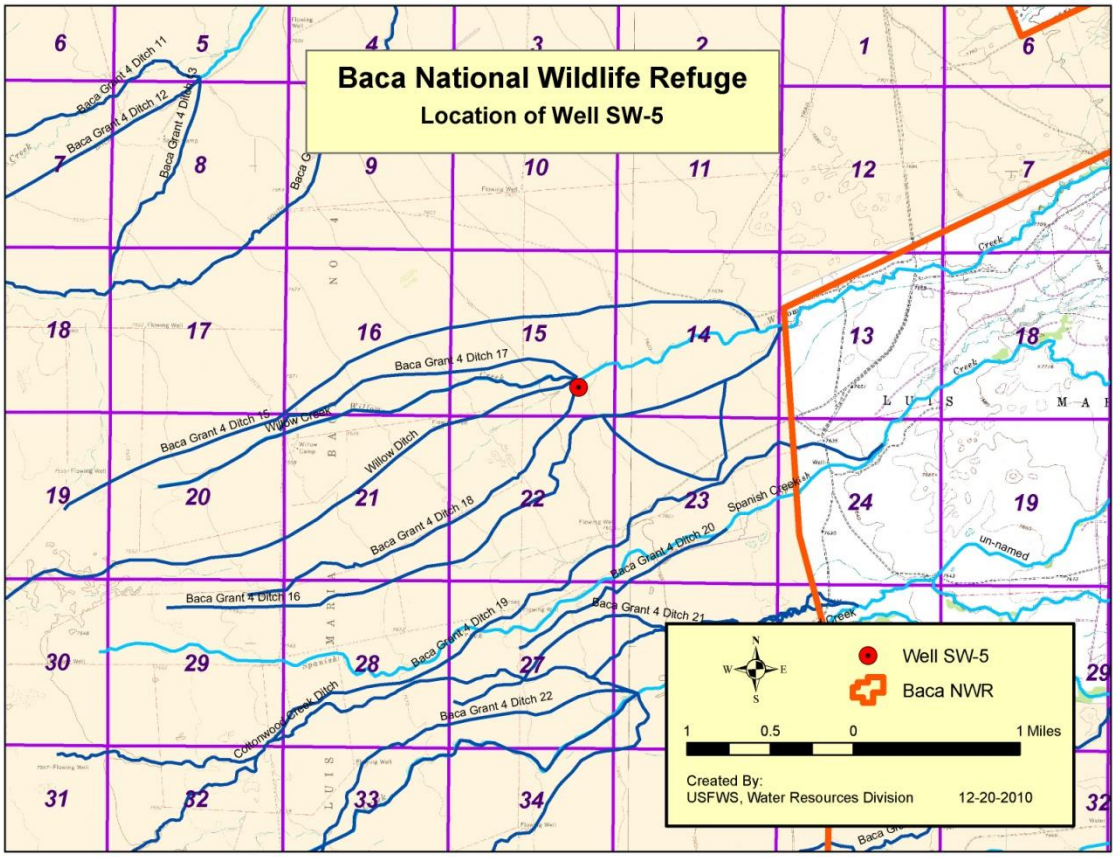


Figure 4-3. Location of Water Well SW-5 on Baca National Wildlife Refuge

Cumulative Impacts

Alternative A

No cumulative impacts to surface or groundwater resources have been identified by the Service. In addition, other than annual irrigation practices, no water projects have been identified in the cumulative effects study area that would create water-related cumulative impacts.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.6 Vegetation and Habitats

Effect on Vegetation and Habitat

In general, impacts can occur directly or indirectly and be short-term, long-term, or permanent. Direct impacts are the result of the physical destruction or degradation of a resource. An example of a direct impact is the excavation and grading of riparian/wetland habitat during the construction of a road. Indirect impacts are foreseeable effects that are somewhat distant from the project in time and/or space (40 CFR 1508.8). A relatively common example of an indirect impact is the introduction and establishment of noxious weeds on newly disturbed soils. The noxious weeds become established and begin to out-compete native plant species and can eventually lead to the degradation of riparian/wetland habitats.

Short-term impacts are temporary and usually restored to pre-impact functionality in less than 5 years. When not permanent, direct impacts to emergent wetlands are often considered short-term because these communities typically recover more quickly than plant communities possessing a woody plant component. Long-term impacts take longer than 5 years to revert to pre-impact functionality but do eventually recover from the impact. Long-term impacts can be expected to occur more frequently in riparian/wetland areas with a tree and shrub component because these woody plants generally take longer to become established and grow to maturity than herbaceous species. No woody riparian/wetland areas are expected to be directly impacted as a result of the proposed project.

Permanent impacts are those impacts where a complete change in functionality occurs (i.e., land conversion) and persist for the lifetime of the facility.

Indirect Impacts

Indirect impacts are foreseeable effects that occur away from the proposed project in time, space, or both. By their very nature, indirect impacts are difficult to quantify before a project is designed. The general types of indirect impacts to riparian/wetland habitat are discussed below.

- *Changes in Drainage or Flow Routes.* The proposed exploration activities could change the way water is routed across the landscape resulting in higher, lower, or no substantial change in surface water or groundwater levels. These changes could be caused by increasing the total amount of impervious cover (i.e., road surface) in an area, and thereby increasing stormwater runoff; crossing natural drainages and interrupting sheetflow on a hillside so that water runs down a roadside ditch instead of down a hillside; constructing roadside ditches to carry stormwater runoff to designated discharge points; or other unforeseeable consequences. An increase in water availability at a riparian/wetland area could cause a shift in plant species toward those more adapted to relatively higher soil moistures or lower soil oxygen regimes. A decrease in water availability at a site would likely result in the site drying and a shift in dominance to species that are better adapted to relatively drier conditions (i.e., higher levels of soil oxygen).
- *Decrease in Water Quality.* Decreased water quality could affect the plant and animal species that inhabit a particular area; for example, an increase in sediment from road runoff could preclude amphibian species from using a particular marsh or water body. Water quality may be degraded adjacent to disturbed areas as earth moving equipment removes vegetation and exposes soils to erosive forces. This type of impact is typically temporary and is addressed in the SWMP that specifies BMPs to minimize these types of impacts.

- *Introduction of Invasive Plant Species*. Seeds and plant parts of noxious weeds and other invasive plant species could be carried into the Project Area on construction equipment (Fleming, 2005); existing weed seeds can be spread during construction; and/or natural distribution methods (such as animals and wind) could deliver weed seeds to newly disturbed soils. These different ways for weeds to be spread in construction areas facilitate both weed establishment and spread. Once established, weeds can spread into nearby undisturbed areas and would slowly degrade habitat quality for various wildlife species and result in a shift in the plant and animal species composition found in a particular area.
- *Loss of Functionality.* In some cases, direct impacts to riparian/wetland habitat could have indirect impacts on the functions performed. For example, the clearing of vegetation could change site hydrology (drier or wetter), which would directly alter flood flow attenuation, water storage, and wildlife functionality, and could indirectly alter nutrient cycling, food chain support, and/or water quality improvement functions.
- *Habitat Fragmentation*. Habitat fragmentation occurs directly through splitting a formerly contiguous habitat block into one or more pieces. This type of impact would occur to upland habitats as a result of the proposed new access road to Baca 5, though not to wetlands. In general, habitat fragmentation also could occur indirectly as a result of increased noise, odors, and/or dust, increased presence of humans or livestock, and other more subtle changes to the environment causing wildlife to avoid otherwise suitable habitats. Temporary indirect habitat fragmentation can be expected during drilling operations due to the increased level of traffic and activity along the main north-south Lexam Road. The impact of this temporary indirect habitat fragmentation can be partially mitigated by the timing of the construction and drilling operations (e.g., outside of the primary breeding/nesting season) outlined in alternative C.

Direct Impacts

Review of access roads and well pad locations relative to NWI mapping suggests that no direct impacts to riparian/wetland areas or non-wetland waters of the United States (e.g., streams) would occur during construction of access roads and well pads. Because no riparian/wetland areas have been identified under alternative C, a permit from the U.S. Army Corp of Engineers (USACE) would not be required. If riparian/wetland areas have the potential to be disturbed under alternative A, a permit would be required by the USACE.

Although unlikely, direct impacts to riparian/wetland areas could occur from a spill event associated with exploration. Should a spill occur, the severity of the impact to riparian/wetland areas would depend on several factors including, but not limited to, the spill size and location, time of year, the presence or absence of surface water, site-specific soil textures, and speed of remedial actions. If a spill occurs, Lexam will follow their SPCC under both alternatives A and C, to minimize and remediate impacts to riparian/wetland areas and/or non-wetland waters of the United States. These actions typically involve the use of on-site containment (e.g., berms), absorbent booms and materials, and removal of contaminated soils and vegetation.

Exploration under alternative A would directly impact 11.7 acres of the San Luis Valley Playa Lake Megasite. The Baca Grande and Reserve PCA would not be impacted. The Baca Grande and Reserve PCA is located roughly 600 feet southeast of the Baca 5 well pad location and roughly 200 feet east of the Baca 7 well pad location.

Direct impacts would also include loss of native vegetation at disturbed sites, soil compaction, potential increased soil erosion, and fragmentation of important habitat to wildlife. These effects would result from the creation of access roads and pad locations. Effects to vegetation in disturbed areas may be long-term given the semi-arid climate and erosive nature of the soils.

Alternative A

To minimize the potential for direct effects to vegetation communities, construction and drilling activities would be conducted in accordance with all federal, state, and local laws and regulations and follow all of the COGCC. Potential impacts to wetlands and riparian areas would be minimized through the implementation of the SWMP and SPCC Plans under state authority. Because Baca #5 is located in close proximity to wetlands, potential impacts could be greater than to important habitat than at Baca #7 which already has an existing access road to

the area designated for the well pad. All disturbed areas would be reclaimed according to the COGCC permit requirements and CDPHE regulations.

Impacts to sensitive plant species or communities would be greater than alternative C since protective measures such as the required re-routing of Baca #5 access road to avoid dense populations of the slender spiderflower would not take place. Well sites and associated roads may be not avoid sensitive wet meadow wetlands under alternative A, thus impeding sheet water flows and potentially altering plant species composition and/or vigor.

To minimize the introduction of noxious and invasive plant species, the COGCC regulations would be implemented. According to COGCC regulations, all disturbed areas shall be kept free of noxious weeds as practicable. However, impacts are potentially greater than alternative C because there would be no on-site monitoring to ensure that vehicle decontamination is done properly, no requirement allowing the Refuge manager to approve all construction material brought in and no requirement preventing the importation of top soils onto the Refuge.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.
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Alternative C

In addition to the laws and regulations of other governmental agencies, impacts to vegetation communities would be minimized through the implementation of Service protective measures including the addition of NRAs; noxious weed control; use of existing roads as much as possible; extra law enforcement personnel to enforce state, federal, Refuge, and wildlife laws; maintenance of historic drainage patterns; reclamation of original site contours when site is abandoned; use of a Service-approved native seed mix in site reclamation; additional requirements as requested by the Service; implementation of the SWMP and SPCC Plan; and the modification of drilling activities as necessary to avoid conflicts with other Refuge management activities. Consideration of future reclamation activities has resulted in access road and well pad layouts and construction methods that best facilitate the complete reclamation of the disturbed areas once Lexam activities have ceased. In addition to these measures, it is recommended that an on-site wetland delineation be completed in the Project Area prior to site disturbance. Riparian areas that do not fit the stricter definition of wetlands should also be mapped so that the extent and quality of this resource is specifically identified. Well sites will not be located in wetlands and will be located as far from sensitive wet meadow wetlands as practicable and timing restrictions will prohibit construction during periods when temporary or seasonal wet meadows are occupied by nesting migratory birds.

Areas temporarily disturbed by construction and operation activities would be reclaimed as described above. In 3 to 5 years following initiation of reclamation, these areas would provide food, cover and nesting wildlife habitat. However, it may require up to 15 to 20 years for vegetation communities, especially shrub communities, to return to pre-disturbance levels. Vegetation disturbed by construction and operation activities would not be available following construction, but reclamation would ensure that vegetation is restored to its pre-construction conditions. Therefore, impacts to vegetation and wetlands would be less than significant under alternative C.

The following protective measures will be required by the Service to reduce impacts to vegetation:

- All vehicles and equipment from outside the Refuge will be decontaminated per USFWS procedures to prevent the introduction of noxious weeds to the Refuge (#1);
- Trained NRAs (#3);
- Impacts to sensitive habitat, wildlife, plants or other sensitive natural or cultural resource features will be avoided to the extent possible while constructing the access road and well pads (#4);

- Lexam will provide a resource monitoring plan which must be approved by Service. The plan should include a schedule for gathering data before, during, and after construction and/or drilling activities occur to determine the impact of exploration on natural resources.;
- Testing of soils for potential contaminants prior to rig-up operations, soil testing upon abandonment, and testing of soil removed from the site (#7);
- Lexam shall conduct a detailed wetland delineation of Project Area vicinity (#8);
- All construction of roads and pads will occur in a way that best facilitates their subsequent complete removal and reclamation once Lexam activities have ceased at these sites. This includes separating and stockpiling topsoil layers on-site to be replaced during reclamation. All disturbed areas will be reclaimed per the COGCC permit requirements and with USFWS input. Only endemic plants and seed mixtures are to be used in reclamation (#11);
- Implementation of a closed loop mud and drill cuttings system will be used to minimize impacts to surrounding habitats (#15);
- Limit activities to periods outside of active growing season (#19);
- All materials brought in to the Refuge to build up the location pad will be authorized by the Refuge Manager or his authorized representative. To minimize the spread of invasive species no top soils will be brought in from off Refuge (#23);
- The Operator will upgrade and maintain all access routes, roads and bridges designated for its use across the Refuge in accordance with acceptable specifications and standards (#27);
- Upon completion of drilling operations, the Refuge Manager or his authorized representative must be advised within 120 days whether the well is to be retained or plugged. If the well site is to be abandoned, the well is to be plugged according to state law, all above ground structures removed and the site and road restored as directed by the Refuge Manager or his authorized representative. Any damage to existing surface vegetation, water channels, or other physical features shall be restored to original site conditions. All costs shall be born by the Operator (#28);
- Limit size of disturbance; drill pads may not exceed 90,000 square feet (#29);
- No discharge of wastewater allowed (#35);
- Prohibition of fires (#42).

Cumulative Impacts

Alternative A

No cumulative impacts to vegetation or habitat have been identified by the Service. In addition, other than annual irrigation practices, no water projects have been identified in the cumulative effects study area that would create wetland-related cumulative impacts.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.7 Wildlife and Fisheries

Effect on Wildlife and Fisheries

The primary issues related to wildlife and fisheries resources include the loss or alteration of native habitats, increased habitat fragmentation, animal displacement, direct loss of wildlife, and impacts associated with water crossings at Crestone and Willow creeks. However, the effects on wildlife species and their habitats would depend on factors such as the sensitivity of the species, seasonal use patterns, type and timing of project activity, and physical parameters (e.g., topography, cover, forage, and climate).

Alternative A

Under alternative A, impacts on terrestrial wildlife, aquatic species, and special status species would be assessed based on standard rules and conditions of approval imposed by the COGCC. Under these rules, Lexam would only be required to avoid adverse disturbances to wildlife when it is cost-effective and technically feasible. Lexam would be required to consult with the CDOW to identify specific sensitive habitats as part of the of COGCC approval. However, Lexam would not be required to follow 10 of the 40 protective measures that specifically apply to protection of big game, small game, non-game species, migratory birds, fisheries, and special status species on the Refuge under alternative C.

Impacts to wildlife would be greater under alternative A than under alternative C. For example, No restrictions on timing of drilling activities would result in some breeding birds being more limited in their ability to temporarily relocate during periods of disturbance because of fidelity to nests and unfledged young. This could result in nest abandonment and failure. Secondly, there would be no buffer zone around surface waters excluding construction activities and no monitoring of surface waters to monitor for potential impacts to fisheries. Construction activities also could cause mortalities to amphibians during their occurrence in terrestrial habitats.

Potential impacts to special status species would be greater than under alternative C. Because there would be no protective measures required by the Service, direct impacts to special status species would include the incremental disturbance of habitat and increased habitat fragmentation. Impacts also could include mortalities of less mobile species (e.g., small mammals and amphibians), nest abandonment, and loss of eggs or young as a result of increase predation or crushing from vehicles and equipment. However, overall impacts would be minimal because of the limited Project Area and temporary nature of the proposed project.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Under this alternative, the Service has developed a number of protection measures in order to mitigate surface impacts to terrestrial wildlife, aquatic species, and special status species within the Project Area. However, there may be some unavoidable direct impacts to wildlife such as a reduction or alteration of vegetation, habitat fragmentation, and animal displacement. Additionally, there may be an increase in indirect impacts such as noise, human presence in sensitive habitats, and vehicle-related mortalities in areas with special status species. Impacts to wildlife and fisheries resources as a result of the proposed project would be minimized to negligible levels by implementation of Service protective measures.

Big Game

Direct impacts to big game species (elk, mule deer, and pronghorn) would result from the incremental disturbance of habitat, increased habitat fragmentation, and increased activity associated with exploration. The loss of available vegetation would be long-term (greater than 20 years), although herbaceous species may become established within 3 to 5 years, depending on reclamation success and future weather conditions. In most instances, suitable habitat adjacent to the disturbed areas would not be available for these species until grasses and woody vegetation were reestablished within the disturbance areas.

Other impacts to big game species would include increased animal disturbance as a result of increased noise levels and human presence. As a result, big game animals may decrease their use within 0.5 mile of surface disturbance activities (Ward 1976). Any decreased use near well sites would be less than significant to big game because of the temporary period (<180 days) when exploration would occur.

Seasonal restrictions on activities would eliminate disturbance to birthing animals and animals caring for newborns. Fences would be used, if needed, to prevent animals from coming in direct contact with machinery and hazardous materials. Other measures would include restricting vehicle traffic to existing Refuge roads and reducing habitat fragmentation and habitat loss by limiting the construction of new roads. Preconstruction surveys and frequent population monitoring for wildlife species including big game would occur in areas where the access roads and well pads would be built. Vehicle speed restrictions would reduce potential for road kill accidents. Impacts to mountain lions and black bears also would be expected to be minimal, based on the infrequent occurrence of these species within the Project Area.

Because of the above conditions, impacts to big game species would be less than significant.

Small Game

Impacts to small game would be greater than those to large game because they are limited in their ability to temporarily relocate during periods of disturbance because of their smaller size. Temporary disturbances and habitat losses could cause unnatural movements of these species away from the disturbance and altered habitats, which may result in an increased vulnerability to predators. Service protective measures would minimize impacts to small game species. Seasonal restrictions on activities would eliminate disturbance to birthing animals and animals caring for newborns. Vehicle traffic would be restricted to existing Refuge roads or new access roads, thereby reducing habitat fragmentation and habitat loss by limiting the construction of new roads. Vehicle speed restrictions would reduce potential for road kill accidents.

Non-game Species

Impacts to non-game species are expected to be minimal because of Service protective measures. Vehicle traffic would be restricted to existing Refuge or new access roads, thereby reducing habitat fragmentation and habitat loss. Seasonal timing restrictions would eliminate disturbance to birthing animals and animals caring for newborn. Preconstruction surveys and frequent population monitoring of non-game species, would occur in areas where the access roads and well pads would be built, and sensitive habitat (e.g., wet meadows and riparian areas) would be avoided whenever possible. Vehicle speed restrictions would reduce potential for road kill accidents.

Migratory Birds

Impacts to migratory birds (waterfowl, shorebirds, passerines and raptors) are expected to be minimal because of Service protective measures. Vehicle traffic would be restricted to existing Refuge or new access roads, thereby reducing habitat fragmentation and habitat loss. Seasonal timing restrictions would eliminate disturbance to nesting birds and those with unfledged young. Preconstruction surveys for wildlife species, including migratory birds, would occur in areas where the access roads and well pads would be built, and sensitive habitat (e.g., wet meadows and riparian areas) would be avoided whenever possible. Vehicle speed restrictions would reduce potential for road kill accidents.

Fisheries

Impact issues evaluated for aquatic communities (i.e., fish and amphibians) and sensitive fish species (i.e., Rio Grande sucker, Rio Grande chub) included potential effects of project activities on water quality and quantity and habitat in the Crestone Creek drainage. The occurrence of nongame fish is limited to Crestone Creek within the Project Area. The aquatic stages of amphibians could occur in Crestone, Willow, and Spanish creeks as well as in wet meadows during spring and fall months. Migrating amphibians in their terrestrial stages may still be occurring during the months of August over many wetter portions of the Project Area. Impacts to migrating amphibians in their terrestrial stages would be minimized by seasonal restrictions resulting in no activity being allowed on the Refuge during the peak migration times of June and July.

Impacts to fisheries would be minimized by implementation of Service protective measures. Construction activities would be required to control fugitive dust and maintain a distance of at least 0.25 mile from sensitive water crossings such as Crestone Creek. Vehicle traffic would be restricted along water crossings with fish present. Water quality monitoring would be conducted in waterways near construction activities to determine the presence

of impacts due to the proposed project and to enable implementation of protective measures to mitigate potential problems.

Special Status Species

The Service protective measures also would minimize impacts to special status species. Vehicle traffic would be restricted to existing Refuge roads and the new access roads, thereby reducing habitat fragmentation and habitat loss by limiting the construction of new roads. Preconstruction surveys for wildlife species including special status species, would occur in areas where the access roads and well pads would be built, and sensitive habitat (e.g., wet meadows and riparian areas) would be avoided. Therefore, impacts to special status species would less than significant

Service Protective Measures #3, #4, #5, #8, #15, #16, #19, #21, #39, #40, and #42 would provide for the following requirements:

- Trained environmental monitors (#3);
- Impacts to sensitive habitat, wildlife, or other sensitive natural resource features will be avoided while constructing the access road and well pads (#4);
- Frequent water, soil, vegetation, and sound monitoring to assess wildlife sensitivities (#5);
- Lexam shall conduct a detailed wetland delineation to avoid sensitive wetland habitat (#8);
- Implementation of a closed loop mud and drill cuttings system will be used to minimize impacts to surrounding habitats (#15);
- Drilling operations will be modified, as necessary at the direction of USFWS, to reduce conflicts with other Refuge management activities (#16);
- Seasonal restrictions (May 1 through July 31) on construction and drilling activities would avoid conflicts with birthing and/or nesting and the fledging of young birds (#19);
- Establish a 0.25-mile buffer zone of no activity around potential and identified sensitive species fisheries habitat (#21);
- Mufflers on drilling rig engines (#39);
- Assist CDOW to manage the needs of any wintering big game temporarily displaced by exploration (#40);
- All vehicle access will be restricted to developed roads and two-tracks (#42);
- Vehicle speed restrictions would reduce potential for road kill accidents (#42).

Cumulative Impacts

Alternative A

The cumulative impact study area for wildlife resources is the Refuge. In the absence of known RFFAs on the Refuge, there would be no cumulative impacts to wildlife resources.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed under alternative A.

4.8 Cultural Resources

Effect on Cultural Resources

The TRC Mariah Class III inventory identified a total of one prehistoric site (5SH3146), one historic canal (5SH3147.1) and four isolated finds (TRC Mariah 2007). Site 5SH3146 and all four of the isolates were

recommended as not eligible for the NRHP; no further work is recommended for these resources. The historic canal was recommended as eligible for the NRHP.

The WCRM Class III inventory identified a total of eight new sites and five previously recorded site segments were documented. The newly recorded sites are laterals associated with three previously recorded irrigation ditches: the Willow Creek Ditch Lateral (5SH3336), the Baca Grant No. 4, Ditch 17 (5SH3341), and the Baca Grant No. 4, Ditch 18 (5SH3342). The entire ditches have been officially determined eligible for inclusion in the NRHP. These sites (5SH3336.2, 5SH3336.3, 5SH3341.2, 5SH3341.3, 5SH3341.4, 5SH 3341.5, 5SH3341.6, and 5SH3342.4) are recommended eligible to the NRHP as contributing elements in the overall ditch systems. These ditches are part of an active irrigation system.

The segments of the previously noted ditches located in the WCRM study area include: one segment of the Baca Grant No. 4 (5SH3339.10), three segments of the Baca Grant No. 4, Ditch 16 (5SH3340.2, 5SH3340.3, and 5SH3340.10), and one segment of the Baca Grant, Ditch 17 (5SH3341.17). The re-evaluated segments have been recommended not eligible for inclusion in the NRHP.

Direct effects to historic properties that could occur as a result of Lexam's proposed exploration program include disturbance or destruction of historical properties as a result of road or well pad construction. Indirect effects include vandalism, illegal collecting, or inadvertent destruction due to increased numbers of people (i.e., construction personnel) in the Project Area and increased erosion due to soil disturbance associated with construction activities.

Alternative A

Lexam's proposed exploration program would be conducted under applicable COGCC rules and regulations as well as the specific conditions that have already been incorporated into Lexam's survey and drilling permits. No cultural resource monitors would be present during ground disturbing activities which would increase the chance of impacts to historic resources in the event of unanticipated discoveries during construction.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Under this alternative, the Service would require protective measures to ensure that Lexam's exploratory drilling project does not unreasonably degrade or impact environmental resources. Lexam proposes to install a culvert to allow vehicular traffic to cross the NRHP-eligible canal (5SH3147.1) without affecting the historic character of the resource. Therefore, no direct adverse effects to the historic canal would occur as a result of alternative A or C.

Section 106 of NHPA would be followed in conjunction with exploration activities on the Refuge, to minimize the potential for indirect effects to historic properties, project personnel would be requested to perform contract operations in a careful and conscientious manner and to perform all work in accordance with all laws and regulations. Little or no indirect effects to historic properties from modifications to erosion/sedimentation rates during drilling activities are anticipated. All construction of roads and pads would occur in a way which best facilitates their complete removal and reclamation once Lexam activities have ceased at these sites. All disturbed areas would be reclaimed based on COGCC rules and regulations and additional protective measures required by the Service.

Given the sand deposits throughout the area and specifically at the well pad and access road locations, monitoring of all proposed ground disturbance would be conducted by a qualified archaeologist. If any previously unknown cultural resources are discovered during well pad and access road development, all construction activities would cease within the vicinity of the discovery and the Service Authorized Officer would be notified of

the find. Steps would be taken to protect the site from vandalism or further damage until the Service Authorized Officer can evaluate the nature of the discovery as outlined in an Unanticipated Discoveries Plan and construction would not resume in the area of the discovery until the Service Authorized Officer has issued a notice to proceed.

If construction or other project personnel discover what may be human remains, funerary objects, or items of cultural patrimony, construction would cease within the vicinity of the discovery, and the Service Authorized Officer would be notified of the find. Any discovered Native American human remains, funerary objects, or items of cultural patrimony would be handled in accordance with NAGPRA. Non-Native American human remains would be handled in accordance with Colorado law. Construction would not resume in the area of the discovery until the Service Authorized Officer has issued a notice to proceed.

All known historic properties identified within the APE would be avoided by project construction. Cultural resource monitors would be present during ground-disturbing activities in the event subsurface materials are discovered. Any previously unknown historic properties that may be discovered during ground-disturbing Activities would be protected in accordance with the Unanticipated Discoveries Plan.

The following Service protective measures would be required #2, #3, and #4:

- On-site cultural resource monitoring during all ground-disturbing activities (#2);
- On-site NRAs (#3);
- Avoidance of sensitive historical sites (#4)

Cumulative Impacts

Alternative A

The cumulative impact study area for cultural resources encompasses the Refuge. Under this alternative, no adverse effects to historical properties would occur; therefore, there would be no incremental impact to historic properties when added to past, present, and RFFAs within the cumulative impact study area.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.9 Native American Traditional Values

Effect on Native American Traditional Values

The effects of federal undertakings on traditional cultural properties (TCPs) or places of religious and cultural significance to contemporary Native Americans are given consideration under the provisions of EO 13007, AIRFA, NAGPRA, and recent amendments to the NHPA. As amended, the NHPA now integrates Indian tribes into the Section 106 compliance process, and also strives to make the NHPA and NEPA procedurally compatible. Furthermore, under NAGPRA, culturally affiliated Indian tribes and federal agencies jointly may develop procedures to be taken when Native American human remains are discovered on federal lands.

Potential direct and indirect impacts to Native American traditional values as a result of the Lexam's proposed exploration program would be the same as those described for cultural resources in section 4.8. Government to-government consultation between the Service and tribal representatives will be initiated upon release of this Draft EA on January 7, 2011. To date, no TCPs or places of cultural and religious importance to the tribes have been identified during the cultural resources inventory.

If a TCP or place of cultural and religious importance is identified by tribal representatives, no surface disturbance would occur within or immediately adjacent to the boundary of the property prior to completion of all consultation required by law. If data recovery or other form of mitigation is required at a TCP or place of cultural and religious importance, a data recovery or mitigation plan would be reviewed and approved by the Service and SHPO. Tribal representatives would be asked to participate in the development of any such data recovery or mitigation plan. Therefore, no adverse effects to Native American traditional values are anticipated as a result of Lexam's proposed exploration program.

Alternative A

Potential direct and indirect impacts to Native American traditional values as a result of this alternative would be the same as those described for Lexam's proposed exploration program in section 4.8.

Under this alternative, Lexam's proposed exploration program would be conducted under applicable COGCC rules and regulations, the provisions of EO 13007, AIRFA, NAGPRA, and recent amendments to the NHPA, as well as the specific conditions that have already been incorporated into Lexam's survey and drilling permits.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Protective measures under this alternative would be the same as described in section 4.8, alternative C. No expected impacts are expected because there have not been any TCPs identified by previous cultural resource surveys.

Cumulative Impacts

Alternative A

The cumulative impact study area for Native American traditional values encompasses the Refuge. To date, no TCPs or places of cultural and religious importance have been identified by tribal representatives. If any properties of tribal importance are identified, the properties would be protected under the same laws and regulations that protect important cultural resources. Therefore, no adverse effects to Native American traditional values are anticipated as a result of this alternative and no incremental impacts to these values would occur when added to past, present, and reasonably foreseeable future actions within the cumulative impact study area.

Reasonably foreseeable future actions that may occur within the cumulative impact study area would be subject to federal and state laws that protect TCPs and places of cultural and religious importance to Native Americans. Class III inventories and government-to-government consultation would be completed for any future proposed development, and potential adverse effects to any Native American traditional values would be avoided or mitigated as appropriate.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.10 Recreation

Effects on Recreation

Lexam's proposed oil and gas exploration would have no impacts to recreation resources within the Refuge because the Refuge is not currently accessible to the public. The proposed activities would not diminish recreational opportunities outside of the Refuge, such as at GSDNPP.

Alternative A

There would be no impacts to recreation because the Refuge is not accessible to the public.

Alternative B

No impacts would occur under this alternative because the proposed oil and gas exploration by Lexam would not occur.

Alternative C

There would be no impacts to recreation because the Refuge is not accessible to the public.

Cumulative Impacts

Alternative A

There would be no impacts to recreation because the Refuge is not accessible to the public.

Alternative B

No cumulative impacts would occur under this alternative because the proposed oil and gas exploration by Lexam would not occur.

Alternative C

There would be no impacts to recreation because the Refuge is not accessible to the public.

4.11 Social and Economic Environment Impacts

Effects on Social and Economic Environment

Economy

Lexam's proposed exploration program is expected to employ approximately 20 personnel on-site for the duration of approximately 4 to 5 months. The exploration itself would be contained within the Refuge; however, project personnel are likely to lodge in Alamosa for the duration of the project. The presence of project personnel in Alamosa would generate a small amount of additional income for local businesses; motels, dining establishments, gas stations, etc. Alamosa County generates about $100,000 in lodging tax revenue (Colorado State Cooperative University Extension 2006), and the additional income would be a small fraction of that revenue. However, the additional room receipts and other personal expenditures would be a minor beneficial impact.

Traffic

Lexam's proposed exploration program would generate additional traffic on local roads, notably CR T, and temporary traffic delays may occur when large equipment is moved to the proposed drill sites. Movement of large

equipment would be regulated by the Colorado DOT and may involve temporary lane closures or traffic detours to accommodate wide loads. Depending on the day of the week and time of day, such disruptions may cause a temporary negative impact on existing local traffic patterns.

In the event water is required to be trucked in to the drill sites, as many as 250 tanker truck loads per well may be required and will increase the impact on existing local traffic patterns.

Emergency Services

Local emergency services may potentially be called upon during Lexam's proposed exploration program in the event that an emergency situation develops. The local emergency response team's capabilities and assets include Emergency Medical Service transport services, a fully trained Hazmat team, police and firefighters, and a Level III trauma center.

Other Socioeconomic Resources

Lexam's proposed exploration program would not have an impact on regional demographics, housing, or land use. There are no Environmental Justice issues relating to Lexam's proposed exploration, as Crestone and The Baca Grande subdivision area does not comprise a low income or minority population.

Alternative A

Lexam would conduct their exploratory project within standard federal, state, and local rules and regulations.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

Lexam would conduct their proposed oil and gas exploration by implementing all Service protective measures and by following all applicable federal, state, and local rules and regulations. Two of the protective measures are relevant to the local community emergency response:

- Protective measures #13 and #14 – SWMP and SPCC plans that outline potential hazards associated with exploration.

- Protective measure #26 – Prior to rig-up, Lexam will prepare an Emergency Preparedness Plan covering exploratory drilling, well control, materials hauling, spill response, and fire evacuation. The plan will be provided to the Refuge Manager and discussed in a pre-operation meeting to be held with local governments. The plan shall contain a telephone list naming key contacts for emergency operations and activation.

No additional protective measures have been identified because impacts to socioeconomics are expected to be temporary (<180 days) and less than significant, as verified by the United States Geological Survey (**Appendix I**).

Cumulative Impacts

Alternative A

Because no RFFAs have been identified in the cumulative effects area and socioeconomic impacts are anticipated to be minimal and temporary, there would be no cumulative impacts.

Alternative B

There would be no cumulative impacts because exploration would not occur.

Alternative C

There would be no cumulative impacts for the same reasons listed in alternative A.

4.12 Aesthetics

There were numerous concerns about the effects of Lexam's two exploration wells on aesthetic resources surrounding the Project Area. The visual aspects and quietness are highly prized values for area residents. The issues addressed under aesthetics, visual resources and noise, address the potential impacts to the values expressed by residents of the area.

Effect on Visual Resources

This section discusses potential visual impacts associated with the project's drill rig, facility lighting, drill pads (2), upgraded access roads, and associated infrastructure. Exploration activities would be temporary, lasting approximately 120 to 180 days. The dominant facility would be the drill rig, which would be approximately 135 feet in height. The project would create night-time glare from the light of the drill rig and facilities that would be seen from viewers in the surrounding viewshed, but will vary depending upon the distance and direction where the rig was viewed from.

The drill rig, facility lighting, roads, and drill pads, which may be visible by viewers at a distance of 2.0 miles or greater, would create an adverse aesthetic impact. This visual impact is estimated to be less than significant due to the middle ground to background viewing distances. While night-time glare from facility lighting would have an adverse affect on viewers, it is estimated that the impact would be less than significant. This glare would reduce the darkness of the night sky and degrades viewers' enjoyment of the night-time sky from secluded residences, trails, and recreation areas. It is possible that lighting may also have an effect on wildlife. The glare is incompatible with the mostly dark night-time sky of the undeveloped areas near the Project Area. However, the lights are needed to allow for the safe operation of the facility at night and to comply with OSHA regulations. Although shielded lighting could potentially reduce the nighttime glare, even the most rigorously mitigated lighting plan would not completely eliminate nighttime glare from a facility that must comply with OSHA's lighting requirements.

The drilling rig would be visible during clear days, but differing vantage points would affect visibility. The tallest object in the Project Area is a tall cottonwood tree that is an estimated 53 feet tall and is visible for long distances. The rig being over 2 times taller than this tree also would be visible over distances of several miles. It would be especially visible from north of the Project Area along CR T. Looking down from the higher elevations to the east, the rig may not stand out above the horizon at a distance of more than a few miles. Atmospheric conditions such as wind-blown dust and haze also would affect view of the rig. On cloudy, windy or snowy days, the rig would be less visible or not visible.

Diminishment of the viewshed is a concern with regard to visitors to the GSDNPP located adjacent to the Refuge. The closest proposed location (Baca #7) is 2 miles from the extreme northern boundary of the park (**Figure 1-1**), but is about 18 miles northwest of the park visitor center. The vast majority of visitors to the park will be at the visitor center and immediate environs. Although the rig would not be viewable at a distance of 18 miles, the elevation of the dunes immediately to the north and northwest would preclude viewing from the visitor center. The nearest that potential visitors traveling to the park would be to the Project Area is if they were traveling on State Highway 17. From the nearest point on Highway 17, travelers would be at least 6 miles due west of the Project Area. At that distance, the rig would be hard to discern by the casual viewer. At night, lights from the Project Area would not likely be distinguishable from the lights of Crestone and the Baca Grande Subdivision that are directly in the line of sight to the east and northeast of the Project Area. It is possible that a few park visitors could view the rig from the northern extent of the park, but as stated above, the park boundary is at least 2 miles from the

closest proposed location and it is not likely that many visitors would be present in that part of the park. Fugitive dust emissions from vehicle traffic also would present visual effects.

The presence of the drill rig, facility lighting, roads, and drill pads, by viewers from the perimeter of the Refuge, could create an adverse short-term aesthetic impact; however, viewing at distances of 2.0 miles or more would diminish the impact. The impacts would be temporary in nature. Therefore, visual impacts would be less than significant.

Alternative A

Lexam would follow applicable rule and regulations implemented by federal (EPA, OSHA) and state (COGCC 800 series rules; COGCC 2009) guidelines to reduce visual impacts. Impacts are expected to be less than significant because exploration would be short-term, lasting 120 to 180 days.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

The Service requires that the following conditions be implemented by Lexam to reduce visual impacts:

- Lexam should ensure to the extent possible for safety purposes that lights on the drilling rig and location are directed to work areas.
- The air quality protective measure #28 of wetting down roads would reduce the visual effects of dust emissions.
- Selection of a paint color for the drilling rig and associated infrastructure that blends in with the natural landscape background.

Effects on Acoustical Environment

Road construction, vehicle operation, and drilling equipment operation would be the sources of noise above ambient levels. The proposed exploration program is located in a setting that can be characterized as rural, where ambient noise levels range from 15 to 45 dBA. Noise is attenuated as the distance from the source to the receptor increases.

Noise monitoring results of natural gas drilling rigs at the Pinedale Anticline in Wyoming recorded the highest average noise levels of 66.8 dBA at 130 feet from the drilling rig in various directions around the rig (ENSR 2007). The drilling activity that is most likely to produce the highest noise levels is drill pipe moving in or out of the hole (tripping). Based on the average 66.8 dBA reading 130 feet from the derrick, noise attenuation calculations (Engineering Page 2007) indicate that at a distance of 2,000 feet from the rig, noise levels would attenuate to 43.1 dBA, within the ambient noise range for the setting of the proposed project and well below the Colorado statutory maximum permissible noise level in a nighttime residential setting (50 dBA). Because noise effects would be at ambient levels at 2,000 feet or less from the rig, and the activities would be temporary in nature, the effects of noise from the project are expected to be less than significant. Noise may have an impact on wildlife, but beyond 2,000 feet from the source, those impacts are also expected to be less than significant.
It is expected that Lexam will use a drilling rig (if available) equipped with a diesel-electric conversion type power system. A diesel electric power system uses diesel engines to power electric motors, which are the prime movers for the system. The use of the system allows for fewer spikes in noise when the rig is pulling heavy loads, as for instance, when tripping drill pipe out of the hole. It is not possible to remove all sources of noise, but Lexam will strive to obtain muffling equipment on all engines that will reduce sound levels to reasonable minimums.

Alternative A

Lexam would follow applicable rule and regulations implemented by federal (EPA, OSHA) and state (COGCC 800 series rules; COGCC 2009) guidelines to reduce noise impacts. Impacts are expected to be less than significant because exploration would be short-term, lasting 120 to 180 days.

Alternative B

If the mineral estate was acquired by the Service, there would be no impacts because the proposed exploration activities would not occur. However, the entire mineral estate must be acquired to preclude exploration by parties holding an outstanding mineral interest.

Alternative C

The Service requires that Lexam implement protective measures #5 to monitor noise levels associated with exploration activities and #39 which requires the use of mufflers on all internal combustion engines and certain compressor components to attenuate noise emissions during all exploration activities.

Cumulative Impacts

Alternative A

Because the visual and noise effects are temporary for the proposed oil and gas exploration and because no RFFAs in the cumulative impacts study area have been identified, there would be no cumulative impacts.

Alternative B

There would be no cumulative impacts because no mineral exploration activities would occur.

Alternative C

There would be no cumulative impacts for the same reasons in alternative A.

4.13 Resource Inventory and Monitoring Plan

Under alternative C, the Service is requiring that Lexam follow a Resource Inventory and Monitoring Plan (RIMP) to determine baseline conditions and quantify any changes from the existing physical environment that may be affected during the construction and drilling of exploration wells, Baca #5 and Baca #7. Lexam would be required to gather data before, during, and/or after construction of access roads and well pads and drilling of wells Baca #5 and Baca #7 depending on the type of resource (e.g., soil, air quality, water, vegetation, visual, and sound resources) that may be affected during each step of the proposed exploration. The Service would require that Lexam's Plan of Operations be modified to minimize negative impacts, if monitoring indicates the need. . Lexam will be required to submit a RIMP to the Service for approval prior to the initiation of exploration activities.

Inventory

The Service defines *inventory as* a survey to determine the presence, relative abundance, status, and distribution of abiotic resources, species, habitat, or ecological communities at a particular point in time (Service Manual, 701 FW 2, USFWS 1995b). Inventories are generally designed to gain baseline information through a survey on a given abiotic or biotic natural resource. For example, an inventory could be conducted to determine vegetation composition and structure at a particular site prior to an application initial management treatment or before vegetation is altered by anthropogenic disturbance to determine proper site characteristics for future reclamation.

To determine the effect of an action on a resource, an inventory survey establishes baseline conditions that are followed by a monitoring protocol to evaluate potential changes over time.

Monitoring

The Service defines *monitoring* as a survey repeated through time to determine changes in the status and demographics of abiotic resources, species, habitats, or ecological communities (Service Manual, 701 FW 2, USFWS 1995b). Monitoring is conducted on a regular or systematic basis, involves collecting data by sampling, and generally follows a trend of a particular indicator variable (e.g., soil quality) over time typically following a management treatment or in response to a potential change in environment.

Inventory and Monitoring Protocol

Natural resource inventory and monitoring is important when assessing potential impacts to the environment. A well designed inventory and monitoring plan is essential to identify and prevent further deleterious effects of anthropogenic disturbances to natural resources.

Under alternative C, protective measure #5 (**Appendix D**), the Service will require that Lexam submit a RIMP to, and for approval by the Service to ensure that Refuge resources receive maximum protection during the proposed exploration. The Service will require that all information collected during inventory and monitoring for the proposed exploration activities be submitted in a final report, which includes raw data files.

The RIMP is designed to safeguard the Refuge from unforeseen negative impacts during the proposed oil and gas exploration. The following conditions are required by the Service and will provide the basis for the Inventory and Monitoring Plan to be submitted by Lexam for approval:

> ***Soils*** – Prior to soil disturbance, Lexam will be required to collect soil samples on all access roads and well pads to determine baseline conditions before the proposed exploration begins. A sufficient number of soil core samples (to be determined by consultation with a NRCS Soil Scientist) should be collected on all soils prone to disturbance, and sent to a professional soil-testing laboratory to determine if heavy metals, chemical pollutants, or other contaminants exist in soils before disturbance occurs. Each soil core sample site should be recorded using a GPS with an accuracy of ±1 meter.
>
> Following the completion of construction of the drilling rig, Lexam will be required to conduct duplicate soil core sample tests at recorded GPS waypoints and submit the samples to the same soil testing laboratory used for initial tests. Finally, a duplicate soil monitoring test will be required at six months following construction of the drilling rig or upon abandonment of the Baca #5 and/or Baca #7.
>
> If contaminated soils are identified after initial soil monitoring, Lexam will be required to follow protective measures #7, 13, 14, and 33 to properly remove affected soils. After contaminated soils are removed, Lexam will be required to conduct duplicate soil sampling to ensure that all affected soils have been removed and the affected area has returned to pre-disturbance conditions.
>
> ***Air Quality*** – Air pollution concentration impacts have been modeled for Lexam's proposed exploration using the EPA's AERMOD model (USEPA 2008b) based on 6-years of representative meteorological data collected at the Alamosa airport station (WMO ID: 72462, WBAN ID: 23061) and upper air data obtained from NOAA's FSL in Albuquerque, New Mexico (WMO ID: 72365, WBAN ID 23050). The results of the AERMOD model predicted that impacts from Lexam's proposed exploration emissions to ambient air pollutant concentrations to be below Class I Significant Levels for all pollutants. Because the effects of Lexam's proposed exploration on air quality are not expected to impact the GSDNPP Class I area due to the temporary period (<180 days) of operations, implementation of protective measures #3, 21, 28, and 38 required by the Service would ensure that potential impacts to air quality would be less than significant. Thus, no additional air quality monitoring would be required by the Service.

Water Resources – Surface water was extensively sampled on South Crestone, Deadman, Cottonwood, Spanish, and Willow creeks in and around the Project Area in 2008 (**Table 3-5**, **Figures 3-13** and **3-14**) by Lexam to determine baseline surface water quality conditions. Results of the surface water sampling indicate that conditions have not changed significantly compared to data obtained from the USGS water database (USGS 2010) that was sampled during 1967-1968. Therefore, no additional surface water sampling will be required by the Service prior to soil disturbance for the proposed exploration.

During construction and drilling activities, the Service will require that Lexam collect surface water samples at WC-W, WC-B5, WC-E near Baca #5 and at SC-W and SC-E near Baca #7 at monthly intervals until drilling is complete. Then, the Service will require Lexam to collect duplicate surface water samples at the same sites initially sampled in 2008 following the completion of drilling or upon the abandonment of Baca #5 and/or Baca #7.

Groundwater sampling of the unconfined and confined aquifers was conducted in 2008 by Lexam to establish baseline conditions (**Table 3-7**, **Figures 3-24** and **3-25**). Results from the 21 wells (8 in the unconfined aquifer, 13 in the confined aquifer) sampled indicate that there were no VOCs detected, no presence of gasoline or diesel fuel, TDS values are generally less than 500 mg/L (a secondary maximum contaminant level for drinking water [CDPHE 2007b]), no unusual concentrations of metals, but methane and ethane were present and likely originated from decomposition of organic matter (Mayo et al. 2006).

The Service will require that Lexam install a minimum of one up-gradient and two down-gradient groundwater monitoring wells around each drill pad (Baca #5 and Baca #7) as outlined by protective measure #41. The wells will be completed in the shallow unconfined aquifer. The locations and elevations of the wells will be surveyed and depth to water will be measured. Water samples will be collected for chemical analysis (as outlined below) before the wells are completed and at predetermined intervals thereafter, which will agreed to by the Service and Lexam. If spills or releases of drilling related chemicals at sites occur, then the sampling frequency may be increased to a frequency agreed to by the Service, Baca Grande Water and Sanitation District, and Lexam. Additionally, the Service will require that Lexam collect and analyze duplicate groundwater samples at the same 21 wells initially sampled in 2008 if a spill or release of drilling related chemicals are detected in the monitoring wells.

> Following is a list of general guidelines for designing the groundwater monitoring wells around each drill pad:
>
> 1. Monitoring wells shall be of sufficient diameter and depth to adequately purge and obtain a representative groundwater sample. Wells shall be screened from full depth to above the highest elevation of expected groundwater fluctuation. It is important that the well screen extends above the groundwater level in the well.
>
> 2. Monitoring wells shall be placed as close as possible to the potential source(s), but far enough away to remain safe and undisturbed during site activities/operations. Knowledge of site operations is helpful to place wells appropriately.
>
> 3. Initially three wells should be placed surrounding the source(s) with the goal of setting at least one up-gradient and one down-gradient well. After placement of the three initial wells, measure groundwater elevation and determine flow direction. Once flow direction is verified, additional wells may be needed to insure that there are sufficient down-gradient well locations to adequately monitor potential contamination from the source(s). At least one true up-gradient well is required to monitor baseline conditions.
>
> 4. Once the alarm-well system is completely established, water quality monitoring should be initiated with baseline sampling prior to any other site activity occurring. Once site activity is initiated, wells shall be monitored regularly during site activities to provide adequate warning if contamination of groundwater occurs. For example, if the well installation takes approximate one month, a weekly sampling and testing period might be appropriate and following any activity which could impact groundwater, such as a spill.

5. The suite of analyses to be conducted should include all parameters listed in Table 2 of the Water Sampling Plan Memorandum, dated September 29, 2006 prepared by Telesto Solutions, Inc. Semi-Volatile Organic Carbons (SVOC) should be added to the list of parameters to be analyzed. These parameters can be effectively monitored at or near the surface of the shallow groundwater aquifer.

6. Lexam Explorations, Inc. shall provide a list of all products that are to be utilized in the site activities and verify that all constituents of concern are being tested, based on process to be utilized. From this list, it can be determined if monitoring near the groundwater surface is the best for all constituents of concern.

Vegetation – Prior to soil disturbance, Lexam will be required to determine site composition, structure, and species richness of vegetation along access road routes and well pads. To characterize vegetation throughout areas where soil is disturbed, the Service will require that Lexam provide the inventory of vegetation data summarized for individual sample plots and among all sampled plots. At minimum, Lexam should collect canopy cover using 20 x 50-cm Daubenmire frames (e.g., Daubenmire 1959) for all individual species and collect information on vegetation structure (e.g., maximum vegetation height, visual obstruction; Robel et al. 1970) readings at 5-m intervals along a 100-m transect (N = 20 per plot) at each individual sample plot. Individual sample plots should be randomly generated within the proposed area of soil disturbance. A minimum of one sample plot per ¼ acre (N = 920 total canopy cover estimates and N = 920 total vegetation structure estimates) should be sampled throughout the 11.7 acres to be disturbed during Lexam's proposed exploration activities.

This information is essential to collect prior to soil disturbance because it will allow for proper reclamation (i.e., seed mixture of endemic plants) of vegetation to pre-disturbance conditions. Also, this inventory would establish a baseline for noxious weed abundance prior to soil disturbance.

Lexam is also required to conduct a detailed wetland delineation in the Project Area vicinity using the USACE Hydrogeomorphic Method (Smith et al. 2005) to identify all wetlands that could be affected as a result of Lexam's exploration activities. The wetland delineation must be completed prior to any soil disturbance.

Visual – A visual impact analysis of emissions from the proposed oil and gas exploration were evaluated using the EPA's VISCREEN model (USEPA 2008c). The VISCREEN model is designed to provide a conservative estimate of the visual effects of a plume from all project sources (e.g., generator, mobile tailpipe, and fugitive dust emissions). The model uses maximum daily emissions for Lexam's proposed oil and gas exploration to calculate an absolute contrast for both a sky and terrain background. The results or the VISCREEN model indicate that that the proposed exploration was within FLAG screening thresholds for visual impacts inside the GSDNPP Class I area. Therefore, if Lexam implements the Service's protective measures and they do not deviate from their proposed Plan of Operations, no additional monitoring of visual emissions will be required for the two proposed wells, unless unforeseen circumstances arise.

Noise – The Service requires that Lexam deploy an acoustic monitoring station (e.g., NPS 2008b) at the Baca #5 well pad for a minimum 30 days prior to the initiation of any construction activities to establish a baseline for the Project Area. Lexam may need to consult with a professional acoustic monitoring team (e.g., NPS Natural Sounds Program) to determine the proper information to collect (i.e. sound pressure levels in the form of A-weighted decibel (dBA) readings by the second, natural and existing ambient sound levels) to establish baseline conditions.

The same acoustic monitoring station should be deployed to collect information for the duration of Lexam's proposed exploration activities to ensure that noise levels are maintained below COGCC's maximum permissible levels (**Table 3-16**). Data should be interpreted by a professional acoustic monitoring team on a monthly basis to ensure that noise thresholds are not exceeded.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge.

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Geology		
Negligible overall effect on geology.	No effect	Same as A.
Minerals		
Negligible because any removal of minerals would only be to test the viability of the well for future production potential.	No effect.	Same as A.
Negligible because any testing of minerals during exploration would be short-term (<180 days)	No effect.	Same as A.
Soils		
Minor short-term negative effects from removal of top soil and vegetation along access roads and well pads.	No effect	Same as A, except negligible to minor short-term negative effects due to increased protective measures.
Negligible short-term effects due to construction of drilling rig and associated facilities at well pad site.	No effect	Same as A.
Minor to moderate short-term negative effects from soil compaction. Soil conditions would be restored to original condition upon reclamation.	No effect	Same as A, except negligible to minor short-term negative effects due to increased protective measures.
Negligible to minor short-term effects due to potential for wind or water erosion.	No effect	Erosion would be minimized to negligible levels by frequent site monitoring and implemented protective measures.
Negligible effects due to minor loss in soil productivity.	No effect.	Same as A.
Negligible to minor short-term risk of potential soil contamination from exploration. Implementation of the Storm Water Management Plan (SWMP) and Spill Prevention Control and Countermeasures (SPCC) reduces this risk.	No effect.	Implementation of SWMP and SPCC along with soil testing and monitoring will decrease risk of soil degradation to negligible levels from heavy metals, chemical pollutants, and other contaminants resulting from exploration.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Soils (continued)		
Negligible to minor short-term risk of sedimentation to adjacent wetlands or riparian zones due to wind or storm water erosion of soil disturbed to construct access roads and well pads.	No effect.	Negligible short-term effect because sedimentation would be controlled by protective measures and frequent monitoring of road and creek crossings.
Air Quality		
Motorized equipment used for construction of infrastructure associated with exploration would have negligible to minor short-term negative effect on air quality.	No effect.	Protective measures including requiring: exploration at only one well, Tier II engines, ultra-low sulfur diesel fuel, and control of fugitive dust will reduce negative effects to a negligible level.
Minor short-term effects of dust emissions from traffic on unpaved roads and well pads. Lexam to follow COGCC and CDPHE rules on dust emissions.	No effect.	Negligible effects because of protective measures that reduce dust emissions.
Approximately 51 tons of Nitrous Oxide and 15 tons of Carbon Monoxide emitted by drilling at two wells. Effect of these emissions will be short-term and negligible to minor.	No effect	Same as A.
Negligible effect of air pollution because emissions would be below Class I Significant Levels for all pollutants.	No effect.	Same as A.
Water Resources		
Minor to moderate short-term effect on water quality of surface water from sedimentation, erosion, or potential contamination. Only the COGCC and CDPHE rules limit these effects.	No effect.	Negligible to minor short-term effect on water quality of surface water because protective measures would reduce the potential for sedimentation, erosion, or contamination during exploration.
Moderate to major potential long-term impacts to aquifer because well casing would not be required to protect Layer #4 of the deep confined aquifer under COGCC regulations.	No effect.	Protective measure #12 would require that well casing extend 500 feet beyond the bottom of Layer #4 of the deep confined aquifer to reduce any potential impacts to groundwater to negligible levels.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Water Resources		
Minor to moderate short-term effect on water quality of surface water from sedimentation, erosion, or potential contamination. Only the COGCC and CDPHE rules limit these effects.	No effect.	Negligible to minor short-term effect on water quality of surface water because protective measures would reduce the potential for sedimentation, erosion, or contamination during exploration.
Moderate to major potential long-term impacts to aquifer because well casing would not be required to protect Layer #4 of the deep confined aquifer under COGCC regulations.	No effect.	Protective measure #12 would require that well casing extend 500 feet beyond the bottom of Layer #4 of the deep confined aquifer to reduce any potential impacts to groundwater to negligible levels.
Negligible to minor effects on water usage during exploration.	No effect.	Same as A.
No additional protective measures outside of regulatory agency rules and regulations.	No effect.	Surface and groundwater protective measures #3, 5, 7, 8, 9, 13, 14, 15, 19, 21, 28, 29, 31, 32, 33, 34, 35, and 42 required by the Service would reduce any potential degradation of water resources to negligible short-term levels.
Vegetation and Habitat		
All areas disturbed during exploration would be reclaimed based on the SWMP and COGCC guidelines resulting in moderate long-term effects from invasion of noxious weeds, erosion, or difficulty in re-establishing vegetation.	No Effect.	In addition to COGCC and SWMP guidelines, protective measures would reduce spread of noxious weeds, erosion, or increase the success of reclamation of vegetation. This would reduce the effect to minor long-term levels.
Moderate to major long-term risk of noxious weed invasion on any disturbed soils.	No effect.	Negligible to minor short-term effect, as noxious weeds would controlled by implementing protective measures #1, 3, 11, 19, 23, and 29.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Vegetation and Habitat (continued)		
Minor to moderate long-term risk for degradation of vegetation near access roads and well pads due to exploration.	No effect.	Vegetation inventory and monitoring before, during, and after construction required by protective measure #5 would reduce long-term effects to minor levels. Inventory would provide basis for appropriate site composition during reclamation.
Wetland delineation would not be required of the entire Project Area by regulatory agencies and short or long-term moderate effects could occur depending on the level of disturbance.	No effect.	The Service would require a wetland delineation be conducted on all wetlands in the Project Area under protective measure #8 to ensure effects on wetlands are held to negligible levels from exploration.
Potential degradation or loss of native habitat on disturbed access roads or well pad sites.	No effect.	Protective measures to reclaim disturbed sites following exploration would reduce degradation of native habitats to negligible levels.
Access road to Baca #5 may not be re-routed and moderate to major long-term effects could occur.	No effect.	Access road to Baca #5 would be re-routed to avoid dense populations of slender spiderflower or other sensitive habitat.
Habitat fragmentation could cause moderate short-term effects to wildlife species that respond negatively to habitat fragmentation.	No effect.	Same as A.
Wildlife and Fisheries		
No wildlife population monitoring would occur resulting in minor to moderate short-term effects to wildlife.	No effect.	Service Biologists would survey wildlife activity and abundance in the Project Area before, during, and after construction to document sensitivities from exploration resulting in negligible effects to wildlife.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Wildlife and Fisheries (continued)		
State COGCC and CDPHE guidelines will be used for fugitive dust control. Short-term effects of dust emission would be minor to moderate to for known areas containing Rio Grande sucker and Rio Grande chub.	No Effect.	Protective measures including: 0.25-mile buffer zone around habitat, specific vehicle crossings with structural monitoring to ensure stability, sampling waterways, and dust suppression will reduce short-term effects to negligible levels for Rio Grande sucker and Rio Grande chub.
Some wildlife species could be displaced by exploration to less suitable habitat. Effect would be short-term and minor to moderate.	No effect.	Same as A.
Effect of sedimentation or alternation of habitat at Crestone and Willow creek crossings on associated fisheries would be short-term and minor.	No effect.	Effect would be reduced to negligible levels because of protective measures that would minimize erosion or severe habitat alternation.
No seasonal restrictions would occur and effects could be moderate to major to wildlife on the Refuge.	No effect.	Protective measures would limit exploration beginning Aug. 1 and ending Apr. 30 to reduce effect of disturbance to negligible levels for all wildlife populations.
Moderate short-term effects on big game. Disturbance of habitat could alter activity patterns and habitat use.	No effect.	Same as A.
Moderate short-term effects on small game due to their lack of movement potential away from disturbed areas.	No effect.	Same as A.
Moderate short-term effects on non-game species.	No effect.	Protective measures would reduce disturbance to nesting bird and impact to sensitive habitat to negligible levels.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Wildlife and Fisheries (continued)		
Moderate short-term effects on fisheries.	No effect.	Protective measures would reduce impact to water quality and important habitat to negligible levels
Moderate short-term effects on special status species.	No effect.	Preconstruction surveys and restrictions to critical habitats would reduce effect of exploration to negligible levels.
Cultural Resources		
Exploration would only be subject to federal and state regulatory agency rules and regulations.	No effect.	Known historical sites would be avoided during all phases of exploration because of monitoring during exploration.
Native American Traditional Values		
Exploration would only be subject to federal and state regulatory agency rules and regulations.	No effect.	Known historical sites would be avoided during all phases of exploration because of monitoring during exploration.
Recreation		
Exploration would have no impact to recreation because the Refuge is not open to the public.	Same as A.	Same as A.
Socioeconomic Resources		
Minor short-term benefit to economy due to temporary employment and additional revenue to local gas stations, dining establishments, and motels. This benefit may be offset by minor short-term negative impacts to local businesses that rely on aesthetic resources.	No effect.	Same as A
Minor to moderate short-term effect of increased traffic to local roads or traffic delays caused by temporary road closures or detours.	No effect.	Same as A.
Minor to moderate short-term negative effect of increased demand for emergency responders.	No effect.	Similar as A.

Table 4-3 Summary of environmental consequences for actions of the Draft Environmental Assessment alternatives for the proposed oil and gas exploration by Lexam Explorations (U.S.A) Inc. on Baca National Wildlife Refuge (Continued).

Alternative A No Additional Protective Measures	***Alternative B*** Acquisition of the Mineral Estate	***Alternative C*** Maximum Protection of Refuge during Exploration
Socioeconomic Resources		
Minor short-term benefit to economy due to temporary employment and additional revenue to local gas stations, dining establishments, and motels. This benefit may be offset by minor short-term negative impacts to local businesses that rely on aesthetic resources.	No effect.	Same as A
Minor to moderate short-term effect of increased traffic to local roads or traffic delays caused by temporary road closures or detours.	No effect.	Same as A.
Minor to moderate short-term negative effect of increased demand for emergency responders.	No effect.	Similar as A.
Exploration would have a negligible short-term effect on regional demographics, housing, or land use.	No effect.	Same as A.
Aesthetic Resources		
Negligible overall effect from exploration infrastructure.	No effect.	Same as A.
Moderate short-term effect (<180 days) of night-time glare from the light of the drilling rigs.	No effect.	Same as A.
Moderate short-term effect (<180 days) of daytime visibility of drilling rig.	No effect.	Same as A.
Moderate short-term effect (<180 days) of noise from road construction, vehicle operation, and drilling equipment.	No effect.	Same as A.
No additional measures to reduce effects of noise.	No effect.	The Service would require mufflers on drilling rig engines to reduce noise emissions.

5.0 List of Preparers and Coordination

5.1 Introduction

The Service is the lead agency for this EA. Saguache County is the only cooperating agency (**Appendix J**).

Table 5-1 List of Preparers - U.S. Fish and Wildlife Service Staff on Planning Team

Name	Position	Contribution
Chris Swanson	Planning Team Leader, Region 6, Lakewood, Colorado	Project coordination, organization, writing, and review
Mike Blenden	Project Leader, San Luis Valley NWR Complex, Alamosa, Colorado	Project oversight, writing and review
Ron Garcia	Refuge Manager, Baca National Wildlife Refuge, Alamosa	Project oversight, writing and review
David Lucas	Chief, Division of Refuge Planning, Region 6, Lakewood, Colorado	Project oversight, writing and review
Rick Coleman	Assistant Regional Director, Region 6, Lakewood, Colorado	Refuge System policy guidance
Mark Ely	GIS Specialist, Region 6, Lakewood, Colorado	GIS map preparation
Barbara Boyle	Refuge Supervisor, Region 6, Lakewood, Colorado	Refuge System policy guidance
Meg Van Ness	Archaeologist, Region 6, Lakewood, Colorado	Assistance with cultural resources
Megan Estep	Chief, Division of Water Resources, Region 6, Lakewood, Colorado	Assistance with water resources.
Laurie Shannon	Planning Team Contributor, Region 6, Lakewood, Colorado	NEPA and alternatives review
Sue Oliveira	Chief, Division of Realty, Region 6, Lakewood, Colorado	Writing and review
Steve Schuck	Realty Operations Manager, Region 6, Lakewood, Colorado	Writing and review

Table 5-2 List of Preparers - Other Consultants

Name	Position	Contribution
Lynne Koontz	Economist, USGS, Fort Collins Science Center, Fort Collins, Colorado	Review of socioeconomic impacts
Jessica Montag	Social Scientist, USGS, Fort Collins Science Center, Fort Collins, Colorado	Review of socioeconomic impacts
Nancy Smith	Senior Program Manager, PBS&J Consulting, Colorado Springs, Colorado	Project management and preparation of technical report
Rich McEldowney	Wetland/Riparian Scientist, PBS&J Consulting, Colorado Springs	Writing and review for technical report
Gary Andres	Hydrogeologist, PBS&J Consulting, Colorado Springs	Writing and review for technical report
Chris Miller	Project Director Energy, PBS&J Consulting, Colorado Springs	Writing and review for technical report
Tyler Etzel	Project Manager/Senior. Scientist- Hazardous Waste, PBS&J Consulting, Colorado Springs	Writing and review for technical report

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Appendix A

Service Manual, Land Use Series, 612 FW 2, Oil and Gas

612 FW 2, Oil and Gas

FWM#: 107 (new)
Date: Oil and Gas
Series: Natural and Cultural Resources Management
Part 612: Minerals Management
Originating Office: Division of Realty

2.1 Purpose. This chapter provides standard policy guidance and background information on management of oil and gas activities on Service lands.

2.2 Scope. This chapter provides the basic information regarding the statutes, regulations, and procedures relating to all oil and gas activities conducted on Service lands.

2.3 Policy. The policy of the Service is governed by authorities for leasing oil and gas on Federal lands as found in the Mineral Leasing Act for Acquired Lands of August 7, 1947, as amended; for public domain lands, the Mineral Leasing Act of February 25, 1920, as amended; and in Alaska, Section 1008 of the Alaska National Interest Lands Conservation Act (16 U.S.C. 3148). Leasing is at the discretion of the Secretary of the Interior who has delegated the Bureau of Land Management authority to administer the laws, but has by regulation restricted oil and gas leasing on lands of the National Wildlife Refuge System to those involving drainage (43 CFR 3101.5-1 and 3100.2).

In conformance with the policy set forth in 50 CFR 27 (National Wildlife Refuge System), 50 CFR 60.3 (Patuxent Wildlife Research Center), and 50 CFR 70.4 (National Fish Hatcheries), the Service usually recommends against leasing when the Bureau of Land Management asks for comments.

In the case of non-federally owned oil and gas rights, it is the policy of the Service to protect project resources to the maximum extent possible without infringing upon the rights of sub-surface owners.

2.4 Objectives. The objectives of oil and gas management on Service lands are to:

A. Protect wildlife populations, habitats, and other resources.

B. Provide for the exercise of non-federal oil and gas rights while protecting Service resources to the maximum extent possible.

2.5 Authorities.

A. National Wildlife Refuge System Administration Act of 1966. This Act established the standard of "compatibility" which requires that uses of National Wildlife Refuge System (NWRS) lands must be determined to be compatible with the purposes for which individual units were established. (See 16 U.S.C. 668dd-668ee, as amended).

B. Alaska National Interest Lands Conservation Act of 1980 (ANILCA). This act includes provisions for resource assessments and oil and gas leasing on Federal lands in Alaska. (See 16 U.S.C. 3101 et seq.).

(1) Section 304 sets forth the requirement for completion of Comprehensive Conservation Plans (CCP) to determine compatibility for oil and gas activities.

(2) Section 1002 authorizes an inventory and assessment of the fish and wildlife resources of the coastal plain of the Arctic National Wildlife Refuge. It authorizes an analysis of the impacts of oil and gas exploration, development, and production, and exploratory activity within the coastal plain in a manner that avoids significant adverse impacts on fish and wildlife and other resources. In addition, this section provides that all public lands within the coastal plain are withdrawn from all forms of entry or appropriation under the mining laws, and from operation of the mineral leasing laws, of the United States.

(3) Section 1003 prohibits the leasing of oil and gas within the boundaries of the Arctic National Wildlife Refuge until authorized by a further act of Congress.

(4) Section 1008 authorizes oil and gas leasing on Federal lands in Alaska. Oil and gas activities (including leasing) may be prohibited when so designated by the law or by the Secretary of the Interior. The Secretary may, after having considered the national interest, determine that exploration, development, or production of oil and gas would be incompatible with the purpose for which the unit was established.

(5) Section 1310 provides for mission purposes of the Department of Defense and other agencies with prior withdrawals on existing or new refuges in Alaska. Except for the mission of the Department of Defense, ANILCA mandated refuge withdrawals primary for all Alaska refuges. No leasing can be allowed unless the Service determines that such leasing would be compatible with the purposes for which the areas were established (43 CFR 3101.5-1 and .5-3).

C. Mineral Leasing Acts.

(1) The Mineral Leasing Act of 1920 (30 U.S.C. 181 et seq.) authorizes the leasing of oil and gas on Service lands withdrawn from the public domain. This Act provides for the disposition of all money received from leasing activity to be paid into the Treasury. Revenues derived from leases outside of Alaska are distributed as follows: 50 percent, State of origin; 40 percent, Reclamation Fund; and 10 percent deposited in the General Fund.

(2) The Mineral Leasing Act for Acquired Lands of 1947 (30 U.S.C. 351 et seq.) authorizes the leasing of oil and gas on Service lands which were acquired by the United States. All funds derived from a leasing activity on acquired lands are paid into the Treasury to be distributed under the provisions of the Refuge Revenue Sharing Act (16 U.S.C. 715s.)

(3) Almost all Service lands are subject to one or both of these mineral leasing laws.

D. Other Laws Relating to Oil and Gas Activity on NWRS Lands.

(1) National Environmental Policy Act of 1969. (42 U.S.C. 4321 et seq.) Refer to 550 FW, National Environmental Policy Act.

(2) Archaeological Resources Protection Act of 1979. (16 U.S.C. 470aa-470ee). Refer to 614 FW, Cultural Resources Management.

(3) Migratory Bird Conservation Act of 1929. (16 U.S.C. 715 et seq). Section 715e provides statutory authority for regulation of reserved mineral rights on refuge lands (it subordinates oil and gas interests to such rules and regulations as may be prescribed by the Secretary from time to time.)

(4) Endangered Species Act of 1973. (16 U.S.C. 1531 et seq.) as amended.

(5) Wilderness Act of 1964. (16 U.S.C. 1131 et seq.).

E. Regulations.

(1) Oil and Gas Leasing on NWRS Lands (43 CFR 3101.5.) This regulation established guidelines covering oil and gas leasing on NWRS lands.

(2) Mineral Operations on NWRS Lands (50 CFR 29.32.) This regulation sets forth general rules governing the exercise of reserved and excepted mineral rights on NWRS lands.

(3) Geological and Geophysical Exploration of the Coastal Plain of the Arctic National Wildlife Refuge, Alaska (50 CFR Part 37.) This regulation establishes guidelines governing geological and geophysical exploration for oil and gas within the coastal plain of the Arctic National Wildlife Refuge.

2.6 Definitions.

A. Abandonment. To cease production of oil and gas from a well when it becomes unprofitable, including but not limited to plugging.

B. Development. The construction of all necessary facilities for collection, treatment, storage, and transportation of oil and gas.

C. Drainage. A process in which petroleum resources in a geologic formation in land controlled by, in this case the Service, are depleted by the extraction of petroleum from the same formation by an operation located on adjacent land of another owner.

D. Excepted Rights. Oil and gas rights outstanding in third parties when the United States (Service) acquires title to the lands.

The owner of excepted (outstanding) oil and gas rights has the right to sell, lease, explore for, and remove those minerals subject to the terms of the instrument by which that interest was acquired or reserved and to the State laws governing protection of the surface and the rights of the surface owner. The project leader is responsible for obtaining proof of legal right to enter for oil and gas operations, (deed, lease agreement, title evidence, etc.). Close cooperation with the operator is necessary to minimize disturbance and damage to the Project Area. Conditions found during inspections should be documented. (See 612 FW 2.9(B).)

E. Exploration. Geological exploration or geophysical exploration or both, and all related activities and logistics associated with either or both.

F. Production. Operation, maintenance, and termination of yielding oil and gas wells and related support facilities.

G. Reserved Rights. A clause in a conveyance, such as a deed, where the seller or grantor retains oil and gas rights on the property sold to the United States on behalf of the Service.

The owner of oil and gas rights reserved, when selling land to the United States, has the right to sell, lease, explore for, and remove those minerals in accordance with the conditions in the deed to the United States and with pertinent State laws. Close cooperation with the operator is necessary to minimize disturbance and damage to the Project Area. Conditions found during inspections should be documented. (See 612 FW 2.9(B).)

2.7 Responsibilities.

A. The Director provides national policy guidance on procedures governing all uses of Service lands, including oil and gas activity.

B. Regional Directors.

(1) Review determinations of project leaders in appeals filed in accordance with 50 CFR 25.45 (refuge permits).

(2) Ensure that project leaders adhere to law and policy when making decisions concerning oil and gas activities.

C. Project Leaders.

(1) Administer all oil and gas activities.

(2) Comply with all applicable laws, policies, and guidance when administering oil and gas activities.

(3) Protect Service lands against all unnecessary damage resulting from oil and gas activities.

(4) Where reserved or excepted mineral rights exist, the project leader is responsible for ensuring that his/her actions do not result in an illegal taking of private property.

2.8 Regulations and Policies Relating to Oil and Gas Activities on NWRS Lands.

A. NWRS Lands Outside of Alaska.

(1) Public Domain and Acquired Lands Within a Withdrawal Boundary. Federally-owned oil and gas rights on NWRS lands embraced in the withdrawal of public domain and acquired lands of the United States are not available for leasing (43 CFR 3101.5-1) except where drainage occurs (43 CFR 3100.2). In a decision by the Interior Board of Land Appeals (57 IBLA 319) in 1981, it was determined that the prohibition against oil and gas leasing on "refuge lands" did not include lands acquired from other sources. (On January 31, 1984, Congress was informed that the Department had no plans to pursue leasing of non-Alaska refuge lands.) Some forms of exploration may be permitted on these lands subject to Regional direction. If so permitted, the applicant seeking exploration privileges must justify the need. Reserved or excepted rights may exist within the embrace of this type of withdrawal on acquired sections. When this situation occurs, the persons holding those privileges have the full right to develop their minerals subject to provisions for maximum protection of wildlife and other resources.

(2) Acquired Lands. Acquired lands are open to oil and gas leasing under the Mineral Leasing Act for Acquired Lands of 1947, but units of the National Wildlife Refuge System are closed under Departmental policy. Exploration of federally-owned minerals on these lands is also subject to Regional direction and justification. Reserved and excepted rights on acquired lands are subject to the same provisions as public domain.

(3) Coordination Lands. Coordination lands, which are withdrawn or acquired lands made available to States by cooperative agreement, may be made available for oil and gas leasing under Departmental regulations. Representatives of the Bureau of Land Management (BLM) and the Service, in cooperation with State game commissions, determine by agreement which coordination lands are not closed to oil and gas leasing (43 CFR 3101.5-2). Regardless of whether an agreement is reached on leasing, some forms of exploration may be permitted. Exploration may occur in accordance with Regional mandates, justification of need by the applicant, and consultation with the applicable State game commission. The exercise of reserved or excepted rights on coordination lands is the same as described in public domain and acquired lands.

B. NWRS Lands in Alaska. Refuges in Alaska, other than the Arctic National Wildlife Refuge, may be open to oil and gas leasing if such use is found to be compatible with the purpose for which they were established. The determination of compatibility is fulfilled through the development of refuge comprehensive conservation plans. Exploration of NWRS lands in Alaska is also permitted when compatible. Reserved and excepted rights occurring on refuge lands are administered in the same manner as those described in NWRS lands outside of Alaska.

C. Drainage. If drainage of NWRS lands is suspected, the project leader should consult with the Bureau of Land Management (BLM) to determine whether drainage is actually occurring. If drainage from oil and gas wells drilled on adjacent lands is confirmed, those affected NWRS lands may be leased under exceptions for drainage described in Departmental regulations and policies (43 CFR 3001.2). In such

situations, leases should stipulate "no surface occupancy" (directional drilling) where possible. Alternatively, an authorized officer and the BLM may execute agreements with the mineral right owners of adjacent lands providing compensation for losses incurred in drainage.

2.9 Procedural Requirements for Permitting Oil and Gas Activities.

A. Plan of Operations. Operational plans detailing oil and gas activities will be required for federally-owned rights and requested on reserved and excepted rights. The proposed plan of operations shall include, as appropriate, the following:

(1) Names, addresses, and phone numbers of owner(s) and operator.

(2) Proof of mineral rights in the form of a copy of the lease, deed, designation of operator, or assignment of rights.

(3) Map(s) showing the location of mineral rights.

(4) Maps showing the location of proposed activity and facilities.

(5) Estimated timetable for completion and periods of activity.

(6) Description of potential hazards to persons and/or environment.

(7) Methods for disposal of all waste including drilling mud.

(8) Provisions for rehabilitation.

(9) Any additional information required by the project leader for evaluation of the operation.

The proposed plan of operations is submitted to the project leader for review. Within 30 days of the receipt of the plan, the project leader will notify the operator of approval or rejection. If rejected, he/she will describe the reason for the rejection and recommend any corrective action if applicable.

B. Managing Private Rights. The mineral holder has a responsibility to show reasonable regard for the surface estate as required by State law. Project leaders should adhere to the following guidelines in managing private mineral activities on Service lands:

(1) On Service lands where mineral activity is occurring or anticipated, the deed should be examined to determine whether the Service's right to require a Special Use Permit was recognized. If recognized, a permit will be required. Such other rules and regulations as may be specifically set out in a given deed will also be strictly enforced. A permit will not be mandatory in other instances. A deed restriction recognized in 16 U.S.C. 715e that subordinates oil and gas interests as may be prescribed by the Secretary from time to time may require a legal interpretation before a permit can be issued. Unusual deed language or other questions should be referred to Regional Realty staff and the Solicitor for review.

(2) Where a deed does not recognize permitting authority, the project leader should seek to clarify the Service's power as a holder of the surface estate under State law. State statutes or case law may give powers beyond the usual common law rights of landowners. Moreover, when an intended use would severely impair or destroy the surface interest, and is a use the Service would not have foreseen at the time of purchase, it may be outside the mineral owner's rights under the deed.

(3) Absent a permitting requirement in the deed, the project leader should pursue voluntary permitting arrangements with the mineral interest owner to specify the reasonable limits of his/her intended operations. The mineral interest owner's inducement for entering into such an agreement is a degree of protection from later being found to have acted unreasonably and to possibly be subjected to civil or criminal liabilities.

(4) If neither mandatory nor voluntary permitting is possible, the mineral owner should be given written notice of all reasonable alternatives which would minimize impacts of the activity. This will enable the project leader to establish, if necessary, that these less-damaging alternatives were disregarded without due consideration of the Service's interests as surface owner should damage occur.

(5) When the owner of the mineral interest exceeds the boundaries of what is reasonably necessary to recover his/her minerals, or fails to take reasonable precautions to minimize the surface damage, the Service may take legal action for damages, secure an injunction, and where appropriate, seek criminal penalties.

(6) The Service's authorities regarding taking of migratory birds or endangered species apply to mineral operators on Service lands. Civil or criminal sanctions should be sought when appropriate.

(7) The key factors in successfully balancing the development of private mineral interests and the protection of wildlife and other resources on Service lands are early and frequent communication and cooperation between the Service and the mineral rights owner, and a commitment to reasonableness on the part of both parties.

(8) Current Service policy does not allow the reservation of minerals other than oil and gas. Great care is to be taken to expressly state in the deed what restrictions will be placed on oil and gas reservations. The provisions should be designed to allow the Service the greatest flexibility possible in dealing with future unforeseen conditions.

C. Performance Bond. A performance bond or certificate of insurance will be required for exploration, development, and production activities. If an operator possesses an existing State or national bond of sufficient coverage, a new bond may not be required. The project leader will determine the potential costs involved should it become necessary for the Service to pay for restoration of damaged areas. These costs will be fully covered by the performance bond or certificate of insurance. Documentation of the existence of the required bond or certificate and its coverage of the Service must be submitted to the project leader prior to issuance of a Special Use Permit.

D. Cost Recovery. The Service has no legal authority to charge an owner for the right to develop outstanding or reserved oil and gas rights. However, charges can be assessed if other than reasonable surface damage occurs. Charges assessed for Special Use Permits should reflect administrative costs

incurred in processing where federally owned oil and gas are involved (drainage). Additional charges may be assessed to cover costs incurred in monitoring these activities.

2.10 Designing Permit/Lease Stipulations and Background Information. The diverse nature of Service projects does not allow for the complete standardization of stipulations and conditions to be imposed on oil and gas operations. Consequently, oil and gas activities must be managed on an individual unit basis, with protective stipulations developed in a site-specific manner. Generally, stipulations attached to the lease or Special Use Permit should include protection of air quality, soils, water, wildlife, wildlife habitat, and other Service resources.

A. Leasing. Where leasing is permitted on Service lands, it will be coordinated with the BLM. Coordination with the BLM, which is responsible for issuing leases, allows the Service to provide input on necessary stipulations to be included in the lease agreement.

B. Access. Regulations pertaining to access to Service lands are covered in 50 CFR Part 26. A Special Use Permit may be issued to persons requiring access to their oil and gas rights. Access should be restricted to a specified area in accordance with the provisions of the lease.

C. Exploration.

(1) Geological and Geophysical Surveys.

(a) Geological exploration is often utilized where the bedrock geology of an area is well exposed. When this condition occurs, it is often possible to predict oil and gas potential. This type of exploration is usually performed with little surface damage since heavy equipment is not required. Geophysical exploration may be used in conjunction with geological exploration. Three subsurface characteristics are usually measured by geophysical methods: gravitational field, magnetic field, and seismic characteristics.

(b) Gravitational surveys detect variations in gravity caused by differences in the densities of various types of subsurface rock. This is usually done with small, portable instruments called gravimeters. This type of activity normally causes very little surface disturbance.

(c) Magnetic surveys may be used alone or as a supplement to gravitational surveys. Magnetic surveys reveal upwarped geological structures (likely to yield oil and gas) because such structures show strong magnetic responses. This type of activity normally causes little surface disturbance.

(d) Seismic surveys are the most commonly used geophysical methods and are reported to give the most reliable results. Seismic surveys gather subsurface geological information through the generation and receipt of impulses from an artificially generated shock wave.

(e) Seismic methods are usually referred to by the method which is utilized to generate the shock wave. The thumper method involves dropping a steel slab weighing about 2.73 metric tons (three tons) to the ground several times along a predetermined line. The vibroseis method involves vehicles equipped with vibrator pads and recording devices. The pads are lowered to the ground and the vibrators triggered electronically from the recorder truck. The dinoseis method can be used with a variety of vehicles,

however. Its shock wave producing device consists of a bell shaped chamber mounted underneath a vehicle. The seismic energy is imparted into the ground through the spark ignition of a propane and oxygen mixture confined in the chamber.

(f) Explosives have been the most widely used way to generate seismic shock waves. Explosives are used in two different methods: subsurface and surface. In the subsurface method, 2.27 - 22.68 kilograms (5-50 pounds) of explosive charge are detonated at the bottom of a 7.62 - 60.96 meters (25-200 foot) drill hole. Drilling of holes may be accomplished by drill rigs mounted on trucks or portable drills depending on access and topography. Up to 1.82 meter (6 foot) craters may result from this method. The surface explosive method involves the placing of explosives directly on the ground.

(g) Vehicular traffic associated with seismic surveys is potentially the most environmentally damaging aspect of seismic activities. Temporary disturbance to wildlife may be accompanied by habitat loss through changes in water, soil, and vegetative characteristics from heavy equipment damage. Use of ground vehicles may result in long term vegetation change and scenic impacts, where trees are clear cut along a straight compass line. This may be mitigated by requiring helicopter transport of the device producing the seismic wave or drilling equipment (when subsurface explosives are used).

(2) Exploratory Drilling.

(a) When geological and geophysical surveys are favorable for oil and gas, exploratory drilling may be justified. There are basically two types of exploratory drilling: core drilling and wildcat tests. Core drilling involves drilling relatively shallow holes to supplement seismic data. The holes are usually 34.48 to several hundred meters (100 to several thousand feet) deep. Wildcat tests involve drilling in unproven territory to provide information about whether the area actually contains oil and gas. Core drilling apparatus is readily helicopter transportable.

(b) Typical drilling facilities consist of access road(s), drill pad, drill rig, mud pumps, mud pit, generators, pipe rack, and tool house. Other requirements include 4,730 to 14,191 liters (5,000 to 15,000 gallons) of water a day for mixing drilling mud, cleaning equipment, cooling engines, et cetera. Mud pits should always be lined to prevent fluid loss, or portable containers should be utilized instead. Drill muds are used to lubricate the drill bit and remove cuttings. Muds are mixed on-site to match downhole physical properties. They may contain heavy metals and other hazardous materials. Cuttings may contain minerals which become contaminants when oxidized on the surface.

(c) Most exploratory wells are drilled relatively straight and vertical. However, in a situation where the drill site cannot be situated directly over the subsurface drill target, directional drilling may be employed. There may be serious physical, economic, and technical constraints on the use of directional drilling. Directional drilling may, in certain instances, present the project leader with a viable alternative method for reconciling oil and gas activities with resource values. When federally owned oil and gas rights are the issue, the project leader may determine that directional drilling is the only method which protects Service resources adequately. In the case of reserved or excepted rights, it may be more difficult to stipulate that directional drilling would be required. In this case, the project leader may have to demonstrate that there is no alternative if Service resources are to be adequately protected. Where surface values would be destroyed by construction of access roads to exploratory sites, exploratory wells

can be drilled by helicopter transportable rigs. In Alaska, temporary winter ice roads can provide access for the drill rig.

D. Development.

(1) If an exploratory well becomes a discovery well; i.e., a well that yields commercial quantities of oil and gas, additional wells may be drilled to confirm the discovery, to establish the extent of the field, and to efficiently chart the reservoir. Spacing of wells drilled under Federal lease is usually a minimum of 16.19 hectares (40 acres) for oil and between 64.78 and 259.11 hectares (160 and 640 acres) for natural gas. Spacing of wells drilled in accordance with reserved or excepted rights would vary by State.

(2) The project leader may decide to designate a temporary road system before a permanent system is decided upon. Permanent road systems may be determined after productive wells are identified and potential production ascertained. In addition to roads, other facilities required in development may include flowlines, storage tanks, separators, treaters, and injection wells.

(3) Occasionally, developers of adjacent mineral rights may enter into agreement to "unitize" the field, which may involve private as well as Service lands. "Unitizing" involves the development and operation of a field as a unit, disregarding separate ownerships. Costs and benefits would be allocated according to agreed terms.

(4) Usually, 10.26 to 15.38 centimeters (4-to-6-inch) diameter pipelines are used to transport the petroleum between the well, treating and separating facilities, and central collection points. These lines may be on the surface, buried, or elevated. Pipelines are usually buried because of flow problems in winter and mechanical damage that may occur on the surface. Two methods are used separately or in conjunction to transport oil out of a lease or unitized area: tanker trucks and pipelines. Oil may be transported by truck from small fields but pipelines are the most common method of transporting oil and gas. Oil and gas must be transported separately because of their different physical characteristics.

E. Production.

(1) Production begins just after the discovery 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.

(2) Many wells require artificial lift to bring oil to the surface. Two methods of artificial lift are generally used: gas lift and pumping. Gas lift involves forcing high pressure gas down the drill hole. Fluid that is standing in the hole is displaced by mixing with gas and rises to the surface. Pumping is the main method of artificial lift with various types of pumps utilized. Pumps are usually powered by electric motors or internal combustion engines on the surface. Electric motors make less noise and require less maintenance but electric power is often not available. One commonly used type of artificial lift device is a rod pump which uses an electric motor (or internal combustion engine) to run a surface device ("pumping jack") that imparts an up-and-down motion to a string of steel rods (sucker rods) which in turn is connected to and operates the bottomhole pump.

(3) Most gas wells produce by normal flow and do not require pumping. Surface use at a flowing gas well is usually limited to a fenced area 6.1 meters (20 feet) square containing a gas well "Christmas tree". On site facilities include those described under development.

F. Abandonment and Rehabilitation.

(1) The life spans of oil and gas fields vary with such factors as reserves; reservoir characteristics; nature of petroleum; subsurface geology; and political, economic, and environmental constraints. Dry wells and those that formerly produced are often plugged with cement, with the casing sometimes filled with heavy mud. After plugging, all related above-ground support facilities must be removed from the site. Removal of subsurface facilities, such as pipelines, is subject to State laws and project leader discretion.

(2) Restoration stipulations will be incorporated into any permits issued, supplemented by detailed information on rehabilitation procedures in the operational plan. Depending on the site, drilling mud may be injected into the well and buried or hauled away in accordance with State law. All hazardous substances will be removed from the site and disposed of in an approved hazardous material dumping site. The permittee shall, unless otherwise directed by the project leader, restore access roads and sites to original surface contours and revegetate with appropriate native flora.

2.11 Ensuring Compliance with Permit Conditions. To ensure that operations are carried out in a reasonable manner, resulting in no unnecessary adverse effects, the project leader shall initiate a written record of activities from initial contact through completion of the oil and gas activity. This file will generally contain records of conversations, correspondence, photos, evaluations, and test results (if required). This record serves an integral function in documenting violations should they occur.

2.12 Coordination and Review. Oil and gas activities may require consultation with other agencies or offices by regulation or as a source of information.

A. Service Offices (Regional Director, Realty, Ecological Services, Law Enforcement). The Regional Director is usually consulted on controversial issues or appeals. Realty is a source of information when the location or ownership of mineral rights is in question. Ecological Services must be consulted when section 404 permits, for dredged or fill material (33 U.S.C. 1344), are required due to wetland alterations. Ecological Services field offices may provide expert advice on oil and gas management plans, project design, and special use permit stipulations. Law Enforcement may be needed when there is a violation of a permit.

B. Other Department Offices (Bureau of Land Management (BLM), U.S. Geological Survey (USGS), Solicitor). Legal questions may be answered or clarified by the Solicitor's office. The BLM is responsible for the issuance of leases on federally owned oil and gas rights. The BLM and USGS may be helpful in designing stipulations or determining drainage.

C. Other Agencies (Corps of Engineers, State agencies). The Corps of Engineers issues 404 permits protecting wetlands. A variety of State agencies may be helpful in the management of oil and gas activities on Service lands, particularly conservation and minerals management sections.

2.13 Preparation of an Oil and Gas Management Plan. An oil and gas management plan is recommended on Service lands where oil and gas activity is projected or active. The format of such a plan should be in accordance with Regional guidelines. At a minimum, the plan should include the following:

A. Current project maps (operational and topographic) and aerial photos.

B. Mineral ownership information by tract.

C. Names and telephone numbers of Federal, State, and local agencies or personnel overseeing oil and gas activities.

D. Descriptions of project purposes and objectives.

E. Descriptions of project populations, habitat and programs including identification of sensitive species and areas.

F. A list of applicable regulations and policies (Federal,

State, and project).

G. Excerpts from deeds regarding mineral rights status.

H. Descriptions of past, present, and proposed oil and gas activities on the unit.

I. A list of suggested standard permit stipulations.

J. Potential impacts and protective and corrective measures.

2.14 Selected References and Sources of Information. The following list of references represents a small selection of source data which may be helpful in managing oil and gas activities on Service lands. The references may be especially useful in designing stipulations to protect resources.

(A) A Primer of Oil Well Service and Workbook, p.106; Petroleum Extension Service, University of Texas, Austin, TX; 1979.

(B) Controlled Directional Drilling, p.49; Petroleum Extension Service, University of Texas; Austin, TX; 1984.

(C) Drilling, a Source Book on Oil and Gas Well Drilling from Exploration to Completion; J. A. Short/Pennwell Publishing Company; Tulsa, OK; 1983.

(D) Drilling Mud, p.71; Petroleum Extension Service, University of Texas; Austin, TX; 1984.

(E) Facts About Oil, p.44; American Petroleum Institute; Washington, DC; 1984.

(F) Geophysics in Petroleum Exploration, p.24; American Petroleum Institute; Washington, DC.

(G) Introduction to Oil and Gas Production, p.81; American Petroleum Institute; Washington, DC; 1983.

(H) Managing Oil and Gas Activities in Coastal Environments, p.541; W.F. Longley, R. Jackson and B. Snyder/U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC; 1981. Also see FWS/OBS - 78/54 Managing Oil and Gas Activities in Coastal Environments, p.66.

(I) Natural Resources Protection and Petroleum Development in Alaska, p.305; U.S. Fish and Wildlife Service, Biological Services Program, Washington, DC; FWS/OBS - 80/22; 1984. Also see FWS/OBS - 80/23 Handbook for Management of Oil and Gas Activities on lands in Alaska, p.64.

(J) Oil and Gas Guide, Northern Region, Training Guide; US Department of Agriculture; US Forest Service, R-l; 1979.

(K) Oil and Gas Use Characterization, Impacts, Guidelines, p.148; US Department of Commerce; Louisiana State University; Baton Rouge, LA; See Grant Publication No. LSU-J-76-006; 1976.

(L) Pipeline Construction, p.123; M. Hosmanck/Petroleum Extension Service, University of Texas; Austin, TX; 1984.

(M) Seismic Exploration Fundamentals, p.85; J.A. Coffeen/PennWell Publishing Company; Tulsa, OK; 1978.

Appendix B

Lexam Explorations (U.S.A.) Inc. Proposed Terms and Conditions

LEXAM EXPLORATIONS (U.S.A.) INC.

CONDITIONS AND PROTECTIVE MEASURES RELATING TO LEXAM EXPLORATION (BACA WELL #5 AND BACA WELL #7) ON THE BACA NATIONAL WILDLIFE REFUGE

United States Fish and Wildlife ("Service") Terms and Conditions

To minimize and mitigate the potential impacts of its exploration program on the surface and subsurface resources of the Baca National Wildlife Refuge, Lexam Explorations (U.S.A.) Inc. ("Lexam" or the "Operator") shall implement the following measures. These measures shall be equally applicable to Lexam's employees, representatives, consultants, contractors and subcontractors.

1) All vehicles and equipment from outside the Refuge will be decontaminated per Service procedures to prevent the introduction of noxious weeds to the Refuge. Decontamination will include removal of skid plates for inspection and cleaning if necessary.

2) All ground-disturbing activities associated with drilling operations and setup will require on-site cultural resource monitoring which will be provided by Lexam. In addition, once timing of road and pad construction activities is determined, Service biologists will survey affected areas to document current wildlife activity and sensitivities to be addressed and/or avoided.

3) Lexam will provide trained environmental monitors, approved by Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts.

4) Impacts to sensitive habitat, wildlife, plants, other sensitive natural or historical resource features will be avoided to the extent possible while constructing the access road and well pads.

5) All construction of roads and pads will occur in a way that best facilitates their subsequent complete removal and reclamation once Lexam activities have ceased at these sites. This includes separating and stockpiling topsoil layers on-site to be replaced during reclamation. All disturbed areas will be reclaimed per the requirements imposed by the Colorado Oil and Gas Conservation Commission ("COGCC") and with Service input. Only endemic plants and seed mixtures are to be used in reclamation.

6) A baseline water quality study of the near-surface unconfined aquifer, deeper aquifers, and surface water in proximity to the proposed well locations will be conducted prior to drilling. In addition, at least three monitoring wells will be installed near each well pad to monitor potential spills or releases.

7) Casings will be set with COGCC-approved cement to 3,000 feet below the surface which will fully protect the aquifers from contamination through communication in the borehole.

8) A closed loop mud and drill cuttings system will be used to minimize impacts to surrounding habitats. In addition, drill cuttings will be isolated in an above-ground tank during drilling. Cuttings will be removed from the Refuge and disposed of off-site in accordance with state regulations.

9) Drilling operations will be modified, as necessary, to reduce conflicts with regular Refuge management activities.

10) A gate guard will be provided by Lexam, and approved by the Service, to document traffic entering and exiting the Refuge and to eliminate potential illegal entry onto the Refuge.

11) Arrangements for additional Service law enforcement personnel will be made in the event it is deemed necessary to effectively enforce state, federal, Refuge, and wildlife laws and regulations during drilling activities.

12) Construction and drilling activities will be conducted from August 1 through April 30 in order to avoid conflicts with wildlife and limit ground disturbance activities to periods of low precipitation to minimize impacts to soil.

13) Well sites will be located as far from sensitive wet meadow wetlands as practicable.

14) Drill pads will be fenced if necessary to prevent large ungulates from gaining access to the sites.

15) To protect special status species such as the Rio Grande Sucker and Rio Grande Chub, Service and Lexam will:

- Establish a 0.25-mile buffer zone of no activity around potential and identified habitat.

- Limit vehicle crossings to existing or pre-approved crossings.

- Sample waterways for particulate matter, creating a baseline and regular monitoring during period of activity.

- Assess stability and suitability of road water crossings prior to road construction and drilling activities and perform upgrades, if needed. Conduct periodic monitoring of crossings during activities and documentation of any deficiencies that may occur that may be indicative of potential structural failure.

- Provide dust suppression in the vicinity of waterway crossings.

16) Pre- and post-drilling aerial photographs will be taken of the proposed drilling and road construction area. The photographs will be color and will provide complete coverage of the drilling and road construction area. The pre-survey documentation shall be submitted within 10 days of initiation of the drilling, the post-survey documentation shall be submitted within 110 days of completion along with a digitized version of the pre-survey photographs. These photographs will become the property of the Refuge.

17) The Operator shall provide detailed maps or plats to the Refuge Manager or his authorized representative of the proposed project layout, showing routes, staging areas, construction areas, and work locations.

18) All materials brought into the Refuge to build up the location pad will be authorized by the Refuge Manager or his authorized representative. To minimize the spread of invasive species, no top soils will be brought in from off the Refuge.

19) Summaries of all the results generated from the water quality sampling, cultural resource work and any other sampling or monitoring, including the results of Lexam’s exploratory drilling, will be provided to the Refuge Manager upon completion and summation.

20) The Operator’s drilling activities will be restricted to the period of August 1 through April 30. Any field operations conducted during the Refuge's migratory bird closure period (May 1 through July 31) must be coordinated and authorized by the Refuge Manager or his authorized representative. Service will consider allowing Lexam to continue work in early May if allowing access is necessary to complete activities and such activities would not impact the Refuge and resources greater than what is anticipated in the EA. Rig up and rig down operations can only be conducted during daylight hours. Drilling operations will be conducted 24 hours per day.

21) The Operator shall designate an onsite representative for field operations who shall be present during all phases of the Operator's operation and be the sole representative of the Operator and subcontractors regarding all communications and decisions of the Refuge Manager or his authorized representative. The Operator shall

keep the Refuge Manager or his authorized representative informed if there is any change of designated representative for field operations.

22) Refuge officials will conduct an on-site meeting before rig-up with representatives of the Operator, drilling contractor, subcontractors, suppliers and service companies. The purpose of the meeting is to go over regulations and such conditions that apply to work crew conduct on the Refuge.

23) Prior to rig-up, an Emergency Preparedness Plan covering exploratory drilling, well control, materials hauling, spill response, and fire evacuation, will be provided to the Refuge Manager and discussed in a pre-operation meeting to be held with local governments. The plan shall contain a telephone list naming key contacts for emergency operations and activation.

24) The Operator will upgrade and maintain all access routes, roads and bridges designated for its use across the Refuge in accordance with acceptable specifications and standards. The Operator shall have road maintenance equipment and operator(s) readily available to perform road repairs and maintenance as needed, or as directed by the Refuge Manager or his authorized representative.

25) Dust levels on regularly traveled access routes must be kept to a minimum. The Operator shall have a water truck and operator(s) readily available to perform dust abatement as needed, or as directed by the Refuge Manager or his authorized representative. Only water will be allowed for dust suppression efforts. Dust control measures shall be implemented throughout the traveled areas of the Project Area in addition to the dust abatement requirement in measure #15.

26) The drill site and immediate access roads shall be constructed of Refuge approved material for all drilling locations. Drill pads may not exceed 90,000 square feet in area. All existing drainage patterns within roads to be constructed shall be maintained uninterrupted by the use of culverts, bridges or other applicable techniques as specified and authorized by the Refuge Manager or his authorized representative.

27) The soils at the location site will be tested using approved standards to determine levels of heavy metals, chemical pollutant, and other contaminants, prior to rig-up operations. Duplicate tests will be conducted before completion or at abandonment. If the exit test reveals levels above the background established by pre-drilling test, cleanup will be required. The most practical method of clean up is soil removal. Any quantity of soil removed will be replaced to the original contours.

28) Upon completion of drilling operations, the Refuge Manager or his authorized representative must be advised within 120 days whether the well is to be retained or plugged. If the well site is to be abandoned, the well is to be plugged according to state law, all above ground structures removed and the site and road restored as directed by the Refuge Manager or his authorized representative. Any damage to existing surface vegetation, water channels, or other physical features shall be restored to original site conditions. All costs shall be born by the Operator.

29) Pits, ponds and/or open tanks are prohibited. Portable tanks must be used in circulating operations for the temporary storage of all drilling fluids, cuttings, mud, and contaminants. All drilling fluids, cuttings, mud, contaminants, portable tanks, and other equipment must be transported off Refuge to a state approved facility upon cessation of drilling activity. It is highly recommended that an auger tank be used for transferring drill cuttings and sand to a vehicle for off Refuge transport.

30) All toxic construction and equipment supplies and refuse (oil, grease, gasoline, diesel, paint, and other petrochemical derivatives) shall be centrally stored. Wastes shall be disposed off Refuge immediately following completion of drilling operations. In the event of an accidental spill or discharge of oil, brine, or any other petrochemical substance, the Operator shall immediately notify the Refuge Manager or his authorized representative. The Operator shall remove contaminated soils for proper disposal off Refuge, and replace such soils with the same type soils or of a type specified and approved by the Refuge Manager or his authorized representative. A site reclamation plan may be required by the Refuge Manager or his authorized representative.

31) Catch pans or other liner systems approved by the Refuge Manager are required for equipment and locations such as mud pumps, bulk mud additive tanks, fuel tanks, mixing shed, generators, accumulator and lines, and under the entire rig floor. The catch pans will cover the entire surface area under the equipment. The rig floor catch pan will be tied to allow for wash down and mud drainage from drill pipe. The catch pans will be kept free and clean from accumulated debris and spill materials.

32) The Operator will be responsible for providing all water needed for drilling operations. No waste water will be discharged onto Refuge lands, ditches, or water bodies. The operator will provide a containerized or temporary septic system for domestic sewage disposal during drilling operations, which shall be removed upon completion of drilling. Use of portable toilets at drill site or the installation of a septic system, or similar treatment system or tanks will be required for any trailer or quarters on site. No surface discharge of septic system or portable toilet water is permitted. Septic tanks must be inspected weekly during operations and pumped as necessary. Upon completion of operations, the septic tanks must be pumped out and all material hauled away.

33) All disposable type materials and trash brought onto the Refuge or generated at the drill site shall be removed from the Refuge on a biweekly basis and upon completion of the drilling activities. The drill site and operational area shall be kept free of debris and trash at all times. Trash shall be contained securely at the drill site in such a manner (fully enclosed trash cages) as to prevent trash from being spread by wind or wildlife. No trash may be disposed of or buried on the Refuge.

34) General Refuge access conditions :

- Access is to allow Lexam and/or its contractors access to portions of the Refuge or the purpose of carrying out drilling of oil and gas exploration wells Baca #5 and Baca #6 or Baca #5 and Baca #7 (either #6 or #7 would be drilled, but not both).

- The Refuge Manager is the coordinating official having immediate jurisdiction and administrative responsibility for oil and gas operations on the Baca National Wildlife Refuge (Refuge) lands and property, all entry upon the Refuge must be coordinated with the Refuge Manager or his authorized representative The Refuge Manager must be advised at least 48 hours in advance of initial activity.

- The failure of the United States to require strict performance of the terms, conditions, covenants, agreements, or stipulations of this permit for access to conduct exploration activities on national wildlife Refuge lands, shall not constitute a waiver or relinquishment of the right of the United States to strictly enforce thereafter such terms, conditions, covenants, agreements, or stipulations which shall, at all times, continue in full force and effect.

- Lexam and/or its contractors shall save, hold harmless, defend, and indemnify the United States , its agents and employees for loss, damages, or judgments and expenses on account of bodily injury, death or property damage, or claims for bodily injury, death or property damage of any nature whatsoever, and by whomever made, arising out of the Operator, his employees, subcontractors or agents with respect to the exploration of any and all mineral rights within the lands administered by the Refuge.

- All applicable federal and state regulations apply and will be in force. Operator shall be responsible for the actions of all exploration and support personnel. Violations of applicable laws or regulations will subject the operator and/or his employees to prosecution under state and/or federal laws. Individuals utilizing the Refuge under the Operator's authorization are subject to inspections of vehicles and their contents by federal and state law enforcement officers.

- Proof of general liability insurance in the amount of $1,000,000 must be furnished to repair/mitigate any damages. This does not limit the liability for damages to this amount.

- Operators will act in a manner that is respectful of Refuge habitats, wildlife, and property. Gates are to be locked or unlocked as they are found.

− All vehicle access will be restricted to developed roads and two-tracks. All terrain vehicle use and deviations to vehicle use must be pre-approved by the Refuge Manager in writing prior to any action taken.

− Vehicle speed limits will be set at the discretion of Refuge Manager and limits will be strictly adhered to.

− No pets will be allowed on the Refuge.

− Possession of firearms, alcoholic beverages or drugs is strictly prohibited on the Refuge.

− Fires are strictly prohibited in any areas of the Refuge.

− Operators are not to be considered agents of the Service and are not to represent the Service in any matters.

− Operators will perform all work in accordance with the highest standards of the industry and to the satisfaction of the Service.

− Operators will perform all work in accordance with all applicable laws and regulations and will obtain all necessary permits or licenses when required to do so.

− All personnel and activities shall be restricted to the immediate drilling area and the direct access road to the drill site.

− Feeding wildlife species is prohibited. Molesting or destroying the home or dens of wildlife is prohibited. If dens are found during the normal course of operations, distinctive flagging will be used to alert all personnel of the den location. Adverse impacts on fish, wildlife and the environment shall be kept to an absolute minimum. All road kills will be reported to the Refuge Manager or his authorized representative.

− Littering is prohibited. All cans, bottles, lunch papers, and operations trash must be removed. Cigarette butts are considered litter. All vehicles will be equipped with a container to carry out trash.

− All necessary permits, contacts and clearances must be completed or obtained by Lexam prior to the start of the activity.

− No overnight quarters will be permitted on the Refuge unless authorized by Refuge Manager.

35) Implement the recommendations contained in the report entitled “Existing Conditions Report for a Portion of the Lexam Road, Saguache County, Colorado,” prepared by Russell Surveyors and Associates, Inc., March 30, 2008, with input from the Service.

36) Implement the recommendations that were the basis for the air quality report analysis set forth in the “Lexam Baca Drilling Project Visibility Impact Evaluation,” Air Sciences Inc., April 30, 2008: (a) power generators will be Tier 2 engines; (b) diesel fuel used in generators and all other non-road engines will be ultra-low-sulfur (less than 0.05 percent sulfur); and (c) disturbed areas will be watered to control the fugitive dust.

37) Upon CDOW recommendation, Lexam has agreed, that in the event of a severe winter, to assisting the CDOW with managing for the needs of any wintering big game temporarily displaced by Lexam’s activities within the designated areas, especially if the temporary displacement results in the potential for a decline in overall physiological health of the animals or in increased game damage claims by private landowners. This assistance could occur as a Lexam funded baiting program, feeding program or other form of distribution management as determined appropriate by CDOW within the severe winter range area.

If Lexam discontinues or fails to perform any of the preceding terms and conditions, and the Refuge Manager believes such failure will lead to unreasonable damages to Refuge

resources, the Service may assess penalties pursuant to 50 C.F.R. Part 28 and may require Lexam to cease exploration activities until the risk of damage to Refuge resources has been removed or mitigated in the sole discretion of the Service.

Colorado Oil and Gas Conservation Commission ("COGCC") Terms and Conditions

The following are the terms and conditions are imposed by the COGCC in Permit No. 2006A069 (Baca Well #5), Permit No. 2006A070 (Baca Well #6) and that certain Sundry Notice changing the location of Well #6, dated April 30, 2008, and Permit No. 20075486 (Baca #7). Terms and conditions Nos. 19 and 20 were added to the Baca #7 permit and apply to Baca #5 and #6 as well. Certain of the COGCC terms and conditions are duplicative of terms and conditions imposed by the Service and described above.

1) Notify David Shelton - COGCC Engineering Supervisor (303-894-2100 x 108) or David Dillon - COGCC Engineering Manager (303-894-2100 x 104) 48 hours prior to moving onto the location with drilling equipment. Advise Mr. Shelton or Mr. Dillon at least 24 hours prior to running any casing string to provide COGCC Field Inspectors sufficient notification time to witness cementing operations and pressure testing of blowout preventers. If the well is a dry hole, notify Mr. Shelton or Mr. Dillon 24 hours prior to plugging and abandoning this well.

2) Any changes to the approved drilling plan and procedures must be approved in writing by the COGCC.

3) Immediately notify the COGCC of any major problems encountered during the drilling, cementing, or completion process.

4) Conductor casing and surface casing will be cemented to surface.

5) Surface casing depth will be set at a depth of 3000 feet. This depth was determined by COGCC staff based upon review of available relevant data, including data from the deep water well located approximately one mile from the drill sites, and after consultation with the Division of Water Resources staff.

6) Prior to commencing operations, an inventory of all chemicals and products that will be used or stored on site must be provided to the COGCC, the surface owner, and local emergency response personnel prior to bringing those substances on to the Baca National Wildlife Refuge. If additional chemicals or products are required, then information about these substances must be provided to the COGCC, the surface owner, and the local emergency response personnel prior to bringing them on to the Baca National Wildlife Refuge.

7) Prior to commencing operations, a meeting with the local emergency response personnel will be held to establish an adequate safety and response plan for drilling, completion, and production activities.

8) A closed loop mud and cutting system will be used and cuttings will be placed in an above ground and lined enclosure, unless landowner approval to use an alternative mud and cutting system is obtained in writing.

9) The drill cuttings will not be left at or buried on the drill site or elsewhere on the Baca National Wildlife Refuge, unless landowner approval is obtained in writing. Cuttings will be disposed in accordance with COGCC Rule 907.

10) Formation temperatures will be recorded and the data provided to the COGCC and the surface owner.

11) If pumping tests are conducted on discrete zones below deepest neighboring water well (2,180 feet below surface), then water samples will be collected for basic water quality tests, including TDS, dissolved metals, common anions, pH and alkalinity. The analytical results will be provided to the COGCC and the surface owner.

12) If production casing is run, then all hydrocarbon and water bearing formations must be covered with cement and a cement bond log must be run to verify coverage. Cementing requirements will be determined by COGCC staff from open-hole logs and other well information obtained during the drilling of the well.

13) If the well is plugged as a dry hole, then the COGCC must be contacted for plugging instructions, which will be based on log and geologic data, and the actual wellbore configuration. Cement plugs will be set to confine all fluids to the reservoirs in which they originally occurred. The plugging procedure will assure that all aquifers are properly isolated and protected.

14) A guard, provided by Lexam, shall be stationed at the property gate on County Road T during all drilling and completion activities. The guard will limit access to the property to Lexam employees, Lexam contractors, and other authorized personnel.

15) Baseline water quality data will be acquired from both near surface (unconfined aquifer) and deeper aquifers in proximity to proposed wells prior to the spud of the wells and again within six months after the wells are completed and/or plugged. Sampling and analysis procedures must be approved by the COGCC staff prior to conducting this work. Data will be provided to the COGCC and the surface owner. Data will used to assess any possible long-term effects on groundwater quality.

16) A minimum of one up-gradient and two down-gradient monitoring wells will be installed around each drill pad. The wells will be completed in the shallow unconfined aquifer. The locations and elevations of the wells will be surveyed and depth to water will be measured. Water samples will be collected for chemical analysis before the wells are spud and at predetermined intervals thereafter, which will agreed to by the United States Fish and Wildlife Service (Service) and Lexam. If spills or releases of drilling related chemicals at sites occur, then the sampling frequency may be increased to a frequency agreed to by the Service, Baca Grande Water and Sanitation District, and Lexam.

17) Equipment and vehicles brought onto the Baca National Wildlife Refuge from outside the San Luis Valley must be cleaned and decontaminated to minimize introduction of non-native species and noxious weeds.

18) Lexam will insure that all drilling and completion operations will be supervised by a WellCAP IADC certified supervisor. All blow prevention equipment shall be rated for 5000 psi and will be installed and tested in accordance with U.S. Bureau of Land Management Onshore Order #1.

19) Approval of the APD is limited to drilling and completion operations and permission shall be obtained from the Director of the Oil and Gas Conservation Commission prior to commencing production from the Baca Wells #5, #6, or #7.

20) Any conditions related to protection of public health, safety, welfare and the environment that are developed as a result of the federal Environmental Assessment process and that are under the jurisdiction of the Oil and Gas Conservation Commission shall be applied to the drilling and completion operations of the Baca Wells #5, #6, or #7.

Saguache County Agreement Terms and Conditions

The following terms and conditions are summarized from that certain “Agreement between Saguache County and Lexam Explorations (U.S.A.) Inc. Related to Drilling and Exploration Activities,” dated April 17, 2007.

1) The County will provide certain signage, at specified locations, as may be agreed to by Lexam and the County and that Lexam will pay the County Road and Bridge Department the sum of a minimum of $100.00 for that signage.

2) Lexam, to comply with the County road weight limitations, will weigh each truck that it owns, contracts for, or controls and uses for its activities within the County, and that will use any road in the County road system.

3) Lexam or its contractors will provide a copy of the weight ticket for each vehicle used or participating in its activities within the County, for each trip that the subject vehicle makes on the County road system, to the County’s Road and Bridge Department.

4) Lexam agrees to pay to the County the sum of $4.29 for each ton of weight that the vehicles subject to this Agreement exceed the County road weight limit of 54,000 pounds.

5) Lexam agrees to purchase a County Road Access Permit for accessing Saguache County Roads, from the Saguache County Road & Bridge Department, at the same cost charged by the County to other, similar users of County roads.

6) All sums payable under the Agreement will be paid to the County on a monthly basis.

7) In order to minimize the cost and effort involved in disposing of cuttings from the drill sites and to minimize the impact that the drilling activities may have on Saguache County, Lexam agrees that it will voluntarily test the "cuttings" which arise from the drilling of any exploration well or other exploration activities within the County of Saguache. Such testing shall be limited to those cuttings that visually exhibit substances other than dirt and rocks and for which Lexam proposes to permanently dispose in the County. These tests will be in addition to, or concurrent with, any other testing which may be required by Federal or State authority. The purpose of this testing is to determine if the cuttings can be safely used as wellsite cover and/or road base materials, as well as to assist in determining if any special precautions are required for the permanent disposal of the cuttings. The testing will include:

- Total petroleum hydrocarbons (TPH);
- Sodium Adsorption Ratio (SAR);
- Heavy metal concentrations;
- pH level;
- Conductivity.

Lexam agrees that it will provide a report of the above tests and all other tests performed on the cuttings and fluids produced results from the drilling operation, as required by Federal or State agencies, to the County Land Use Department. Said testing will conform to the generally acceptable testing standards for the industry.

Appendix C

Scoping Notice and Comments

U.S. Fish and Wildlife Service

San Luis Valley National Wildlife Refuge Complex
9383 El Rancho Lane • Alamosa, CO 81101
Phone (719)589-4021• Fax (719)587-0595

October 13, 2010
For Immediate Release 10-72

Contact: Michael Blenden (719)589- 4021 ext.1001
Laurie Shannon (303) 236-4317

U.S. FISH AND WILDLIFE SERVICE TO HOLD A PUBLIC OPEN HOUSE TO IDENTIFY ISSUES ASSOCIATED WITH OIL AND GAS EXPLORATION ON BACA NATIONAL WILDLIFE REFUGE

The U.S. Fish and Wildlife Service (Service) will hold a public open house on **October 26, 2010 at 6:30 p.m. at the Colorado College Baca Conference Center.**

The purpose of this open house is to solicit concerns and issues for the Service to consider in a new environmental analysis of Lexam Explorations, Inc.'s proposal to explore natural gas or oil resources they own, underlying the Baca National Wildlife Refuge. This new analysis is the product of a settlement agreement between the parties in a 2007 lawsuit filed by the San Luis Valley Ecosystem Council and the Citizens for San Luis Valley Water Protection Coalition against the Service challenging the Service's compliance with the National Environmental Policy Act. The end product will be either an Environmental Assessment and Finding of No Significant Impact or, if the federal action is determined to have a significant effect on the environment, an Environmental Impact Statement and Record of Decision.

In 2006 Lexam proposed drilling two exploratory wells on the Baca National Wildlife Refuge to assess the potential for marketable quantities of natural gas or oil. The current operating plan provided by Lexam for these exploration activities is available at:
http://www.fws.gov/alamosa/bacaNWR.html

If you cannot attend this meeting, comments can be sent electronically to BacaScopingComments@fws.gov. **Comments during this scoping period will be accepted until Wednesday, November 10, 2010.**

The Baca National Wildlife Refuge was authorized with passage of the Great Sand Dunes National Park and Preserve Act of 2000. It was established in 2003 and expanded in 2004 with acquisition of the Baca Ranch. The legislated purpose of the refuge is to restore, enhance, and maintain wetland, upland, riparian, and other habitats for native wildlife, plant, and fish species in the San Luis Valley.

The U.S. Fish and Wildlife Service is the principal federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Service manages the 97-million-acre National Wildlife Refuge System, which encompasses 548 national wildlife refuges, thousands of small wetlands and other special management areas. It also operates 69 national fish hatcheries, 64 fishery resources offices and 81 ecological services field stations. The agency enforces federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign and Native American tribal governments with their conservation efforts. It also oversees the Federal Assistance program, which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

- FWS -

Scoping Results

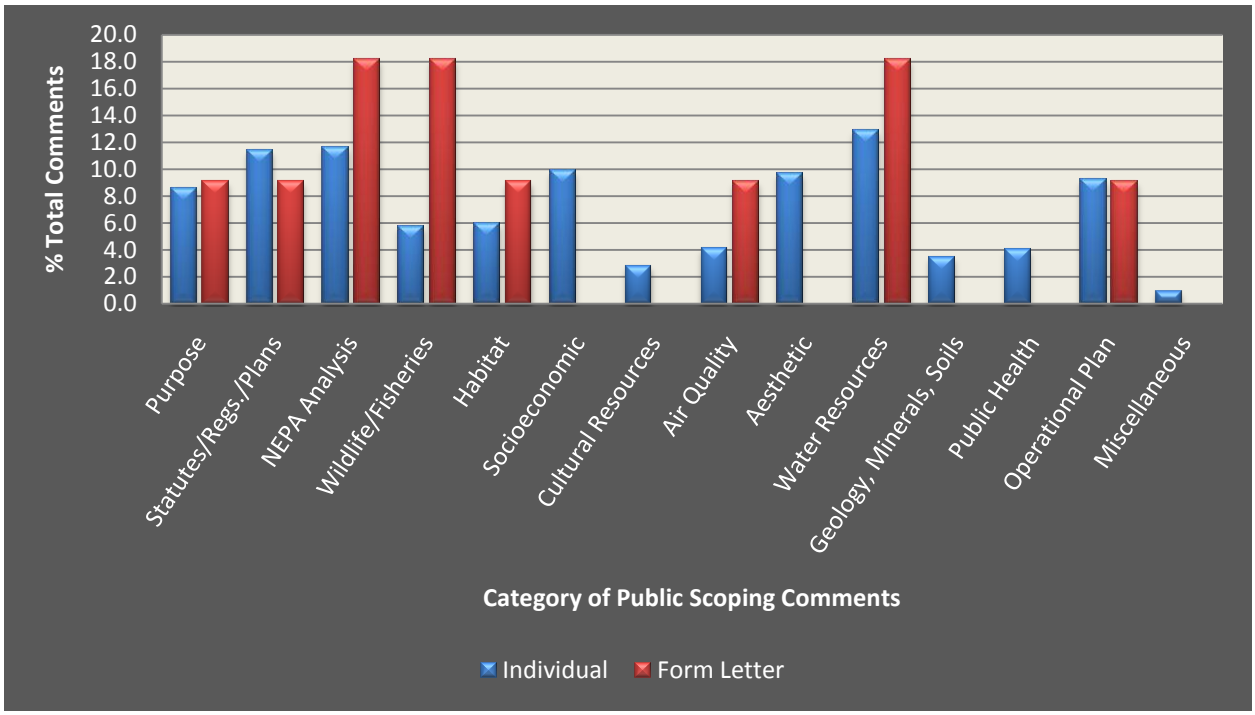
The following summarizes the methods for comment collection and analysis, the number and source of comments received and a summary of the comments. Comments were received through the public meeting, letters, and email.

Methods for Comment Collection and Analysis

The objective of the scoping process is to gather the full range of comments, questions and concerns that the public has about the proposed action. All comments, questions, or issues, whether from written submissions or recorded at the public meetings were organized by topic into a spreadsheet and coded for organizational purposes. Every effort was made to document all issues, questions, and concerns. Regardless of whether comments and questions were general in nature or about specific points of concern, they were added to the spreadsheet one time.

All comments received on Service NEPA documents become part of the final official public record. Requests for information contained in comments are handled in accordance with the Freedom of Information Act, NEPA (40 CFR 1506.6 (f) and other Department of Interior and Service policies and procedures. In compliance with the policies of the Service regarding disclosure of personal information, any names, addresses, or other personal information of individuals (does not apply to agencies or organizations) who commented will not be published in this document unless that information was spoken in a public meeting. It should be noted that public scoping is not a voting process, and each comment is considered to be of equal importance. **Figure A-1** illustrates the percentage of comments received on the general topics concerning the proposed action.

Figure A-1. Summary of Public Scoping Comments by Category for the Proposed Action.



Number and Source of Comments Received

During the course of the public scoping process, the Service received 35 questions and comments during the public meeting and 7,231 written responses in the form of letters or emails from the 30-day public scoping period. Overall, 35 questions and comments were read at the public meeting, 7,114 form letter comments (no

organizational affiliation), 13 from agencies and organizations (**Table A-1**), and 104 individual letters or emails, respectively.

Table A-1. List of Agencies and Organizations that Submitted Comments

U.S. Environmental Protection Agency	Lexam Explorations (U.S.A.), Inc.
U.S. National Park Service	Crestone Baca Land Trust
Saguache County	Conejos County Clean Water, Inc
San Luis Valley Ecosystem Council	Samten Ling Retreat Center
San Luis Valley Citizens Alliance	Dharma Ocean Foundation
Shumei International Institute	Haidakhandi Universal Ashram
Crestone Spiritual Alliance	

Summary of Scoping Comments

Below is a summary of the issues, questions, and comments raised during public scoping. Comments were submitted in writing during the 30-day public scoping period that ended November 10, 2010 and/or offered at the public meeting held on October 26, 2010 in Alamosa, Colorado.

Purpose and Need

General comment that Refuge needs to be protected; exploration would disrupt and/or contaminate the environment; exploration is unreasonable; exploration is not in the best interest of the public; concern that deep exploration could impact natural resources; interagency cooperation in the San Luis Valley could be impacted by exploration activities; a compatibility determination should be completed on proposed action; general comment that disapproves of exploration on Refuge.

Statutes, Regulations, and Plans

Comment suggesting Service should purchase and retire mineral rights from Lexam; exploration should not be considered until an accurate CCP assessment is complete; the analysis is premature since a CCP has not been completed; the proposed action is contradictory to Refuge purpose; the mineral rights should be sold to an organization for wilderness protection; a lack of a CCP will create difficulty for Refuge staff to manage Refuge; exploration could impact trust resources on federal lands; Lexam can provide documentation of their willingness to sell their mineral interest; mineral exploration will generate important information for CCP development; the Service should consider compliance with Section 106 of National Historic Preservation Act.

NEPA/Analysis

Comment that Service should begin an EIS instead of Draft EA; EIS is required or should be prepared; Service should postpone Lexam's plans to drill in the Refuge until impacts are known; purchasing and retiring mineral rights should be the preferred alternative in the Draft EA; Service should postpone Lexam's plans to drill in the Refuge until CCP and EIS are completed; a site-specific analysis through an EIS is required to determine impact to all natural/cultural/economic resources; a production analysis should be completed in Draft EA; exploration could lead to future actions having significant impacts; under current CEQ NEPA section 1508.27, significant impacts have potential to exist for 8 of 10 factors; an EIS is required to assess potential future production impacts; an EIS should be required beyond assessment of two exploration wells; an analysis of reasonably foreseeable energy development be included in the Draft EA; all resources on the Refuge need to be inventoried to determine impact; an Draft EA cannot address long-term impacts of production to the Refuge; the NEPA process should consider cumulative impacts; an EIS is required to assess larger ecological boundary of surrounding watersheds/airshed; the drilling of exploratory wells should be considered the federal action; the alternative of mineral exploration with no surface protective measures be excluded from Draft EA; the no action alternative should be no exploration based on purchase of mineral interest; the Service should consider but not select drilling until CCP is complete, directional drilling, and drilling one well instead of two as alternatives; comment asking if Lexam is the driving force for the Draft EA; comment asking what Lexam’s involvement with the Draft EA is; is the former NEPA process invalid; comment asking if the Service can say no to drilling at a later date; how will the new Draft EA be different from the previous Draft EA; comment questioning the Service's definition for the proposed action; comment asking how comfortable the Service is with the current project timeline; how many resources are

being used by the Service; comment asking who is writing the Draft EA; comment that Draft EA does not address people inside of the Refuge.

Wildlife/Fisheries
General comment that exploration will negatively impact wildlife populations; exploration could affect threatened and endangered species; concern for potential impacts to Gunnison's prairie dog; a CCP and EIS are needed to address potential impacts to endangered species; concern about potential impacts to wildlife movements, elk calving areas, foraging patterns, and habitat fragmentation; an EIS should be prepared including a inventory of all wildlife on the Refuge; comment that migratory birds require unpolluted water resources during migration; concern about the health of the aquifer in relation to the ecosystem and wildlife; the impact to native species should be assessed in the Draft EA; exploration activity will impact feeding, breeding, and migration patterns of wildlife; exploration could cause incidental take of threatened or endangered species; exploration activities could increase sedimentation from roads to riparian habitat to Rio Grande sucker; an EIS should be prepared to determine the effect of exploration to wildlife at landscape scale; an EIS is needed to assess impacts to migratory birds; general concern about impact to natural resources; have southwestern willow flycatchers been documented on the Refuge?

Habitat
Comment that exploration will impact wildlife habitat; a monitoring protocol with regulations should be put in place to avoid negative impacts to Refuge resources; concerned about impact to wetland, riparian, and/or aquatic habitat; directional exploration away from sensitive habitats should be considered; exploration will impact wilderness in the San Luis Valley; exploration could impact habitat to native fishes; wildlife habitat be inventoried before exploration; comment requesting an alternative for no exploration near riparian habitat.

Socioeconomic Resources
Concern about the potential impact to local economy; the proposed exploration by Lexam will lead to additional industrial development in area; exploration would impact personal livelihood/lifestyle; exploration will impact the human environment; local emergency responders do not have resources to respond to a accident associated with exploration; general concern about impact to the local community; concern about potential impact to tourism; an EIS should be prepared to evaluate impacts to local residents; concern to local property values; exploration could impact socioeconomic resources; comment that temporary exploration (approx. 6 months) would impact natural resources causing failure of local businesses; exploration by Lexam would have long term impacts to local economy; an analysis of emergency responders capability to handle oil field fire or explosion; the health of the aquifer sustains that local economy; exploration would impact sustainable living practices to local community; request that an EIS be prepared to evaluate the potential for a environmental disaster caused by exploration; exploration could damage food production in San Luis Valley; additional recreational use of the Refuge would provide economic opportunities to local communities; an EIS is needed because of unique local community and cultural resources; an EIS is needed to assess impact to human welfare; an economic analysis of spiritual centers is necessary; an analysis of the socioeconomic influence of exploration to local spiritual groups is needed;

Cultural Resources
Comment that all historical and cultural sites be preserved; concern about impact of exploration noise to spiritual functions; all archaeological sites should be inventoried and protected; cultural and aesthetic resources are interrelated; a CCP is required to evaluate potential impacts (including archeological surveys) to cultural resources; comment questioning if Lexam will be liable for any damage to cultural resources; an EIS is necessary to analyze cultural uniqueness and religious practices.

Air Quality
Comment that proposed exploration would contaminate air quality; air quality should be monitored during exploration; the Service should consult with NPS to ensure minimal air pollution during exploration; air quality would be impacted by full scale production in future; an additional air quality and potential pollutant study be initiated.

Aesthetics
Concern about noise caused by exploration activities; general comment about the effect on aesthetic resources; concern about traffic associated with proposed exploration; exploration would degrade the pristine nature and

solitude of area; exploration with cause pollution to light levels; visual resources will be impacted during exploration; concern about the change in ambient sound levels and impact to nearby town and rural residents; an EIS is necessary to assess aesthetic resources (visual & sound) including cumulative impacts.

Water Resources
General concern about contamination to water resources; concern that exploration would contaminate aquifer; comment that exploration would negatively impact groundwater; Comment that water resources should be protected in the Rio Grande Basin; concerned about the efficacy of casing to prevent contamination to aquifer during exploration; concern that chemicals used during exploration could contaminate aquifer; comment questioning the cost to mitigate and restore a aquifer that could potentially be contaminated during exploration; concern that exploration could deplete or alter water resources; an EIS is needed to evaluate impacts to water resources; concern for any impact to drinking water; concern that deep exploration could affect hydrology of system; questioning why casing depth is to 3,000 ft and not beyond this depth; deep exploration could affect hydrology of system; there should be a monitoring plan to assess groundwater during exploration including conductivity, dissolved and suspended solids, metals, pH, temperature, dissolved oxygen, physical aquatic habitat parameters, and sensitivity of impact; wetlands be should be restored including appropriate mitigation measures; an analysis of legal protections relative to water resources should be analyzed; the layered structure of the confined aquifer should be assessed; cumulative impacts to groundwater and aquifer should be addressed; exploration would negatively affect the Rio Grande Compact; exploration by Lexam has unknown risks to aquifer; the Draft EA should analyze how the lower part of aquifer (beyond 3,000 ft) should be protected from contamination; Draft EA should analyze potential impact of casing design, cementing, and pit liner requirements to groundwater; the adequacy of casing be discussed with the Rio Grande Water Conservation District; comment asking who the responsible party will be if contamination of water resources occurs from exploration; wetlands should be inventoried and mapped in Project Area; comment that Draft EA include how Service mitigate for wetlands under Section 404b of Clean Water Act; the Draft EA should describe groundwater resources within Project Area including quality/quantity of aquifer; Draft EA should describe groundwater in vicinity of BNWR including location of domestic, irrigation, stock, & public supply; Service should require a minimum of 2 to 1 mitigation for disturbed wetland/stream/riparian habitats; Service require avoidance of disturbance to any fen wetland; Service require 100 ft buffer zones surrounding wetland/riparian habitat; an analysis of potential downstream landowners should be included in Draft EA.

Geology, Mineral Resources, and Soils
Comment that soil monitoring should take place during exploration activities; degradation of soil resources; comment that deep drilling may cause earthquakes; concern that deep drilling could affect the geology of the San Luis Valley by contaminating water resources; a study should be initiated to evaluate any impact to geology and hydrology from exploration activities; a study should be initiated to evaluate potential impacts to fault lines resulting from exploration; comment asking what the results of the seismic data were and are the results available to the public?

Public Health
Comment concerned about the potential impact of exploration chemicals to natural resources and public health; potential contamination of aquifer is a public health concern; general comment concerning potential impact of exploration to public health; impact to public safety from exploration; noise levels caused by exploration could affect public health; comment questioning if Lexam will be held liable for potential damages/accidents/health risks resulting from exploration; a list of drilling chemicals should be made public that would be used during exploration.

Operational Plan
Comment that mitigation measures should be used to protect resources on the Refuge if exploration occurs; request that the highest standards are upheld if hazardous materials are used during exploration; request that the highest standards for pollution control are implemented during exploration; a site-specific analysis should be completed for each well pad and associated infrastructure; comment that exploration will lead to production; the Draft EA analysis should consider directional exploration from an off-Refuge site; a performance bond should be acquired from Lexam prior to exploration; the size of a performance bond should be determined through an EIS; comment questioning who would be liable for any problems during exploration; speed limits should be restricted during specific time periods allowed for exploration; comment asking if roads will be repaired by Lexam if they cause damage; questioning if constant supervision will occur during exploration to ensure no mistakes take place;

dust from exploration activity could have a negative impact to resources; provide a list of chemicals used by Lexam during exploration to public; an alternative access road away from Crestone Creek be used by Lexam; the Draft EA should consider reasonably foreseeable impacts from low probability catastrophic spills with appropriate spill prevention measures to prevent impacts; there should be strict guidelines for disposal of garbage by Lexam during exploration; Service compliance with OGCC Rules 209 , 317, and 317B; Service should discuss terms and conditions for environmental monitoring and enforcement for cessation of drilling activities; closed/enclosed systems should be used during exploration; best management practices proposed by Lexam during exploration in their operational plan are inadequate; an analysis of Lexam's operational plan is necessary; concerned about how casing will be maintained; analysis should include impact of exploration activity such as dust control, sediment runoff, & hazardous materials; Service should require a detailed plan for dust control in Project Area and surrounding roads; BMPs and mitigation measures should be used and included into alternatives under consideration; comment questioning what happens with the earthen pad after reclamation; concern regarding the level of disturbance if local water is used during exploration; comment asking if water is trucked, how many passes will occur during exploration and during a 24-hour period; comment asking if the two wells will be drilled sequentially; what has changed in this administration's philosophy concerning drilling policies compared to the last administration; concern about whether fracturing techniques would be used during exploration; describe the closed-loop system; when would drilling commence.

Miscellaneous

Comment asking if there is a guarantee that damage to natural resources will not occur; switch the project to a solar project; the outcome of the Draft EA has already been decided; the previous Draft EA was biased towards exploration; exploration will contribute to global warming.

Summary of Future Actions

Although the formal scoping period is complete, an additional opportunity for official public involvement will be available during the 30-day public comment period on the Draft EA. At anytime during the NEPA process, the Service welcomes comments from the public. Additional comments, questions, or concerns can be directed to:

U.S. Fish and Wildlife Service
Attn: Baca NWR - Draft EA
9383 El Rancho Lane
Alamosa, Colorado 81101
Phone: 719-589-4021
Fax: 719-587-0595

Appendix D

U.S. Fish and Wildlife Service Protective Measures Required Under Alternative C

Under the Maximum Protection of the Refuge during Drilling Alternative (Alternative C), the Service would require that specific protective measures and standards be followed during all phases of oil and gas exploration being proposed by Lexam, including the proposed drilling of two exploratory oil and gas wells on the Refuge, to ensure that the surface estate of the Refuge and associated resources are not unreasonably degraded or impacted. These measures shall be equally applicable to Lexam's employees, representatives, consultants, contractors and subcontractors. The Service also will require that Lexam resubmit a new Plan of Operations that addresses deficiencies identified in the current Plan of Operations and implements protective measures required by the Service.

Under this alternative, drilling would occur from a vertical well at Baca #5 and a vertical well at Baca #7. However, at the request of the Service, Lexam has agreed to conduct their exploration activities including construction of roads and pads in sequential order, beginning first at their primary target (Baca #5). After Baca #5 is drilled, Lexam will make a decision on whether sufficient information was obtained, or if proceeding with construction and drilling at Baca #7 is necessary. The Service's request for sequential exploration at Baca #5 then at Baca #7 does not affect the scope of the analyses in this Draft EA because the impacts of both wells (Baca #5 and Baca #7) have been assessed throughout Chapter 4.

Specific protective measures would be required by the Service to minimize and mitigate the potential effects of Lexam's Plan of Operations on the surface and subsurface resources of the Refuge. These protective measures were developed by the Service through information obtained during public scoping, from the Final Settlement Agreement dated September 23, 2010 involving the litigation of the proposal by Lexam (Operator), and by new evidence outlining the potential impacts to resources protected by the Refuge. Of these, protection measures #5, 8, 10, 12, 13, 14, and 32 included in the list below were modified or not included as conditions of approval for prior permits to drill on the Refuge.

Under this alternative, Lexam would be required to implement the following protective measures and conditions outlined below. Specific reference to federal and state laws and regulations are not intended to be all inclusive. Therefore, all applicable federal and state laws in addition to those highlighted below would still apply to the proposed exploration activities.

1) All vehicles and equipment from outside the Refuge will be decontaminated per Service procedures to prevent the introduction of noxious weeds to the Refuge. Decontamination will include removal of skid plates for inspection and cleaning if necessary. This measure is subject to the following rules:

    - COGCC rule 1004(e) – "All areas being reclaimed shall be kept as free as practicable of all undesirable plant species designated to be noxious weeds. Weed control measures shall be conducted in compliance with the Colorado Noxious Weed Act, C.R.S. §35-5.5-115 and the current rules pertaining to the administration and enforcement of the Colorado Noxious Weed Act. It is recommended that the operator consult with the local weed control agency or other weed control authority when weed infestation occurs. It is the responsibility of the operator to monitor affected and reclaimed lands for noxious weed infestations. If applicable, the Director may require a weed control plan."

    - Plants and animals or their parts taken elsewhere shall not be introduced, liberated, or placed on any national wildlife refuge except as authorized. (50 C.F.R. 27.52)

2) In order to protect cultural resources Lexam will provide on-site cultural resource monitoring during all ground disturbing activities. This measure is subject to the following rules:

    - No person shall search for or remove from national wildlife refuges objects of antiquity except as may be authorized by 43 CFR part 3. (50 C.F.R. 27.62)

    - No person shall search for buried treasure, treasure trove, valuable semi-precious rocks, stones, or mineral specimens on national wildlife refuges unless authorized by permit or by provision of this subchapter C; Permits are required for archeological studies on national wildlife refuges in accordance with the provisions of this subchapter C. (50 C.F.R. 27.63)

3) Lexam will provide trained natural resource advisors (NRAs), approved by Service, who will continue to serve as liaisons between the Refuge Manager, construction contractor, and drill rig personnel and ensure that all operations are conducted in a manner that minimizes surface impacts. NRAs have specific skills and duties when working on "sensitive lands," like a NWR, that enable them to identify deficiencies or negligent activities before issues arise that have the potential to cause unreasonable degradation of the surface and subsurface estate of the Refuge.

4) Impacts to sensitive habitat, wildlife, plants, other sensitive natural or historical resources will be avoided to the extent possible while constructing the access road and well pads. This measure is subject to the following rules:

- COGCC rule 1002(e) – "Existing roads shall be used to the greatest extent practicable to avoid erosion and minimize the land area devoted to oil and gas operations. Roadbeds shall be engineered to avoid or minimize impacts to riparian areas or wetlands to the extent practicable. Unavoidable impacts shall be mitigated. Road crossings of streams shall be designed and constructed to allow fish passage, where practicable and appropriate."

5) Lexam will provide a resource monitoring plan which must be approved by Service. This plan should include a schedule for gathering data before, during, and after construction and/or drilling activities occur. It should include an assessment of baseline water quality of surface waters, the near-surface unconfined aquifer and the deeper confined aquifers in proximity to the proposed well locations (both up gradient and down gradient), as well as baseline information on soils, vegetation, air quality, sound (e.g., hourly sound pressure, ambient sound levels, etc.), and visual impacts. In addition, it should include provisions for re-sampling in the event of anomalous detections.

6) Pre- and post-drilling aerial photographs will be taken of the proposed drilling and road construction area. The photographs will be color and will provide complete coverage of the drilling and road construction area. The pre-survey documentation shall be submitted within 10 days of initiation of the drilling, the post-survey documentation shall be submitted within 110 days of completion along with a digitized version of the pre-survey photographs. These photographs will become the property of the Refuge. This measure is subject to the following rule:

- COGCC rule 303(d)(3) – "A minimum of four (4) color photographs, one (1) of the staked location from each cardinal direction. Each photograph shall be identified by: date taken, well or location name, and direction of view."

7) The soils at the location site will be tested using approved standards to determine levels of heavy metals, chemical pollutant, and other contaminants, prior to rig-up operations. Duplicate tests will be conducted before completion or at abandonment. If the exit test reveals levels above the background established by pre-drilling test, cleanup will be required. The most practical method of clean up is soil removal. Any quantity of soil removed will be replaced to the original contours. This measure is subject to the following rules:

- COGCC rule 1003(e)(2) – "**Revegetation of non-crop lands.** All segregated soil horizons removed from non-crop lands shall be replaced to their original relative positions and contour as near as practicable to achieve erosion control and long-term stability, and shall be tilled adequately in order to establish a proper seedbed. The disturbed area then shall be reseeded in the first favorable season following rig demobilization. Reseeding with species consistent with the adjacent plant community is encouraged. In the absence of an agreement between the operator and the affected surface owner as to what seed mix should be used, the operator shall consult with a representative of the local soil conservation district to determine the proper seed mix to use in revegetating the disturbed area. In an area where an operator has drilled or plans to drill multiple wells, in the absence of an agreement between the operator and the affected surface owner, the operator may rely upon previous advice given by the local soil conservation district in

determining the proper seed mixes to be used in revegetating each type of terrain upon which operations are to be conducted."

Interim reclamation of all disturbed areas no longer in use shall be considered complete when all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, compacted, covered, paved, or otherwise stabilized in such a way as to minimize erosion to the extent practicable, or a uniform vegetative cover has been established that reflects pre-disturbance or reference area forbs, shrubs, and grasses with total percent plant cover of at least eighty percent (80%) of pre-disturbance levels or reference areas, excluding noxious weeds. Re-seeding alone is not sufficient."

8) Lexam shall provide Service with a detailed wetland delineation, which shall be performed prior to any disturbance in the immediate Project Area vicinity. This determination should follow U.S. Army Corps of Engineers Hydrogeomorphic Method (Smith et al. 1995). Based on information gathered from the wetland delineation, well sites will be located as far from sensitive wet meadow wetlands as practicable. This measure is important to determine if the following rules apply:

- COGCC rule 303(f) – "**Oil and gas locations in wetlands.** In the event that an operator, otherwise required to file a Form 2A, acquires an Army Corps of Engineers permit pursuant to 33 U.S.C.A. §1342 and 1344 of the Water Pollution and Control Act (Section 404 of the federal "Clean Water Act") for construction of an oil and gas location, the operator shall so indicate on the Oil and Gas Location Assessment, Form 2A."

- COGCC rule 1002(e)(2) – "Operators shall avoid or minimize impacts to wetlands and riparian habitats to the degree practicable."

9) Summaries of all the results generated from the water quality sampling, cultural resource work and any other sampling or monitoring, including the results of Lexam's exploratory drilling, will be provided to the Refuge Manager upon completion and summation. This measure is subject to the following rule:

- COGCC rule 608(b)(5) – "Copies of all test results described above shall be provided to the Commission and the water well owner within three (3) months of collecting the samples. The analytical data and surveyed well locations shall also be submitted to the Director in an electronic data deliverable format."

10) Lexam will provide a detailed description of all best management practices that will be used during any aspect of the proposed exploration project. This measure is subject to the following rule:

- COGCC rule 1002(f)(2&3) – Stormwater management - best management practices.

11) All construction of roads and pads will occur in a way that best facilitates their subsequent complete removal and reclamation once Lexam activities have ceased at these sites. This includes separating and stockpiling and covering topsoil layers on-site to be replaced during reclamation. All disturbed areas will be reclaimed per the requirements imposed by the COGCC and with Service input. Only endemic plants and seed mixtures are to be used in reclamation. This measure is subject to the following rules:

- COGCC rule 1002(b)(2) – "The operator shall separate and store the topsoil horizon or the top six (6) inches, whichever is deeper, and mark or document stockpile locations to facilitate subsequent reclamation. When separating the soil horizons, the operator shall segregate the horizon based upon noted changes in physical characteristics such as organic content, color, texture, density, or consistency."

- COGCC rule 1002(c) – "All stockpiled soils shall be protected from degradation due to contamination, compaction and, to the extent practicable, from wind and water erosion during

drilling and production operations. Best management practices to prevent weed establishment and to maintain soil microbial activity shall be implemented."

- COGCC rules 1003 & 1004 – "Final reclamation of all disturbed areas shall be considered complete when all activities disturbing the ground have been completed, and all disturbed areas have been either built upon, compacted, covered, paved, or otherwise stabilized in such a way as to minimize erosion, or a uniform vegetative cover has been established that reflects pre-disturbance or reference area forbs, shrubs, and grasses with total percent plant cover of at least eighty percent (80%) of pre-disturbance or reference area levels, excluding noxious weeds, or equivalent permanent, physical erosion reduction methods have been employed. Re-seeding alone is not sufficient."

12) To fully protect the aquifers from contamination through communication in the borehole. The intermediate casing shall extend 500 feet beyond the bottom of Layer #4 of the deep confined aquifer[22]. The bottom of Layer #4 must be determined by detailed logging of the lithology during drilling. Although, existing information suggests that the bottom of Layer #4 could be 3,500 feet below the surface, Lexam shall consult with an independent professional geologist (reference CRS-34-1-201) approved by the Service to confirm when the appropriate depth has been reached based on data collected from drill logs.

- COGCC rule 317(d) – "**Casing program to protect hydrocarbon horizons and groundwater.** The casing program adopted for each well must be so planned and maintained as to protect any potential oil or gas bearing horizons penetrated during drilling from infiltration of injurious waters from other sources, and to prevent the migration of oil, gas or water from one (1) horizon to another, that may result in the degradation of groundwater. A Sundry Notice, Form 4, including a detailed work plan and a wellbore diagram, shall be submitted and approved by the Director prior to any routine or planned casing repair operations. During well operations, prior verbal approval for unforeseen casing repairs followed by the filing of a Sundry Notice, Form 4, after completion of operations shall be acceptable."

- COGCC rule 317(e) **– "Casing where subsurface conditions are unknown.** In areas where pressure and formations are unknown, sufficient surface casing shall be run to reach a depth below all known or reasonably estimated utilizable domestic fresh water levels and to prevent blowouts or uncontrolled flows, and shall be of sufficient size to permit the use of an intermediate string or strings of casings. Surface casing shall be set in or through an impervious formation and shall be cemented by pump and plug or displacement or other approved method with sufficient cement to fill the annulus to the top of the hole, all in accordance with reasonable requirements of the Director."

13) Lexam shall provide a Storm Water Management Plan (SWMP) which must be approved by Service. This plan should be prepared according to *SWMP* guidelines prepared by the Colorado Department of Public Health and Environment (CDPHE). ***CDPHE guidelines for General Permit Application and Stormwater Management Plan Preparation Guidance*** and should include sufficient information and narrative descriptions regarding construction activities along the existing waterways, locations of all proposed potential discharges, identification of potential pollutant sources, maps detailing all ground disturbing activities at sites, and details and figures for proposed BMPs for these construction activities. An outline is available from CDPHE and should be followed.

- COGCC rule 1002(f)(2&3) - "Oil and gas operators shall implement and maintain Best Management Practices (BMPs) at all oil and gas locations to control stormwater runoff in a manner that minimizes erosion, transport of sediment offsite, and site degradation. BMPs shall be

[22] Lexam must case the entire deep confined aquifer (Aquifer Layer #4). The CDWR (2004) described five separate hydrogeological layers that comprise the aquifer in the San Luis Valley. Each layer is defined based on one or more lithologies with similar hydrogeologic characteristics. Layer #4 occurs within a Sante Fe formation that is predominantly sand and gravel and has up to 50% clay layers in most areas of the SLV. Approximate depth of Layer #4 is from 1,200 to 3,500 feet.

maintained until the facility is abandoned and final reclamation is achieved pursuant to Rule 1004. Operators shall employ BMPs, as necessary to comply with this rule, at all oil and gas locations, including, but not limited to, well pads, soil stock piles, access roads, tank batteries, compressor stations, and pipeline rights of way. BMPs shall be selected based on site-specific conditions, such as slope, vegetation cover, and proximity to water bodies, and may include maintaining in-place some or all of the BMPs installed during the construction phase of the facility. Where applicable based on site-specific conditions, operators shall implement BMPs in accordance with good engineering practices."

- The Water Quality Control Act (§25-8-501(1), C.R.S.) - Establishes a state water quality management program administered by the Water Quality Control Division (WQCD) which prohibits any person from "discharg[ing]…any pollutant into any state water from a point source without first having obtained a permit from the division for such discharge . . ." Stormwater management for construction activities at oil and gas related sites is currently regulated under two separate agencies within the State of Colorado, the WQCD and the COGCC.

14) Lexam shall provide a Spill Prevention and Countermeasures Plan (SPCC), which must be approved by Service. This plan shall include: a listing of secondary containment and/or diversionary structures or equipment for all oil handling containers, equipment, and transfer areas. It should also include a table identifying tanks and containers at the facility with the potential for an oil discharge; the mode of potential failure; the likely flow direction and potential quantity of the discharge; as well as, provide the secondary containment method and containment capacity. In addition, the plan should include the physical layout of the facility and a facility diagram, which must mark the location and contents of each container. The facility diagram must also include all transfer stations and connecting pipes.

15) A closed loop mud and drill cuttings system will be used to minimize impacts to surrounding habitats. In addition, drill cuttings will be isolated in an above-ground tank during drilling. Cuttings and drilling fluids will be removed from the Refuge and disposed of off-site in accordance with state regulations (50 C.F.R. 27.94; 50 C.F.R. 29.32).

16) Drilling operations will be modified, as necessary, to reduce conflicts with regular Refuge management activities.

17) A gate guard will be provided by Lexam, and approved by the Service, to document traffic entering and exiting the Refuge and to eliminate potential illegal entry onto the Refuge.

18) Arrangements for additional Service law enforcement personnel will be made in the event it is deemed necessary to effectively enforce state, federal, refuge, and wildlife laws and regulations during drilling activities.

19) The Operator's construction and drilling activities will be restricted to the period of August 1 through April 30 to avoid conflicts with wildlife and limit ground disturbance activities to periods of low precipitation minimizing impacts to soil. Any field operations conducted during the Refuge's migratory bird closure period (May 1 through July 31) must be coordinated and pre-authorized by the Refuge Manager or his authorized representative. Service will consider allowing Lexam to continue work in early May if allowing access is necessary to complete activities and such activities would not impact the Refuge and resources greater than what is anticipated in the EA. Absolutely no activities will be permitted beyond May 15. Rig up and rig down operations can only be conducted during daylight hours. However, drilling operations can be conducted 24 hours per day. This measure is subject to the following rules:

- COGCC rule 306(a) – "**Consultation with surface owner**. In locating roads, production facilities, and well sites, or other oil and gas operations, and in preparation for reclamation and abandonment, the operator shall consult in good faith with the surface owner…Such good faith consultation shall allow the surface owner or appointed agent the opportunity to provide comments to the operator regarding preferences for the timing of oil and gas operations and preferred locations for wells and associated facilities."

- CDOW Actions to Minimize Adverse Impacts to Wildlife Resources - "Schedule construction, drilling, and completion activities to avoid particularly sensitive seasonal wildlife habitats."

20) Refuge Manager or his authorized representative may require drill pads to be fenced if necessary to prevent large ungulates from gaining access to the sites.

- CDOW Actions to Minimize Adverse Impacts to Wildlife Resources - "Fence livestock and/or wildlife out of newly reclaimed areas until reclamation standards have been met and plants are capable of sustaining herbivory."

21) To protect special status species such as the Rio Grande Sucker and Rio Grande Chub, the Service requires that Lexam:

− Establish a 0.25-mile buffer zone of no activity around potential and identified habitat.
− Limit vehicle crossings to existing or pre-approved crossings.
− Sample waterways for particulate matter, creating a baseline and regular monitoring during period of activity.
− Assess stability and suitability of road water crossings prior to road construction and drilling activities and perform upgrades, if needed. Conduct periodic monitoring of crossings during activities and documentation of any deficiencies that may occur that may be indicative of potential structural failure.
− Provide dust suppression in the vicinity of waterway crossings.

22) The Operator shall provide detailed maps or plats, as required by COGCC the Refuge Manager or his authorized representative of the proposed project layout, showing routes, staging areas, construction areas, and work locations. This measure is subject to the following rules:

- COGCC rule 303 (c) - "Attached to and part of the Permit-to-Drill, Form 2, as filed shall be a current 8½" by 11" scaled drawing of the entire section(s) containing the proposed well location with the following minimum information:
  (1) Dimensions on adjacent exterior section lines sufficient to completely describe the quarter section containing the proposed well shall be indicated. If dimensions are not field measured, state how the dimensions were determined.
  (2) The latitude and longitude of the proposed well location shall be provided on the drawing with a minimum of five (5) decimal places of accuracy and precision using the North American Datum (NAD) of 1983 (e.g.; latitude 37.12345 N, longitude 104.45632 W). If global positioning system (GPS) technology is utilized to determine the latitude and longitude, all GPS data shall meet the requirements set forth in Rule 215. a. through h.
  (3) For directional drilling into an adjacent section, that section shall also be shown on the location plat and dimensions on exterior section lines sufficient to completely describe the quarter section containing the proposed productive interval and bottom hole location shall be indicated. (Additional requirements related to directional drilling are found in Rule 321.)
  (4) For irregular, partial or truncated sections, dimensions will be furnished to completely describe the entire section containing the proposed well. (5) The field-measured distances from the nearer north/south and nearer east/west section lines shall be measured at ninety (90) degrees from said section lines to the well location and referenced on the plat. For unsurveyed land grants and other areas where an official public land survey system does not exist, the well locations shall be spotted as footages on a protracted section plat using GPS technology and reported as latitude and longitude in accordance with Rule 215.
  (6) A map legend.
  (7) A north arrow.
  (8) A scale expressed as an equivalent (e.g. - 1" = 1000').
  (9) A bar scale.

(10) The ground elevation.
(11) The basis of the elevation (how it was calculated or its source).
(12) The basis of bearing or interior angles used.
(13) Complete description of monuments and/or collateral evidence found; all aliquot corners used shall be described.
(14) The legal land description by section, township, range, principal meridian, baseline and county.
(15) Operator name.
(16) Well name and well number.
(17) Date of completion of scaled drawing."

- COGCC rule 303 (d)(3)(D) - "A topographic map showing all surface waters and riparian areas within one thousand (1,000) feet of the proposed oil and gas location, with a horizontal distance and approximate bearing from the oil and gas location."

- COGCC rule 303 (d)(3)(E) - "An 8 1/2" by 11" vicinity or U.S. Geological Survey topographic map showing the access road from the highway or county road providing access to the proposed oil and gas location."

23) All materials brought into the Refuge to build up the location pad will be authorized by the Refuge Manager or his authorized representative. To minimize the spread of invasive species, no top soils will be brought in from off the Refuge. (50 C.F.R. 27.52; 50 C.F.R. 29.32)

24) The Operator shall have an on-site independent oil and gas consultant present during all phases of exploration and they shall be the sole representative of the Operator and subcontractors regarding all communications and decisions of the Refuge Manager or his authorized representative. The consultant's sole responsibility is to ensure daily compliance with Refuge, ensure that all oil and gas laws and regulations are followed, report all accidents and/or injuries and keep the Project Leader informed daily. The Operator shall keep the Refuge Manager or his authorized representative informed if there is any change of designated independent oil and gas consultant. (50 C.F.R. 25.72)

25) Refuge officials will conduct an on-site meeting before rig-up with representatives of the Operator, drilling contractor, subcontractors, suppliers and service companies. The purpose of the meeting is to go over regulations and conditions that apply to work crew conduct on the Refuge.

26) Prior to rig-up, an Emergency Preparedness Plan covering exploratory drilling, well control, materials hauling, spill response, and fire evacuation, will be provided to the Refuge Manager and discussed in a pre-operation meeting to be held with local governments. The plan shall contain a telephone list naming key contacts for emergency operations and activation. This measure is subject to the following rules:

- COGCC rule 306 - **Consultation.** The operator shall consult in good faith, as provided . . .[with] local governments that have appointed a local governmental designee and have indicated to the Director a desire for consultation shall be given an opportunity to engage in such consultation."

- COGCC rule 317(l) - "**Flaring of gas during drilling and notice to local emergency dispatch**. Any gas escaping from the well during drilling operations shall be, so far as practicable, conducted to a safe distance from the well site and burned. The operator shall notify the local emergency dispatch as provided by the local governmental designee of any such flaring. Such notice shall be given prior to the flaring if the flaring can be reasonably anticipated, and in all other cases as soon as possible but in no event more than two (2) hours after the flaring occurs."

- COGCC rule 317(B)(d)(6) - "An emergency spill response program that includes employee training, safety, and maintenance provisions and current contact information for downstream Public Water System(s) located within fifteen (15) stream miles of the DCPS Operation, as well as the ability to notify any such downstream Public Water System(s) with intake(s) within fifteen (15) stream miles downstream of the DCPS operations."

27) The Operator will upgrade and maintain all access routes, roads and bridges designated for its use across the Refuge in accordance with acceptable specifications and standards. The Operator shall have road maintenance equipment and operator(s) readily available to perform road repairs and maintenance as needed, or as directed by the Refuge Manager or his authorized representative.

28) Dust levels on regularly traveled access routes must be kept to a minimum. The Operator shall have a water truck and operator(s) readily available to perform dust abatement as needed, or as directed by the Refuge Manager or his authorized representative. Only water will be allowed for dust suppression efforts. Dust control measures shall be implemented throughout the traveled areas of the Project Area in addition to the dust abatement requirement in measure #15. This measure is subject to the following rule:

- COGCC rule 1002(e)(1) - In order to reasonably minimize land disturbances and facilitate future reclamation, well sites, production facilities, gathering pipelines, and access roads shall be located, adequately sized, constructed, and maintained so as to reasonably control dust and minimize erosion, alteration of natural features, removal of surface materials, and degradation due to contamination.

29) The drill site and immediate access roads shall be constructed of Refuge approved material for all drilling locations. Drill pads may not exceed 90,000 square feet in area. All existing drainage patterns within roads to be constructed shall be maintained uninterrupted by the use of culverts, bridges or other applicable techniques as specified and authorized by the Refuge Manager or his authorized representative. This measure is subject to the following rule:

- COGCC rule 1002(d) - The drilling location shall be designed and constructed to provide a safe working area while reasonably minimizing the total surface area disturbed. Consistent with applicable spacing orders and well location orders and regulations, in locating drill pads, steep slopes shall be avoided when reasonably possible. The drill pad site shall be located on the most level location obtainable that will accommodate the intended use. If not avoidable, deep vertical cuts and steep long fill slopes shall be constructed to the least percent slope practical. Where feasible, operators shall use directional drilling to reduce cumulative impacts and adverse impacts on wildlife resources.

30) Upon completion of drilling operations, the Refuge Manager or his authorized representative must be advised within 120 days whether the well is to be retained or plugged. If the well site is to be abandoned, the well is to be plugged according to state law, all above ground structures removed and the site and road restored as directed by the Refuge Manager or his authorized representative. Any damage to existing surface vegetation, water channels, or other physical features shall be restored to original site conditions. All costs shall be born by the Operator. This measure is subject to the following rules:

- COGCC rule 1001(a) - The rules and regulations of this series establish the proper reclamation of the land and soil affected by oil and gas operations and ensure the protection of the topsoil of said land during such operations. The surface of the land shall be restored as nearly as practicable to its condition at the commencement of drilling operations.

- Upon the cessation of operations the area shall be restored as nearly as possible to its condition prior to the commencement of operations. (50 C.F.R. 29.32)

31) Pits, ponds and/or open tanks are prohibited. Fully enclosed portable tanks must be used in circulating operations for the temporary storage of all drilling fluids, cuttings, mud, and contaminants. All drilling fluids, cuttings, mud, contaminants, portable tanks, and other equipment must be transported off Refuge to a state approved facility upon cessation of drilling activity. On-site disposal of drilling fluids is prohibited. It is highly recommended that an auger tank be used for transferring drill cuttings and sand to a vehicle for off Refuge transport. This measure is subject to the following rule:

- COGCC rule 907(c)(2)(c) – Drilling Fluids. Treatment and Disposal. Drilling fluid may be disposed as follows:
    B. Disposal at a commercial solid waste disposal facility

32) Lexam must provide Service with a written description of how potential produced water and condensate resulting from drill stem testing will be handled and disposed of, in the event that the proposed exploratory wells intersect gas reserves. On-site disposal of produced water is prohibited. Produced water may only be disposed of at an off-site state approved facility following:

- COGCC rule 907(c)(2)(c) – **Produced water disposal.** Produced water may be disposed as follows:
    C. Disposal at permitted commercial facilities

33) All toxic construction and equipment supplies and refuse (oil, grease, gasoline, diesel, paint, and other petrochemical derivatives) shall be centrally stored. Wastes shall be disposed off Refuge immediately following completion of drilling operations. In the event of an accidental spill or discharge of oil, brine, or any other petrochemical substance, the Operator shall immediately notify the Refuge Manager or his authorized representative. The Operator shall remove contaminated soils for proper disposal off Refuge, and replace such soils with the same type soils or of a type specified and approved by the Refuge Manager or his authorized representative. A site reclamation plan may be required by the Refuge Manager or his authorized representative. (50 C.F.R. 29.32) This measure is subject to the following rules:

- CDPHE rule 6 C. C. R. 1007-2&3. Solid and Hazardous Waste Commission Regulations. Hazardous wastes require storage, treatment, and disposal practices in accordance with 6 C.C.R. 1007-3. All non-hazardous/non-E&P wastes are considered solid waste, which require storage, treatment, and disposal in accordance with 6 C.C.R. 1007-2.

34) Catch pans or other liner systems approved by the Refuge Manager are required for equipment and locations such as mud pumps, bulk mud additive tanks, fuel tanks, mixing shed, generators, accumulator and lines, and under the entire rig floor. The catch pans will cover the entire surface area under the equipment. The rig floor catch pan will be tied to allow for wash down and mud drainage from drill pipe. The catch pans will be kept free and clean from accumulated debris and spill materials. (50 C.F.R. 27.94; 50 C.F.R. 29.32)

35) The Operator will be responsible for providing all water needed for drilling operations. No waste water will be discharged onto Refuge lands, ditches, or water bodies. The Operator will provide a containerized or temporary septic system for domestic sewage disposal during drilling operations, which shall be removed upon completion of drilling. Use of portable toilets at drill site or the installation of a septic system, or similar treatment system or tanks will be required for any trailer or quarters on site. No surface discharge of septic system or portable toilet water is permitted. Septic tanks must be inspected weekly during operations and pumped as necessary. Upon completion of operations, the septic tanks must be pumped out and all material hauled away.

36) All disposable type materials and trash brought onto the Refuge or generated at the drill site shall be removed from the Refuge on a biweekly basis and upon completion of the drilling activities. The drill site and operational area shall be kept free of debris and trash at all times. Trash shall be contained securely at the drill site in such a manner (fully enclosed trash cages) as to prevent trash from being spread by wind or wildlife. No trash may be disposed of or buried on the Refuge. (50 C.F.R. 27.94)

37) Lexam must implement the recommendations contained in the report entitled “Existing Conditions Report for a Portion of the Lexam Road, Saguache County, Colorado,” prepared by Russell Surveyors and Associates, Inc., March 30, 2008, with input from the Service.

38) Lexam must implement the recommendations that were the basis for the air quality report analysis set forth in the “Lexam Baca Drilling Project Visibility Impact Evaluation,” Air Sciences Inc., April 30, 2008: (a)

power generators will be Tier 2 engines; (b) diesel fuel used in generators and all other non-road engines will be ultra-low-sulfur (less than 0.05 percent sulfur); and (c) disturbed areas will be watered to control the fugitive dust.

39) Lexam must use mufflers on all internal combustion engines and certain compressor components that are designed to further attenuate noise emissions during all exploration activities.

- COGCC rule 802(b) - "Oil and gas operations at any well site, production facility, or gas facility shall comply with the following maximum permissible noise levels. Operations involving pipeline or gas facility installation or maintenance, the use of a drilling rig, completion rig, workover rig, or stimulation is subject to the maximum permissible noise levels for industrial zones. The type of land use of the surrounding area shall be determined by the Commission in consultation with the local governmental designee taking into consideration any applicable zoning or other local land use designation."

40) Upon CDOW recommendation, Lexam has agreed, that in the event of a severe winter, to assist the CDOW with managing for the needs of any wintering big game temporarily displaced by Lexam's activities within the designated areas, especially if the temporary displacement results in the potential for a decline in overall physiological health of the animals or in increased game damage claims by private landowners. This assistance could occur as a Lexam funded baiting program, feeding program or other form of distribution management as determined appropriate by CDOW within the severe winter range area.

41) A minimum of one up-gradient and two down-gradient monitoring wells will be installed around each drill pad. The wells will be completed in the shallow unconfined aquifer. The locations and elevations of the wells will be surveyed and depth to water will be measured. Water samples will be collected for chemical analysis before the wells are spud and at predetermined intervals thereafter, which will agreed to by the Service and Lexam. If spills or releases of drilling related chemicals at sites occur, then the sampling frequency may be increased to a frequency agreed to by the Service, Baca Grande Water and Sanitation District, and Lexam.

42) General Refuge access conditions:

− Access is to allow Lexam and/or its contractor's access to portions of the Refuge for the purpose of carrying out drilling of oil and gas exploration wells Baca #5 and Baca #7. (50 C.F.R. 26.22)

− The Refuge Manager is the coordinating official having immediate jurisdiction and administrative responsibility for oil and gas operations on the Baca National Wildlife Refuge (Refuge) lands and property, all entry upon the Refuge must be coordinated with the Refuge Manager or his authorized representative The Refuge Manager must be advised at least 48 hours in advance of initial activity. (50 C.F.R. 26.22)

− The failure of the United States to require strict performance of the terms, conditions, covenants, agreements, or stipulations of this permit for access to conduct exploration activities on National Wildlife Refuge lands, shall not constitute a waiver or relinquishment of the right of the United States to strictly enforce thereafter such terms, conditions, covenants, agreements, or stipulations which shall, at all times, continue in full force and effect.

− Lexam and/or its contractors shall save, hold harmless, defend, and indemnify the United States, its agents and employees for loss, damages, or judgments and expenses on account of bodily injury, death or property damage, or claims for bodily injury, death or property damage of any nature whatsoever, and by whomever made, arising out of the Operator, his employees, subcontractors or agents with respect to the exploration of any and all mineral rights within the lands administered by the Refuge.

− All applicable federal and state regulations apply and will be in force. Operator shall be responsible for the actions of all exploration and support personnel. Violations of applicable laws or regulations will subject the operator and/or his employees to prosecution under state and/or federal laws. Individuals utilizing the Refuge under the Operator's authorization are subject to inspections of vehicles and their contents by federal and state law enforcement officers.

− Proof of general liability insurance in the amount of $1,000,000 must be furnished to repair/mitigate any damages. This does not limit the liability for damages to this amount.

- COGCC rule 708 - **General Liability Insurance.** All operators shall maintain general liability insurance coverage for property damage and bodily injury to third parties in the minimum amount of one million dollars ($1,000,000) per occurrence. Such policies shall include the Commission as a “certificate holder” so that the Commission may receive advance notice of cancellation.

− Operators will act in a manner that is respectful of Refuge habitats, wildlife, and property. Gates are to be locked or unlocked as they are found. (50 C.F.R. 27.21; 50 C.F.R 27.51)

− All vehicle access will be restricted to developed roads and two-tracks. All terrain vehicle use and deviations to vehicle use must be pre-approved by the Refuge Manager in writing prior to any action taken. (50 C.F.R. 27.31)

− Vehicle speed limits will be set at the discretion of Refuge Manager and limits will be strictly adhered to. (50 C.F.R. 27.31)

− No pets will be allowed on the Refuge. (50 C.F.R. 28.42; 50 C.F.R. 28.43)

− Possession of firearms, alcoholic beverages or drugs is strictly prohibited on the Refuge. (50 C.F.R. 27.41; 50 C.F.R. 27.42; 50 CFR 27.81; 50 C.F.R. 27.82)

− Fires are strictly prohibited in any areas of the Refuge. (50 C.F.R. 27.95)

− Operators are not to be considered agents of the Service and are not to represent the Service in any matters. (50 C.F.R. 27.84)

− Operators will perform all work in accordance with the highest standards of the industry and to the satisfaction of the Service.

− Operators will perform all work in accordance with all applicable laws and regulations and will obtain all necessary permits or licenses when required to do so. (50 C.F.R. 25.13; 50 C.F.R. 29.32)

− All personnel and activities shall be restricted to the immediate drilling area and the direct access road to the drill site. (50 C.F.R. 26.22)

− Feeding wildlife species is prohibited. Molesting or destroying the home or dens of wildlife is prohibited. If dens are found during the normal course of operations, distinctive flagging will be used to alert all personnel of the den location. Adverse impacts on fish, wildlife and the environment shall be kept to an absolute minimum. All road kills will be reported to the Refuge Manager or his authorized representative. (50 C.F.R. 27.51)

− Littering is prohibited. All cans, bottles, lunch papers, and operations trash must be removed. Cigarette butts are considered litter. All vehicles will be equipped with a container to carry out trash. (50 C.F.R. 27.94)

− All necessary permits, contacts and clearances must be completed or obtained by Lexam prior to the start of the activity. (50 C.F.R. 25.13)

− No overnight quarters will be permitted on the Refuge unless authorized by Refuge Manager. (50 C.F.R. 27.92)

− Re-route the access road to Baca #5 to avoid sensitive plant species and wet meadow habitat (**Figure 2-1**).

Under this alternative, if Lexam discontinues or fails to perform any of the preceding protective measures, and the Refuge Manager believes such failure will lead to unreasonable damages to Refuge resources, the Service may assess penalties pursuant to 50 CFR Part 28 or any of the aforementioned CFRs listed above. The Service may require Lexam to cease exploration activities until the risk of damage to Refuge resources has been removed or mitigated in the sole discretion of the Service.

Appendix E

Lexam Explorations(U.S.A) Inc. Letter from Consulting Geologist

20/20 Exploration, LLC
475 17th St. Suite 510 Denver CO 80202 303 298-8000

Lexam Explorations (U.S.A.)
c/o W. Jack Clark
Clark Mining services, LLC
6052 South Newport Street
Centennial, CO 80111

Dear Mr. Clark,

At your request, this letter will serve to further discuss the need for vertical wells during the exploratory phase of drilling on the Baca Land Grant, specifically the Baca #5 and Baca #7 wells. Please refer to the diagrammatic cross section attached to the end of this letter. This cross section runs from NW to SE through the 2 well locations. It is drawn approximately to scale – the wellbores are 12,000' in depth and the distance between the locations is approximately 7,600'. The cross section is based on the 3D seismic image and interpretation.

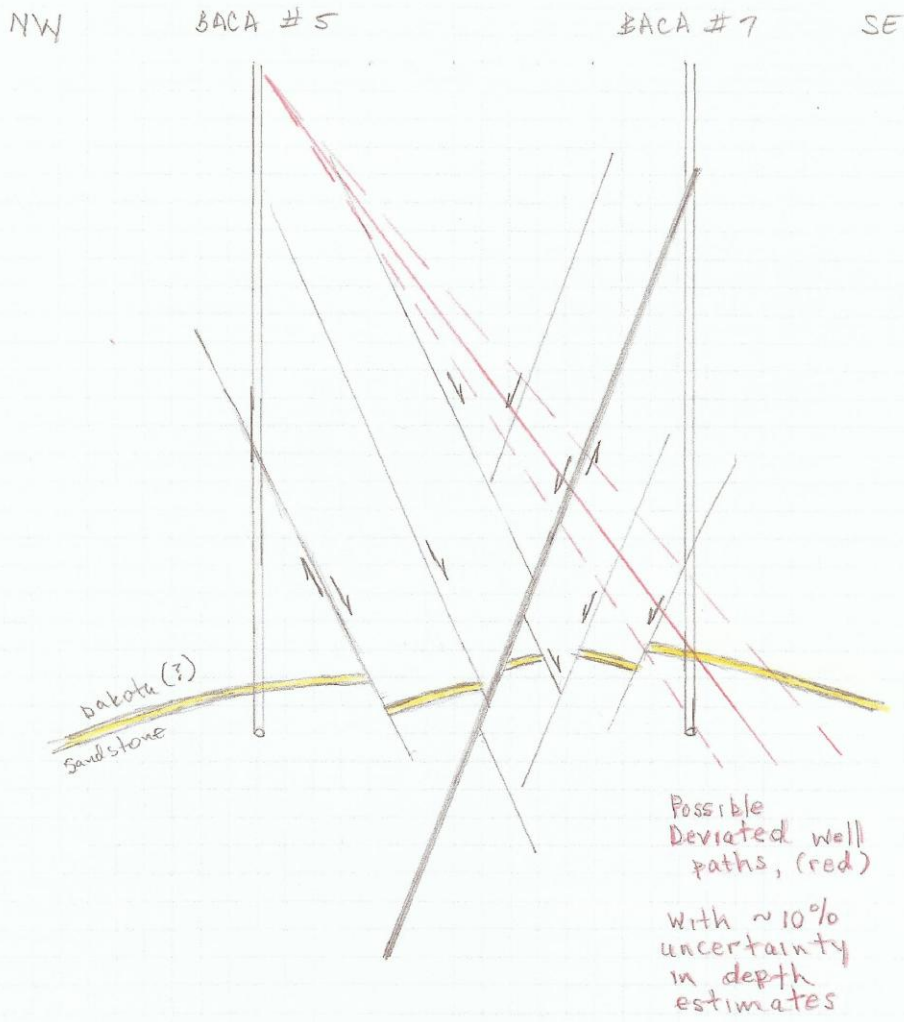
The Dakota Sandstone is the geologic formation drawn on the cross section, which is interpreted to be one of the primary targets of the exploration. Between the 2 well locations are drawn a number of normal faults, with direction of displacement shown by the arrows. The fault pattern is typical of a complex graben, resulting from tensional stress. The #5 and #7 wells target structural traps on opposite side of the graben. The #5 well is located downthrown to the dominant fault, which is drawn more heavily. The #7 well is thus upthrown to the major fault.

The red lines on the cross section illustrate possible deviated wellbores from the # 5 surface location to the Dakota target beneath the #7 location. The solid red line shows the ideal well path, should our depth estimates be exactly correct. The dashed red lines illustrate well paths with about a 10% error in our depth estimates. The more shallow of these would encounter the Dakota substantially downdip of the preferred structural position. The deeper alternative shows that the Dakota could possibly be faulted out of the wellbore and missed altogether. Because we have so little data to constrain our depth estimates, it is my opinion that the uncertainty in those estimates could easily be 10% or greater.

The cross section illustrates another significant issue with any attempted deviated well path. Such a deviated well path would necessarily traverse the heart of the complexly faulted graben. The fault density is greater in the shallow section than at depth, and a deviated well would intersect a number of normal faults.

Respectfully submitted,

John S. Belcher


NW
BACA #5
BACA #7
SE
dakota (?)
Sandstone
Possible
Deviated well
paths, (red)
With ~10%
uncertainty
in depth
estimates

Appendix F

Agreement Between Saguache County and Lexam Explorations (U.S.A) Inc.

AGREEMENT BETWEEN SAGUACHE COUNTY AND LEXAM EXPLORATIONS (U.S.A.) INC. RELATING TO DRILLING AND EXPLORATION ACTIVITIES IN SAGUACHE COUNTY, COLORADO

This Agreement is entered into this 17 day of April, 2007, by and between the County of Saguache, Colorado, a governmental entity ("County"), and Lexam Explorations (U.S.A.) Inc. ("Lexam").

WHEREAS, the County has the legal authority to adopt regulations establishing weight limitations and usage restrictions for roads which belong to the County; and

WHEREAS, the County had adopted a series of Resolutions in 1990 establishing weight limitations on County roads and certain usage restrictions. These Resolutions also established a permitting system and an excessive weight impact fee. The County and Lexam had entered into an agreement relating to those impact fees and certain activities then being conducted by Lexam in Saguache County; and

WHEREAS, those Resolutions, permit requirements and weight limitations have remained in effect since 1990; and

WHEREAS, Lexam is conducting certain activities with the County which have and will result in certain services being provided by the County which are not normally supplied to private entities and certain of Lexam activities will place an undue burden on the County roads; and

WHEREAS, the County adopted Resolution No. 2007 G-2 to update the weight limitations for the County road system and update the impact fees for use of the system to reflect current costs associated with undue impact by special activities and usage. The Resolution also provides that the County and entities whose activities will have an undue impact on the County roads may enter into an Agreement to address that impact; and

WHEREAS, the County and Lexam desire to enter into an Agreement to address the impact that Lexam's activities will and may have on the County roads and services, as well as other matters affecting the County created by Lexam's activities.

THEREFORE, in consideration for the mutual promises and covenants contained herein, and for such other good consideration, the sufficiency of which is hereby acknowledged, the parties agree as foHows:

1. That the County will provide certain signage, at specified locations, as may be agreed to by Lexam and the County and that Lexam will pay the County Road and Bridge Depaliment the sum of a minimum of $100.00 for that signage.

2. That Lexam, to comply with the County road weight limitations, will weigh each truck that it owns, contracts for, or controls and uses for its activities within the County, and that will use any road in the County road system.

3. Lexam or its contractors will provide a copy of the weight ticket for each vehicle used or participating in its activities within the County, for each trip that the subject vehicle makes on the County road system, to the County's Road and Bridge Department.

4. Lexam agrees to pay to the County the sum of $4.29 for each ton of weight that the vehicles SUbject to this Agreement exceed the County road weight limit of 54,000 pounds.

5. That Lexam agrees to purchase a County Road Access Permit for accessing Saguache County Roads, from the Saguache County Road & Bridge Department, at the same cost charged by the County to other, similar users of County roads.

6. Said sum will be paid to the County on a monthly basis.

7. In order to minimize the cost and effort involved in disposing of cuttings from the drill sites and to minimize the impact that the drilling activities may have on Saguache County, Lexam further agrees that it will voluntarily test the "cuttings" which arise from the drilling of any exploration well or other exploration activities within the County of Saguache. Such testing shall be limited to those cuttings that visually exhibit substances other than dirt and rocks and for which Lexam proposes to permanently dispose in the County. These tests will be in addition to, or concurrent with, any other testing which may be required by Federal or State authority. The purpose of this testing is to determine if the cuttings can be safely used as weBsite cover and/or road base materials, as well as to assist in determining if any special precautions are required for the permanent disposal of the cuttings. The testing will include:

- Total petroleum hydrocarbons (TPH),
- Sodium Adsorption Ratio (SAR),
- Heavy metal concentrations,
- pH level, and
- Conductivity.

Lexam agrees that it will provide a report of the above tests and all other tests performed on the cuttings and fluids produced results from the drilling operation, as required by Federal or State agencies, to the County Land Use Department. Said testing will conform to the generally acceptable testing standards for the industry.

8. The County will discuss, following the receipt of the above tests, the possibility of potential uses for the cuttings from the drilling activities with Lexam.

9. The parties may modify the terms of this Agreement in a writing signed by authorized agents of both parties.

The undersigned, by executing this Agreement, hereby affirm that they have the authority to enter into this Agreement and to be bound by the terms contained herein.

SAGUACHE COUNTY:

Name:
Title:

LEXAM EXPLORATIONS (U.S.A.) INC.:

Name: Stefan M. Speers
Title: VP Strategic Dev.

Appendix G

Baseline Surface Water and Groundwater Sampling Analytical Results

Baseline Chemistry for Ground Water

Sample Name	199723	375307	C-18	C-20	C-22	C-23	C-24	C-25	C-27	C-57	C-7	FL-3	FL-4	MOTEL WELL	DOMESTIC WELL	SW-5 From Pump	SW-5 From Bailer	WELL 14	WELL 15	WELL 17	WELL 18	WELL 2
Location Type	Flowing Well	Pumped Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Flowing Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well	Pumped Well
Aquifer	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Confined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined	Unconfined
Treatment	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(g)	(g)	(g)	(g)	(g)	(g)	(g)
Profile I (Major ions, metals, general)																						
pH (std. units)	8.53	8.35	8.45	8.15	8.3	8.38	8.38	8.39	8.29	8.17	8.31	8.48	8.01	7.36	7.64	(f)	7.47	7.44	7.66	6.8	6.83	7.06
pH - Field (s.u.)	8.6	8.21	8.67	8.06	8.60	8.54	8.30	8.5	8.22	8.32	8.65	8.45	8.07	7.83	8.15	8.28	8.25	7.45	7.85	7.07	6.98	6.96
Conductivity - Field	148.1	1147	366	832	313	145.5	741	1602	2410	126.6	174.2	1130	395	65.7	140.3	111.9	113.5	136.5	193.5	96.5	111.2	85.0
Temperature - Field	31.3	25.1	(e)	14	(e)	18.4	16.7	(e)	(e)	16.2	(e)	18.8	18.0	13.4	(e)	14.2	12.1	10.6	(e)	11.2	13.5	(e)
Alkalinity (mg/L as CaCO3)	434	661	210	298	136	166	384	813	1410	138	85.4	628	153	62.9	72.5	(f)	56.3	67.9	98.8	43.2	52.5	154
Bicarbonate (mg/L as CaCO3)	416	654	202	298	134	161	377	800	1410	138	83	610	153	62.9	72.5	(f)	56.3	67.9	98.8	43.2	52.5	154
Carbonate (mg/L as CaCO3)	18	7	8	<1	2.1	5	7.2	12.8	5.3	<1	2.5	17.9	<1	<1	<1	(f)	<1	<1	<1	<1	<1	<1
Chloride	10.3	7.87	2.74	3.1	2.02	2.05	4.77	9.08	19.3	1.92	2.1	4.85	9.07	1.17	1.02	(f)	0.97	0.36	1.18	0.4	0.65	2.09
Fluoride	**7.78**	3.39	1.73	1.68	2.19	2.54	2.74	3.71	3.3	2.02	0.68	3.18	2.18	<0.1	0.17	(f)	<0.1	0.1	<0.1	<0.1	<0.1	0.18
Sulfate	0.72	0.46	0.49	0.68	<0.3	0.53	<0.3	0.32	<0.3	0.43	0.91	0.95	<0.3	3.53	1.82	(f)	1.75	3.57	6.63	2.75	3.11	8.05
Total Dissolved Solids	**548**	**777**	251	335	171	181	423	**929**	**1560**	182	133	**722**	228	85	103	(f)	90	94	125	55	67	175
Aluminum (mg/L)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	(f)	<0.08	<0.08	<0.08	<0.08	<0.08	(b)
Antimony (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	(f)	<0.003	<0.003	<0.003	<0.003	<0.003	(b)
Arsenic (mg/L)	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	(f)	<0.025	<0.025	<0.025	<0.025	<0.025	(b)
Barium (mg/L)	0.0122	0.0376	0.0223	0.0498	0.0319	0.0266	0.0283	0.0299	0.0619	0.0453	0.0315	0.0283	0.0783	0.0423	0.022	(f)	0.0347	0.0379	0.0701	0.0287	0.0367	(b)
Beryllium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	(f)	<0.002	<0.002	<0.002	<0.002	<0.002	(b)
Boron (mg/L)	1.67	0.85	0.15	0.26	0.13	0.19	0.36	0.99	1.49	0.12	<0.04	0.93	0.13	<0.04	<0.04	(f)	<0.04	<0.04	<0.04	<0.04	<0.04	(b)
Cadmium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	(f)	<0.002	<0.002	<0.002	<0.002	<0.002	(b)
Calcium (mg/L)	2.71	5.24	4.27	8.41	7.44	7.05	4.11	3.04	3.82	9.29	10.2	2.99	24.8	17.4	16.2	(f)	13.1	19.8	30.1	14.2	17	(b)
Chromium (mg/L)	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	(f)	<0.006	<0.006	<0.006	<0.006	<0.006	(b)
Copper (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	(f)	<0.01	<0.01	<0.01	<0.01	<0.01	(b)
Iron (mg/L)	<0.06	<0.06	<0.06	0.11	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.08	0.07	<0.06	<0.06	(f)	<0.06	<0.06	<0.06	<0.06	<0.06	(b)
Lead (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	(f)	<0.003	<0.003	<0.003	<0.003	<0.003	(b)
Magnesium (mg/L)	0.61	2.3	0.91	2.77	1.03	1.32	1.47	1.88	5.19	1.68	0.7	1.84	3.94	3.59	2.41	(f)	3.83	3.25	3.73	1.7	2.11	(b)
Manganese (mg/L)	0.006	0.038	0.017	0.074	0.018	0.015	0.027	0.026	0.034	0.033	0.012	0.011	0.044	<0.004	0.005	(f)	0.024	<0.004	<0.004	<0.004	<0.004	(b)
Mercury (mg/L)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	(f)	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	(b)
Nickel (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	(f)	<0.01	<0.01	<0.01	<0.01	<0.01	(b)
Potassium (mg/L)	4.16	8.39	5.14	7.68	6.86	5.71	6.01	8.64	13	7.16	5.47	5.61	4.5	1.13	3.36	(f)	2.17	1.15	1.34	0.64	0.54	(b)
Selenium (mg/L)	0.0092	<0.003	0.0043	0.0082	0.0043	<0.003	<0.003	0.006	0.0042	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	(f)	<0.003	<0.003	<0.003	<0.003	<0.003	(b)
Silver (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	(f)	<0.005	<0.005	<0.005	<0.005	<0.005	(b)
Sodium (mg/L)	188	297	77.4	109	44.6	53.7	149	339	485	46.9	20.1	279	40.8	4.81	8.02	(f)	4.71	4.45	7.91	2.05	2.51	(b)
Thallium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	(f)	<0.002	<0.002	<0.002	<0.002	<0.002	(b)
Zinc (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.088	(f)	0.046	<0.01	<0.01	<0.01	<0.01	(b)
Hydrocarbons																						
Diesel (mg/L)	<0.1	<0.1	<0.1	(e)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Gasoline (mg/L)	<0.1	<0.1	<0.1	(e)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethane (mg/L)	0.0186	0.0157	0.00304	(e)	0.00199	0.00231	0.00472	0.0179	0.0104	0.00165	<0.001	0.013	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Methane (mg/L)	11.7	25.8	18.1	(e)	7.23	9.33	25.7	22.1	15.8	9.12	0.792	23.7	0.929	0.00109	0.00354	<0.001	0.0172	<0.001	<0.001	0.00129	<0.001	0.0296
VOCs																						
1,1,1,2-Tetrachloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,1-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2-Trichloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1-dichloropropene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-Trichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,3-Trichloropropane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-Trichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2,4-Trimethylbenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dibromo-3-chloropropane(DBCP) (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dibromoethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3,5-Trimethylbenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,2-Dichloropropane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-hexanone (µg/L)	<2.5	<2.5	<2.5	(e)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
4-Chlorotoluene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acetone (µg/L)	<2.5	<2.5	<2.5	(e)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Acrylonitrile (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromochloromethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromodichloromethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Bromoform (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Bromomethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon disulfide (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbon Tetrachloride (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorobenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloroform (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chloromethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,2-dichloroethene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromochloromethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibromomethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dichlorodifluoromethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isopropylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m+p-Xylene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methyl ethyl ketone (µg/L)	<2.5	<2.5	<2.5	(c)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Methyl isobutyl ketone (µg/L)	<2.5	<2.5	<2.5	(c)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Methylene chloride (µg/L)	<2.5	<2.5	<2.5	(c)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
methyl-t-butyl ether (MTBE) (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Propylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
o-Xylene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
p-isopropyltoluene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
s-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Styrene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
t-Butylbenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetrachloroethene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,2-Dichloroethene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-1,3-Dichloropropene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Trichloroethene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trichlorofluoromethane (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Vinyl Chloride (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
SVOCs																						
1,2,4-Trichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,2-Diphenyl hydrazine (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,3-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,4-Dichlorobenzene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1-Methylnaphthalene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,3,4,6-Tetrachlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,3,5,6-Tetrachlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-Trichlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-Trichlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dichlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dimethylphenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dinitrophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-Dinitrotoluene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,6-Dinitrotoluene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chloronaphthalene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Chlorophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylnaphthalene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Methylphenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitroaniline (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2-Nitrophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3,3'-Dichlorobenzidine (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3+4-Methylphenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
3-Nitroaniline (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4,6-Dinitro-2-methylphenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Bromophenyl-phenylether (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloro-3-methylphenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chloroaraline (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Chlorophenyl-phenylether (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitroaniline (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4-Nitrophenol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Acenaphthylene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aniline (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Anthracene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzidine (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(ghi)perylene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo[a]anthracene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo[a]pyrene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo[b]fluoranthene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo[k]fluoranthene (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzyl alcohol (µg/L)	<0.5	<0.5	<0.5	(c)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

bis(2-Chloroethoxy)methane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
bis(2-Chloroethyl)ether (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
bis(2-chloroisopropyl)ether (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
bis(2-Ethylhexyl)phthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	1.21	<0.5	0.692	<0.5	<0.5	<0.5	<0.5	<0.5	3.09	0.551	<0.5	<0.5	<0.5	<0.5
Butylbenzylphthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Carbazole (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chrysene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenz[a,h]anthracene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dibenzofuran (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Diethylphthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dimethylphthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Di-n-butylphthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Di-n-octylphthalate (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluoranthene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Fluorene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobutadiene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorocyclopentadiene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachloroethane (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno[1,2,3-cd]pyrene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Isophorone (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Naphthalene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrobenzene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrosodimethylamine (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Nitroso-di-n-propylamine (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
n-Nitrosodiphenylamine (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pentachlorophenol (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenanthrene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenol (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyrene (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pyridine (µg/L)	<0.5	<0.5	<0.5	(e)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Organic compound or gas above detection limit
Analyzed as part of December 2006 sampling event

(a) Unfiltered except for metals and major ions
(b) Sample bottle drained during shipment; no analysis performed
(c) Not accessible June 2007
(e) Due to lag time, measured temperature not reflective of in situ water temperature
(f) Not sampled from pump during December 2007

Baseline Chemistry for Surface Water

Sample Name	COTTONWOOD CREEK INTAKE		DEADMAN CREEK		SOUTH CRESTONE CREEK		SPANISH CREEK - EAST		SPANSIH CREEK - WEST		WILLOW CREEK - EAST		WILLOW CREEK - BACA 5		WILLOW CREEK - WEST	
Location Type	Surface Water		Surface Water		Surface Water		Surface Water		Surface Water		Surface Water		Surface Water		Surface Water	
Aquifer	n/a		n/a		n/a		n/a		n/a		n/a		n/a		n/a	
Treatment	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered
Profile I (Major ions, metals, general)																
pH (std. units)	6.7		6.56		7.28		7.62		7.82		7.5		8.23		8.3	
pH - Field (s.u.)	7.86		8.02		7.89		7.53		(d)		7.97		8.54		(d)	
Conductivity - Field	49.9		47.7		55.8		178.9		(d)		86.7		353		(d)	
Temperature - Field	(e)		12.9		10.4		16.3		(d)		14.9		(e)		(d)	
Alkalinity (mg/L as CaCO3)	32.3		15.9		25.8		94		145		44.8		155		132	
Bicarbonate (mg/L as CaCO3)	32.3		15.9		25.8		94		145		44.8		155		131	
Carbonate (mg/L as CaCO3)	<1		<1		<1		<1		<1		<1		<1		1.4	
Chloride	0.41		0.51		0.95		1		2.9		0.46		2.02		1.66	
Fluoride	0.12		0.4		0.1		0.22		0.31		0.15		0.38		0.3	
Sulfate	4.67		3.13		1.62		3.71		5.17		2.23		4.8		3.18	
Total Dissolved Solids	39		50		46		129		214		70		212		168	
Aluminum (mg/L)	<0.08	<0.08	**0.87**	<0.08	0.17	<0.08	<0.08	<0.08	<0.08	<0.08	**0.55**	<0.08	0.1	<0.08	<0.08	<0.08
Antimony (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Arsenic (mg/L)	<0.025	<0.025	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Barium (mg/L)	0.0073	0.0069	0.016	0.0068	0.023	0.0197	0.0412	0.0399	0.0503	0.0499	0.0372	0.0239	0.0459	0.0448	0.0357	0.036
Beryllium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Boron (mg/L)	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium (mg/L)	12	11.8	6.9	6.34	8.42	8.13	19.2	18.4	28.5	28	12.4	11.6	25.3	25	23.5	23.6
Chromium (mg/L)	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Copper (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (mg/L)	<0.06	<0.06	**1.06**	<0.06	0.23	<0.06	<0.06	<0.06	0.13	0.08	**1.03**	0.08	0.2	<0.06	<0.06	<0.06
Lead (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Magnesium (mg/L)	1.43	1.4	0.98	0.76	0.89	0.84	5.83	5.59	7.84	7.73	2.12	1.75	9.83	9.61	7.67	7.69
Manganese (mg/L)	0.004	<0.004	0.0223	<0.004	0.0113	<0.004	<0.004	<0.004	0.0211	0.0116	0.0509	0.014	0.007	0.0068	<0.004	<0.004
Mercury (mg/L)	<0.0002	<0.0002	0.00021	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Potassium (mg/L)	<0.5	<0.5	0.77	0.59	<0.5	<0.5	2.31	2.24	6.08	6.04	1.63	1.49	4.34	4.25	4.15	4.12
Selenium (mg/L)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Silver (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium (mg/L)	1.64	1.61	1.1	1.06	0.98	0.96	10.7	10	17.9	17.4	1.98	1.91	24.2	23.6	16.1	15.9
Thallium (mg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Zinc (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hydrocarbons																
Diesel (mg/L)	<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1	
Gasoline (mg/L)	<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.25	
Ethane (mg/L)	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
Methane (mg/L)	<0.001		<0.001		<0.001		0.0307		0.0349		0.00472		0.00621		0.00112	
VOCs																
1,1,1,2-Tetrachloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1,1-Trichloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1,2,2-Tetrachloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1,2-Trichloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1-Dichloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1-Dichloroethene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,1-dichloropropene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2,3-Trichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2,3-Trichloropropane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2,4-Trichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2,4-Trimethylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dibromo-3-chloropropane(DBCP) (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dibromoethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dichloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dichloropropane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,3,5-Trimethylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,3-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,3-Dichloropropane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,4-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,2-Dichloropropane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Chlorotoluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-hexanone (µg/L)	<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5	
4-Chlorotoluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Acetone (µg/L)	<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5	
Acrylonitrile (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Bromobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Bromochloromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Bromodichloromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	

Bromoform (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Bromomethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Carbon disulfide (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Carbon Tetrachloride (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Chlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Chloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Chloroform (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Chloromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
cis-1,2-dichloroethene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
cis-1,3-Dichloropropene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Dibromochloromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Dibromomethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Dichlorodifluoromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Ethylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Hexachlorobutadiene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Isopropylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
m+p-Xylene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Methyl ethyl ketone (µg/L)	<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5	
Methyl isobutyl ketone (µg/L)	<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5	
Methylene chloride (µg/L)	<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5		<2.5	
methyl-t-butyl ether (MTBE) (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Naphthalene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
n-Butylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
n-Propylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
o-Xylene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
p-isopropyltoluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
s-Butylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Styrene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
t-Butylbenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Tetrachloroethene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Toluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
trans-1,2-Dichloroethene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
trans-1,3-Dichloropropene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Trichloroethene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
trichlorofluoromethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Vinyl Chloride (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
SVOCs																
1,2,4-Trichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,2-Diphenyl hydrazine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,3-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1,4-Dichlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
1-Methylnaphthalene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,3,4,6-Tetrachlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,3,5,6-Tetrachlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4,5-Trichlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4,6-Trichlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4-Dichlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4-Dimethylphenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4-Dinitrophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,4-Dinitrotoluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2,6-Dinitrotoluene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Chloronaphthalene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Chlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Methylnaphthalene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Methylphenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Nitroaniline (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
2-Nitrophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
3,3'-Dichlorobenzidine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
3+4-Methylphenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
3-Nitroaniline (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4,6-Dinitro-2-methylphenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Bromophenyl-phenylether (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Chloro-3-methylphenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Chloroaniline (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Chlorophenyl-phenylether (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Nitroaniline (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
4-Nitrophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Acenaphthene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Acenaphthylene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Aniline (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Anthracene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzidine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzo(ghi)perylene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzo[a]anthracene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzo[a]pyrene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzo[b]fluoranthene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzo[k]fluoranthene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	
Benzyl alcohol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5	

bis(2-Chloroethoxy)methane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
bis(2-Chloroethyl)ether (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
bis(2-chloroisopropyl)ether (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
bis(2-Ethylhexyl)phthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		3.33		0.583
Butylbenzylphthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Carbazole (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Chrysene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Dibenz[a,h]anthracene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Dibenzofuran (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Diethylphthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Dimethylphthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Di-n-butylphthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Di-n-octylphthalate (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Fluoranthene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Fluorene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Hexachlorobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Hexachlorobutadiene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Hexachlorocyclopentadiene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Hexachloroethane (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Indeno[1,2,3-cd]pyrene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Isophorone (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Naphthalene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Nitrobenzene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Nitrosodimethylamine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
n-Nitroso-di-n-propylamine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
n-Nitrosodiphenylamine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Pentachlorophenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Phenanthrene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Phenol (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Pyrene (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		
Pyridine (µg/L)	<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		<0.5		

Organic compound or gas above detection limit
Analyzed as part of December 2006 sampling event

(d) Field parameters not measured
(e) Due to lag time, measured temperature not reflective of in situ water temperature

Appendix H

Air Quality Emissions Calculations

Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Sabrina Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 243 - 1 - 1	PAGE: 1	OF: 4	SHEET: 1
	SUBJECT: Drilling Program Emissions	DATE: September 26, 2008		

DRILLING ELECTRIC COMBUSTION EMISSIONS

			Reference
Power Generator Horsepower (capacity)	1,476	*hp/engine*	*CAT 3512B*
Number of Operating Engines	2	*engines*	*Drill supervisor Apr 10, 2008*
Power Engine Use	24	*hrs/day*	*Maximum schedule per day*
Power Generator Starter Engine Hp (capacity)	500	*hp/engine*	*Drill supervisor Apr 10, 2008*
Starter Engine Use	1.0	*hr/day*	*Drill supervisor Apr 10, 2008*
Length of drill activity per hole	90	*days*	*J. Clark March 10, 2008*
Number of holes drilled in program	2	*holes/yr*	*J. Clark March 10, 2008*
Engine max daily operating capacity factor	70	%	*Drill supervisor Apr 10, 2008**
			** long-term avg = 40%, short term max = 100%*

ASSUMPTIONS

Heat Content of Diesel	137,000	Btu/gal	*EPA AP-42 Appendix A*
Sulfur Content of Diesel	0.0015	%	*Ultra Low sulfur - highway grade*
Density of Diesel	7.05	*lbs/gal*	*EPA AP-42 Appendix A*
Internal Combustion Engine Efficiency	7,000	*Btu/hp-hr*	*AP-42 Table 3.3-1*

FUEL CONSUMPTION

	Annual	Maximum Daily	Maximum Hourly
Power Production	*8,989,848 hp-hr/yr*	*49,944 hp-hr/day*	*3,452 hp-hr/hr*
Diesel consumption	*459,335 gal/yr*	*2,552 gal/day*	*176 gal/hr*

EMISSION FACTORS - GENERATORS (assumed to meet or exceed Tier 2 standards)

Pollutant	*g/kW-hr*	*g/hp-hr*	*g/MMBtu*	Reference
NO_x	6.4	4.8	*681.8*	*40 CFR part 89.112, kW≥560 (Tier 2)*
VOC	1.3	1.0	*138.5*	*40 CFR part 89.112, kW≥560 (Tier 2)*
CO	3.5	2.6	*372.8*	*40 CFR part 89.112, kW≥560 (Tier 2)*
PM_{10}*	0.20	0.15	*21.31*	*40 CFR part 89.112, kW≥560 (Tier 2)*
PM_{25}*	0.20	0.15	*21.31*	*40 CFR part 89.112, kW≥560 (Tier 2)*
SO_2	--	--	*0.70*	*calculation*

*All particulate assumed to be ≤1μm in diameter (AP-42 Table 3.3-1)

EMISSIONS - GENERATORS

	Emissions		
Pollutant	**tons/yr**	**lbs/day**	**lb/hr**
NO_x	47.3	525.5	36.3
VOC	9.6	106.7	7.4
CO	25.9	287.4	19.9
PM_{10}	1.5	16.4	1.1
PM_{25}	1.5	16.4	1.1
SO_2	0.05	0.5	0.04

Conversion Factors	
453.59	g/lb
2,000	lb/ton
1.341	hp/kW

blue values are input black values are calculated

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ENGINEERING CALCULATIONS	PROJECT NO: 243 - 1 - 1	PAGE: 2	OF: 4	SHEET: 1
	SUBJECT: Drilling Program Emissions	DATE: September 26, 2008		

MOBILE SOURCE EMISSIONS

Vehicle Operation	*hrs/day**	*days/yr*	*units**	*gal/hr/unit**	*gal/day*	*gal/yr*	
Service Vehicles	2	180	6	10.0	120	21,600	*(watering, lube/fuel, mud removal)*
Supervisory Trucks	12	180	6	0.3	20	3,600	
Total					**140**	**25,200**	

* Project-specific estimates

ASSUMPTIONS

Heat Content of Diesel	137,000 *Btu/gal*	*EPA AP-42 Appendix A*
Sulfur Content of Diesel	0.0015%	*40 CFR part 80.29*
Density of Diesel	7.05 *lbs/gal*	*EPA AP-42 Appendix A*
Internal Combustion Engine Efficiency	7,000 *Btu/hp-hr*	*AP-42 Table 3.3-1*

EMISSION FACTORS - MOBILE (assumed to meet or exceed Tier 1 standards)

Pollutant	*g/kW-hr*	*g/hp-hr*	*g/MMBtu*	*Reference*
NO_x	9.2	6.9	*980.1*	*40 CFR part 89.112, 75 ≤kW≤225 (Tier 1)*
VOC	1.3	1.0	*138.5*	*40 CFR part 89.112, 75 ≤kW≤225 (Tier 1)*
CO	11.4	8.5	*1,214*	*40 CFR part 89.112, 75 ≤kW≤225 (Tier 1)*
PM_{10}*	0.54	0.40	*57.53*	*40 CFR part 89.112, 75 ≤kW≤225 (Tier 1)*
$PM_{2.5}$*	0.54	0.40	*57.53*	*40 CFR part 89.112, 75 ≤kW≤225 (Tier 1)*
SO_2	--	--	*0.70*	

*All particulate assumed to be ≤1µm in diameter (AP-42 Table 3.3-1)

EMISSIONS - MOBILE

	Emissions		
Pollutant	**tons/yr**	**lbs/day**	**lb/hr**
NO_x	3.7	41.4	18.25
VOC	0.5	5.9	2.58
CO	4.6	51.4	22.62
PM_{10}	0.2	2.4	1.07
$PM_{2.5}$	0.2	2.4	1.07
SO_2	0.003	0.030	0.013

CONVERSIONS

453.59	g/lb
2,000	lb/ton
1.341	hp/kW

Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Sabrina Pryor		
ENGINEERING CALCULATIONS	PROJECT NO: 243 - 1 - 1	PAGE: 3	OF: 4	SHEET: 1
	SUBJECT: Drilling Program Emissions	DATE: September 26, 2008		

FUGITIVE DUST EMISSIONS

		Number of holes drilled	2 holes
Length of access road to site	4.0 miles		0.02 holes/day
Round-trips on access road	15.0 trips/day		2 holes/yr
Vehicle miles traveled (VMT)	120 VMT/day		
	21,600 VMT/yr	Conversion Factors	
		453.6 g/lb	
Vehicle Operation	180 days/yr	2,000 lb/ton	

EMISSION FACTOR - UNPAVED ROAD FUGITIVES

Reference

$E = k(s/12)^a \times (W/3)^b$ — AP-42 Chapter 13.2.2.2

where:
- E= Emission Factor (lb/VMT)
- k= constant (lb/VMT)
- s= surface material silt content (%)
- W= mean vehicle weight (tons)

	PM_{10}	$PM_{2.5}$	
k=	1.5	0.15	AP-42 Table 13.2.2-2; Industrial Roads
s=	2.6 %		AP-42 Section 13.2.2, Related Info. r13s0202_dec03
a=	0.9	0.9	AP-42 Table 13.2.2-2; Industrial Roads
W=	5.0		Project-specific estimate
b=	0.45	0.45	AP-42 Table 13.2.2-2; Industrial Roads

PM_{10} E= $1.5(2.60/12)^{0.9} \times (5/3)^{0.45}$

$PM_{2.5}$ E= $0.15(2.60/12)^{0.9} \times (5/3)^{0.45}$

E= 0.48 *lb PM_{10}/VMT* $E_{watering\ controlled}$ = 0.12 *lb PM_{10}/VMT*

E= 0.05 *lb $PM_{2.5}$/VMT* 0.01 *lb $PM_{2.5}$/VMT*

Watering Control Effectiveness for Unpaved Travel Surfaces

Moisture Ratio. M	2	Operational estimate
Control Efficiency	75%	AP-42 Figure 13.2.2-2

EMISSION FACTOR - DRILLING FUGITIVES

E= 1.3 *lb/hole TSP* — *EPA AP-42 Table 11.9-4 (Overburden Drilling)*

Scaling Factors PM_{10} 0.52 $PM_{2.5}$ 0.03 — *EPA AP-42 Table 11.9-1 (Overburden Blasting)*

E= 0.676 *lb/hole PM_{10}* 0.039 *lb/hole $PM_{2.5}$*

EMISSIONS - FUGITIVE

	Un-Paved Road Emissions		Drilling Emissions	
Pollutant	**tons/yr**	**lbs/day**	**tons/yr**	**lbs/day**
PM_{10}	1.29	14.3	0.001	0.015
$PM_{2.5}$	0.129	1.4	0.0000	0.001

Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Sabrina Pryor		
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	SUBJECT: Drilling Program Emissions	DATE: September 26, 2008		

OTHER POLLUTANT EMISSIONS

EMISSION FACTORS

Pollutant	*lb/10^{12} Btu*	*lb/MMBtu*	*g/MMBtu*	**Reference**
Pb		2.9E-05	*1.3E-02*	*L & E Air Emissions from Sources of Lead and Lead Compounds, Section 5.2.2 (EPA 454/R-98-006)*
Hg	6.2	*6.2E-18*	*2.8E-15*	*L & E Air Emissions from Sources of Mercury and Mercury Compounds, Table 6-12 (EPA-454/R-97-012)*
H_2CO		1.2E-03	*5.4E-01*	*AP42 Table 3.3-2, Gasoline and Diesel Industrial Engines*

EMISSIONS - GENERATORS

	Emissions	
Pollutant	**tons/yr**	**lbs/day**
Pb	9.12E-04	0.01
Hg	1.95E-16	2.17E-15
H_2CO	3.71E-02	4.13E-01

EMISSIONS - MOBILE

	Emissions	
Pollutant	**tons/yr**	**lbs/day**
Pb	5.01E-05	5.56E-04
Hg	1.07E-17	1.19E-16
H_2CO	2.04E-03	2.26E-02

EMISSIONS TOTALS

Pollutant	**tons/yr**	**lbs/day**
NO_X	51.0	566.9
VOC	10.1	112.6
CO	30.5	338.7
PM_{10}	3.0	33.2
$PM_{2.5}$	1.8	20.3
SO_2	0.1	0.6
Pb	9.63E-04	1.07E-02
Hg	2.06E-16	2.29E-15
H_2CO	3.92E-02	4.35E-01

Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Tim Martin		
ENGINEERING CALCULATIONS	PROJECT NO: 243-1-1	PAGE: 1	OF: 4	SHEET: 1
	SUBJECT: Source Characteristics	DATE: September 22, 2008		

SOURCE RELEASE CHARACTERISTICS FOR AERMOD MODELING

Source Description	Model Src ID	Source Type	Vertical or Horizontal?	Source Location X (m)	Source Location Y (m)	Rel Ht. [1] (m)	Stk Dia. (m)	Exit Temp. (deg K)	Exit Vel. (m/s)	Sigma Y (m)	Sigma Z (m)
Generator 01	GEN01	POINT	horizontal	432751.8	4197205.4	7.00	0.40	500	0.001	N/A	N/A
Generator 02	GEN02	POINT	horizontal	432758.8	4197212.4	7.00	0.40	500	0.001	N/A	N/A
Fugitive [1]	FUGTV	VOLUME	N/A	432755.3	4197208.9	2.29	N/A	N/A	N/A	39.1	1.1

[1] Fugitives are emissions from mobile sources, un-paved roads, and drilling activities.
These emissions are released from a 15 foot tall by 7 acre volume source surrounding the location of the generators.
N/A = not applicable

EMISSION RATES FOR AERMOD MODELING

		Emission Rate 1-Hour		24-Hour		Annual	
Source Name	Model ID	lb/hr	g/sec	lb/day	g/sec	ton/year	g/sec [2]
NOx Emissions							
Generator 01	GEN01	--	--	--	--	23.6	0.68
Generator 02	GEN02	--	--	--	--	23.6	0.68
Fugitives [1]	FUGTV	--	--	--	--	3.7	0.11
$PM_{2.5}$ Emissions							
Generator 01	GEN01	--	--	8.2	0.04	0.7	0.02
Generator 02	GEN02	--	--	8.2	0.04	0.7	0.02
Fugitives [1]	FUGTV	--	--	3.9	0.02	0.3	0.01
PM_{10} Emissions							
Generator 01	GEN01	--	--	8.2	0.04	0.7	0.02
Generator 02	GEN02	--	--	8.2	0.04	0.7	0.02
Fugitives [1]	FUGTV	--	--	16.7	0.09	1.5	0.04
SO_2 Emissions							
Generator 01	GEN01	0.02	0.002	0.3	0.001	0.02	0.001
Generator 02	GEN02	0.02	0.002	0.3	0.001	0.02	0.001
Fugitives [1]	FUGTV	0.01	0.002	0.03	0.0002	0.003	0.0001

[1] Fugitives are emissions from mobile sources, un-paved roads, and drilling activities.
[2] On an annual basis, modeled emissions are adjusted to account for 180 days when the source is operating and 185 days when the source is not operating. Thus, the model is run for a period of 180 days (Oct. 1 - Mar 29) and the resultant model output is representative of impacts from the source on an annual basis.

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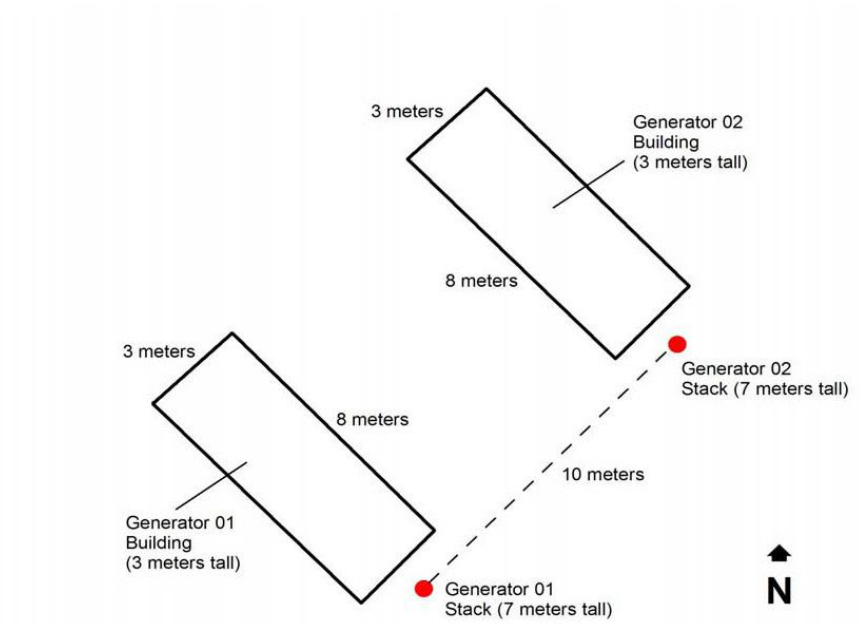
ENGINEERING CALCULATIONS	PROJECT NO: 243-1-1	PAGE: 2	OF: 4	SHEET: 2
	SUBJECT: Building Downwash	DATE: September 22, 2008		

BUILDING INFORMATION FOR BPIP ANALYSIS

Structure Name	Generator 01 Bldg.		Generator 02 Bldg.	
Height Above Ground *	3.0 m		3.0 m	
# Structure Corners	4		4	
Structure	**Coordinate**		**Coordinate**	
Corner #	X(m)	Y(m)	X(m)	Y(m)
1	432750.0	4197205.0	432757.1	4197212.1
2	432744.3	4197210.7	432751.4	4197217.7
3	432746.5	4197212.8	432753.5	4197219.9
4	432752.1	4197207.1	432759.2	4197214.2

* Base elevation for buildings and stacks is 2311.9 meters above sea level.

CONFIGURATION OF GENERATOR SOURCES



Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Tim Martin		
	PROJECT NO: 243-1-1	PAGE: 3	OF: 4	SHEET: 3
ENGINEERING CALCULATIONS	SUBJECT: Deposition Calculations	DATE: September 22, 2008		

NITROGEN AND SULFUR DEPOSITION CALCULATIONS - GREAT SAND DUNES NP CLASS I AREA

The U.S.D.A. Forest Service provides a screening methodology to calculate nitrogen and sulfur deposition (USDA, 2000).

Some models (e.g., AERMOD) may report all S outputs as SO_2 and all N outputs as NO_2.
In this case, the calculation below is used to estimate total (wet plus dry) deposition of S from SO_2 and N from NO_2.

Ds or Dn = (X)(Vd)(R)(DEP)(Fc), where:

Ds = sulfur deposition flux (kg/ha/yr)
Dn = nitrogen deposition flux (kg/ha/yr)
X = pollutant concentration (ug/m3)
Vd = deposition velocity of 0.005 m/sec for SO_2 or 0.05 m/sec for HNO_3 (ref. IWAQM Phase1)
R = Ratio of molecular weights of elements to convert from SO_2 to S and NO_2 to N (14/46 = .3 for NO_2; 32/64 = .5 for SO_2).
Molecular weight of H=1, N=14, O=16, S=32.
DEP = total deposition to dry deposition ratio (assume this equals 2.0 unless there is other info)
Fc = units conversion of ug/m3 x m/sec to kg/ha/yr (315.4)

Nitrogen Deposition Calculations

X = max. modeled NO_2 concentration (ug/m3)	0.045
Vd = deposition velocity (m/sec)	0.05
R = ratio of molecular weights of elements to convert from NO_2 to N (14/46 = .3 for NO_2)	0.3
DEP = total deposition to dry deposition ratio	2
Fc = units conversion of ug/m3 x m/sec to kg/ha/yr	315.4
Dn = nitrogen deposition flux (kg/ha/yr)	*0.4*
FLM Screening Threshold (kg/ha/yr)	3.0

Sulfur Deposition Calculations

X = max. modeled SO_2 concentration (ug/m3)	0.00005
Vd = deposition velocity (m/sec)	0.005
R = ratio of molecular weights of elements to convert from SO_2 to S (32/64 = .5 for SO_2)	0.5
DEP = total deposition to dry deposition ratio	2
Fc = units conversion of ug/m3 x m/sec to kg/ha/yr	315.4
Ds = sulfur deposition flux (kg/ha/yr)	*0.0001*
FLM Screening Threshold (kg/ha/yr)	3.0

Air Sciences Inc.	PROJECT TITLE: Lexam Baca Drilling Project	BY: Tim Martin		
ENGINEERING CALCULATIONS	PROJECT NO: 243-1-1	PAGE: 4	OF: 4	SHEET: 4
	SUBJECT: VISCREEN Model Inputs	DATE: September 24, 2008		

VISCREEN MODEL INPUT INFORMATION

Input emissions for [3]:	
Particulates	0.75 lb/hr
NOx (as NO_2)	23.62 lb/hr
Primary NO_2	0 lb/hr
Soot [1]	0.63 lb/hr
Primary SO_4	0 lb/hr

** Default Particle Characteristics Assumed

Transport Scenario Specifications:	
Background Ozone:	0.04 ppm
Background Visual Range [2]:	170 km
Source-Observer Distance:	16.1 km
Min. Source-Class I Distance:	16.1 km
Max. Source-Class I Distance:	31.6 km
Plume-Source-Observer Angle:	11.25 degrees
Stability:	6 (6 = F stability)
Wind Speed:	1.0 m/sec

[1] For diesel-burning sources, assume that 80% of particulate emissions are soot (carbon). *Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements*, Federal Register January 18, 2001 (Volume 66, Number 12).

[2] Background visual range value provided in Figure 9 EPA's *Workbook for Plume Visual Impact Screening and Analysis (Revised)*. Oct 1992. *Research Triangle Park, NC. EPA-454/R-92-023.*

[3] Emissions most representative of expected short-term operations (max. daily values adjusted to hourly values).

Appendix I

U.S. Geological Service Technical Review Memorandum to the U.S. Fish and Wildlife Service

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Fort Collins Science Center
2150 Centre Ave., Bldg.C
Fort Collins, Colorado 80526-8118

January 6, 2011

TO: Chris Swanson, Ph.D.
U.S. Fish and Wildlife Service
Kulm Wetland and Management District
Kulm, ND

FROM: Jessica M. Montag, Ph.D.
U.S. Geological Survey
Policy Analysis and Science Assistance Branch
Fort Collins Science Center
Fort Collins, CO

SUBJECT: Technical review of the social and economic components of Baca National Wildlife Refuge Environmental Assessment for planned oil and gas exploration

My technical review of the social and economic components of BACA National Wildlife Refuge Environmental Assessment for planned oil and gas exploration (BACA EA) focused both on the content included in identified social and economic components and whether additional social and economic components should be addressed. I based my review upon several social science and economic resources that provide guidance on suggested social and economic components to consider for management actions[1]. I also reviewed the U.S. Fish and Wildlife Service NEPA Reference Handbook with emphasis on the Environmental Impact Checklist for Social Concerns and the Environmental Impact Checklist for Economic Concerns. Additionally, I reviewed similar planned actions on Bureau of Land Management (BLM) lands to identify what social and economic components were addressed.

The proposed action of two exploratory wells within the BACA National Wildlife Refuge indicates the action would likely have little effects on the social and economic well-being of surrounding communities. Due to the temporary nature (4-6 months) and limited scope (only two exploratory wells, possibly up to 20 workers during timeframe) of the proposed action, the minimal potential effects on surrounding communities' populations, demographic characteristics, and emergency services such as medical, police, and fire are supported by the information provided. Additionally, although social well-being can be subjective, the proposed action minimally affecting any community member interactions, recreation related services, and public health or safety, again due to the temporary nature and limited scope, is also supported by the information provided. The potential effects on aesthetics/noise and transportation issues related to Saguache CR T, which from the scoping comments seem to be concerns to many community residents, I believe, are adequately addressed.

The BACA EA addresses the limited workforce needed and the temporary duration of drilling. The BACA EA conclusion of these having a minimal effect on local employment opportunities, community businesses, and local income is supported by the information provided.

To the best of my knowledge the social and economic components of the planned action in the BACA EA are adequately addressed. The aesthetics of the area, which appear to be of concern to public members, is addressed in the BACA EA. The social and economic components addressed in the BACA EA are quite similar to a BLM EA on two exploratory wells in Sweetwater County, WY[2]. The BLM is well versed in conducting environmental assessments for exploratory wells and as such, provides reference to potential social and economic components to address. I believe that the BACA EA has addressed the pertinent social and economic components effectively.

[1] Sources reviewed include the following:

Bureau of Land Management. 2004. BLM Social Science Guideline 1: Checklist for Socio-Economic Analysis in Resource Management Plans, Version 1.1.

Bright, A. D., H.K. Cordell, A.P. Hoover, and M.A. Tarrant. 2003. A Human Dimensions Framework: Guidelines for Conducting Social Assessments. USDA Forest Service, GTRSRS-65.

Burdge, R.J. 1994. *A Conceptual Approach to Social Impact Assessment, Revised Edition*. Middletown, WI: Social Ecology Press.

Community Impact Assessment. Community Impact Assessment: A Quick Reference for Transportation. www.ciatrans.net/CIA_Quick_Reference/Chapter1.html, accessed November 6, 2009.

Crone, L.K., P. Reed, and J. Schaefers. 2002. Social and Economic Assessment of the Chugach National Forest Area. USDA Forest Service, PNW-GTR-561, December.

Dani, A.A. (ed.). 2003. *Social Analysis Sourcebook.* World Bank, December.

Fitzsimmons, S.J., L.I. Stuart, and P.C. Wolff. 1977. *Social Assessment Manual: A Guide to the Preparation of the Social Well-Being Account for Planning Water Resource Projects*. Boulder, CO: Westview Press.

The Interorganizational Committee on Principles and Guidelines for Social Impact Assessment. 2003. Principles and Guidelines for Social Impact Assessment in the USA. *Impact Assessment and Project Appraisal*, 21(3): 231-250, September.

The Interorganizational Committee on Principles and Guidelines for Social Impact Assessment. 1994. Guidelines and Principles for Social Impact Assessment. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Marine Fisheries Service, May.

Millennium Ecosystem Assessment. 2003. *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, D.C.: Island Press.

Phillips, R. 2003. Community Indicators. American Planning Association, Planning Advisory Service, Report No. 517.

Redman, C. 1999. Human Dimensions of Ecosystem Studies. *Ecosystems,* 2: 296-298.

Seesholtz, D., D. Wickwar, and J.C. Russell. 2006. Social Economic Profile Technical Guide. USDA Forest Service, General Technical Report WO-74, September.

USDA Forest Service. 2002. Monitoring for Forest Management Unit Scale Sustainability: The Local Unit Criteria and Indicators Development (LUCID) Test, Management Edition. *Inventory and Monitoring Institute,* Report No. 5.

USDA Soil Conservation Service. 1984. National Social Sciences Manual, 420-V, Issue 1.

U.S. Department of the Interior. 2001. Social Analysis Manual, Volume 1: Manager's Guide to Using Social Analysis. Bureau of Reclamation Technical Service Center.

U.S. Department of the Interior. 2001. Social Analysis Manual, Volume 2: Social Analyst's Guide to Doing Social Analysis. Bureau of Reclamation Technical Service Center.

[2] Bureau of Land Management, Rock Springs Field Office, 2008. Environmental Assessment Baxter Natural Gas Exploratory Proposal, Sweetwater County, WY: #WYW040EA08171.

Appendix J

U.S. Fish and Wildlife Service and Saguache County Cooperator Agreement

MEMORANDUM OF UNDERSTANDING

Between the
U.S. DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
and
SAGUACHE COUNTY
BOARD OF COUNTY COMMISSIONERS

Concerning
Agency Cooperation on the Environmental Assessment of Proposed Gas and Oil Exploration, Baca National Wildlife Refuge, Colorado

I. INTRODUCTION

The Fish and Wildlife Service (Service) requests the Saguache County, Board of County Commissioners (County) to be a Cooperating Agency in the development of the Environmental Assessment (EA) of Proposed Gas and Oil Exploration for Baca National Wildlife Refuge.

The EA must comply with the provisions of the National Environmental Policy Act of 1969 (NEPA) 42 U.S.C. Sec. 4321 and all subsequent regulations implementing the act (see Council on Environmental Quality (CEQ)) regulations, 40 CFR Part 1500-1508, and Department of the Interior requirements listed in Department Manual 516 "Environmental Quality."). The Service also considered the *Memorandum for the Heads of Federal Agencies, Subject: Cooperating Agencies in Implementing the Procedural Requirements of the National Environmental Policy Act,* James Connaughton, January 30, 2002 and *Memorandum for Heads of Federal Agencies, Subject: Designation of Non-Federal Agencies to be Cooperating Agencies in Implementing the Procedural Requirements of the National Environmental Policy Act,* George T. Frampton, Council on Environmental Quality, July 28, 1999 and Executive Order 13352, August 26, 2004, Facilitation of Cooperative Conservation.

II. PURPOSE OF AGREEMENT

The purpose of this Memorandum of Understanding (MOU) is to establish an agreement between the Service and the County regarding the roles and responsibilities of the agencies during the NEPA process. The Service will be the lead federal agency and the County will be the cooperating agency on the project.

The intent of this agreement is to provide to the County a draft Environmental Assessment (EA) of Lexam Exploration Incorporated's oil and gas exploration proposal as soon as possible.

The County and the Service understand that preparation of this EA is result of a settlement reached between the plaintiffs, the intervener and the Service in September, 2010. The agreement set a very rigorous schedule for completion of a draft (January 7,

2011) and final EA (April 1, 2011). The Service envisions needing most of the time between the date this agreement is signed and January 7, 2011 to produce a draft document that can be reviewed by the County.

In this agreement the Service is committing to provide the County a draft EA as soon as physically possible to enable the County to provide the most meaningful comments possible given the accelerated schedule of EA development and the county's unique role in oil and gas exploration.

III. JUSTIFICATION AND ROLE OF COOPERATING AGENCY

A. Justification for Cooperating Agency Status

1. The County is appointed as a cooperating agency because the County has information and expertise that will assist in the preparation of the EA and associated operating plans, pertaining to:

- Transportation
- Land Use Planning and Regulations
- Emergency Services preparedness and response
- Reclamation practices
- Maintaining consistent minimum standards in protecting the health, safety and welfare of the citizens and environment throughout Saguache County, as pertains to Oil & Gas development

2. The County agrees to provide information or data within their area(s) of expertise, attend planning team meetings, and review and comment on documents. Cooperating Agency status comes with an expectation that the Cooperating Agency will bring resources to the table to facilitate the timely completion of the NEPA process.

3. The County will perform all tasks outlined in this MOU at their own expense.

4. The County agrees to assist the Service in providing accurate information to the public. The EA planning process for the refuge is intended to be transparent with all agencies, organizations, stakeholder groups and the general public. The Service regularly provides information about its planning process through planning updates, press releases, briefings, hard copies of documents, and posting documents on its website. All written information presented to the public must be approved for publication by the Service. Any release of predecisional information (including working drafts) in a manner that undermines or circumvents this MOU or consistently misrepresents the planning process may be grounds to terminate the cooperating agency status.

B. County as Cooperating Agency

1. The County provides data, expertise and other benefits to the Service as it completes the NEPA process regarding oil and gas development in Saguache County.

2. The County shall assign a representative to speak on the county's behalf. It is the responsibility of the assigned representatives to keep the Board of County Commissioners briefed on the key developments of the EA. To ensure consistency in communications, the same representatives shall serve for the duration of the project if at all possible.

C. Roles and Responsibilities

1. The County understands that their cooperating agency status does not confer to them any special authority to change, edit, or veto all or part of the document.

2. In cases where the County provides information it considers confidential, the Service will work with a County to present the information in a manner that protects the rights of the County before further sharing the information necessary for the environmental analysis. The Service agrees not to distribute information the County considers confidential.

The County will have access to all information necessary for its participation in the environmental analysis to the extent permitted by applicable law and preparation schedule. The County agrees that all records or information requested of any party shall remain the property of the releasing party for public record disclosure purposes and will not be disclosed, transmitted, or otherwise divulged until the Service issues its final NEPA decision document. Any breach of this provision may result in termination of this MOU.

3. The Service possesses sole authority to direct the actions of its Contractors.

4. The Service is responsible for all substantive decisions involving the EA and is the final decision maker for disputes that may arise in the process. The County agrees that, once such disputes are resolved, they will not be revisited unless the Service agrees that new information warrants reconsideration. However, the County retains the right to comment on all issues related to the EA, including those in dispute, through the normal NEPA process.

5. Veto or decision-making power does not accompany cooperating agency status. As. the lead agency charged with carrying out the NEPA process under Section 102(2)(c) of NEPA, the Service retains sole decision-making authority over the EA and its process.

6. The Service may terminate this agreement at any time by providing written notice of the termination to the other parties.

IV. AUTHORITY

This memorandum is entered into under the following authorities:

A. National Environmental Policy Act of 1969, as amended, PL 91-190, 42 U.S.C. 4321

B. Council of Environmental Quality NEPA Regulations (40 CFR Parts 1500-1508)

C. National Wildlife Refuge System Administration Act of 1966, as amended (16USC 668dd et seq.) The act formally defines the mission of the Refuge System as the administration of *"a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitat within the United States for the benefit of present and future generations of Americans" (16 USC 668dd(a)(2)).*

V. PROCESS AND PROCEDURE

A. The Service is the lead agency for ensuring full compliance of the document with the requirements of NEPA. Under applicable laws, rules, regulations, orders, and policies, the Service shall ensure that all necessary consultation and consideration is performed with all Federal, State, Local, and Tribal governments and private organizations.

B. The Service has full responsibility for implementing procedures and regulations including, but not limited to public review of the EA, public distribution of the EA, and required decision documentation.

C. The Service will provide the County with opportunities to review and comment on the Draft EA. The County will provide comments to the Service within the overall time schedule. Both the Service and County realize the draft must be completed by January 7, 2011. Due to this short deadline the Service will provide the County a draft document as soon as possible before that date.

D. The primary designated points of contacts for the Service shall be Michael Blenden, Project Leader for the San Luis Valley National Wildlife Refuge Complex which includes the Baca National Wildlife Refuge.

E. The County shall provide responses for data requests and provide review comments to the Service.

F. The Service will document all meetings, emails, and phone conversations for inclusion in the Administrative Record for the EA. The County shall provide outside correspondence or phone conversations regarding the EA that are of a substantive nature to the Service in a timely manner for inclusion into the Administrative Record.

G.. The Service will have primary responsibility for writing and rewriting all sections, parts, or chapters of the EA and for reestablishing a schedule for completion of chapters consistent with the overall time schedule.

H. The Service will be the recipient of all comments on the EA resulting from the review and comment period.

VI. ADMINISTRATION

A. Modifications to this MOU may be proposed by the County and shall become effective upon the written approval of both parties. Changes to this MOU must be initialed and dated on each replacement page by an authorized agent of each party.

B. Any party may withdraw from this MOU after 30 days written notice of their intention to do so to the other parties.

C. Nothing in this agreement will be construed as limiting or affecting in any way the authority or responsibility of the Service or the County to perform within their authority. This MOU will become effective upon the signature of all of its participants.

Approved

Michael Blenden, Project Leader,
San Luis Valley National Wildlife Refuge Complex — Date: 1/4/2010

Sam Pace, Chairman
Saguache County — Date: 12-14-10