BLM

FES 08-32

Proposed Oil Shale and Tar Sands Resource Management Plan Amendments to Address Land Use Allocations in Colorado, Utah, and Wyoming and Final Programmatic Environmental Impact Statement

Volume 2: Chapters 5 & 6

September 2008

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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U.S. Department of the Interior
Bureau of Land Management

September 2008

MISSION STATEMENT

It is the mission of the Bureau of Land Management (BLM), an agency of the Department of the Interior, to manage BLM-administered lands and resources in a manner that best serves the needs of the American people. Management is based upon the principles of multiple use and sustained yield taking into account the long-term needs of future generations for renewable and nonrenewable resources.

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DOCUMENT CONTENTS

VOLUME 1

VOLUME 2

VOLUME 3

VOLUME 4

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VOLUME 2 CONTENTS

CONTENTS (Cont.)

CONTENTS (Cont.)

CONTENTS (Cont.)

CONTENTS (Cont.)

CONTENTS (Cont.)

FIGURES

FIGURES (Cont.)

FIGURES (Cont.)

FIGURES (Cont.)

FIGURES (Cont.)

TABLES

TABLES (Cont.)

TABLES (Cont.)

TABLES (Cont.)

TABLES (Cont.)

TABLES (Cont.)

TABLES (Cont.)

NOTATION

The following is a list of acronyms and abbreviations, chemical names, and units of measure used in this document. Some acronyms used only in tables may be defined only in those tables.

GENERAL ACRONYMS AND ABBREVIATIONS

ACEC	Area of Critical Environmental Concern
AGFD	Arizona Game and Fish Department
AGR	aboveground retort
ANFO	ammonium nitrate and fuel oil
API	American Petroleum Institute
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
AQRV	air quality related value
ARCO	Atlantic Richfield Company
ATP	Alberta Taciuk Process
ATSDR	Agency for Toxic Substances and Disease Registry
AWEA	American Wind Energy Association
BA	biological assessment
BCD	barrels per calendar day
BLM	Bureau of Land Management
BMP	best management practice
BO	biological opinion
BOR	U.S. Bureau of Reclamation
BPA	Bonneville Power Administration
BSD	barrels per stream day
CAA	Clean Air Act
CAPP	Canadian Association of Petroleum Producers
CARB	California Air Resources Board
CASTNET	Clean Air Status and Trends NETwork
CBOSC	Cathedral Bluffs Oil Shale Company
CCW	coal combustion waste
CDC	Centers for Disease Control and Prevention
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDW	Colorado Division of Wildlife
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CHL	combined hydrocarbon lease

CIRA	Cooperative Institute for Research in the Atmosphere
CPC	Center for Plant Conservation
CRBSCF	Colorado River Basin Salinity Control Forum
CRSCP	Colorado River Salinity Control Program
CSS	cyclic steam stimulation
CSU	Controlled Surface Use
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
EA	environmental assessment
EGL	EGL Resources, Inc.
EIA	Energy Information Administration
E-ICP	bare electrode in situ conversion process
EIS	environmental impact statement
EMF	electric and magnetic field
E.O.	Executive Order
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act of 1973
EUB	Alberta Energy and Utilities Board
FLPMA	Federal Land Policy and Management Act of 1976
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FTE	full-time equivalent
FY	fiscal year
GCR	gas combustion retort
GHG	greenhouse gas
GIS	geographic information system
GSENM	Grand Staircase–Escalante National Monument
HAP	hazardous air pollutant
HAZCOM	hazard communication
HMA	Herd Management Area
HMMH	Harris Miller Miller & Hanson, Inc.
I-70	Interstate 70

IARC	International Agency for Research on Cancer
ICP	in situ conversion process
IEC	International Electrochemical Commission
IPPC	Intergovernmental Panel on Climate Change
ISA	Instant Study Area
ISWS	Illinois State Water Survey
IUCNNR	International Union for Conservation of Nature and Natural Resources
JMH CAP	Jack Morrow Hills Coordinated Activity Plan
KOP	key observation point
KSLA	Known Sodium Leasing Area
LAU	Lynx Analysis Unit
LETC	Laramie Energy Technology Center
LPG	liquefied petroleum gas
L_{dn}	day-night average sound level
L_{eq}	equivalent sound pressure level
M&I	municipal and industrial
MFP	Management Framework Plan
MIS	modified in situ recovery
MLA	Mineral Leasing Act
MMC	Multi Minerals Corporation
MMTA	Mechanically Mineable Trona Area
MOU	Memorandum of Understanding
MPCA	Minnesota Pollution Control Agency
MSHA	Mine Safety and Health Administration
MSL	mean sea level
MTR	military training route
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAGPRA	Native American Graves Protection and Repatriation Act
NCA	National Conservation Area
NCDC	National Climate Data Center
NEC	National Electric Code
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966
NLCS	National Landscape Conservation System
NMFS	National Marine Fisheries Service
NNHP	Nevada Natural Heritage Program
NOI	Notice of Intent
NORM	naturally occurring radioactive materials
NOSR	Naval Oil Shale Reserves
NPDES	National Pollutant Discharge Elimination System

NPS	National Park Service
NRA	National Recreation Area
NRHP	*National Register of Historic Places*
NSC	National Safety Council
NSO	No Surface Occupancy
NWCC	National Wind Coordinating Committee
OHV	off-highway vehicle
OOSI	Occidental Oil Shale, Inc.
OPEC	Organization of Petroleum Exporting Countries
OSEC	Oil Shale Exploration Company
OSEW/SPP	Oil Sands Expert Workgroup/Security and Prosperity Partnership
OSHA	Occupational Safety and Health Administration
OTA	Office of Technology Assessment
PA	Programmatic Agreement
PADD	Petroleum Administration for Defense District
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEIS	programmatic environmental impact statement
PFYC	Potential Fossil Yield Classification
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 μm or less
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 μm or less
PPE	personal protective equipment
PRLA	preference right lease area
PSD	Prevention of Significant Deterioration
R&I	relevance and importance
RBOSC	Rio Blanco Oil Shale Company
RCRA	Resource Conservation and Recovery Act of 1976
RD&D	research, development, and demonstration
RF	radio frequency
RFDS	reasonably foreseeable development scenario
RMP	Resource Management Plan
ROD	Record of Decision
ROI	region of influence
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
SAGD	steam-assisted gravity drainage
SAMHSA	Substance Abuse and Mental Health Services Administration
SDWA	Safe Drinking Water Act of 1974
SFC	Synthetic Fuels Corporation
SHPO	State Historic Preservation Office(r)

SIP	State Implementation Plan
SMA	Special Management Area
SMP	suggested management practice
SPR	Strategic Petroleum Reserve
SRMA	Special Recreation Management Area
SSI	self-supplied industry
STSA	Special Tar Sand Area
SWCA	SWCA, Inc., Environmental Consultants
SWPPP	Stormwater Pollution Prevention Plan
SWWRC	Sates West Water Resources Corporation
TDS	total dissolved solids
THAI	toe to head air injection
TIS	true in situ recovery
TMDL	Total Maximum Daily Load
TOSCO	The Oil Shale Corporation
TSCA	Toxic Substances Control Act of 1976
TSDF	treatment, storage, and disposal facility
UDEQ	Utah Department of Environmental Quality
UDNR	Utah Department of Natural Resources
UDWR	Utah Division of Wildlife Resources
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USC	*United States Code*
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCRS	Visual Contrast Rating System
VOC	volatile organic compound
VRI	visual resource inventory
VRM	Visual Resource Management
WCA	areas recognized as having wilderness characteristics
WDEQ	Wyoming Department of Environmental Quality
WGFD	Wyoming Game and Fish Department
WRAP	Western Regional Air Partnership
WRCC	Western Regional Climate Center
WRSOC	White River Shale Oil Corporation
WSA	Wilderness Study Area
WSR	Wild and Scenic River
WTGS	wind turbine generator system
WYCRO	Wyoming Cultural Records Office

CHEMICALS

CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
H_2S	hydrogen sulfide
NH_3	ammonia
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
SO_2	sulfur dioxide
SO_x	sulfur oxides

UNITS OF MEASURE

ac-ft	acre foot (feet)
bbl	barrel(s)
Btu	British thermal unit(s)
°C	degree(s) Celsius
cfs	cubic foot (feet) per second
cm	centimeter(s)
dB	decibel(s)
dBA	A-weighted decibel(s)
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^3	cubic foot (feet)
g	gram(s)
gal	gallon(s)
GJ	gigajoule(s)
gpd	gallon(s) per day
gpm	gallon(s) per minute
GW	gigawatt(s)
GWh	gigawatt hour(s)
h	hour(s)
ha	hectare(s)
Hz	hertz
in.	inch(es)
K	degree(s) Kelvin
kcal	kilocalorie(s)
kg	kilogram(s)
km	kilometer(s)
kPa	kilopascal(s)
kV	kilovolt(s)
kWh	kilowatt-hour(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
mm	millimeter(s)
MMBtu	thousand Btu
mph	mile(s) per hour
MW	megawatt(s)
ppm	part(s) per million
psi	pound(s) per square inch
rpm	rotation(s) per minute
s	second(s)
scf	standard cubic foot (feet)
yd^2	square yard(s)
yd^3	cubic yard(s)
yr	year(s)
μm	micrometer(s)

ENGLISH/METRIC AND METRIC/ENGLISH EQUIVALENTS[a]

The following table lists the appropriate equivalents for English and metric units.

Multiply	By	To Obtain
English/Metric Equivalents		
acres	*0.4047*	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
degrees Fahrenheit (ºF) –32	0.5555	degrees Celsius (ºC)
Feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m^3)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
miles per hour (mph)	1.609	kilometers per hour (kph)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
short tons (tons)	0.9072	metric tons (t)
square feet (ft^2)	0.09290	square meters (m^2)
square yards (yd^2)	0.8361	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
yards (yd)	0.9144	meters (m)
Metric/English Equivalents		
centimeters (cm)	0.3937	inches (in.)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
cubic meters (m^3)	264.2	gallons (gal)
degrees Celsius (ºC) +17.78	1.8	degrees Fahrenheit (ºF)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
kilometers per hour (kph)	0.6214	miles per hour (mph)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
meters (m)	1.094	yards (yd)
metric tons (t)	1.102	short tons (tons)
square kilometers (km^2)	0.3861	square miles (mi^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)

[a] In general in this PEIS, only English units are presented. However, where reference sources provided both English and metric units, both values are presented in the order in which they are given in the source.

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5 EFFECTS OF TAR SANDS TECHNOLOGIES

In the NOI announcing the preparation of this PEIS (70 FR 73791–73792), the BLM indicated its intent to amend land use plans to allow for leasing of oil shale and tar sands resources in Colorado, Utah, and Wyoming. Through a public scoping process, the BLM solicited comments on the proposed PEIS and undertook additional analysis and consultation as part of the PEIS process. After preparation and analysis of an internal draft PEIS and discussion with its cooperating agencies, the BLM elected not to issue leases for development of tar sands on the basis of this PEIS. For tar sands, rather than amending plans to support immediate issuance of leases for commercial development of these resources without further NEPA analysis, the BLM proposes to amend land use plans to (1) identify lands within the designated STSAs that will be open to commercial leasing, exploration, and development; (2) stipulate requirements for future NEPA analyses and consultation activities; and (3) specify that the BLM will consider and give priority to the use of land exchanges to facilitate commercial tar sands development pursuant to Section 369(n) of the Energy Policy Act of 2005. Specific land use plan amendments are provided in Appendix C. (See Chapter 4 for the discussion of oil shale resources.) In the case of both oil shale and tar sands, additional NEPA analysis will be conducted prior to the issuance of leases.

Although the proposal analyzed in this PEIS has now shifted away from supporting issuance of commercial leases of oil shale and tar sands resources, substantial information was identified regarding current and emerging development technologies that will still be useful for decision makers and the public with respect to the proposal to amend the land use plans. This chapter of this PEIS contains summary information on tar sands technologies and their potential environmental and socioeconomic impacts. Some of the information on the environmental consequences of tar sands development in this chapter was based on past tar sands development efforts. For the purposes of analysis, in the absence of more specific information on the tar sands technologies to be implemented in the future and the environmental consequences of implementing those technologies, information derived from other types of mineral development (oil and gas, and underground and surface mining of coal) were used in preparing this chapter. The BLM has taken this approach because it anticipates, to the best of its knowledge, that the surface-disturbing activities involved with these other types of mineral development are comparable to those that may result from oil shale and tar sands development. There is a wealth of information concerning the consequences of oil and gas and underground and surface mining activities, and formulating projections on the basis of this information, to the extent that it is applicable, permits a decision maker to decide whether to open areas to future application for leasing or to protect the specific resources by closing areas.

This chapter also includes a brief description of mitigation measures that the BLM may consider using if warranted by the results of NEPA analysis undertaken prior to issuance of site-specific tar sands commercial leases and/or approval of detailed plans of development. Use of the mitigation measures will be evaluated at that time.

It is important to understand that information on the technologies presented here is provided for the purpose of general understanding and does not necessarily define the range of possible technologies and issues that may develop in the coming years. Prior to approval of future commercial leases, additional NEPA analyses would be completed that would consider site- and project-specific factors for proposed development activities. The magnitude of impacts and the applicability and effectiveness of the mitigation measures would need to be evaluated on a project-by-project basis in consideration of site-specific factors (e.g., existing land use, presence of paleontological and cultural resources, proximity to surface water, groundwater conditions, existing ecological resources, and proximity to visual resources) and project-specific factors (e.g., which technologies would be used, magnitude of operations, water consumption and wastewater generation, air emissions, number of employees, and development time lines).

5.1 ASSUMPTIONS AND IMPACT-PRODUCING FACTORS FOR INDIVIDUAL FACILITIES BY COMMERCIAL TAR SANDS TECHNOLOGY

Although no tar sands development is currently taking place on public lands in Utah, for the purposes of analysis in this PEIS, it is assumed that development is possible in any of the 11 STSAs listed in Table 2.3-1. This section summarizes some of the assumptions and potential impact-producing factors related to the different commercial tar sands technologies being considered, as well as the potential impacts associated with establishing transmission line and crude oil pipeline ROWs and building employer-provided housing. Impact-producing factors are defined as activities or processes that cause impacts on the environmental or socioeconomic setting, such as surface disturbance, water use, numbers of employees hired, and generation of solid and liquid waste. Specifically, this section identifies the data used and assumptions made to define potential impact-producing factors for hypothetical tar sands development facilities. The information presented here is summarized, in part, from more detailed discussions contained in Appendix B (the tar sands development background and technology overview), as well as previous environmental documents. In those instances where specific data are not available to define a potential impact-producing factor, best professional judgments have been made to establish reasonable assumptions. Discussions relating to air emissions are not included in this section but instead are presented in Section 5.6.

The technologies considered in this PEIS for tar sands development include surface mines with surface retorts or solvent extraction, and in situ facilities using steam injection or combustion. The application of underground mining technologies for commercial tar sands development was not considered because, at this time, they do not appear to be commercially viable. Available information on impact-producing factors that would be applicable to Utah tar sands development is very limited. Many of the assumptions used to estimate tar sands development impacts in this PEIS are based on published information for a proposed 20,000-bbl/day-capacity plant designed for recovery of oil from a diatomaceous earth tar sands deposit in California (Daniels et al. 1981), or on the Utah Combined Hydrocarbon Leasing Regional Final EIS (BLM 1984).[1] In general, the information provided in Sections 5.1 and 5.2 is based on an assumed production rate of 20,000 bbl/day. However, values for some variables

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1 Although more recent data exist from tar sands development ongoing in Canada, those data are not applicable to Utah tar sands because of the different chemical characteristics of the tar sands (i.e., the Canadian tar sands have an aqueous layer between the sand and the bitumen, making separation easier).

(e.g., acres disturbed, water use, and employment levels) were not considered to have a direct linear relationship to production levels. Alternate assumptions for these variables are discussed, where applicable, in Sections 5.1.1 and 5.1.2. Also, for purposes of analysis, this assessment looks at the potential impacts from a single facility, although the actual level of development that could occur in the future is not known. Subsequent NEPA analysis will occur both prior to leasing and to approval of plans of development when more information on specific technologies and production levels is available.

All applicable federal, state, and local regulatory requirements will be met (see Section 2.2 and Appendix D of the PEIS), and the effects of these requirements are included in the analysis of impacts. Within the following text, specific assumptions that have been made for each technology, or major activity that could occur during commercial operations have been identified. In most instances, these assumptions represent good engineering practice or reflect the BLM's understanding of design or performance limitations of various tar sands development activities. In those instances where various options have equal standing as practicable within the industry, the option offering the greatest potential environmental impacts was selected so as not to inadvertently understate these impacts.

5.1.1 Surface Mine with Surface Retort or Solvent Extraction Projects

The information presented in Table 5.1.1-1 identifies the key assumptions associated with surface mining with surface retorting or solvent extraction of tar sands for a facility sized to support production levels of 20,000 bbl/day of oil. These data may be used to extrapolate assumptions for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. The mine area and spent tar sands disposal areas would be reclaimed on an ongoing basis. Spent tar sands may be disposed of by being returned to the mine as operations would permit; there also would be some spent tar sands disposal on other parts of the lease area. The amount of land used for spent tar sands disposal would vary from project to project but is expected to be encompassed within the estimated development area identified in Table 5.1.1-1.

Water sources for tar sands surface mine facilities would be varied but may include a combination of groundwater, surface water, and treated process water. Groundwater pumped from the mine or from dewatering wells would be of variable quality; the higher quality water would most likely be used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Assumptions regarding surface mining, surface retorts, spent tar sands from surface retorting, and upgrading activities associated with surface retorting include the following.

TABLE 5.1.1-1 Assumptions Associated with a Surface Mine with Surface Retort or with Solvent Extraction for Production Levels of 20,000 bbl/day of Syncrude[a,b]

Impact-Producing Factor	Value Used in Impact Analyses
Footprint of development area (acres)[c]	2,950
Surface disturbance (acres)[c]	5,760
Water use for mining (bbl/day)[d]	25,000
Water use for retort (bbl/day)[d]	12,000
Water use for solvent extraction (bbl/day)[d]	107,000
Water use for upgrading (bbl/day)[d]	386,000
Noise at mine site (dBA at 500 ft)	61[e]
Noise at retort, solvent extraction, or upgrading sites (dBA at 500 ft)	73–88
Spent (processed) sand (tons/day)	52,000
Direct employment for surface mining	
Construction	1,200
Operations	480
Total employment[f]	
Mine and retort/extraction facility construction	1,800
Mine and retort/extraction facility operations	750

[a] Values based on a 20,000-bbl/day facility using a diatomaceous earth deposit (see Appendix B; Daniels et al. 1981), unless otherwise noted.

[b] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[c] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. The assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[d] See Appendix B for sources for water use values. Approximately 3.5% of the process water used for mining, 100% of that used for a retort, and 22% of that used for solvent extraction would need to be fresh water (Daniels et al. 1981)

[e] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[f] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

Surface Mining

- Surface mining would occur only in areas where the overburden thickness is equal to or less than the thickness of the mined tar sands.

- Topsoil and subsoil removed as overburden would be separately stockpiled and vegetated to mitigate or eliminate erosion.

- When mine site dewatering is necessary, recovered water would be used for fugitive dust control, moisturizing spent tar sands, and other nonconsumptive uses, to the extent allowable given water quality considerations.

- Explosives would be used in the mining process to remove overburden and fracture the tar sands.

- Raw tar sands would be loaded by shovel into trucks for delivery to the crusher that would be adjacent to the retort and would feed the retort by conveyor belt.

- Strip mine development would provide for disposal of spent tar sands in previously mined areas of the mine, to the extent that the disposal can be accommodated by available capacity.

- Reclamation would be conducted contemporaneously with mining activities.

Surface Retorts

- In the absence of additional data, it is assumed the emissions from the surface retorts would be consistent with those from the Lurgi-Ruhrgas retort (see Appendix B).

- Surface retorts would be operated continuously for maximum energy efficiency, and mining and other processing activities that support the retorts would be scaled to provide a relatively constant supply of material to allow the retort to operate continuously at its rated capacity; multiple, simultaneous mining and crushing operations may therefore be required.

- Retorts would be positioned at or near the mine entrance, and tar sands would be delivered by truck to the crushing operation that would be adjacent to the retort and feed the retort by conveyor.

- Primary and secondary crushing would take place adjacent to the retort.

- Flammable gases from retorting would be captured, filtered to remove suspended solids, dewatered, and consumed on-site as supplemental fuel in external combustion devices.

- Condensable liquids would be filtered, dewatered, and delivered to the adjacent upgrading facility.

- Indirect heat sources for surface retort would be provided by external combustion sources fueled by natural gas delivered to the site by pipeline, propane stored in pressure tanks on-site, or diesel fuel provided by commercial suppliers and stored in on-site aboveground tanks. Each commercial fuel source would be supplemented by combustible gases recovered from the retort.

- Fuel for direct-burn surface retorts would be provided by natural gas, propane, or diesel fuel, each of which would be delivered to the site and stored as noted above and supplemented by combustible gases recovered from the retort.

Upgrading Activities Associated with Surface Retorting

- All bitumen recovered from the tar sands facilities would require some degree of upgrading.

- At a minimum, upgrading would consist of:

  – Dewatering;
  – Filtering of suspended solids;
  – Conversion of sulfur-bearing molecules to H_2S;
  – Removal of H_2S and conversion to elemental sulfur by the use of a conventional Claus process or equivalent;
  – Conversion of nitrogen-bearing compounds to ammonia, recovery of ammonia gas, and temporary storage and sale of ammonia gas as fertilizer feedstock; and
  – Hydrogenation or hydrocracking of organic liquids only to the extent necessary to sufficiently change physical properties (API gravity, pour point) of the resulting syncrude to allow for conveyance from the mine site by conventional means (tanker truck and/or pipeline).

- Hydrogen used in upgrading would be supplied by a commercial vendor and stored temporarily in transport trailers (high-pressure tube trailers) before use in upgrading reactions; no long-term storage of hydrogen would take place on-site; no steam reforming of methane to produce hydrogen would be conducted on-site.

- Fuel for upgrading activities would be commercial natural gas, propane, or diesel, augmented to the greatest extent practical by flammable gases recovered from upgrading activities.

- Water for upgrading would be recovered from surface water bodies (including on-site stormwater retention ponds), mine dewatering operations, or on-site groundwater wells.

- Treatment of wastewaters from upgrading activities would occur on-site; water recycling would be practiced to the greatest extent practical.

Solvent Extraction

- Solvent extraction would occur after tar sands were recovered from a surface mine.

- Solvent extraction facilities would be located near the upgrading operations and could be at some distance from the surface mine.

- Preparation of mined sand, such as crushing or screening, would occur adjacent to the solvent extraction facility.

- Since the temperatures involved are not high (212ºF [100ºC] or less), solvent extraction units would not need to operate continuously but could do so to support upgrading operations.

- Solvent would be recycled after separation from the bitumen.

- Although other processes could be used, solvent recovery would be accomplished by steam stripping and evaporation followed by decanting to separate solvent from water.

- Solvent would be stored on-site in aboveground storage tanks.

- Makeup solvent would be delivered to the site by commercial suppliers in tanker trucks.

- In addition to recovery of the dissolved bitumen, recycling would require, at a minimum:

  – Dewatering, particularly if hot or cold water solvent extraction were used (however, in some processes, some of the solvent/water mixture can be recycled without complete dewatering);
  – Removal of spent sand and suspended solids; and
  – Removal of any dissolved gases.

- Process heat and steam would be provided by external combustion sources fueled by natural gas delivered by pipeline, propane stored in pressurized tanks on-site, and/or diesel fuel stored on-site in aboveground tanks and delivered by commercial suppliers.

- Upgrading of the recovered bitumen would be required.

5.1.2 In Situ Facilities with Steam Injection or Combustion

The information presented in Table 5.1.2-1 identifies the key assumptions associated with in situ steam injection or combustion projects sized to support production levels of 20,000 bbl/day. These data may be used to extrapolate impacting factors for facilities with higher production levels (see Appendix B). Development is assumed to occur with a rolling footprint so that, at any given time, portions of the lease area would be (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; and (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots.

TABLE 5.1.2-1 Assumptions Associated with In Situ Facilities with Steam Injection or Combustion for Production Levels of 20,000 bbl/day of Syncrude[a]

Impact-Producing Factor	Value Used in Impact Analyses
Footprint of development area (acres)[b]	80–200
Surface disturbance (acres)[b]	5,760
Water use for steam injection (bbl/day)[c]	100,000
Water generated through combustion (bbl/day)[c]	40,000
Water use for upgrading (bbl/day)[c]	386,000
Noise at upgrading site (dBA at 500 ft)[d]	73–88
Direct employment for in situ	
Construction	1,200
Operations	480
Total employment[e]	
Steam injection or combustion facility construction	1,830
Steam injection or combustion facility operations	750

[a] bbl = barrel; 1 bbl syncrude = 42 gal, 1 bbl water = 55 gal.

[b] These acreages represent the assumed area of surface disturbance that could occur at any given time during the life of the project once commercial production levels are reached. Development is expected to occur with a rolling footprint so that, ultimately, the entire lease area would be developed and then restored. Assumed lease area of 5,760 acres is based on provisions of the MLA as revised by Section 369(j) of the Energy Policy Act of 2005.

[c] See Appendix B for sources for water use values. For steam injection, they are based on an estimated 5 bbl of water use per bbl of syncrude produced; for combustion, the basis is 1 to 2 bbl of wastewater produced per bbl of syncrude. For upgrading, the water use represents evaporative losses from the coker unit.

[d] Noise level for a 20,000-bbl/day facility is from Daniels et al. (1981).

[e] The total employment values include both direct and indirect jobs. The values are based on average data for both a surface mine and an in situ facility (BLM 1984). The methodology is discussed in Appendix G.

Water for tar sands facilities using in situ production would come from wells, surface sources, and treated process water. Groundwater and process water would be of variable quality, with the higher-quality water being used for industrial processes, dust control, and revegetation. Water of lower quality would be reinjected or otherwise disposed of pursuant to state requirements.

Additional assumptions regarding in situ combustion or steam injection include the following:

- Some degree of upgrading of the bitumen can be expected to occur within the formation, before product recovery occurs.

- Upgrading of recovered products would be required and is likely to include:

  - Dewatering;
  - Gas/liquid separations;
  - Filtering of suspended solids from both gaseous and liquid fractions;
  - Removal of H_2S gas, treatment to elemental sulfur, temporary on-site storage, and sale;
  - Removal of ammonia gas, temporary on-site storage, and sale as fertilizer feedstock;
  - Hydrogenation/hydrotreating/hydrocracking performed on condensable liquids only if necessary to adjust API gravity and viscosity to allow for transport by conventional means (tanker truck transport and/or pipeline) to a conventional petroleum refinery;
  - Temporary storage of recovered and/or upgraded liquid products on-site in aboveground tanks before delivery to market or conventional petroleum refineries by tanker truck or pipeline; and
  - Dewatering of 100% of flammable gases recovered from the formation, then filtering of suspended solids, and consumption on-site as supplemental fuel in external combustion sources.

5.1.3 Transmission Line and Crude Oil Pipeline ROWs

Tar sands projects (except those at the Tar Sand Triangle STSA) would need to connect to the existing transmission grid (or to new regional transmission lines) to obtain electricity. The maximum distance from an existing 500-kV transmission line to any of the STSAs is approximately 140 mi. The maximum distance from an existing 230-kV transmission line to any of the STSAs is approximately 80 mi. The greater distance of 140 mi has been assumed for all hypothetical tar sands projects, although some projects would be located at shorter distances from existing transmission lines. Project economics would likely select for sites closest to existing infrastructure.

For the purposes of analyses, it is assumed that one connecting transmission line and ROW would serve any tar sands project and would be 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide (equivalent to a disturbed area of 1,700 acres during operations and 2,500 acres during construction). The 140-mi distance assumption and 100-ft ROW size represent probable maximum sizes. Power needs at the Tar Sand Triangle STSA would be expected to be met by on-site power generation because the remote location of this STSA would likely preclude extensive transmission line construction.

In addition, it is assumed that tar sands projects would need to connect to existing regional crude pipelines (or to new regional pipelines) through the installation of new feeder pipelines. It is assumed that one pipeline and ROW would serve each project. The maximum length from an existing pipeline to any tar sands resource is approximately 95 mi. For purposes of analysis, it is assumed that these pipeline ROWs would be 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (equivalent to a disturbed area of 570 acres during operations and 1,200 acres during construction). The 95-mi distance assumption and 100-ft ROW size represent probable maximum sizes.

5.1.4 Workforce Operational Details and Employer-Provided Housing

A number of assumptions have been made regarding the operations schedule and housing for workers who move into the study area to support future commercial tar sands development. It is assumed that at commercial scale, all projects would operate 24 hours a day, 7 days a week. It is further assumed that about 30% of the construction and operations workers, including those hired directly to work on tar sands projects as well as those hired for jobs indirectly related to the development, would bring families with them, with an average family size of 2.6 (see Section 5.11). Some portion of these incoming people would live in housing provided by the operators. The locations of the employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands. Employer-provided housing would be constructed as needed to house the workforce and provide facilities and infrastructure (e.g., groceries, basic medical care, schools, and recreation). A density of 35 people per acre is assumed for this employer-provided housing.

The BLM has made assumptions regarding what percentage of workers and their families would be housed in employer-provided housing, as opposed to those that would move into existing communities. Section 5.11 provides a more detailed discussion of these and related assumptions. Table 5.1.4-1 provides estimates of the number of people that would be housed in local communities versus employer-provided housing, and the number of acres that would be required to support the employer-provided housing by technology.

5.1.5 Expansion of Electricity-Generating Capacity

Given the limited amount of electrical power needed, power needs for commercial development projects at the STSAs would be met by anticipated expansion of existing coal-fired plants in Utah. Power needs for any projects at the Tar Sand Triangle STSA are expected to be met by on-site power generation because of the remote location of this STSA.

TABLE 5.1.4-1 Estimated Housing Distribution of Incoming People and Acres Impacted by Employer-Provided Housing for the Construction and Operations Phases of Commercial Tar Sands Development

Parameter	Construction	Operations
Total population (including families)[a]		
Employer-provided housing	1,700	450
Local communities	930	640
Maximum size of employer-provided housing (acres)[b]	49	13

[a] The total population, including families, was calculated on the basis of the total number of new direct and indirect workers that would move into the area, assuming that 30% of them would bring families with an average family size of 2.6 people.

[b] These estimates are based on an assumed density of 35 people per acre for employer-provided housing. This acreage is not expected to be on public lands.

5.1.6 Refining Needs for Tar Sands Development Projects

Factors that would likely impact the incorporation of tar sands–derived crude into the refinery market are discussed in Attachment B1 to Appendix B. This attachment specifically examines the anticipated refinery market response to potential tar sands production over the 20-year time frame assessed in this PEIS. It provides a brief overview of the U.S. petroleum refinery market and identifies some of the major factors that would influence decisions regarding construction or expansion of refineries and displacement of comparable volumes of crude. On the basis of the discussion in Attachment B1, it is concluded Utah tar sands–derived crude oil and/or asphalt that might be produced during the 20-year time frame evaluated in this PEIS (up to approximately 300,000 bbl/day) would not trigger significant expansions in either long-range crude transportation pipelines or refineries, either within the region or beyond. Therefore, additional refinery capacity is not considered to be necessary as a result of tar sands development and is not further considered in this PEIS. It is assumed that all processing required to upgrade the product(s) to render them suitable for pipeline transport and acceptance at refineries would be conducted on-site.

5.1.7 Additional Considerations and Time Lines

The above assumptions broadly describe the impact-producing factors for commercial tar sands development. Within these general facility descriptions, many permutations are possible. For example, various surface retort designs exist, and each has a unique set of environmental impacts and resource demands. In addition, indirect impacts may occur. For example, there may be a need for major upgrades to existing road systems; the magnitude of this impact, however, would depend on project site locations. A detailed definition of each possible permutation and a subsequent analysis of its impacts would be impractical and speculative, because there is no means of identifying the precise development schemes that may be proposed by future developers. Furthermore, while it is likely that commercial development would be accompanied by the centralization or consolidation of some services (e.g., product storage, waste management, and equipment maintenance), it is not possible at this time to predict how this would evolve. This PEIS, therefore, provides an analysis of the range of impacts from each of the major technologies that might be deployed in the future, along with an analysis of the supporting services that would be required by each technology, but it does not analyze specific facility configurations or technology combinations. Efficiencies and economies that would be realized from integrated systems or centralized services are not considered. As a result, outcomes from this analysis could inadvertently overstate some impacts, especially if the resulting impacts are added together to accommodate multiple projects.

Although there are many unknowns with respect to time lines for construction and operations of commercial-scale tar sands production facilities, in general, it can be assumed that projects using in situ technologies would require about 3 years of construction and permitting before pilot testing, that pilot testing would last 6 years, and that additional construction to scale up to commercial levels would take 2 more years. It can be assumed that the permitting and construction phases for surface mines would take longer than such phases for in situ projects, such that construction and permitting before pilot testing would take about 7 years, pilot testing would last 6 years, and permitting and construction to scale up to commercial levels would take 5 more years. For all commercial tar sands projects, regardless of the technologies used, it can be assumed that maximum production levels would be reached after 3 to 5 years of commercial operations.

5.2 LAND USE

5.2.1 Common Impacts

As discussed in Section 3.1, lands within Utah where commercial tar sands development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro herd management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial tar sands development activities could have a direct effect on these uses, displacing them from areas being developed to process tar sands. Likewise, currently established uses may also prevent or modify tar sands development. Valid existing rights represented by existing permits or leases may convey superior rights to the use of public lands, depending upon the terms of the permits or leases.

Indirect impacts of tar sands development would be associated with changes in existing off-lease land uses, including the conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families who move to the region in support of commercial tar sands development. Increases in traffic, increased access to previously remote areas, and development of tar sands facilities in currently undeveloped areas would continue changing the overall character of the landscape that had already begun as a result of oil and gas development. The value of private ranches/residences in the area affected by tar sands developments or associated ROWs either may be reduced because of perceived noise, human health, or aesthetic concerns, or may be increased by additional demand.

FLPMA directs the BLM to manage public lands for multiple use, and as a multiple-use agency, the BLM is required to implement laws, regulations, and policies for many different and often competing land uses and to resolve conflicts and prescribe land uses through its land use plans. FLPMA makes it clear that the term "multiple use" means that not every use is appropriate for every acre of public land and that the Secretary can "…make the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use. . . ." [FLPMA, Section 103(c) (43 USC §1702(c)]. Like hunting, grazing, oil and gas development, and recreation, commercial tar sands operations are statutorily authorized uses of BLM lands. The BLM is aware that not all authorized uses can occur on the same lands at the same time; conflicts among resource uses are not new, and this PEIS is not intended to solve all potential conflicts involving oil shale leasing. The intent of FLPMA is for the Secretary of the Interior to use land use planning as a mechanism for allocating resource use, including energy and mineral development, as well as conserving and protecting other resource values for current and future generations. Future decisions regarding tar sands leasing and approval of operating permits will be informed by NEPA analysis of the conflicting or alternative land uses of individual areas.

Although transmission and pipeline ROWs associated with commercial tar sands development would not necessarily preclude other land uses, they would result in both direct and indirect impacts. Direct impacts (e.g., the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW) would last as long as the transmission lines and pipelines were in place. Indirect impacts (e.g., the introduction of or increase in recreational use to the area due to improved access, avoidance of the area adjacent to public lands for residential or recreational use for aesthetic reasons, and increased traffic) could occur and be long-term.

The specific impacts on land use and their magnitude would depend on project location; project size and scale of operations; proximity to roads, transmission lines, and pipelines; and development technology. The following sections discuss the common impacts on different types of land uses and potential mitigation measures that may be applicable on a site-by-site basis.

5.2.1.1 Other Mineral Development Activities

As discussed in Section 1.4.2, in October 2005, in response to Section 350 of the Energy Policy Act of 2005, the BLM issued an interim final rule on leasing in STSAs (70 FR 58610–58516). The interim rule replaced the CHL Program that was established in 43 CFR Part 3140 in 1983. Under the new interim rule, within the designated STSAs, the BLM is authorized to issue separate leases for tar sands development, separate leases for oil and gas development, and CHLs in any areas that contain tar sands and oil or gas resources. This rule paves the way for tar sands development to coincide with oil and gas development in the future, as deemed appropriate at the time of leasing. However, simultaneous development of tar sands and other mineral resources would require coordination of extraction technologies and schedules. As a result, commercial tar sands development might be incompatible in those portions of the STSAs that already are undergoing or leased for other mineral development activities and would likely preclude these activities, such as the development of oil and gas resources while tar sands development and production is ongoing. Areas with tar sands resources where there are existing oil and gas or other mineral leases may be precluded from tar sands development, because the existing leases have priority. Without some accommodation being made between tar sands developers and prior lease holders, tar sands development may not be able to proceed. Conflicts between competing mineral resource uses would be resolved in the future at the leasing stage or plan of development stage.

In those areas where commercial tar sands leases would overlap with other existing leases, the right to develop under the primary lease (i.e., the lease issued first) would prevail (depending on the lease terms) unless the lease holders negotiated some other arrangement. It is the BLM’s policy to optimize recovery of natural resources in an endeavor to secure the maximum return to the public in revenue and energy production; prevent avoidable waste of the public’s resources utilizing authority under existing statutes, regulations, and lease terms; honor the rights of lessees, subject to the terms of existing leases and sound principles of resource conservation; and protect public health and safety and mitigate environmental impacts. Conflicts among competing resource uses are generally considered and resolved when processing potential leasing actions or evaluating requests for approvals of plans of development on existing leases. In areas where no other mineral development lease was held, the issuance of a commercial tar sands lease would establish a primary right to development.

The authorization of ROWs for connecting transmission lines and oil pipelines supporting commercial tar sands projects would result in fewer impacts on other mineral development activities than would the commercial tar sands development projects. It is assumed that ROWs serving tar sands development could be located in a manner that would largely avoid impacts on other mineral development activities by avoiding areas of mineral development or by being co-located in a manner that is consistent with planned resource development.

Demand for reliable, long-term water supplies to support commercial tar sands development could lead to acquisition of new water supplies (depending on availability) or to the conversion of existing water rights from current uses. Water would be needed to support direct tar sands operations and to support both additional population and potential power plant operation. While it is not presently known how much surface water may be needed to support future development of a tar sands industry or the role that groundwater or reclaimed water would play in future development, it is likely that in some areas agricultural water rights could be acquired to provide water supplies. Depending on the locations and magnitude of such acquisitions, there could be reductions in local agricultural production and land use when the water is converted to supporting tar sands development.

5.2.1.2 Acquisition, Conversion, or Transfer of Water Rights

Demand for reliable, long-term water supplies to support commercial tar sands development could lead to acquisition of unallocated water supplies (depending on availability) or to the conversion of existing water rights from current uses. Water would be needed to support direct tar sands operations and to support both additional population and potential power plant operation. While it is not presently known how much surface water may be needed to support future development of a tar sands industry or the role that groundwater or reclaimed water would play in future development, it is likely that in some areas agricultural water rights could be acquired to provide water supplies. Depending on the locations and magnitude of such acquisitions, there could be reductions in local agricultural production and land use when the water is converted to supporting tar sands development.

5.2.1.3 Grazing Activities

Grazing activities would be precluded by commercial tar sands development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Grazing might be possible in the remaining undeveloped portions of the lease area or on portions that were successfully restored after development. On the basis of assumptions discussed above regarding the amount of land that would be disturbed at any given time for different technologies, it is possible that 2,810 to 5,680 acres within a 5,760-acre lease area would remain available for grazing. Depending on conditions unique to the individual grazing allotment, temporary or long-term reductions in authorized grazing use may be necessary because of loss of a portion of the forage base.

Once established, transmission line and pipeline ROWs would not prevent the use of any land for grazing other than the areas physically occupied by aboveground facilities. The establishment of employer-provided housing might preclude grazing activities, depending on how the housing is developed and the location, although this development is not expected to occur on public lands.

5.2.1.4 Recreational Land Use

Commercial tar sands development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird watching, OHV use, and camping). As discussed in Section 5.2.1.2 regarding grazing activities, recreational land use could be precluded from those portions of the lease area, depending on the technology employed. While recreational use could be possible in undeveloped or restored portions of a lease area, the amount of land that would be available would vary from project to project. The change in the overall character of the undeveloped BLM-administered lands to a more industrialized, developed area would displace people seeking more primitive surroundings in which to hunt, camp, ride OHVs, etc. Many BLM field offices have designated lands as open, closed, or available for limited OHV use. Areas that would be open to application for commercial tar sands development may be currently available for some level of OHV use, and commercial tar sands development in these areas would displace this use. Even if access could be granted to portions of the lease area for recreational use, visitors might find the recreational experience to be compromised by the nearby development activities. Such impacts could also occur on recreational users of adjacent, off-lease lands. In addition, impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial tar sands projects. To the extent that commercial developments might be clustered, the effect on recreation uses would be magnified by changing the overall character of a larger area and by dominating a larger portion of the landscape.

Once established, transmission line and pipeline ROWs would have fewer impacts on recreation users than would the actual commercial development projects. Access to the land in the ROWs would not be precluded; however, depending on the type of recreation, the overall recreational experience could be adversely affected by the visual disturbance to the landscape and potential noise impacts associated with overhead transmission lines. The establishment of employer-provided housing, although not likely to be located on public lands, would preclude recreational land use and might cause indirect impacts on recreational land use on adjacent lands, depending on how the housing is developed and the location.

5.2.1.5 Specially Designated Areas, Potential ACECs, and Areas with Wilderness Characteristics

As discussed in Section 1.2, the BLM has determined that certain designated areas are excluded from commercial tar sands leasing. These areas include all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are closed to mineral development. Because of these exclusions, these designated areas would not incur direct impacts associated with commercial tar sands development. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial tar sands development on adjacent lands or areas within the general vicinity. Section 5.9 discusses impacts on visual resources in greater detail.

Existing ACECs that are not closed to mineral development and potential ACECs that are currently under consideration for designation as part of ongoing land use planning efforts would be available for application for commercial leasing in the future. See Section 1.4.3 for a discussion of ongoing BLM planning activities. Decisions regarding either the designation of the potential ACECs or commitment of the areas to other uses would be made by local BLM field offices utilizing the BLM planning process and NEPA analyses.

Another category of lands available for application for commercial leasing in the future are those that have been recognized by the BLM as having one or more wilderness characteristics yet are not eligible for formal recognition as WSAs. Lands that have been identified in this manner by the BLM are discussed in Section 3.1. Commercial tar sands development activities and the development of transmission line and pipeline ROWs within these areas would cause a loss of the wilderness characteristics in and around the disturbed areas. Commercial development on adjacent lands or within the general vicinity of an area with wilderness characteristics could result in both direct and indirect impacts on the wilderness attributes. Decisions regarding either the protection and management of such wilderness characteristic areas or committing the areas to other uses would be made by local BLM field offices utilizing the BLM planning process and NEPA analyses.

All specially designated areas, potential ACECs, and areas with wilderness characteristics that are located in the vicinity of the STSAs are identified in Section 3.1.

5.2.1.6 Wild Horse and Burro Herd Management Areas

As discussed in Section 3.1.1, the STSAs coincide with a number of designated Wild Horse and Wild Burro HMAs. Specifically, the following HMAs overlie the STSAs: the Muddy Creek, Sinbad, and Range Creek Wild Horse HMAs and the Sinbad Wild Burro HMA in the Price Field Office; the Canyon Lands Wild Burro HMA in the Richfield Field Office; and the Hill Creek Wild Horse HMA in the Vernal Field Office. At least some portion of each of these HMAs coincides with lands proposed to be available for application for leasing under the tar sands alternatives.

As discussed in Section 5.2.1.2 regarding grazing activities, the management of wild horse and burro herds is not compatible within those portions of commercial tar sands lease areas that are (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing reclamation after development; or (4) occupied by long-term surface facilities, such as office buildings, laboratories, retorts, and parking lots. Animals would likely be displaced from the areas of commercial development, and, depending on the conditions in the individual HMA, it might be necessary to reduce herd numbers to match forage availability on the undisturbed portion(s) of the HMA. If horses emigrate out of HMA boundaries because of the disturbance within the HMA, they could be removed via the capture and adoption program. Transmission line and pipeline facilities would not prevent use of the land by horses or burros other than in the areas physically occupied by aboveground facilities, although they could be subject to disturbance or harassment from people using the ROWs for access. For more information about impacts on wild horses, see Section 5.8.1.3 and Table 5.8.1-3.

5.2.1.7 Different Tar Sands Development Technologies

For the most part, impacts on land use would be the same regardless of the development technology used. However, the amount of potential land disturbance would vary by technology. Assuming a rolling footprint of development for in situ projects involving either steam injection or combustion, the acreage disturbed at any given time is expected to range from 80 to 200 acres. For surface mining projects coupled with either surface retorting or solvent extraction, the estimated area of disturbance at any given time is 2,950 acres.

5.2.2 Mitigation Measures

The direct and indirect impacts on land use described above could be mitigated to some extent by a number of actions, including, in some instances, application of specific engineering practices. The effectiveness of these potential mitigation measures and the extent to which they are applicable would vary from project to project and would need to be examined in detail in future NEPA reviews of project plans of development. Potential mitigation measures include these:

- Consulting with federal and state agencies, property owners, and other stakeholders as early as possible in the planning process to identify potentially significant land uses and issues, rules that govern commercial tar sands development locally, and land use concepts specific to the region;

- During the project design and planning phase, incorporating considerations regarding the use of lands in undeveloped or restored portions of the lease area to maximize their potential for other uses (e.g., grazing, recreational use, or wild horse or burro herd management);

- During the project design and planning phase, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts;

- During the project design and planning phase, providing for consolidation of infrastructure wherever possible to maximize efficient use of the land;

- During the design, siting, and planning phase for employer-provided housing, incorporating considerations regarding the use of adjacent lands to minimize direct and indirect off-lease land use impacts; and

- Developing and implementing effective land restoration plans to mitigate long-term land use impacts.

To address more specific impacts on land use, such as impacts on grazing, recreational use, and wild horse herd management, potential mitigation measures could also include the following:

- Coordinating the activities of commercial operators with livestock owners to ensure that impacts on livestock grazing on a portion of a lease area were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and location of livestock water sources.

- Coordinating the activities of the commercial operators with the BLM and local authorities to ensure that adequate safety measures (e.g., access control and traffic management) were established for recreational visitors.

- Coordinating the activities of the commercial operators with the BLM to ensure that impacts on the wild horse herds and their management areas were minimized. Issues that would need to be addressed could include installation of fencing and access control, delineation of open range, traffic management (e.g., vehicle speeds), and access to water sources.

5.3 SOIL AND GEOLOGIC RESOURCES

5.3.1 Common Impacts

The potential impacts on soil and geologic resources would vary somewhat according to the four different technologies under consideration. There would also be some STSA-specific impacts. However, many of the impacts would be common to each technology and common to project phases. This section discusses the common impacts on soil and geologic resources, including phase-specific impacts.

5.3.1.1 Soil Resources

Tar sands operations could have an impact on soil resources. A significant concern is increased soil erosion because of ground disturbance. This problem pertains to each technology considered in this PEIS.

Soil erosion varies with location within and among the STSAs, generally ranging from moderate to high, depending on local conditions of soil properties and slope. Individual project sites would need to be assessed to determine their erosion potential. The San Rafael STSA is the only STSA with a very high level of erosion over a significant portion of its land area. Cryptobiotic soils are present in some portions of Utah and may be present in the study area. The biological crusts, when intact, serve to reduce wind and water erosion of these soils.

Soil erosion can be increased in areas disturbed through construction activities. The maximum land area that is assumed to be disturbed for tar sands facilities is the entire leased area for surface mines and in situ facilities (up to 5,760 acres). The degree of the impact depends on factors such as soil properties, slope, vegetation, weather, and distance to surface water. Specific activities that could create soil erosion (and possibly increase turbidity in surface water) include removal and stockpiling of overburden for surface mining (and, to a lesser extent, for subsurface mining); traffic on unpaved roads; and erosional gullies formed on land regraded for in situ work areas, support facilities, roads, etc. Surface disturbance may include vegetation clearing, grading, and contouring that can affect the vegetation, soil structure, and biological crust, thereby increasing erosion potential. The drainage along roads may contribute additional soil erosion as surface runoff is channeled into the drainages. Compaction by vehicles or heavy equipment may reduce infiltration and promote surface runoff. Wind erosion would be enhanced though ground disturbance.

The construction or installation of other facilities in addition to buildings and of utilities would require disturbance of soil. These activities would include, but not be limited to, utility tower installation, telephone pole installation, parking area construction, buried utility installation (e.g., water mains, wastewater lines, and electrical or communication cables), drilling to prepare for in situ operations, drilling for resource evaluation, and drilling for groundwater monitoring well installation. Some of these activities, such as exploratory drilling and road grading, may also take place during preliminary site assessment.

ROWs for transmission lines would be built to connect all project sites with regional utilities except those located at the Tar Sand Triangle STSA, where power needs are expected to be met by on-site generation. These ROWs would cause up to 1,700 acres of longer-term disturbance and 2,500 acres of disturbance during construction (see Section 5.1.3). A pipeline ROW is also assumed to be constructed for each project site (up to 570 acres of longer-term disturbance and 1,200 acres disturbed during construction). Likewise, employer-provided housing would likely be built, which would have a limited longer-term disturbance (e.g., housing would occupy approximately 49 acres during construction of a commercial tar sands facility). The locations of employer-provided housing are unknown at this time; however, housing is not expected to be located on public lands.

Erosion rates are expected to be higher along ROWs and at construction sites, access roads, surface mines, and river banks. Site grading and drainage design would cause changes in the local hydrology and may result in increased runoff focused at certain discharge locations. This situation may cause increased erosion in creeks and drainages and on hill slopes, with subsequent increases in downstream sediment loads. Following site construction, soil conditions may stabilize, resulting in reduced erosion and sediment input to surface water. Localized erosion may continue to take place, requiring maintenance and remedial measures.

The pipelines associated with tar sands development would include those conveying hydrocarbons extracted from in situ retorting or from surface retorts or upgrading facilities, as well as possible pipelines for water or sanitary waste. Flood events have the potential to cause pipeline breakage and subsequent contamination of surface water.

Soil and geology impacts would differ during tar sands operations depending on the technological approach. All techniques would affect ongoing situations with soil erosion and runoff management in areas of disturbed soil (water and wind erosion, rutting, potential salinity impacts, etc.) as described above. All four technologies would result in widespread ground disturbance and associated problems related to erosion and increased sediment and salinity input to streams. The use of pesticides and herbicides and accidental spills or leaks of product, fuels, or chemicals could result in soil contamination. The potential soil contamination would be localized in extent and could be addressed with appropriate remediation measures.

The surface mining approach requires removing and stockpiling the overburden, source rock, and waste rock, thereby creating a potentially large source of sediment and salinity in site runoff. Up to 2,950 acres would be disturbed at any one time during commercial operations, with a total of 5,760 acres potentially disturbed. The various stockpiles are also susceptible to wind erosion. Much of the spent sands could be returned to the mine, but some overflow would be placed in disposal areas outside the excavation. Ongoing stabilization of the waste piles would likely be required.

In situ techniques would result in rolling operations areas, with continuous ground disturbance areas and reclamation areas. In situ techniques are estimated to result in smaller disturbed land areas than surface mining techniques, with 80 to 200 acres disturbed at any one time. A total of 5,760 acres would potentially be disturbed and subject to erosion and sediment runoff.

During reclamation, potential geologic and soil impacts would be similar to those during the construction phase. The replacement of stockpiled topsoil on former work or support areas, roads, or in reclaimed surface mines would require time for reestablishment with stabilizing vegetation, and these areas may be a source of erodible material depending on factors such as slope and weather conditions. Monitoring of soil reclamation areas for erosion and ecology are also part of a reclamation phase (DOI and USDA 2006).

Tar sands development may have a significant impact on surface water quality in the greater Colorado River Basin because of ground disturbance. As discussed in Section 5.5, soil erosion increases both the sediment load to streams and the salinity of runoff reaching these streams. Increases in surface water salinity due to project site runoff could be high. The sensitivity of the surface water throughout the PEIS study area makes soil management a key factor in environmentally acceptable energy development. The infiltration of precipitation through stockpiled tar sands or through waste piles of spent material has the potential to impact surface water or shallow aquifers with leached hydrocarbons and salts.

5.3.1.2 Geologic Resources

A variety of other geologic resources are present in the STSAs. Tar sands development could impact these resources, including contributing to the loss of resources. Sand and gravel and crushed stone supplies are widespread throughout the study areas, and their use at project sites (for construction, fill, etc.) would not be expected to impact their availability.

Oil and gas occur at the P.R. Spring and Pariette STSAs, are likely at the Hill Creek and Raven Ridge STSAs, and are possible at other STSAs. Significant oil shale is present stratigraphically above the tar sands along the northern edge of the P.R. Spring, Hill Creek, Pariette, and Raven Ridge STSAs. Coal occurs at the Sunnyside STSA at a depth that would require underground mining. Coal is also possible at the Hill Creek, P.R. Spring, and Asphalt Ridge STSAs. Uranium may occur in localized areas at the Circle Cliffs, Tar Sand Triangle, White Canyon, and San Rafael STSAs. Localized copper deposits are present at the San Rafael STSA.

5.3.2 Mitigation Measures

Various mitigation measures may be taken to reduce the impact of tar sands activities on soil and geologic resources during construction, operations, and reclamation and could include the following. The subsequent effects on water quality may therefore be reduced (see Section 5.5).

- Guidance, recommendations, and requirements related to management practices are described in detail in the BLM Solid Minerals Reclamation Handbook (BLM 1992), the BLM Gold Book (DOI and USDA 2006), BLM pipeline crossing guidance (Fogg and Hadley 2007), and in BLM field office RMPs. These actions include, but are not limited to, minimizing the amount of disturbed land; stockpiling topsoil prior to construction or regrading; mulching and seeding in disturbed areas; covering loose materials with geotextiles; using silt fences to reduce sediment loading to surface water; using check dams to minimize the erosive power of drainages or creeks; and installing proper culvert outlets to minimize erosion in creeks.

- Surface pipeline crossings must be constructed above the highest anticipated flood stage, and subsurface crossings must be installed below the scouring depth. The BLM (Fogg and Hadley 2007) provides guidance on hydraulic analysis necessary for proper design of pipeline crossings.

- Mapping of highly erosive soils and soils with a high salt content should be performed in proposed project areas and on their connecting roads, so that site-specific information could be used to guide project planning. A proper road grading analysis should be performed to reduce the potential for problems such as erosion or cut slope failure (DOI and USDA 2006).

- The revegetation and restoration potential of soil, as was the case for many other soil factors described above, is site-specific and would be addressed in a project-level NEPA analysis. Mitigations involving soil erosion control, stabilization, and reseeding would limit the impact of soil erosion.

- Stockpiling of topsoil prior to the construction of roads, parking areas, buildings, work areas, or surface mining is a practice that should aid reclamation efforts following the completion of work activities in a certain area. During reclamation, replacement of the stockpiled topsoil would aid in a return to somewhat natural conditions for local vegetation.

- Detailed geotechnical analyses would be required to address the stability of quarry walls and slopes; these analyses would include an assessment of slope cuts for the creation of roads or work areas.

- Site-specific soil mapping would be necessary in assessing the condition of any proposed project site. Geologic resources may vary at the STSAs, and current information on exploration would be required to understand the potential for conflict between tar sands development and other energy or mineral development. Geologic hazards are expected to be similar among the STSAs, with varying potential for landslides.

- Literature and field studies focused on the region surrounding STSAs should be undertaken to assess faulting and earthquake potential.

5.4 PALEONTOLOGICAL RESOURCES

5.4.1 Common Impacts

Significant paleontological resources could be affected by commercial tar sands development. The potential for impacts on paleontological resources from commercial tar sands development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered.

Impacts on paleontological resources could result in several ways, as described below.

- Complete destruction of the resource could result from the clearing of the project area; grading, excavation, and construction of facilities and associated infrastructure; and extraction of the tar sands resource, if paleontological resources are located within the development area.

- Degradation and/or destruction of near-surface resources could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if near-surface paleontological resources are located near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact near-surface paleontological localities downstream of the project area by potentially eroding away materials and portions of sites, the accumulation of sediment could serve to protect some localities by increasing the amount of protective cover. Agents of erosion and sedimentation include wind, water, ice, downslope movements, and both human and wildlife activities.

- Increases in human access and subsequent disturbance (e.g., looting and vandalism) of near-surface paleontological resources would result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes paleontological sites to a greater probability of impact from a variety of stressors.

Paleontological resources are nonrenewable; once they are damaged or destroyed, they cannot be recovered. Therefore, if a paleontological resource was damaged or destroyed during tar sands development, it would constitute an irretrievable commitment of this scientific specimen. Data recovery and resource removal are ways in which at least some information can be salvaged should a paleontological site be developed, but certain contextual data are invariably lost. The discovery of otherwise unknown fossils would be beneficial to the scientific community, even if such resources were ultimately lost, but only if sufficient data were recorded prior to destruction or loss.

5.4.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation with the BLM could reduce or eliminate (if avoidance of the resource is chosen) the potential for adverse impacts on significant paleontological resources. Consultations between the operator and the BLM would be required for all projects before lease areas could be developed. The use of BMPs, such as training and education programs to reduce the amount of inadvertent destruction to paleontological sites, could also reduce the occurrences of human-related disturbances to nearby sites. The specifics of these BMPs would be established in project-specific consultations between the operator and the BLM.

A paleontological overview was completed for the project area (Murphey and Daitch 2007). The overview synthesized existing information and generated maps showing areas with the PFYC and paleontological condition. This phase of the analysis did not identify geographical areas that would preclude moving areas forward for leasing. During the leasing phase, the overview will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

Mitigation measures to reduce impacts on paleontological resources would be required and could include the following:

- The sedimentary context of the project area and its potential to contain paleontological resources would be identified prior to development in consultation with the BLM. A records search of published and unpublished literature may be required for past paleontological finds in the area. Paleontological researchers working locally in potentially affected geographic areas and rock units may be consulted in order to obtain invaluable information and insights that should be taken into account when considering alternative actions and developing mitigation strategies. Depending on the extent of paleontological information, the BLM may require completion of a paleontological survey. If paleontological resources are present at the site, or if areas with a high potential to contain paleontological material have been identified, the development of a paleontological resources management plan may be required to define required mitigation measures (i.e., avoidance, removal, and monitoring) and the curation of any collected fossils.

- If an area has a high potential but no fossils are observed during the survey, monitoring by a qualified paleontologist may be required during all excavation and earthmoving in the area. Monitoring of high-potential areas during earthmoving activities would be conducted by a professional paleontologist, when required by the BLM. Development of a monitoring plan is recommended. An exception may be authorized by the BLM.

- If fossils are discovered during construction, the BLM will be notified immediately. If feasible (i.e., when safe to do so), work will be halted at the fossil site and continued elsewhere until a qualified paleontologist could visit the site and make site-specific recommendations for collection or (other) resource protection.

If these types of mitigation measures are implemented during the initial project design and planning phases and adhered to throughout the course of development, the potential impacts on paleontological resources discussed under the common impacts section would be mitigated to the fullest extent possible. Implementation of mitigation measures does not mean that there would be no impacts on paleontological resources. The exact nature and magnitude of the impacts would vary from project to project and would need to be examined in detail in future NEPA reviews of lease areas and project plans of development.

5.5 WATER RESOURCES

5.5.1 Common Impacts

Similar to oil shale development, tar sands development would impact water resources as a result of ground surface disturbance, water withdrawal and use, disposal of wastewater and potential contaminant sources, alteration of hydrologic flow systems for both surface water and groundwater, and the interaction between groundwater and surface water. These factors are interdependent and depend on the technologies used for tar sands development. In this section, the range of potential impacts of tar sands development on water resources is discussed. Because STSAs are located in areas where surface water resources are limited, water storage facilities and delivery systems are likely to be needed for water use at development sites. The construction or modification of storage facilities and new delivery systems may cause additional environmental impacts on water resources and additional competition among various water use sectors. The consequences could affect water quality and quantity in both groundwater and surface water on- and off-site.

Common impacts could include:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;

- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;

- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;

- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;

- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;

- Construction of reservoirs that might alter natural streamflow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;

- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Spent tar sands that might be sources of contamination for salts, metals, and hydrocarbons for both surface and groundwater;

- Degradation of groundwater quality resulting from injection of lower-quality water; from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased; and, from spent tar sands;

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses; and

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected.

The following sections place these common impacts in the context of specific operating parameters and also show that many of the impacts are interconnected with the multiple activities that could occur in a single operation. Indeed, it is necessary to understand the context of each of the above summary findings to clearly understand the impact dynamics and the rationale behind the mitigative measures that follow the impact analysis.

5.5.1.1 Ground Surface Disturbance

Ground surface disturbance is unavoidable in tar sands development. The disturbance comes from mining, site development, material (including waste) handling, access road construction, supportive infrastructure construction (e.g., reservoir, pipelines for water and products, and transmission lines), reclamation activities, and onroad and offroad traffic. Specific actions may include:

- Clearing of vegetation and stripping of overburden;
- Stockpiling of topsoil and overburden;
- Drilling and blasting;
- Backfilling, grading, and contouring;
- Onroad and offroad traffic;
- Mining operations;
- Material handling of mined tar sands and disposal of tailings;
- Developing facilities to support mining operations, including pipelines, sewers and drainage facilities, water treatment plants, gas cleaning facilities, control facilities, offices, housing, warehouses, evaporation and cooling ponds, boiler houses, electric generation facilities, electricity substations, pump houses, and storage tanks for fuels, chemicals, and products;
- Drainage construction; and
- Land reclamation from access roads, mines, spent tar sands storage areas, and facility sites.

These activities can affect surface water flows and surface water and groundwater quality in various ways. Disturbed lands are generally susceptible to soil erosion and affect surface water quality with increased salt, metals, and sediment loads until the disturbed areas are reclaimed and stabilized. Silt and potential contaminants from tar sands may be transported into surface water bodies by runoff. Leaching of stockpiles and overburden piles can also enhance the transport of organics, salts, and trace metals into the water courses and into shallow groundwater. Fallout of dust from access roads, mines, and material handling may affect surface waters. Diverted surface runoff from the disturbed areas can also adversely impact nearby water bodies.

5.5.1.2 Water Use

The water use in tar sands development is closely related to the technologies used to extract the bitumen from the source rock and the conservation measures adopted in a site. Various water uses also depend on water quality. For example, the highest quality of fresh water is needed for human consumption. Poor-quality water, such as brackish groundwater, may be used for dust suppression or hydrotransport (transporting mined tar sands as a water slurry). A list of water uses for tar sands development follows:

- Consumptive use of surface water and/or groundwater for dust suppression (including the use of poor-quality water) in mines, access roads, stockpiles of source rock and spent tar sands, well drilling, equipment maintenance, and solid waste compaction;

- Consumptive use of surface water and/or groundwater in processes, boilers, coolers, and ancillary operations;

- Consumptive use of domestic water, including potable and nonpotable water;

- Optional consumptive use for hydrotransport;

- If in situ steam injection technology is used to extract bitumen, a large amount of good-quality water is needed to make steam; the steam mixed with bitumen and formation water can be recovered at a rate of 90 to 95% and recycled for further use; and

- If in situ combustion technology is used to extract bitumen, water from combustion and source rock formation could be collected; surplus water may be possible.

The potential impact of transferring agricultural water rights for tar sands development can be attributed to the potential change of delivery systems and return flows from agricultural lands. Tar sands project sites need not be in the same general locations as the irrigated lands where the original water applies, which implies that new delivery systems would be built or some existing systems would be modified. The use of old systems may be reduced or abandoned. The construction of the new systems would cause new ground disturbance. Sediment and dissolved solids from the disturbed area would be carried by surface runoff and transported to downgradient water bodies. If the new system is constructed with pipes rather than ditches or canals, water loss during the delivery through evaporation or percolation would be reduced. Because water rights are based on consumptive uses, water loss due to evaporation, percolation, and surface runoff during water delivery is not counted as part of the water rights. Using a pipe delivery system would reduce the amount of water diverted from a water body to meet the same water rights. The impacts on the water resource by using a pipe delivery system include:

- Increased streamflow because of the reduction of the amount of water diverted to meet the same water rights,

- Improved water quality of the stream because of streamflow increase,
- Improved water quality because the returned flow from percolated water (which generally contains higher dissolved solids) during the delivery is reduced,
- Reduced groundwater recharge from infiltrated water because of the reduction of percolation, and
- Reduced evaporation from open ditches or canals.

As agricultural water rights are transferred, the acreage of agricultural lands is expected to decline. Irrigation is reduced as well as the base flow of the irrigated water to surface water bodies. The impacts on the water resources include:

- Improved water quality of the streams receiving the base flows from farms as leaching by base flows is reduced,
- Reduced groundwater recharges from the percolation of base flows, and
- Reduced yield of groundwater wells that relied on base flow recharge.

Additional impacts would be caused by the use or recycling of wastewater at project sites; such impacts are described in Section 4.5.1.

Water may be drawn from surface water bodies or underground aquifers, depending on project locations, water availability, and water quality. Withdrawal from a surface water body would reduce its flow and cause sediment deposition in the stream channel. In the case of streams receiving groundwater discharge (which generally has a higher dissolved salt content), the withdrawal can degrade the water quality of the stream downgradient from the point of withdrawal because the relative proportion of groundwater remaining in the stream would increase. Because of the generally poor groundwater quality, the receiving stream may result in increases of dissolved salt, selenium, and other metals.

Withdrawal of water from local streams can inadvertently affect water temperature. With reduced flow, water depths in depleted streams tend to decrease. Stream temperature would increase with the same amount of solar radiation in summer time. On the other hand, cooling of stream water is going to be more effective in cold seasons. Groundwater withdrawals from a shallow aquifer would produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater. The withdrawal could reduce streamflows, and the effects would increase with the amount of water withdrawn.

Groundwater may be extracted from aquifers for use as a resource or for dewatering to control groundwater inflow into a mine. Mine dewatering would be necessary where saturated conditions, including perched aquifers, are present. Dewatering would lower the potentiometric surfaces and/or water table of the aquifers that are intercepted by the surface mine. Because some deeper groundwater is the source for springs and seeps in the region, the lowering of the potentiometric surface could have a similar effect as withdrawals from shallow, surficial aquifers—reducing or eliminating flow of the connected springs and seeps. Existing groundwater supply wells within the cones of depression also would have reduced yields or could be dewatered. Permanent changes to the groundwater flow regime due to mining and drilling could affect water rights to specific aquifers. The growth of a cone of depression may be time-delayed and affect water rights in the future.

If surface water is used to supply tar sands operations, it may be necessary to construct storage reservoirs to accumulate enough water to provide the necessary supply. If reservoirs are required, they have their own set of impacts that would need to be addressed. Effects frequently associated with reservoirs include alteration of natural streamflow patterns, impacts on local fisheries, temporary increase of salt loading, changes in downstream channel profiles, loss of natural sediment transport mechanisms, increase in evapotranspiration losses, and loss of existing land uses in the reservoir area.

The water quality of surface water bodies and shallow alluvial aquifers generally is higher than that of deeper aquifers. Therefore, surface water or shallow groundwater is generally preferred as a source of supply if it is available. Withdrawal of surface water would reduce streamflow downstream from the point of diversion. Because of the reduced flow, the stream's capacity for carrying sediment would also be reduced, and in-channel sediment deposition would be increased. The morphology of the stream channel would also adjust to the reduced flows. For stream segments where natural groundwater discharge into the stream occurs, the water withdrawal could increase the relative proportion of the groundwater contribution to the stream, thereby lowering the overall quality of the stream.

For in situ processes, the impact of in situ processing on groundwater during the operations phase is twofold. First, the permeability of the aquifers and perhaps the aquitards between the aquifers in the retort areas would likely be permanently increased because of rock fracturing and removal of hydrocarbons. Second, the residual hydrocarbons, salts, and trace metals in rock and the reagents or chemicals used in flooding treated areas that are not removed would be exposed for later groundwater leaching as a result of increased permeability. It appears that there would be some risk in allowing vertical flow of groundwater between previously isolated aquifers through fractures created by thermal expansion and contraction. The extent to which there would be the possibility of introducing lower-quality water into higher-quality aquifers previously isolated from one another is not yet known. In addition, water rights to specific aquifers could be affected by a change in the groundwater flow regime.

5.5.1.3 Discharge, Waste Handling, and Contaminant Sources

The discharge of mine water (from dewatering operations), wastewater (after treatment), cooling water (for cooling equipment such as crushers, bearings, pumps, and compressors), and diverted surface runoff from a tar sands site can adversely impact nearby water bodies. The impacts are attributed to potential contaminants in the water and potential change of streamflow.

In addition, contaminants released by non-point sources associated with the project (through access roads, air emissions, and groundwater discharge) could further degrade the surface water quality.

The water and potential contaminants associated with surface mining include:

- Dewatering operations and possible underground reinjection or discharge to surface water;
- Discharge of the surface runoff from project sites;
- Spills of fuels, chemicals, and products;
- Discharge of treated sanitary and domestic wastewaters; and
- Discharge of effluents from the treatment of process waters, such as sour water, hydrocarbon storage tanks condensate, boiler condensate, boiler water blowdown, and pump and compressor cooling water blowdown.

The water and potential contaminants associated with leachate include:

- Stockpiled mined or spent tar sands, and other stored materials;
- Drilling wastes;
- Sludges recovered from water treatment, wastewater treatment, blowdown from boilers, and solvent extraction;
- Fly ash and boiler bottom ash; and
- Tailings ponds, backfilled mined areas, or backfilled valleys or gullies.

Management of mine water, wastewater, and surface runoff could involve various forms of reuse or disposal. Deep groundwater or mine water in the region generally has a high dissolved solids content. This water, as well as wastewater with or without treatment, could be used to support facility operations, including dust suppression along access roads, at the project site, in the mine, or on stockpiles of source rocks or tailings.

Underground injection, as a means to dispose of low-quality water, especially brine water from a water treatment plant, could affect groundwater quality. The injection could take place at locations hydraulically downgradient of the mine. Injection would be governed by the state UIC program, except on Tribal land, which is managed by the EPA. Tribes may complete a process to gain eligibility to self enforce UIC. The permitted injection into deep, confined aquifers would be presumed to avoid water quality problems with potable aquifers and eventual discharge of the injectate into surface water or springs. The potential for induced seismicity would require evaluation if underground injection is used for the disposal of the produced water.

Surface discharge of treated or nontreated surface runoff, wastewater, or mine water to a stream from the project site could potentially change the streamflow as well as the stream's water quality, especially during the low-flow season. The water to be discharged may come from domestic wastewater, industrial wastewater, tailing pond drainage, overland flow, and treated water from a leachate collection system. If discharge to a surface water body is selected, the water generally requires treatment and an NPDES permit. The permit specifies the quality and flow of the discharged water, thus limiting the impact on surface water quality. The discharges from a plant generally would have poorer water quality than the natural water of the surface water body. The discharge would increase streamflow at outfalls.

At mining sites after reclamation, the spent tar sands piles and mine tailings could be potential sources of contamination with salts, metals, and hydrocarbons. Leachate containing these contaminants may enter nearby surface water bodies or shallow aquifers and continue to degrade the surface water quality well after the reclamation phase.

For surface mining with surface retort technologies, if the direct coking process is used to upgrade bitumen, fly ash and boiler bottom ash would be produced as wastes. Leaching of the wastes might produce an additional potential source of contamination for surface water or groundwater. If hot water extraction or cold water extraction technology is used, the amounts of processed water and wastewater generated would be substantial. The impacts attributed to the disposal of wastewater are greater for hot water or cold water extraction technologies if the wastewater is not treated and reused.

Spills of chemicals and tar sands products on-site are possible. They are also potential sources of contaminants for nearby surface water bodies and shallow aquifers. Another potential source of water contamination is from pesticides and herbicides, which are commonly used to control vegetation growth along pipelines and transmission lines. These treatments may adhere to soil particles and be carried by wind and surface runoff into nearby surface water bodies, creating nonpoint sources of contaminants for those waters. Vehicle traffic would also raise airborne dust levels along access roads and increase the sediment and salt loadings of nearby streams.

At river crossings, pipelines may be placed under streambeds or foundations may be built for elevated pipelines. A temporary increase of stream sediment at the crossings would likely occur during their construction. Regular disturbance of river banks through maintenance activities or vehicular traffic can also increase the sediment loading of the river. In the case of natural drainage channels that are rerouted, modified, or diverted, the surface runoff could be altered accordingly, affecting downstream flow.

If a solvent (e.g., heptane, cyclohexane, or ethanol) extraction technology is used to extract the bitumen from the source rock, the spent tar sands (tailings) are expected to contain residual solvents after most are recovered for recycling. The waste could be subjected to leaching processes when it is disposed of in open areas. The leachate could potentially enter into surface water bodies or into shallow groundwater and pollute the resource unless sufficient controls, including leachate collection and treatment, are implemented. Solvent spills or leaks are other potential sources of impacts on surface water or shallow groundwater.

In situ combustion could produce large volumes of water from the underground burning and thermal cracking of bitumen, estimated to be 1 to 2 bbl of water for each barrel of oil produced. The produced water from in situ combustion may contain increased levels of potential contaminants such as TDS, chloride, hydrocarbons, and heavy metals.

Residual organic compounds are expected to be present in a formation following in situ processing. In a laboratory study, Raphaelian et al. (1981) analyzed water samples obtained from two in situ tar sands experiments. Water from the combustion experiment was found to contain cyclic cyclohexonyl compounds, acetophenones of ketones, alcohols, quinolines, pyridines, phenyl piperidines, pyrazoles, phenols, carboxylic acids, and lactones. The sample from the steam injection experiment contained alkenes, cyclohexanes, cyclic ketones, toluenes, quinolines, acridines, pyrazoles, pyridines, phenyl piperidines, piperidines, and phenols. Steam from injection can also dissolve organics and metals from source rocks, potentially contaminating groundwater. All of these potential contaminants could migrate with the groundwater to reach wells or discharge locations (i.e., springs, seeps, or surface water). The quality of the surface water could consequently be impacted.

Several of the STSAs are drained in part by state-classified Category 1 streams. These include the Sunnyside, Argyle Creek, and Asphalt Ridge STSAs. According to the state, such streams are of “exceptional recreational or ecological significance or have been determined to be a State or National resource requiring protection, [and] shall be maintained at existing high quality through designation, by the Board after public hearing, as High Quality Waters - Category 1. New point source discharges of waste water, treated or otherwise, are prohibited in such segments” (BLM 2007a). For this reason, any point source or non-point-source releases from these STSAs could potentially degrade these Category 1 streams.

Tar sands development eventually results in population growth in local communities near project sites and on-site (see Section 5.11.1). With population growth, the loading in local wastewater treatment plants or on-site treatment plants would increase. The effluent from the plants is likely to be an additional source of nutrients, such as phosphorus and nitrogen-containing compounds, and other potential pollutants to nearby waters. Such impacts are closely related to where people would settle and the streamflow of the receiving water. A relatively large water quality impact is expected in areas where population growth is large and the receiving water is small.

5.5.1.4 Alteration of Hydrologic Flow Systems

In the case of natural drainage channels that are rerouted or modified for the construction of roads or facilities, the surface runoff would be altered, affecting downstream flow. Erosion of streambeds may occur in this case and affect downstream water quality. Whether the water is derived from a surface water body with or without the use of a reservoir, the downstream flow would be reduced, which could cause deposition of stream sediment and change the morphology of the stream. If a reservoir is built for regulating the water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of the streambed) and deposition along the stream channel would respond to the streamflows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

The dewatering operations of a mine or dewatering through wells that may penetrate multiple aquifers can reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected. The consequence could be diminished flows of seeps, springs, or water courses even at areas remote from the mine. Depending on pumping rates and site-specific hydrogeological factors, significant groundwater withdrawals for dewatering the overburden and/or the tar sands, or for meeting operational needs, may reduce surface water base flow, spring discharges, and water levels in nearby wells.

Streamflow could be affected by both water withdrawal and wastewater discharge (after water treatment). The streamflow would be reduced in areas downstream of water intakes and increased in areas downstream from discharge outfalls. The change of the streamflow could trigger the deposition or erosion of sediments along a stream channel.

By extracting the bitumen, in situ processes could affect the permeability of the treated formation. The change in permeability for in situ–treated formations would be increased further by dissolving soluble minerals and hydrofracturing the rock formation. Subsidence may also occur. Changes to the site groundwater flow field could occur. This could continue after reclamation of the project site.

At sites with a dewatered surface mine or in situ operations, groundwater levels would begin to recover after dewatering activities ceased. As groundwater regained its original water level, surface water previously depleted by the dewatering would be replenished by seeps and springs, and the streamflow would eventually return to predevelopment patterns.

In the case of natural drainage channels that are rerouted or modified for the construction of roads or facilities, the surface runoff would be altered, affecting existing downstream flow. Access roads are likely to be added or modified with tar sands development. The construction activities on access roads involve clearing vegetation, grading, and building drainages. These activities would increase salt loading of streams near the roads. Sediment load could also be increased by the fallout of airborne dust and surface runoff, although these could be reduced or minimized by BMPs. In the case where natural drainage channels are rerouted or modified because of access roads, the impact on the streams downgradient would be similar to that described in the previous paragraph. Whether the water for operations is derived from a surface water body with or without the use of a reservoir, the downstream flow would be reduced, which could cause deposition of steam sediment and change the morphology of the stream. If a reservoir is built for regulating water supply, sediment would be trapped upstream of the dam. The flow pattern of the stream could change depending on the discharge of the reservoir. The degradation (erosion of streambed) and deposition along the stream channel would adjust to the new streamflows. Losses due to evaporation and seepage in the reservoir would affect the amount of water available (Keefer and McQuivey 1979).

The improvement of the drainage tends to increase surface runoff drainage efficiency, and, thus, the erosion power of the runoff. The receiving stream downgradient would be impacted by additional loading of dissolved salt and sediments.

5.5.2 Water Budget for Individual Tar Sands Projects

5.5.2.1 Overall Water Budget

Table 5.5.2-1 summarizes the water consumption for tar sands development sites using different technologies, each with a 20,000-bbl/day capacity. The estimated water consumption does not include water use on access roads and other supportive facilities. In general, traditional surface mining operations consume large amounts of water for dust suppression at the mine site, access roads, source rock crushing locations, and source rock stockpiles. However, new hydrotransport technologies mix water with tar sands and transport the slurry through a pipeline to the processing facility. This process is able to reduce water consumption by reducing water use for dust suppression on access roads. Water used in hydrotransport becomes part of the process water and can later be recycled, resulting in great savings in water use. An oil sands company using surface mining and surface upgrading in Canada (Syncrude Canada Ltd.) claims that its water consumption is 2.3 m^3 for each cubic meter of synthetic crude oil produced (Table 5.5.2-1). However, it is expected that the water use for tar sands development in Utah using the same technologies and water conservation could be higher because the deposits are oil-wet tar sands.

Less water consumption for extracting bitumen from tar sands is expected from the use of solvent extraction technology (mixing 10 to 15% of solvent with water and source rock) than from the use of hot water extraction technology. However, the efficiency of recovering the relatively expensive solvent and the potential contaminant from spent tar sands pose a challenge in the solvent extraction technology.

In situ combustion technology uses a portion of the tar sands as fuel to raise the temperature of source rock and mobilize bitumen. The partially upgraded bitumen, gas, and water are collected by vertical or horizontal wells. Because of the combustion, water is formed. In addition, the water in the source rock is recovered. It is possible that the process water collected from the subsurface may exceed the water need in the tar sands plant. However, the captured water would need treatment before it could be reused.

In the toe to heel air injection (THAI) technology (one of the in situ combustion technologies; see Appendix B), steam injection is used in start-up to extract bitumen (leaving residual bitumen behind) before in situ combustion is conducted. Water is required to make up the steam. The majority of the steam is recaptured in production wells.

The in situ combustion variation known as wet combustion would require water. In this approach, water and air are both injected into the heated formation. Another technology option

TABLE 5.5.2-1 Estimated Water Consumption for Tar Sands Development

Production (bbl/day)	Technology	Water for Mining (bbl/day)	Process Water (bbl/day)	Produced Wastewater from Formation (bbl/day)[b]	Potable Water (operation phase) (bbl/day)	Net Water Requirement (bbl/day)	Net Water Requirement (ac-ft/yr)
20,000	In situ steam injection	0	10,000[a]–80,000	0[b]	950[c]	11,000–81,000	520–3,810
20,000	In situ combustion	0	0	–40,000[d]		e	44
20,000	Surface mine with surface retort	0–25,000[f]	46,000[g]–90,000	0	0[h]	46,000–115,000[i]	2,160–5,410
20,000	Surface mine with solvent extraction	0–25,000[f]	21,800[j]	0	950	22,800–47,800[k]	1,070–2,250

[a] The lower number is for SAGD (steam-assisted gravity drainage) technology, and the higher number is for CSS (cyclic steam stimulation) steam injection technology. Start-up water used for steam injection in the first phase in SAGD is 100,000 bbl/day; thereafter, 90% of steam/water is assumed to be recovered from steam and formation water (E&P 2007; Alberta Chamber of Resources 2004). Assumes 42 gal/bbl of water.

[b] Water from source rock formation mixed with steam and bitumen is collected (E&P 2007) as produced water.

[c] A demand of 135 gal/person/day, a consumptive rate of 35%, and a population of 1,100 are assumed. The consumptive rate is based on the Colorado M&I consumptive rate (CWCB 2004).

[d] Water from source rock formation and from combustion, assumed to be 2 bbl for each bbl of oil produced. The water could be used beneficially, subject to water quality and possible treatment. About 100,000 bbl of start-up water is required to make steam for the first phase of bitumen extraction in the toe to heel air injection (THAI) technology. No process water is needed thereafter (The Oil Drum 2007). Upgrading may need additional water.

[e] For potable water.

[f] The lower number is for hydrotransport; mined tar sands are mixed with water/solvent to make slurry, which is then transported through a pipeline from the mine to the process plant. The water/solvent is counted as processed water use. The larger water use number is for mined tar sands transported by truck. Water is used for haul-road spraying (brackish water), irrigation, and dust containment (fresh water) (Daniels et al. 1981).

[g] The low number is from Syncrude Canada Ltd., which uses 2.3 bbl of water per barrel of crude oil produced, half of the industry average (Thompson 2006; Syncrude Canada Ltd. 2006; Alberta-Canada 2007). Note that Canadian oil sands are water-wet tar sands, while the deposit in Utah is oil-wet sands (also see Appendix B). The number includes upgrading water use. Water demand is 14.2 bbl per barrel of crude oil produced; most of it is recycled.

[h] Potable water is included in the reporting process water.

[i] Water use for upgrading is included; final product is syncrude.

[j] For the solvent extraction process, about 109,000 bbl/day of water is required. If 80% of the water is recycled, consumption would be 21,800 bbl/day. Water use for upgrading is not included (Daniels et al. 1981).

[k] Water use for upgrading is not included.

among in situ combustion techniques that require water is a combination of water flooding with combustion. The water needs associated with these technologies would need to be addressed at individual project sites.

Estimated domestic water needs are estimated for the workforce and family population required for a single 20,000-bbl/day tar sands facility. The construction workforce and families could number about 2,600 people, and the operations workforce and families would number about 1,100 people. Assuming an overall requirement of 135 gal/day/person, the fresh water need is 8,360 and 3,540 bbl/day, respectively (1 bbl of water = 42 gal). Using a consumptive rate of 0.35, the water consumption during the construction phase and operation phase would be about 2,900 and 1,240 bbl/day (140 and 58 acre-ft/yr), respectively.

5.5.2.2 Water Availability for Individual Tar Sands Projects in STSAs

To develop tar sands, there must be enough water available, both physically and legally. This section describes the availability of water for potential tar sands development. Legal availability is discussed in terms of the allocation of the Upper Colorado River water in Utah, based on the Upper Colorado River Basin Compact of 1948. The discussion of physical availability focuses on the water resources near the STSAs.

In Chapter 3, Table 3.4.1-3 provides the projected consumptive use of water in the years 2020 and 2050. Without counting the potential water use for tar sands development, the projected consumptive uses as percentages of the Utah allocated water are 79.4% and 85.9% for the two years. That implies about 281,000 and 193,000 acre-ft/yr are available for 2020 and 2050, respectively.

Water physically available may be limited in a dry environment such as that of the STSAs. Keefer and McQuivey (1979) analyzed surface water and groundwater resources associated with specific STSAs and related the water availability to the water requirements estimated for in situ steam injection, which uses the highest amount of water among various in situ technologies (Table 5.5.2-1). In the following subsections, the physical availability of water in various STSAs is provided. The availability can be compared with the estimated water consumption used in different tar sands technologies as shown in Table 5.5.2-1.

Although water may be legally and physically available, that does not imply that it is readily available for tar sands development. Hydrologic basins enriched with surplus water resources are not necessarily coincident with the STSAs. Storage infrastructures and delivery systems have to be built to capture water for various uses. Also, water rights and water storage rights (for reservoirs) have to be transferred or purchased before the water can be used for development, as most water rights and storage rights have been claimed in the Upper Colorado River Basin. Finally, the water uses for the development have to meet different state and federal regulations. All in all, whether enough water is available for tar sands development depends on the results of intensive negotiations among various parties, including water right owners, state and federal agencies, municipal water providers, and the tar sands developers.

5.5.2.2.1 Asphalt Ridge. Keefer and McQuivey (1979) describe shallow groundwater in the Ashley Creek alluvial aquifer as the best source of water for pilot facilities in the vicinity of Asphalt Ridge and Whiterocks. This water is fresh to slightly saline. They also note that Ashley Creek, with a flow of 82,000 ac-ft/yr near Vernal, could supply a production facility with treatment of its high-salinity water.

Bedrock aquifers northeast of Asphalt Ridge are also a possible source of water to support production. These aquifers are at depths of 4,000 to 6,000 ft and have fresh water. Other surface water sources in the vicinity include perennial streams with flow rates that, like that of Ashley Creek, vary in response to weather and location along the watercourse, as diversions may result in lower flow rates at downstream locations. These streams and flow rates are Dry Fork (15,000 to 26,000 ac-ft/yr), Mosby/Deep Creek (no data available), and Whiterocks River (71,000 to 88,000 ac-ft/yr) (UDWR 1999). Any water obtained from surface water or groundwater sources would not only have to be transported (by pipeline or truck) some distance to a particular project site but might also have to ascend a significant vertical elevation. Overall, it appears that water might be available to support the 20,000-bbl/day plant using in situ technologies, although water rights might need to be purchased, suitable water quality would have to be confirmed, and the economics of transporting the water to the project area would need to be assessed. A 20,000-bbl/day plant using surface mining and surface processing technologies would use more than 6% of the annual average of Ashley Creek, a significant amount when other water users may rely on the same water source.

5.5.2.2.2 P.R. Spring and Hill Creek. Willow Creek has an average flow of 13,000 ac-ft/yr, although its flow is intermittent. Other streams in the vicinity of the STSA include perennial stream Sweetwater Canyon, Bitter Creek, and Center Ford, and intermittent Evacuation Creek. No flow data are available for these creeks from the Utah Division of Water Resources (UDWR 1999). No reliable groundwater sources were noted for P.R. Spring by Keefer and McQuivey (1979). However, springs are quite common in the P.R. Spring STSA, especially east of Willow Creek.

Water resource support for any of the proposed project sites at P.R. Spring may require the purchase of water rights to the distant White River, a regional resource. Willow Creek, even if only 10% of its water was dedicated to the tar sands operations, would not support a 20,000-bbl/day operation using surface mining and processing technologies. If in situ combustion technology is selected, it will consume about 3.5% of the annual average streamflow of Willow Creek. Whether water from the other, ungauged streams in the vicinity could be combined to support one or more tar sands operations is uncertain, because of unknown flow rates and availability of water rights. Reservoir construction may be necessary on one or more of the rivers and creeks selected for tar sands operations. Willow Creek is classified as Category 5A impaired waters (UDEQ 2006). Discharge of any low-quality water from a project site, such as untreated wastewater or surface runoff, may further adversely affect the water quality in the lower reaches.

For P.R. Spring, Keefer and McQuivey (1979) recommend a White River reservoir as the best water source, despite its distance from the STSA. This river has a flow on the order of

480,000 ac-ft/yr (Keefer and McQuivey 1979). Withdrawing water from the Green River is another possible option.

5.5.2.2.3 Sunnyside. For this STSA, Keefer and McQuivey (1979) recommend constructing a reservoir on intermittent Minnie Maude Creek (estimated at 12,000 ac-ft/yr) or obtaining water from Price River (75,000 ac-ft/yr). However, Minnie Maude Creek falls far short of being able to support production at the proposed level, even with a reservoir.

Minnie Maude Creek and Price River are two streams in the vicinity of the Sunnyside STSA, with average annual flows of 12,000 ac-ft/yr and 75,000 ac-ft/yr, respectively. Minnie Maude Creek flows into the perennial Nine Mile Creek, which has a flow of 38,000 ac-ft/yr near its junction with the Green River (UDWR 1999) and 12,000 ac-ft/yr at an unspecified upstream point (Keefer and McQuivey 1979). Minnie Maude Creek was a designated TMDL impaired stream in 2006, and the water of the Price River may be of low quality (Keefer and McQuivey 1979). Both locations would require the transport of water over long distances and elevation increases to the STSA. Other creeks in the vicinity of the STSA include perennial creeks Dry Creek and Cottonwood Canyon. The UDWR (1999) does not provide flow data for these creeks. The intermittent headwaters of Range Creek are nearby, but flow is only 5,000 ac-ft/yr (UDWR 1999), and it is a state-classified Category 1 stream. The upper reaches of Nine Mile Creek, Dry Creek, and Cottonwood Creek drain the tar sands area and are classified as Category 5A impaired waters (UDEQ 2006). Groundwater in the area has high TDS.

Overall water resources in the Sunnyside vicinity are limited, as compared with the operational water consumption using surface mining and process technologies. The in situ combustion process uses much less water (about 4% of the average annual flow of Minnie Maude Creek) for potable use. Development of the tar sands in this area would likely degrade the surface water further and diminish the flow of the streams and their tributaries.

5.5.2.2.4 Tar Sand Triangle. The Dirty Devil River flows in the vicinity of the STSA. Mean flow for the Dirty Devil is about 74,000 ac-ft/yr, although it runs dry each summer for 1 to 2 months. Other creeks in the vicinity of the Tar Sand Triangle are the intermittent Horse Canyon and the perennial Big Water Canyon/Happy Canyon. No flow data are available on those (UDWR 2000). The STSA is situated in the eastern part of Lower Dirty Devil River groundwater basin. The Navajo Sandstone of Mesozoic age is a major aquifer in the basin (UDWR 2000). The extent and yield of the aquifer near the STSA are unclear. However, spring sites are found in the STSA area (UDWR 2000).

In situ combustion and steam injection technologies with conservation practices are likely capable of supporting a 20,000-bbl/day tar sands development site in the Tar Sand Triangle by using Dirty Devil River water. Other technologies could consume more than 5% of the Dirty Devil River mean flow. Other water sources may include the Colorado or Green Rivers.

5.5.2.2.5 Other STSAs. Other STSAs are expected to have water availability problems similar to those described above. The UDWR (1999, 2000) provides average annual flows for creeks and rivers in the STSA study areas. The available water rights to these flow systems have not been determined, and the given average flows are likely representative of downstream values rather than values in upland areas adjacent to (both areally and vertically) the STSAs.

For any reservoir project, Keefer and McQuivey (1979) note that losses due to evaporation and seepage would affect the amount of water available. Also, the use of reservoirs would change the flow of natural water bodies downstream of the reservoir and modify the erosional and depositional features of the river channels. Sedimentation would be enhanced along the stream channels upstream of the reservoirs. Discharge of treated or nontreated wastewater to a stream from the project site could potentially change the streamflow as well as the stream's water quality, especially during the low-flow season. Water rights would be a key issue for any intended use of groundwater or surface water.

5.5.3 Mitigation Measures

The potential impacts on water resources are closely related to the technologies used to mine, extract, process, and upgrade the bitumen from the tar sands. At the programmatic level, the impacts can be tremendously reduced starting from the planning stage. Local hydrologic conditions, including surface water and groundwater and the interactive relationship between them, must be characterized and considered in selecting areas for developmental sites, access roads, pipelines, transmission lines, and/or reservoirs. Sensitive areas should be avoided or receive special attention in tar sands development. Important factors include but are not limited to:

- Highly erodible geologic material;
- Steep terrain prone to soil erosion;
- Groundwater discharge and recharge areas; and
- River/stream segments that are sensitive to human impacts (such as streamflow, water quality, and channel modification) that can affect ecosystems.

In selecting the technologies to develop tar sands, the technologies that would minimize potential contaminant sources should be considered. Several important factors to reduce impacts on water resources include:

- Technologies that result in minimum footprint of disturbed areas;
- Technologies that have minimum total water consumption;

- Technologies that can use wastewater or brackish water in processing source rocks;

- Technologies that result in minimum disturbance between groundwater flow regimes to avoid cross flows between aquifers; and

- Technologies that have the highest recovery of tar sands, leaving spent material with the least amount of contaminants to be leached.

Other mitigation measures that the BLM might consider requiring, if warranted by the results of the lease-stage or plan of development–stage NEPA analyses, are related to engineering practices. They are as follows:

- Water should be treated and recycled as much as practical.

- The size of cleared and disturbed lands should be minimized as much as possible, and disturbed areas should be reclaimed as quickly as possible.

- Erosion controls that comply with county, state, and federal standards and BLM guidelines (Fogg and Hadley 2007; USFS Region 2 2000) should be applied.

- Existing roads and borrow pits should be used as much as possible.

- Earth material would not be excavated from, and excavated material would not be stored in, any stream, swale, lake, or wetland.

- Vegetated buffers would be maintained near streams and wetlands. Silt fences could be used along edges of streams and wetlands to prevent erosion and transport of disturbed soil, including spoil piles.

- Earth dikes, swales, and lined ditches could be used to divert work-site runoff that would otherwise enter streams.

- Topsoil removed during construction should be stockpiled and reapplied during reclamation. Practices such as jute netting, silt fences, and check dams should be applied near disturbed areas.

- Operators should identify unstable slopes and local factors that could induce slope instability (such as groundwater conditions, precipitation, earthquake potential, slope angles, and dip angles of geologic strata). Operators also should avoid creating excessive slopes during excavation and blasting operations. Special construction techniques should be used where applicable in areas of steep slopes, erodible soil, and stream channel or wash crossings.

- Existing drainage systems should not be altered, especially in sensitive areas such as erodible soils or steep slopes. Culverts of adequate size should be in compliance with applicable state and federal requirements and take the flow regime into consideration for temporary and permanent roads. Potential soil erosion should be controlled at culvert outlets with appropriate structures. Catch basins, roadway ditches, and culverts should be cleaned and maintained regularly.

- Runoff controls would be applied to disconnect new pollutant sources from surface water and groundwater.

- Foundations and trenches should be backfilled with originally excavated material as much as possible. Excess excavated material should be disposed of only in approved areas.

- When pesticides and herbicides are used, the goal would be to minimize unintended impacts on soil and surface water bodies. Common practices include but are not limited to (1) minimizing the use of pesticides and herbicides in areas with sandy soils near sensitive areas; (2) minimizing their use in areas with high soil mobility; (3) maintaining the buffer between herbicide and pesticide treatment areas and water bodies; (4) considering the climate, soil type, slope, and vegetation type in determining the risk of herbicide and pesticide contamination; and (5) evaluating soil characteristics prior to pesticide and herbicide application, to assess the likelihood of their transport in soil.

- Pesticides used should be limited to nonpersistent, immobile ones, and should only be applied in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

- An erosion and sedimentation control plan, as well as a surface water protection plan, should be prepared in accordance with federal and state regulations.

Adopting mitigation measures such as these does not mean that there would be no impacts on water resources. The exact nature and magnitude of the impacts would vary from project to project and would need to be examined in detail in future NEPA reviews of lease areas and project plans of development.

5.6 AIR QUALITY AND CLIMATE

5.6.1 Common Impacts

The potential for air quality impacts from commercial tar sands development, including ancillary facilities such as access roads, upgrading facilities, and pipelines, is directly related to the amount of land disturbance, drilling/mining operations, processing methods, and the quantity of oil and gas equivalent produced. Indirect effects, such as impacts resulting from secondary population growth, are also considered.

Impacts on air quality would occur in several ways, as described below.

- Temporary, localized impacts (primarily PM and SO_2, with some CO and NO_x emissions) would result from the clearing of the project area; grading, excavation, and construction of facilities and associated infrastructure; and mining (extraction) or drilling of the tar sands resource.

- Long-term, regional impacts (primarily CO and NO_x, with lesser amounts of PM, SO_2, and VOC emissions) would result from tar sands processing, upgrading, and transport (pipelines). Depending on location, meteorology, and topography, NO_x and SO_2 emissions could cause regional visibility impacts (through the formation of secondary aerosols) and contribute to regional nitrogen and sulfur deposition. In turn, atmospheric deposition could cause changes in sensitive (especially alpine) lake chemistry. In addition, depending on the amounts and locations of NO_x and VOC emissions, photochemical production of ozone (a very reactive oxidant) is possible, with potential impacts on human health and vegetation. Localized impacts due to emissions of HAPs (particularly benzene, toluene, ethylbenzene, xylene, and formaldehyde) and diesel PM could also present health risks to workers and nearby residents.

It is not possible to predict site-specific air quality impacts until actual tar sands projects are proposed and designed. Once such a proposal is presented, impacts on these resources would be further considered in project-specific NEPA evaluations and through consultations with the BLM prior to actual development.

The tar sands deposits that are in the study area for this PEIS are found only in the state of Utah. There are two tar sands–rich areas: one is in the Uinta Basin near Vernal, Utah, and the other is near Canyonlands and Capitol Reef National Parks in east central Utah. Table 5.6.1-1 identifies those counties where direct and indirect air pollutant emissions could result from tar sands development.

Impacts on air quality would be limited by applicable local, state, Tribal, and federal regulations, standards, and implementation plans established under the CAA and administered by the applicable air quality regulatory agency (e.g., the Utah Department of Environmental Quality-Division of Air Quality (UTDEQ-DAQ), with EPA oversight. Air quality regulations require that proposed new or modified existing air pollutant emission sources undergo a permitting review before their construction can begin. Therefore, the state agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees, and control devices prior to construction and/or operation. The U.S. Congress (through CAA Section 116) authorized local, state, and Tribal air quality regulatory agencies to establish air pollution control requirements that are more (but not less) stringent than federal requirements.

TABLE 5.6.1-1 Counties within the Tar Sands Study Area That Could Be Affected by Air Pollutant Emissions

			Estimated Population	
State	County	Land Area (mi^2)	July 1, 2001	July 1, 2005
Utah	Carbon	1,478	19,768	19,437
	Duchesne	3,238	14,563	15,354
	Emery	4,452	10,751	10,711
	Garfield	5,174	4,691	4,470
	Grand	3,682	8,490	8,743
	San Juan	7,820	13,607	14,104
	Uintah	4,477	25,773	26,995
	Utah	1,998	389,866	443,738
	Wasatch	1,177	16,172	18,974
	Wayne	2,460	2,529	2,450
Regional	Total	35,956	506,210	564,976

Source: U.S. Bureau of the Census (2007a,b).

All leases and approvals of plans of development will require lessees to comply with all applicable state, federal, or Tribal environmental regulations within the leased area, including air quality standards and implementation plans.

Before tar sands development could occur, additional project-specific NEPA analyses would be performed, subject to public and agency review and comment. The applicable air quality regulatory agencies (including the states and EPA) would also review site-specific preconstruction permit applications to examine potential projectwide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impact analyses or mitigation measures. Those evaluations would take into consideration the specific project features being proposed (e.g., specific air pollutant emissions and control technologies) and the locations of project facilities (including terrain, meteorology, and spatial relationships to sensitive receptors). Project-specific NEPA assessments would predict site-specific impacts, and these detailed assessments (along with BLM consultations) would result in the required actions by the applicant to avoid or mitigate significant impacts. Under no circumstances can the BLM conduct or authorize activities that would not comply with all applicable local, state, Tribal, or federal air quality laws, regulations, standards, or implementation plans.

Ongoing scientific research has identified the potential effects of so-called GHG emissions (including CO_2, CH_4, nitrous oxide, water vapor, and several trace gases) on global climate. Recent industrialization and burning of fossil carbon sources have caused CO_2 concentrations to increase dramatically and are likely to contribute to overall climatic changes. Increasing CO_2 concentrations also lead to preferential fertilization and growth of specific plant species. The assessment of GHG emissions and climate change is in its formative phase, and it is not yet possible to know with confidence the net impact on climate. However, the IPCC (2007) recently concluded that "warming of the climate system is unequivocal" and that "most of the observed increase in globally average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic [man-made] greenhouse gas concentrations."

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (Goddard Institute for Space Studies 2007). However, the northern latitudes (above 24°N—which includes all of the United States) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHG are likely to accelerate the rate of climate change. The direct emissions of climate change air pollutants from tar sands development facilities are likely to be a small fraction of global emissions.

The lack of scientific tools designed to predict climate change on regional or local scales limits the ability to quantify potential future impacts. However, potential impacts on air quality due to climate change are likely to be varied. For example, if global climate change results in a warmer and drier climate, increased particulate matter impacts could occur because of increased windblown dust from drier and less stable soils. Cool season plant species' spatial ranges are predicted to move north and to higher elevations, and extinction of endemic threatened and endangered plants may be accelerated. Because of the loss of habitat or competition from other species whose ranges may shift northward, the population of some animal species may be reduced. Less snow at lower elevations would be likely to impact the timing and quantity of snowmelt, which, in turn, could impact aquatic species.

5.6.1.1 Impacts from Emissions Sources for Tar Sands Facilities

To estimate total potential air pollutant emissions, emission factors for a specific activity must be identified and then multiplied by activity levels and engineering control efficiencies. The emission factors from proposed project activities would be estimated in future NEPA analyses by using appropriate equipment manufacturer's specifications, testing information, EPA AP-42 emission factor references (EPA 1995), and other relevant references. Anticipated levels of operational activities (e.g., load factors, hours of operation per year, and vehicle miles traveled) would be computed. Emission inventories would be made for selected years during the assumed plant life (including construction, operation, maintenance, and reclamation).

5.6.1.1.1 Construction. Mining and surface process technologies may include construction of a surface mine and mine bench, with primary crushing facilities, processing and upgrading facilities, spent material disposal areas, reservoirs for flood control, and a catchment dam below the disposal pile. For ICPs, considerable construction and preproduction development work includes extensive drilling and construction of upgrading/refining facilities.

Irrespective of surface or in situ technologies, additional construction activities include access roads, power distribution systems, pipelines, water storage and supply facilities, construction staging areas, hazardous materials handling facilities, housing, and auxiliary buildings.

Impacts on air quality associated with these construction activities include fugitive dust emissions and engine exhaust emissions from heavy equipment and commuting/delivery vehicles on paved and/or unpaved roads. Another emission source affecting air quality is wind erosion of soil disturbed by construction activities or from soil stockpiles.

5.6.1.1.2 Production. Emissions impacting air quality could result from surface operations (such as mining and crushing activities), processing (such as pyrolysis of the base material at high temperatures), upgrading of the hydrocarbon products, support utilities, and the disposal of waste products. Major processing steps for in situ processes would include heating the base material in place, extracting the liquid from the ground, and transporting the liquid to an upgrading/refining facility. Because in situ processing does not involve mining, with limited waste material disposal, such processing does not permanently modify land surface topography and, therefore, produces fewer air pollutant emissions.

5.6.1.1.3 Maintenance. Maintenance activities primarily include access road maintenance and periodic visits to facilities and structures away from the main facilities. The primary emissions that could affect air quality would be fugitive dust and engine exhaust emissions.

5.6.1.1.4 Reclamation. During reclamation activities, which proceed continuously throughout the life of the project, waste material disposal piles would be smoothed and contoured by bulldozers. Topsoil would be placed on the graded spoils, and the land would be prepared for revegetation by furrowing, mulching, etc. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion. Fugitive dust and engine exhaust emissions from reclamation activities are similar to those from construction activities, although with a lower level of activity.

5.6.1.1.5 Population Growth. Population growth and related emission increases associated with potential development would include those resulting from direct employment; employees of suppliers (e.g., equipment, materials, supplies, and services); consumers (e.g., additional retail stores); additional employees in federal, state, and local governments; and families.

5.6.1.1.6 Mobile (onroad and nonroad). Additional air pollutant emissions that could affect air quality would be associated with onroad mobile sources (e.g., cars, trucks, and buses) and nonroad mobile sources (e.g., graders and backhoes used in construction).

5.6.2 Mitigation Measures

Since all activities conducted or approved through use authorizations by the BLM must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future tar sands leasing and development would cause significant adverse air quality impacts.

However, on a case-by-case basis, future individual leases and use authorizations could include specific measures to minimize potential air quality impacts. These mitigation measures could include, but are not limited to (1) treating access roads with water or other surfactants to reduce fugitive dust from traffic; (2) reducing vehicle speeds on dirt roads to reduce fugitive dust from traffic; (3) specifying emission control devices on production equipment to reduce potential CO, NO_x, $PM_{2.5}$, PM_{10}, and VOC emissions; (4) specifying low-sulfur-content fuels to reduce potential SO_2 emissions; and/or (5) regulating the timing of emissions to reduce the formation of O_3 in the atmosphere from NO_x and VOC emissions.

In addition, to ensure that BLM-authorized activities comply with applicable ambient air quality standards as well as those applying to potential impacts on AQRVs (e.g., visibility, atmospheric deposition, and noise), specific monitoring programs may be established.

Potential global warming impacts could be reduced if tar sands–derived fuels were substituted for other fossil carbon-based energy sources, or if atmospheric loadings were reduced by emission controls or sequestration methods.

5.7 NOISE

Generic noise impacts from construction, operation, and reclamation of tar sands extraction facilities were estimated; however, detailed information on equipment types, schedules, layouts, and locations was not available at the programmatic level. When available, published estimates of noise impacts from technology assessments and EAs for facilities expected to be similar to those considered here were used as the basis for this assessment. Use of these existing studies required making reasonable assumptions and extrapolations. In addition, the lack of detailed information also precluded making quantitative estimates of the impacts from noise mitigation measures that might be applied, if warranted by the results of lease-stage and/or plan of development–stage NEPA analyses.

The characteristics of the area around a noise source influence the impacts caused by that source. However, sources produce the same amount of noise independent of their location; also, to a first approximation, noise propagates identically everywhere. At the programmatic level, information that could help differentiate between noise impacts in different locations is unavailable, as are estimates of the noise levels associated with some of the technologies. The approach taken here assesses the impacts of technologies. Noise levels are assumed to be independent of location. Thus, differences in impacts due solely to restrictions in areas available for leasing are not considered.

When published estimates for facilities were unavailable, simple noise modeling was used to estimate noise impacts (HMMH 1995). To predict an impact, the model requires that the noise level associated with the technology be assessed. Noise levels were not available for some technologies. In these cases, noise levels associated with similar technologies were used.

Published information was generally for a facility with a single capacity. Noise impacts were extrapolated by using a conservative approach equivalent to the 3-dBA rule of thumb.[2] For example, if noise levels were available for a reference facility producing 20,000 bbl/day, the noise impact of a 40,000-bbl/day facility was assumed to be 3 dBA higher, an assumption equivalent to locating two 20,000-bbl/day facilities at the same point.

Noise Modeling Parameters

All calculations:	
Ground type	Soft
For calculating L_{dn}:	
Daytime background noise level	40 dBA (typical of rural areas)
Nighttime background noise level	30 dBA (typical of rural areas)
Daytime hours	15 hours from 7 a.m. to 10 p.m.
Nighttime hours	9 hours from 10 p.m. to 7 a.m.

As is generally the practice, this PEIS uses the EPA guideline of 55 dBA (L_{dn}), deemed adequate to protect human health and welfare, as a significance criterion for assessing noise impacts (EPA 1974). However, tar sands development would occur mostly in remote rural locations. In these areas, background (already existing) noise levels are low (40 dBA during the day and 30 dBA during the night are representative levels), and an increase in noise levels to 55 dBA would be noticeable and annoying to people (Harris 1991). This guideline may not be appropriate for people seeking solitude or a natural, wilderness experience. Depending on ambient conditions, the activities being pursued by the receptors, and the nature of the sound, wildlife and human activities can be affected at levels below 55 dBA, but quantitative guidelines were unavailable. In addition, the NPS has determined that L_{dn} and L_{eq} alone are not appropriate for determining impacts in National Parks and typically uses audibility metrics to characterize impacts on humans and wildlife. Site-specific impacts on resources administered by the NPS would be assessed by using audibility-based metrics and other appropriate data and methodologies. See Sections 5.8 and 5.9 for impacts on wildlife and human aesthetic experiences, respectively, that could result from increased levels of noise.

2 A 3-dB change in sound level is considered barely noticeable on the basis of individuals' responses to changes in sound levels (NWCC 1998; MPCA 1999).

5.7.1 Common Impacts

Noise impacts from the construction and reclamation of tar sands facilities would be largely independent of the type of facility being constructed and are discussed below. Noise impacts from associated onroad vehicular traffic would also be largely independent of the facility type. Deviations from these general discussions are noted in the discussions of specific technologies. The noise from electric transmission lines and the product pipeline associated with these facilities is also discussed.

5.7.1.1 Construction

Construction would include a variety of activities, including building of access roads, grading, drilling, pouring concrete, trenching, laying pipe, cleaning up, revegetating, and perhaps blasting. With the exception of blasting, construction equipment constitutes the largest noise source at construction sites. Table 5.7.1-1 presents noise levels for typical construction equipment. For a programmatic assessment of construction impacts, it can be assumed that the two noisiest pieces (derrick crane and truck) would operate simultaneously and in close proximity to each other. Together these would produce a noise level of 91 dBA. Assuming a 10-hour workday, noise levels would exceed the EPA guideline of 55 dBA (L_{dn}) up to about 850 ft from the location where the equipment was operating. Construction impacts could last up to 2 years and could recur during the operational phase if additional processing facilities needed to be constructed.

TABLE 5.7.1-1 Noise Levels at Various Distances from Typical Construction Equipment

	Noise Level $L_{eq(1\text{-}h)}$[a] at Distances (dBA)					
Construction Equipment	50 ft	250 ft	500 ft	1,000 ft	2,500 ft	5,000 ft
Bulldozer	85	66	58	50	40	32
Concrete mixer	85	66	58	50	40	32
Concrete pump	82	63	55	47	37	29
Crane, derrick	88	69	61	53	43	35
Crane, mobile	83	64	56	48	38	30
Front-end loader	85	66	58	50	40	32
Generator	81	62	54	46	36	28
Grader	85	66	58	50	40	32
Shovel	82	63	55	47	37	29
Truck	88	69	61	53	43	35

[a] $L_{eq(1\text{-}h)}$ is the equivalent steady-state sound level that contains the same varying sound level during a 1-hour period.

Source: HMMH (1995).

If used, blasting would create a compressional wave with an audible noise portion. Potential impacts on the closest sensitive receptors could be determined, but most sensitive receptors, at least human sensitive receptors, would probably be located at a considerable distance from the construction sites.

5.7.1.2 Vehicular Traffic

Heavy-duty trucks produce most of the noise associated with vehicular traffic during construction.[3] Vehicular traffic includes hauling of materials, transport of equipment, delivery of water for fugitive dust control, and worker personal vehicles. Light-duty trucks, such as pickups and personal vehicles, produce less noise than heavy-duty trucks (10 passenger cars make about the same noise as a single heavy-duty truck on an L_{eq} basis). Except for short periods when workers are arriving at and leaving the construction site, heavy-truck traffic would dominate the vehicular traffic. Table 5.7.1-2 presents the noise impacts from heavy trucks estimated at various distances from a road for different hourly levels of truck traffic. For these estimates, a peak pass-by noise level from a heavy-duty truck operating at 35 mph was based on Menge et al. (1998) and a 10-hour working day. Except for locations very close to the road or with high traffic levels, noise levels would not exceed the EPA guideline level.

5.7.1.3 Surface Mining with Surface Retort

No well drilling would be required for surface mining with surface retort (see Section 5.7.1.1 for general construction impacts). This assessment relies on data on noise from a mine supporting a 20,000-bbl/day surface retort and its associated surface mine (Appendix B). Noise from the retort is expected to be 73 to 88 dBA at 50 ft, while noise from the

TABLE 5.7.1-2 Noise Levels at Various Distances from Heavy Truck Traffic

	Noise Level L_{dn} at Distances (dBA)[a]					
Hourly Number of Trucks	50 ft	75 ft	100 ft	125 ft	250 ft	500 ft
1	48	45	43	42	37	32
10	58	55	53	52	47	42
50	65	62	60	58	54	49
100	68	65	63	62	57	52

[a] Estimated assuming a 10-hour daytime shift and heavy trucks operating at 35 mph.

Source: Menge et al. (1998).

3 The average noise from a passing car is about 15 dBA less than that from a passing truck (BLM 2006a).

mine is expected to be about 61 dBA at 500 ft.[4] Both the retort and the mine would operate continuously. To be conservative, the higher noise level was used for the retort, and both sources were modeled at the same point. Table 5.7.1-3 presents the results. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts from surface mines and retorts should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

TABLE 5.7.1-3 Noise Levels from a Surface Mine with Surface Retort Site and a Surface Mine with Solvent Extraction Site

Plant Capacity (10^3 bbl/day)	Distance to L_{dn} of 55 dBA (ft)[a]
20	1,640

[a] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA.

5.7.1.4 Surface Mining with Solvent Extraction

No well drilling would be required for this technology (see Section 5.7.1.1 for general construction impacts). The noise levels for operation of this technology described in Appendix B are identical to those for surface mining with surface retorting. Noise impacts would be identical to those noted in Section 5.7.1.3.

5.7.1.5 In Situ Steam Injection

The BLM provides noise impact estimates for construction of a 30,000-bbl/day in situ steam injection tar sands processing facility (BLM 1984). At 250 ft, typical maximum construction noise was estimated to be 67 dBA. This estimate was revised to include the ground effects and to estimate L_{dn}, assuming 10 hours per day of construction time. The distance to where the L_{dn} noise level reached the EPA guideline level was modeled. Table 5.7.1-4 gives this distance for an in situ steam plant with a capacity of 20,000 bbl/day.

TABLE 5.7.1-4 Noise Levels from an In Situ Steam Injection Site

	Distance to L_{dn} of 55 dBA (ft)	
Plant Capacity (20,000 bbl/day)	Construction[a]	Operation[b]
20	300	1,860

[a] Assuming 10 hours per day for daytime construction, the estimated noise level at a given distance is about 58.7 dBA.

[b] Assuming 24 hours per day for continuous operation, the estimated noise level at a given distance is about 48.5 dBA.

During operation, the BLM (1984) estimated a maximum noise level of 78 dBA at 250 ft. This estimate was also revised by assuming 24 hours per day of operational time; the results are presented in Table 5.7.1-4. The reference noise levels were estimated by using a simple aggregation technique and ignoring the spatial separation of the sources. This practice will generally lead to overestimates of noise levels. In view of the potential for overestimation of these noise estimates, the potential noise impacts of in situ steam injection plants should be evaluated thoroughly.

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4 The reference estimate included only the effects of geometric spreading and is equivalent to a level of 81 dBA at 50 ft.

5.7.1.6 In Situ Combustion

On the basis of estimates in Daniels et al. (1981), a 20,000-bbl/day in situ combustion operation might have about 80 wells covering 160 acres operating at any time. The wells would be spaced about 330 ft apart. Daniels et al. (1981) did not specify the number of drilling rigs used during construction. For estimation purposes, it was assumed that 9 to 10 drilling rigs would be operating 10 hours per day. This situation was modeled as a square array of 9 sources, each separated by 800 ft. This arrangement would allow all 81 wells to be drilled while about the same separation between rigs would be maintained as they moved to new locations. The results indicate that the L_{dn} noise level would be reached at just under 500 ft, with a corresponding noise level of almost 59 dBA. (For additional construction impacts see Section 5.7.1.1.)

To estimate noise levels during operations, a square array of 81 pumps (one for each well) was modeled, and operation of 24 hours per day was assumed. The noise level for each pump was taken as 82 dBA at 50 ft (BLM 2000). The results indicated that the EPA L_{dn} guideline level might be exceeded to about 3,700 ft, with a corresponding noise level of 48 dBA. Given the distances at which the EPA guideline level might be exceeded, these results indicate that the potential noise impacts of in situ combustion should be evaluated thoroughly. If high noise impacts are projected, noise-reduction equipment such as mufflers, blowdown mutes, and pipe wrap and enclosures may be required (Daniels et al. 1981).

As indicated in Appendix B, in situ combustion is the only technology for possible deployment in the Tar Sand Triangle STSA. Much of the leasable land in this STSA is located within 3,000 to 6,000 ft of special designated areas such as potential ACECs and WSAs (see Figure 3.1.1-9). In addition, some part of the leasable lands lies within the Glen Canyon NRA and abuts with other lands in the NRA that are zoned for natural use. In all these areas, the intrusion of noise into the natural environment may be a particular concern with regard to the development of in situ combustion projects.

5.7.1.7 Reclamation

In general, noise impacts from reclamation activities would be similar to but less than those associated with construction activities because the activity type and level would be similar but shorter in duration. Most reclamation would also occur during the day when noise is better tolerated by people, and noise levels would return to background levels at night and would be intermittent in nature. Reclamation activities would last for a short period compared with the period of construction operations.

5.7.1.8 Transmission Lines

General construction impacts are discussed in Section 5.7.1.1. During operation, the main sources of noise from the transmission line would be substation noise and corona discharge. Substation noise comes primarily from transformers and switchgear. A transformer produces a constant low-frequency hum. The average A-weighted sound level at about 490 ft for a transformer of abut 400 MW is about 49 dBA (Wood 1992). The number and size of transformers are currently unknown, but a single transformer could exceed the EPA guideline at 500 ft. Transformer noise and mitigating measures must be addressed if substations are required along the transmission lines. Switchgear noise is generated when a breaker opens, producing an impulsive sound that is loud but of short duration. These sounds occur infrequently, and the industry trend is toward breakers that generate significantly less noise. The potential impacts of switchgear noise would be temporary, infrequent, and minor.

Transmission lines generate corona discharge, which produces a noise having a hissing or crackling character. During dry weather, transmission line noise is generally indistinguishable from background noise at the edge of typical ROWs. During rainfall, the level would be less than 47 dBA at 100 ft from the center of a 500-kV transmission line (BPA 1996). This is the noise level typical of a library (MPCA 1999). Even if several transmission lines of this capacity were required, the overall corona noise would be lost even in rural background noise within several hundred feet.

5.7.1.9 Pipeline

General construction impacts are discussed in Section 5.7.1.1. Depending on the topography, a pipeline 95 mi long could require several pump stations. Pumps will generally be the noisiest equipment associated with a pump station. Contra Costa County (2003) gives a noise level of 94 dBA at 3 ft from a 400-hp pump but does not specify the throughput. Assuming that three pumps would be needed, the EPA guideline would be exceeded to a distance of about 260 ft from the pumps. Pumps are almost always located in structures for protection from the weather and for security. The enclosure would reduce noise levels. Because the pumps that would be needed to move the assumed output may be larger and noisier than those assumed here, noise impacts would need to be assessed during planning for the actual pump stations.

5.7.2 Mitigation Measures

Regulatory requirements regarding noise already largely address the mitigation of impacts. To reinforce those regulatory requirements, mitigation measures will be required and could include those that follow.

5.7.2.1 Preconstruction Planning

- Developers should conduct a preconstruction noise survey to identify nearby sensitive receptors (e.g., residences, schools, child-care facilities, hospitals, livestock, ecological receptors of critical concern, and areas valued for solitude and quiet) and establish baseline noise levels along the site boundary and at the identified sensitive receptors.

- On the basis of site-specific considerations identified through the preconstruction noise survey, proponents should develop a noise management plan to mitigate noise impacts on the sensitive receptors. The plan would cover construction, operations, and reclamation. The plan should ensure that the standards to be implemented reflect conditions specific to the lease site. This plan could provide for periodic noise monitoring at the facility boundary and at nearby sensitive receptors on a monthly or more frequent basis at a time when the facility is operating at normal or above-normal levels. Monitoring results could be used to identify the need for corrective actions in existing mitigation measures or the need for additional noise mitigation.

5.7.2.2 Construction and Reclamation

Wherever there are sensitive receptors, as identified in the preconstruction survey, construction noise should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to receive any noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- General construction activities could be limited to daytime hours between 7 a.m. and 7 p.m. On the basis of the results of the baseline noise survey, these hours could be extended to between 7 a.m. and 10 p.m. in areas remote from sensitive receptors.

- Particularly noisy activities, such as pile driving, blasting, and hauling by heavy trucks, could be limited to daytime hours between 8 a.m. and 5 p.m. on weekdays and prohibited on weekends and state and federal holidays. The noise management plan could identify alternate methods for conducting noisy activities and available mitigation methods. The least noisy of these could be chosen for use during construction unless its use was precluded by site-specific characteristics.

- When feasible, different particularly noisy activities could be scheduled to occur at the same time, since additional sources of noise generally do not add significantly to the perceived noise level. That is, less-frequent noisy activities may be less annoying than frequent less-noisy activities.

- If blasting or other impulsive-noise activities are required, nearby sensitive human receptors could be notified in advance.

- All construction equipment should have sound control devices that are no less effective than those provided on the original equipment. Construction equipment and the equipment's sound control devices could be required to be well tuned, in good working order, and maintained in accordance with the manufacturer's specifications. Appropriate record keeping of these maintenance activities could be required.

- Where possible, construction traffic could be routed to minimize disruption to sensitive receptors.

- Temporary barriers could be erected around areas where construction noise could disturb sensitive receptors.

- To the extent possible, stationary noisy equipment (such as compressors, pumps, and generators) could be located as far as practicable from sensitive receptors.

5.7.2.3 Operation

Wherever there are sensitive receptors, as identified in the preconstruction survey, noise from operations should be managed to the extent necessary to mitigate adverse impacts on the sensitive receptors. Efforts to mitigate these impacts could include the following measures:

- A noise complaint manager could be designated to handle noise complaints from the public. This employee could have the responsibility and authority to convene a committee to investigate noise complaints, determine the causes of the noise leading to the complaints, and recommend mitigation measures.

- Noisy equipment (such as compressors, pumps, and generators) could be required to incorporate noise-reduction features such as acoustic enclosures, mufflers, silencers, and intake noise suppression.

- Facilities could be required to demonstrate compliance with the EPA's 55-dBA guideline at the nearest human sensitive receptor. Sensitive ecological receptors and appropriate associated lower noise levels could also be considered. In special areas where quiet and solitude have been identified as a value of concern, a demonstration that a lower noise level would be attained might be required. Such demonstrations might require use of additional or different criteria such as audibility.

- Depending on the specific site, maintenance of off-site noise at suitable levels might require the establishment of an activity-free buffer inside the fence line.

- Facility design could include all feasible noise-reduction methods, including, but not limited to, mounting equipment on shock absorbers; mufflers or silencers on air intakes, exhausts, blowdowns, and vents; noise barriers; noise-reducing enclosures; noise-reducing doors and windows; sound-reducing pipe lagging; and low-noise ventilation systems.

- Where feasible, facility design could be required to incorporate low-noise systems such as ventilation systems, pumps, generators, compressors, and fans.

5.8 ECOLOGICAL RESOURCES

5.8.1 Common Impacts

5.8.1.1 Aquatic Resources

Impacts on aquatic resources from the tar sands development projects and associated facilities could occur because of (1) direct disturbance of aquatic habitats within the footprint of construction or operation activities; (2) sedimentation of nearby aquatic habitats as a consequence of soil erosion from operational areas; (3) changes in water quantity or water quality as a result of construction (e.g., grading that affects surface runoff patterns) and operations (e.g., reductions or increases in discharges of water into nearby aquatic habitats), or releases of chemical contaminants into nearby aquatic systems; or (4) development of infrastructure such as roads and ROWs that increase public access to fishery resources. These impacts could occur to some degree during the construction period and throughout the operational life of the projects. In addition, some impacts could continue to occur beyond the operational life of the project. Potential impacts on aquatic resources from various impacting factors associated with tar sands development are discussed below and are summarized in Table 5.8.1-1. The potential magnitudes of the impacts that could result from tar sands development are presented separately for aquatic invertebrates and for fish. Potential impacts on federally listed, state-listed, and BLM-designated sensitive aquatic species are presented in Section 5.8.1.4, and potential impacts on other types of organisms that could occur in aquatic habitats (e.g., amphibians and waterfowl) are presented in Section 5.8.1.3.

Depending on the characteristics of specific development projects, new aquatic habitats could be formed after site development. For example, over time, drainage patterns associated with sediment control ponds that caught runoff from disturbed surfaces could create habitats that would support aquatic plants and invertebrates as well as fish. Although the development of such habitats could be beneficial in some instances, their ecological value would depend on the amount of habitat created and the types and numbers of species supported. In general, it is anticipated that the ecological value of these created habitats would be limited. Habitats that promoted the survival and expansion of non-native aquatic species that competed with or preyed upon native species could have negative ecological impacts on existing aquatic habitats.

TABLE 5.8.1-1 Potential Impacts on Aquatic Resources Resulting from Commercial Tar Sands Development

Impact Category	Potential Magnitude of Impacts According to Organism Group[a]	
	Aquatic Invertebrates	Fish
Sedimentation from runoff	Large	Large
Water depletions	Large	Large
Changes in drainage patterns	Small	Small
Disruption of groundwater flow patterns	Moderate	Moderate
Temperature increases in water bodies	Moderate	Moderate
Increases in salinity	Small	Small
Introduction of nutrients	Small	Small
Oil and contaminant spills	Moderate	Large
Movement/dispersal blockage	Small	Small
Increased human access	Small	Small

[a] Potential impact magnitude (without mitigation) is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 30%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a local population, and result in a large measurable change in carrying capacity or population size in the affected area.

Turbidity and sedimentation from erosion are part of the natural cycle of physical processes in water bodies, and most populations of aquatic organisms have adapted to short-term changes in these parameters. However, if sediment loads are unusually high or last longer than they would under natural conditions, adverse impacts could occur (Waters 1995). Increased sediment loads could suffocate aquatic vegetation, invertebrates, and fish; decrease the rate of photosynthesis in plants and phytoplankton; decrease fish feeding efficiency; decrease the levels of invertebrate prey; reduce fish spawning success; and adversely affect the survival of incubating fish eggs, larvae, and fry (Waters 1995). The addition of fine sediment to aquatic systems is considered a major factor in the degradation of stream fisheries (Waters 1995). Thus, although the organisms in many aquatic systems are capable of coping with smaller, short-term increases in sediment loads, exceeding (largely unmeasured) threshold levels or durations would be expected to have detrimental effects on the affected aquatic ecosystems.

The potential for soil erosion and sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed areas at any given time, and the proximity to aquatic habitats. The presence of riparian vegetation buffers along waterways helps control sedimentation in waterways because it reduces erosion by binding soil, due to the presence of root systems, and by dissipating water energy of surface runoff during high flow events. Vegetation also helps to trap sediment contained in surface runoff. Consequently, tar sands development activities that affect the presence or abundance of riparian vegetation would be expected to increase the potential for sediment to enter adjacent streams, ponds, and reservoirs. Because fine sediments may not quickly settle out of solution, impacts of sediment introduction to stream systems could extend downstream for considerable distances.

It is anticipated that areas being actively disturbed during construction or operations would have a higher erosion potential than areas that are undergoing reclamation activities, and that reclamation areas would become less prone to erosion over time because of completion of site grading and reestablishment of vegetated cover. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential. In addition to areas directly affected by construction and operations, surface disturbance could occur as a result of the development of access roads, utility corridors, and employer-provided housing. Implementation of measures to control erosion and runoff into aquatic habitats (e.g., silt fences, retention ponds, runoff-control structures, and earthen berms) would reduce the potential for impacts from increased sedimentation.

Changes in flow patterns of streams and depletion of surface water within tar sands development areas could affect the quality of associated aquatic habitats and the survival of populations of aquatic organisms within affected bodies of water. Most obviously, perhaps, complete dewatering of streams or stream segments would preclude the continued presence of aquatic communities within the affected areas. However, changes in flows and flow patterns could affect the nature of the aquatic communities that are supported, even if there is not complete dewatering. Reductions in flow levels can result in depth changes and reductions in water quality (e.g., water temperatures and dissolved oxygen levels) that some species of fish and invertebrates may be unable to tolerate. Reduced depths can also affect the susceptibility of some fish species to predation from avian and terrestrial predators. Depending upon the magnitude of the water depletion in a particular waterway, aquatic habitat in all downstream portions of a watershed could be affected.

Aquatic organisms have specific temperature ranges within which survival is possible, and exceeding those temperatures, even for short periods, can result in mortality. In addition, aquatic organisms such as fish and macroinvertebrates use oxygen dissolved in the water to breathe, and if dissolved oxygen levels fall below the tolerances of those organisms they will be unable to survive unless there are areas with suitable conditions nearby. The level of dissolved oxygen in water is highly dependent on temperature, and the amount of oxygen that can dissolve in a given volume of water (i.e., the saturation point) is inversely proportional to the temperature of water. Thus, with other chemical and physical conditions being equal, the warmer the water, the less dissolved oxygen it can hold. In the arid regions where the tar sands deposits described in this PEIS are found, surface water temperatures during hot summer months can approach lethal limits and the resulting depressed dissolved oxygen levels are often already near the lower limits for many of the aquatic species that are present, especially in some of the smaller streams. Consequently, increasing water temperatures even slightly may, in some cases, adversely affect survival of aquatic organisms such as fish and mussel species in the affected waterways.

Tar sands development activities could affect water temperatures through removal of surface vegetation, especially riparian vegetation, and by reducing streamflows or inputs of cooler groundwater into nearby waterways due to water depletions. Removing vegetation alters the amount of shading of the earth's surface and increases the temperature of overlying waters or surface water runoff. Fish typically avoid elevated temperatures by moving to areas of groundwater inflow, to deeper holes, or to shaded areas where water temperatures are lower. If temperatures exceed thermal tolerances for extended periods and no refuge is available, fish kills may result. The level of thermal impact associated with clearing of riparian vegetation would be expected to increase as the amount of affected shoreline increases. The potential for water depletions to affect surface water temperatures by depressing groundwater flows is not easily predicted, although as the proportion of groundwater discharge decreases, surface water temperatures during critical summer months would be expected to increase. Water depletions in the Colorado River Basin are of particular concern to native fish in the basin, including the four endangered Colorado River Basin fish species (humpback chub, razorback sucker, Colorado pikeminnow, and bonytail). As identified in Section 5.8.1.4, any water depletions from the upper Colorado River Basin are considered an adverse effect on endangered Colorado River fishes.

As identified in Section 5.5.1.1, surface disturbance in the tar sands areas could also negatively affect water quality by increasing the salinity of surface waters in downstream areas. Depending upon the existing salinity levels and the types of aquatic organisms present in receiving waters, such increases could affect species composition in affected areas. The potential for surface disturbance to increase salinity levels in surface waters would decrease as the distance between disturbed areas and waterways increases (Section 5.5.1.1). Once salts have entered waterways, they are not generally removed from solution. Consequently, salinity tends to increase with increasing downstream distance in a watershed, representing the accumulation of salt from many different sources. Section 5.5.3 identifies a number of potential mitigation measures that could be implemented to reduce the potential for negative effects on water quality from salinity due to tar sands development.

Nutrients (especially dissolved nitrogen and phosphorus) are required in small quantities for the growth and survival of aquatic plants. When the levels of nutrients become excessive, plant growth and decay are promoted. This, in turn, may favor the survival of certain weedy species over others and may result in severe reductions in water quality aspects such as oxygen levels. As discussed in Section 5.11, tar sands development could result in increases in human populations within the immediate area of specific developments and within the region as a whole. If these population increases resulted in increased nutrient loading of streams due to additional inputs from sewage treatment facilities, survival of some aquatic species could be affected and changes in biodiversity could result. Depending upon the magnitude of nutrient inputs, aquatic habitat in extended downstream portions of a watershed could be affected.
The loss of native freshwater mussel species in some aquatic systems has been partially attributed to increases in nutrient levels (Natural Resources Conservation Service and Wildlife Habitat Council 2007). Because the water quality of effluents from such facilities is typically

regulated under permits issued by state agencies, negative impacts on aquatic systems from increases in nutrient levels are expected to be small.

Contaminants could enter aquatic habitats as a result of leachate runoff from exposed tar sands deposits, including spent tar sands; the accidental release of fuels, lubricants, or pesticides; or spills from pipelines used to transport petroleum products from the site. Both raw and spent tar sands remaining on the surface could become a chronic source of contaminated runoff unless adequate containment measures are implemented or unless they are transported off-site for disposal. Tar sands development sites would be subject to stormwater management permits and the application of BMPs that would control the quality and quantity of runoff entering nearby aquatic habitats. Exposure to the leachate from tar sands and spent tar sands tailings has been shown to reduce the survival of some fish and aquatic invertebrate species if the concentrations are high enough (Siwik et al. 2000; Sik-Cheung et al. 2001; Colavecchia et al. 2004). Thus, spent tar sands returned to surface mine pits following processing could affect aquatic resources if they result in contaminants entering surface waters via surface runoff or groundwater. Spent tar sands remaining underground following in situ combustion or steam injection could similarly contaminate aquatic habitats if groundwater passes through these spent sands deposits and later enters surface waters. Because the resulting concentrations in aquatic habitats would depend largely on the dilution capability, and, therefore, the flow of the receiving waters, impacts would be more likely if runoff from spent tar sands deposits entered small perennial streams than if it entered larger streams.

Toxic materials (e.g., fuels, lubricants, and herbicides) could also be accidentally introduced into waterways during construction and maintenance activities or as a result of leaks from pipelines used to transport petroleum products from the project site to collection areas. The level of impacts from releases of toxic materials would depend on the type and volume of chemicals entering the waterway, the location of the release, the nature of the water body (e.g., size, volume, and flow rate), and the types and life stages of organisms present in the waterway. In general, lubricants and fuel would not be expected to enter waterways in detrimental quantities as long as (1) heavy machinery is not used in or near waterways, (2) fueling locations for construction and maintenance equipment are situated away from waterways, and (3) measures are taken to control spills that occur. Because tanker trucks are often used to transport petroleum products from collection sites, there is a potential for roadway accidents to release toxicants into adjacent waterways. Such releases could result in substantial mortality of fish and of the aquatic biota.

In areas where access roads, pipelines, or utility corridors cross streams, obstructions to fish movement could occur if culverts, low-water crossings, or buried pipelines are not properly installed, sized, or maintained. During periods of low water, vehicular traffic can result in rutting and accumulation of cobbles in some crossings that can interfere with fish movements. In streams with low flows, flow could become discontinuous if disturbance of the streambed during construction activities results in increased porosity or if the altered channel spreads across a wider area. Restrictions on fish movement would likely be most significant if they occurred in streams that support species that need to move to specific areas in order to reproduce.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. Fisheries could be impacted by increased fishing pressure, and other human activities (e.g., OHV use) could disturb riparian vegetation and soils, resulting in erosion, sedimentation, and potential impacts on water quality, as discussed above. Such impacts would be smaller in locations where existing access roads or utility corridors that already provide access to waterways would be utilized. Because all of the proposed projects would require similar levels of infrastructure that could result in increased public access, the level of impact would be similar regardless of the technology used. Overall, it is anticipated that impacts on fishery resources from increased access would be minor. Tar sands development also has the potential to affect fishing pressure in locations outside the immediately affected watershed if the development results in a loss of current fishing opportunities, either because developed locations become unavailable or because development results in decreases in catchable fish within adjacent or downstream areas. In such cases, displaced anglers could utilize nearby reservoirs or other streams or rivers, resulting in greater exploitation of fishery resources in those waterways. If water depletions associated with tar sands development affect water storage within reservoirs in nearby areas, fishing opportunities in those reservoirs could be affected.

5.8.1.2 Plant Communities and Habitats

Potential impacts on terrestrial, riparian, and wetland plant communities and habitats from activities associated with tar sands development would include direct impacts from habitat removal, as well as a wide variety of indirect impacts. Impacts would be incurred during initial site preparation and continue throughout the life of the project, extending over a period of several decades. Some impacts may also continue beyond the termination of asphalt or syncrude production. The potential magnitude of the impacts that could result from tar sands development is presented for different habitat types in Table 5.8.1-2.

Direct impacts would include the destruction of habitat during initial land clearing on the lease site, as well as habitat losses resulting from the construction of ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing. Land clearing on the site would be required for the construction of processing facilities, storage areas for soil and spent tar sands, and excavation areas. Land clearing would also occur incrementally throughout the life of the project, resulting in continued losses of habitat. Storage of woody vegetation cleared from project areas would impact additional areas of vegetation. Native vegetation communities present in project areas would be destroyed. Riparian habitats or wetlands may be affected by ROWs that cross streams or other water bodies. E.O. 11990, “Protection of Wetlands,” requires all federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (U.S. President 1977). Impacts on jurisdictional wetlands (those under the regulatory jurisdiction of the CWA, Section 404, and the USACE) on or near the project site or locations of ancillary facilities would be avoided or mitigated. Preconstruction surveys would identify wetland locations and boundaries, and the permitting process would be initiated with the USACE for unavoidable impacts.

TABLE 5.8.1-2 Potential Impacts on Plant Communities Resulting from Commercial Tar Sands Development

	Potential Magnitude of Impacts According to Habitat Type[a]	
Impact Category	Upland Plants	Wetland and Riparian Plants
Vegetation clearing	Large	Large
Habitat fragmentation	Moderate	Moderate
Dispersal blockage	Moderate	Moderate
Alteration of topography	Moderate	Large
Changes in drainage patterns	Moderate	Large
Erosion	Large	Large
Sedimentation from runoff	Large	Large
Oil and contaminant spills	Moderate	Large
Fugitive dust	Moderate	Moderate
Injury or mortality of individuals	Large	Large
Human collection	Moderate	Moderate
Increased human access	Moderate	Moderate
Fire	Large	Large
Spread of invasive plant species	Large	Large
Air pollution	Moderate	Moderate
Water depletions	Small	Large
Disruption of groundwater flow patterns	Small	Moderate
Temperature increases in water bodies	None	Moderate

[a] Potential impact magnitude (without mitigation) is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of a plant community or local species population (less than 10%), and does not result in a measurable change in community characteristics or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of a plant community or local species population (10 to 30 %), and result in a measurable but moderate (not destabilizing) change in community characteristics or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a plant community or local species population, and result in a large, measurable, and destabilizing change in community characteristics or population size in the affected area.

Reclamation of impacted areas would include reestablishment of vegetation on restored soils. Although revegetation of disturbed soils in many locations may successfully establish a productive vegetation cover, with biomass and species richness similar to those of local native communities, the resulting plant community may be quite different from native communities in species composition and the representation of particular vegetation types, such as shrubs (Newman and Redente 2001). Community composition of revegetated areas would likely be greatly influenced by the species that are initially seeded, particularly perennial grasses, and colonization by species from nearby native communities may be slow (Newman and Redente 2001; Paschke et al. 2005; Belnap and Herrick 2006). The establishment of mature native plant communities may require decades. Successful reestablishment of some vegetation types, such as shrubland communities, may be difficult and would require considerable periods of time, likely more than 20 years. Restoration of plant communities in STSAs with arid climates (generally averaging less than 9 in. of annual precipitation), such as shadscale-saltbush communities, may be very difficult (Monsen et al. 2004). Although vegetation within ROWs would become reestablished, ROW management programs may prevent the establishment of mature native communities. Areas along ROWs that would be impacted by ROW construction would be restored in the same manner as other disturbed project areas. The loss of intact native plant communities could result in increased habitat fragmentation, even with the reclamation of impacted areas.

Disturbed soils may provide an opportunity for the introduction and establishment of non-native invasive species. Seeds or other propagules of invasive species may be inadvertently brought to a project site from infested areas by heavy equipment or other vehicles used at the site. Invasive species may also colonize disturbed soils from established populations in nearby areas. The establishment of invasive species may greatly reduce the success of the establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. In addition, the planting of non-native species in reclaimed areas may result in the introduction of those species into nearby natural areas. The establishment of invasive species may alter fire regimes, including an increase in the frequency and intensity of wildfires, particularly from the establishment of annual grasses such as cheatgrass. Native species, particularly shrubs, which are not adapted to frequent or intense fires, may be adversely affected and their populations may be reduced.

Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. Impacts on surface water and groundwater systems, which subsequently affect terrestrial plant communities, wetlands, and riparian areas, are described in Section 5.5. Deposition of fugitive dust, including associated salts, generated during clearing and grading, construction, and use of access roads or resulting from wind erosion of exposed soils, could reduce photosynthesis and productivity in plants near project areas and could result in foliar damage. Plant community composition could be subsequently altered, resulting in habitat degradation. In addition, pollinator species could be affected by fugitive dust, potentially reducing pollinator populations in the vicinity of a tar sands project. Temporary, localized effects on plant populations and communities could occur if seed production in some plant species is reduced. Soil compaction could reduce the infiltration of precipitation or snowmelt and, along with reduced vegetation cover, result in increased runoff and subsequent erosion and sedimentation. Reduced infiltration and altered surface runoff and drainage characteristics could result in changes in soil moisture characteristics, reduced recharge of shallow groundwater systems, and changes in the hydrologic regimes of downgradient streams and associated wetlands and riparian areas. Soils on steep slopes, such as those that occur in many STSAs, could be particularly susceptible to increased erosion resulting from changes in stormwater flow patterns.

Erosion and reductions in soil moisture could alter affected terrestrial plant communities adjacent to project activities, resulting in reduced growth and reproduction. Altered hydrologic regimes, particularly reductions in the duration, frequency, or extent of inundation or soil saturation (potentially resulting from elimination of ephemeral or intermittent streams), could result in species or structural changes in wetland or riparian communities, changes in distribution, or reduction in community extent. Increased volumes or velocities of flows could affect wetland and riparian habitats, thereby removing fine soil components, organic materials, and shallow-rooted plants. Large-scale surface disturbance that reduces infiltration may increase flow fluctuations, reduce base flows, and increase flood flows, resulting in impacts on wetland and riparian community composition and extent. Sedimentation, and associated increases in dissolved salts, could degrade wetland and riparian plant communities. Effects may include reduced growth or mortality of plants, altered species composition, reduced biodiversity, or, in areas of heavy sediment accumulation, reduction in the extent of wetland or riparian communities. Disturbance-tolerant species may become dominant in communities affected by these changes in hydrology and water quality. Increased sedimentation, turbidity, salt loading, or other changes in water quality may provide conditions conducive to the establishment of invasive species.

Alterations of groundwater flow or quality in project areas, such as during tar sands extraction or in situ processing, may affect wetlands and riparian areas that directly receive groundwater discharge, such as at springs or seeps, or that are present in streams with flows maintained by groundwater. Wetland and riparian communities far downgradient from tar sands extraction or retorting activities may be affected by reduced flows or reduced water quality. Flow reductions in alluvial aquifers from tar sands extraction, water withdrawals, or pipeline installation may also result in reductions, or changes in community composition, in wetland or riparian communities associated with streams receiving alluvial aquifer discharge. Water withdrawals from surface water features, such as rivers and streams, may reduce flows and water quality downstream, which may, in turn, reduce the extent or distribution of wetlands and riparian areas along these water bodies or degrade these plant communities. The construction of reservoirs would also affect downstream wetlands and riparian areas by reducing flows and sediment transport and increasing salt loading. Wetlands and riparian areas within the area of the reservoir and dam would be lost.

Plant communities and habitats could be adversely affected by impacts on water quality, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Leachate from stockpiles of spent tar sands or overburden may adversely affect terrestrial (such as phreatophytic), riparian, or wetland plant communities as a result of impacts on surface water or groundwater quality. Produced water from tar sands retorting or saline water pumped from lower aquifers, if discharged on the land surface, may result in impacts on terrestrial, riparian, or wetland communities because of reduced water quality. Herbicides used in ROW maintenance could be carried to wetland and riparian areas by surface runoff or may be carried to nearby terrestrial communities by air currents. Impacts on surface water quality from deposition of atmospheric dust or pollutants from equipment exhaust could degrade terrestrial, wetland, and riparian habitats. Accidental spills of chemicals, fuels, or oil would adversely affect plant communities. Direct contact with contaminants could result in mortality of plants or degradation of habitats. Spills could impact the quality of shallow groundwater and indirectly affect terrestrial plants.

Oil shale endemic species that occur in STSAs would be potentially subject to the direct and indirect impacts described above. Habitats occupied by these species could be degraded or lost, and individuals could be destroyed. Local populations could be reduced or lost as a result of tar sands development activities. Establishment and long-term survival of these species on reclaimed land may be difficult. The potential introduction and spread of noxious weed species from project areas into the habitat of oil shale endemics could threaten local populations. In addition, the increased accessibility resulting from new roads could result in increased impacts from human disturbance or collection. Because of the generally small, scattered populations of oil shale endemics, impacts could result in greater consequences for these species than for commonly occurring species. However, many oil shale endemics are federally listed, state-listed, or BLM-designated sensitive species, and are protected by applicable federal or state requirements and agency policies.

5.8.1.3 Wildlife (Including Wild Horses and Burros)

All tar sands leasing projects that would be constructed and operated have the potential to affect wildlife, including wild horses (*Equus caballus*) and burros (*E. asinus*), over a period of several decades. Reclamation that would occur in parallel with or after extraction activities are completed would reduce or eliminate ongoing impacts to the extent practicable by recreating habitats and ecological conditions that could be suitable to wildlife species. The effectiveness of any reclamation activities would depend on the specific actions taken; the best results, however, would occur where original site topography, hydrology, soils, and vegetation patterns could be reestablished. However, as discussed in Section 5.8.1.2, this reestablishment may not be possible in all situations.

The following discussion provides an overview of the potential effects on wildlife that could occur from the construction and operation of a tar sands project. The use of mitigation measures and standard operating procedures (e.g., predisturbance surveys, erosion and dust suppression control practices, establishment of buffer areas, reclamation of disturbed areas using native species, and netting of on-site ponds) would reduce impacts on wildlife species and their habitats. The specifics of these practices would be established through consultations with federal and state agencies and other stakeholders.

Impacts on wildlife from tar sands projects could occur in a number of ways and are related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement; (3) mortality; and (4) increase in human access. These can result in changes in habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminants.

Wildlife may also be affected by human activities that are not directly associated with the tar sands project or its workforce but that are instead associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal harvest and an increase of invasive vegetation, and (2) an increase in the incidence of fires.

Wildlife impacts from the impacting factors discussed below are summarized in Table 5.8.1-3. The potential magnitude of the impacts that could result from tar sands development is presented for representative wildlife species types. Impacts are designated as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population, and result in a measurable but moderate change (less than 50%) in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 50% of a local population, and result in a large measurable change (50% or more) in carrying capacity or population size in the affected area.

5.8.1.3.1 Habitat Disturbance. The reduction, alteration, or fragmentation of habitat would result in a major impact on wildlife. Habitats within the construction footprint of the projects, utility ROWs, access roads, and other infrastructure would be destroyed or disturbed. The amount of habitat impacted would be a function of the degree of disturbance already present in the project site area. With certain exceptions, areas lacking vegetation (e.g., operational areas, access roads, and active portions of tar sands mining) provide minimal habitat. The construction activities associated with the projects would not only result in the direct reduction or alteration of wildlife habitat within the project footprint but could also affect the diversity and abundance of area wildlife through habitat fragmentation. Habitat fragmentation causes both a loss of habitat and habitat isolation.

A decline in wildlife use near roads or other facilities would be considered an indirect habitat loss. Avoidance of habitat associated with roads has been reported to be 2.5 to 3.5 times as great as the actual habitat loss associated with the road's footprint (Reed et al. 1996). Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) may avoid areas up to 0.40 km (0.25 mi) from a project area (BLM 2006c). Similarly, bird nesting may be disrupted within 0.40 km (0.25 mi) of construction activities during the nesting and brooding periods (e.g., February 1 to August 25) (BLM 2006a). Road avoidance by wildlife could be greater in open landscapes compared with forested landscapes (Thomson et al. 2005). Mule deer use declined within 2.7 to 3.7 km (1.7 to 2.3 mi) of gas well pads, suggesting that indirect habitat loss can be larger than direct habitat loss (Sawyer et al. 2006). Density of sagebrush obligates, particularly Brewer's sparrow (*Spizella breweri*) and sage sparrow (*Amphispiza belli*), was reduced 39 to 60% within a 100-m (328-ft) buffer around dirt roads with low traffic volumes. The declines may have been due to a combination of traffic, edge effects, habitat fragmentation, and increases in other passerine species along road corridors. Thus, declines may persist until roads are fully reclaimed (Ingelfinger and Anderson 2004). Those individual animals that make use of areas within or adjacent to project areas could be subjected to increased physiological stress. This combination of avoidance and stress reduces the capability of wildlife to use habitat

TABLE 5.8.1-3 Potential Impacts on Wildlife Species Resulting from Commercial Tar Sands Development

	Potential Magnitude of Impacts According to Species Type[a]						
Impact Category	Amphibians and Reptiles	Shorebirds and Waterfowl	Land Birds	Raptors	Small Game and Nongame Mammals	Big Game Mammals	Wild Horses and Burros
Vegetation clearing	Large	Small	Large	Large	Large	Large	Large
Habitat fragmentation	Moderate	Small	Moderate	Moderate	Moderate	Moderate	Moderate
Blockage of movement and dispersal	Moderate	Small	Small	Small	Moderate	Moderate	Moderate
Alteration of topography and drainage patterns	Small	Small	Small	Small	Small	Small	Small
Water depletions	Large	Large	Moderate	Moderate	Moderate	Moderate	Moderate
Stream impoundment and changes in flow pattern	Large	Large	Large	Large	Large	Large	Large
Erosion and sedimentation	Small	Small	Small	Small	Small	Small	Small
Contaminant spills	Small	Small	Small	Small	Small	Small	Small
Fugitive dust	Small	Small	Small	Small	Small	Small	Small
Injury or mortality	Moderate	Moderate	Large	Moderate	Large	Large	Moderate
Collection	Large	Large	Small	Small	Small	Small	Small
Human disturbance/harassment	Small	Moderate	Large	Large	Large	Large	Large
Increased predation rates	Moderate	Moderate	Moderate	Small	Moderate	Moderate	Small
Noise	Small	Large	Large	Large	Large	Large	Large
Spread of invasive plant species	Small	Small	Moderate	Small	Moderate	Small	Small
Air pollution	Small	Small	Small	Small	Small	Small	Small
Fire	Small	Small	Moderate	Small	Moderate	Small	Small

[a] Potential impact magnitude (without mitigation) is presented as small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population (10 to 30%), and result in a measurable but moderate (not destabilizing) change in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a local population, and result in a large, measurable, and destabilizing change in carrying capacity or population size in the affected area.

effectively (WGFD 2004). As noise and human presence are reduced (e.g., as may occur following the switch from construction to operation), wildlife may increase their use of otherwise suitable habitats, although probably not at the same levels as before disturbance began (BLM 2006d).

Some species, such as the common raven (*Corvus corax*), are more abundant along roads because of automobile-generated carrion, whereas ravens and other raptors are more common along transmission lines because of the presence of perch and nest sites (Knight and Kawashima 1993).

Displaced animals would likely have lower reproductive success because nearby areas are typically already occupied by other individuals of the species that would be displaced (Riffell et al. 1996). Increasing the concentration of wildlife in an area may result in a number of adverse effects, including potential mortality of the displaced animals from depletion of food sources, increased vulnerability to predators, increased potential for the propagation of diseases and parasites, increased intra- and interspecies competition, and increased potential for poaching.

Long-term displacement of elk, mule deer, pronghorn (*Antilocapra americana*), or other species from critical (crucial) habitat because of habitat disturbance would be considered significant (BLM 2004a). For example, activities around parturition areas have the potential to decrease the usability of these areas for calving and fawning. A tar sands development project located within a crucial winter area could directly reduce the amount of habitat available to the local population. This could force the individuals to use suboptimal habitat, which could lead to debilitating stress. Habitat loss and an associated decrease in the raptor prey base could increase the foraging area necessary to support an individual and/or decrease the number of foraging raptors an area could support (BLM 2006d). With decreasing availability of forbs and grasses, greater sage-grouse (*Centrocercus urophasianus*) broods could move longer distances and expend more energy to find forage. Increased movement, in addition to decreased vegetative cover, could expose chicks to greater risk of predation (see BLM 2006d). The following text box provides more detailed information about how greater sage-grouse may be impacted by tar sands development, including information about possible measures to mitigate impacts.

Potential impacts on waterfowl and shorebirds could primarily occur from impacts on habitat or changes in habitat. Construction could cause short-term changes in water quality from increases in siltation and sedimentation related to ground disturbance. Long-term impacts could result from habitat alterations (i.e., changing forested wetlands to scrub-shrub and emergent wetlands within the ROWs). This could have a slight beneficial impact on most waterfowl and shorebird species.

Water needs for construction and operation could lead to localized to regional water depletions depending on local conditions, process methods, and number of leases developed. Water depletions can be expressed in a number of ways ranging from decreases in soil moisture, reduced flow of springs and seeps, loss of wetlands, and drawdowns of larger rivers and streams. A number of direct and indirect impacts on wildlife can result from water depletions. These include reduction and degradation of habitat; reduction in vegetative cover, forage, and drinking water; attraction to human habitations for alternative food sources; increased stress, disease,

Tar Sands Leasing and Greater Sage-Grouse

Most concerns about the effects of tar sands development on greater sage-grouse (*Centrocercus urophasianus*) have focused on potential impacts associated with the reduction, fragmentation, and modification of grassland and shrubland habitats.

Populations of greater sage-grouse can vary from nonmigratory to migratory (having either one-stage or two-stage migrations) and can occupy an area that exceeds 1,040 mi^2 on an annual basis. The distance between leks (strutting grounds) and nesting sites can exceed 12 mi (Connelly et al. 2000; Bird and Schenk 2005). Nonmigratory populations can move 5 to 6 mi between seasonal habitats and have home ranges up to 40 mi^2. The distance between summer and winter ranges for one-stage migrants can be 9 to 30 mi. Two-stage migrant populations make movements among breeding habitat, summer range, and winter range. Their annual movements can exceed 60 mi. The migratory populations can have home ranges that exceed 580 mi^2 (Bird and Schenk 2005). However, the greater sage-grouse has a high fidelity to a seasonal range. They also return to the same nesting areas annually (Connelly et al. 2000, 2004).

The greater sage-grouse needs contiguous, undisturbed areas of high-quality habitat during its four distinct seasonal periods: (1) breeding, (2) summer-late brooding and rearing, (3) fall, and (4) winter (Connelly et al. 2000). The greater sage-grouse occurs at elevations ranging from 4,000 to 9,000 ft. It is omnivorous and consumes primarily sagebrush and insects. More than 99% of its diet in winter consists of sagebrush leaves and buds. Sagebrush is also important as roosting cover, and the greater sage-grouse cannot survive where sagebrush does not exist (USFWS 2004).

Leks are generally areas supported by low, sparse vegetation or open areas surrounded by sagebrush that provide escape, feeding, and cover. They can range in size from small areas of 0.1 to 10 acres to areas of 100 acres or more (Connelly et al. 2000). The lek/breeding period occurs March through May, with peak breeding occurring from early to mid-April. Nesting generally occurs 1 to 4 mi from lek sites, although it may range up to 11 mi (BLM 2004a). The nesting/early brood-rearing period occurs from March through July. Sagebrush at nesting/early brood-rearing habitat is 12 to 32 in. above ground, with 15 to 25% canopy cover. Tall, dense grass combined with tall shrubs at nest sites decreases the likelihood of nest depredation. Hens have a strong year-to-year fidelity to nesting areas (BLM 2004a). The late brood-rearing period occurs from July through October. Sagebrush at late brood-rearing habitat is 12 to 32 in. tall, with a canopy cover of 10 to 25% (BLM 2004a). The greater sage-grouse occupies winter habitat from November through March. Suitable winter habitat requires sagebrush 10 to 14 in. above snow level with a canopy cover ranging from 10 to 30%. Wintering grounds are potentially the most limiting seasonal habitat for greater sage-grouse (BLM 2004a).

While no single factor or combination of factors have been proven to have caused the decline in greater sage-grouse numbers over the past half-century, the decline is thought to be caused by a number of factors, including drought, oil and gas wells and their associated infrastructure, power lines, predators, and a decline in the quality and quantity of sagebrush habitat (due to livestock grazing, range management treatments, and development activities) (Connelly et al. 2000; Crawford et al. 2004). West Nile virus is also a significant stressor of greater sage-grouse (Naugle et al. 2004).

Loud, unusual sounds and noise from construction and human activities disturb greater sage-grouse, cause birds to avoid traditional use areas, and reduce their use of leks (Young 2003). Disturbance at leks appears to limit reproductive opportunities and may result in regional population declines. Most observed nest abandonment is related to human activity (NatureServe 2006). Thus, site construction, operation, and site-maintenance activities could be a source of auditory and visual disturbance to greater sage-grouse.

Tar sands lease area facilities, transmission lines, pipelines, access roads, and employer-provided housing may adversely affect important greater sage-grouse habitats by causing fragmentation, reducing habitat value, or reducing the amount of habitat available (Braun 1998). Transmission lines, aboveground portions of pipelines,

Continued on next page.

and other structures can also provide perches and nesting areas for raptors and ravens that may prey upon the greater sage-grouse.

Measures that have been suggested for management of greater sage-grouse and their habitats (e.g., Paige and Ritter 1999; Connelly et al. 2000; WGFD 2003) that have pertinence to tar sands projects and associated facilities include the following:

- Identify and avoid both local (daily) and seasonal migration routes.
- Consider greater sage-grouse and sagebrush habitat when designing, constructing, and utilizing project access roads and trails.
- Avoid, when possible, siting energy developments in breeding habitats.
- Adjust the timing of activities to minimize disturbance to greater sage-grouse during critical periods.
- When possible, locate energy-related facilities away from active leks or near other greater sage-grouse habitat.
- When possible, restrict noise levels to 10 dB above background noise levels at lek sites.
- Minimize nearby human activities when birds are near or on leks.
- As practicable, do not conduct surface-use activities within crucial greater sage-grouse wintering areas from December 1 through March 15.
- Maintain sagebrush communities on a landscape scale.
- Provide compensatory habitat reclamation for impacted sagebrush habitat.
- Avoid the use of pesticides at greater sage-grouse breeding habitat during the brood-rearing season.
- Develop and implement appropriate measures to prevent the introduction or dispersal of noxious weeds.
- Avoid creating attractions for raptors and mammalian predators in greater sage-grouse habitat.
- Consider measures to mitigate impacts at off-site locations to offset unavoidable greater sage-grouse habitat alteration and reduction at the project site.
- When possible, avoid establishing artificial water bodies (e.g., stormwater and liquid industrial wastewater ponds) that could serve as breeding habitat for mosquitoes.

The BLM manages more habitats for greater sage-grouse than any other entity; therefore, it has developed a National Sage-Grouse Habitat Conservation Strategy for BLM-administered public lands to manage public lands in a manner that will maintain, enhance, and restore greater sage-grouse habitat while providing for multiple uses of BLM-administered public lands (BLM 2004c). The strategy is consistent with the individual state greater sage-grouse conservation planning efforts. The purpose of this strategy is to set goals and objectives, assemble guidance and resource materials, and provide more uniform management directions for the BLM's contributions to the multistate greater sage-grouse conservation effort being led by state wildlife agencies (BLM 2004c). The BLM strategy includes guidance for (1) addressing sagebrush habitat conservation in BLM land use plans, and (2) managing sagebrush plant communities for greater sage-grouse conservation. This guidance is designed to support and promote the rangewide conservation of sagebrush habitats for greater sage-grouse and other sagebrush-obligate wildlife species on public lands administered by the BLM and presents a number of suggested management practices (SMPs). These SMPs include management or reclamation activities, restrictions, or treatments that are designed to enhance or restore sagebrush habitats. The SMPs are divided into

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two categories: (1) those that will help maintain sagebrush habitats (e.g., practices or treatments to minimize unwanted disturbances while maintaining the integrity of the sagebrush communities), and (2) those that will enhance sagebrush habitat components that have been reduced or altered (BLM 2004c).

SMPs that are or may be pertinent to energy transmission facilities include the following:

- Development of monitoring programs and adaptive management strategies.
- Control of invasive species.
- Prohibition or restriction of OHV activity.
- Consideration of greater sage-grouse habitat needs when developing reclamation plans.
- Avoidance of placing facilities in or next to sensitive habitats such as leks and wintering habitat.
- Location or construction of facilities so that facility noise does not disturb greater sage-grouse activities or leks.
- Consolidation of facilities as much as possible.
- Initiation of reclamation practices as quickly as possible following land disturbance.
- Installation of antiperching devices on existing or new power lines in occupied greater sage-grouse habitat.
- Design of facilities to reduce habitat fragmentations and mortality to greater sage-grouse.

In addition to BLM's national greater sage-grouse habitat conservation strategy, the Western Association of Fish and Wildlife Agencies has produced two documents that make up a Conservation Assessment for Greater Sage-Grouse. The first is the *Conservation Assessment of Greater Sage-Grouse and Sagebrush Habitats* (Connelly et al. 2004). The second document is the *Greater Sage-Grouse Comprehensive Conservation Strategy* (Stiver et al. 2006). In addition, state agencies have proposed statewide and, in some cases, regional greater sage-grouse conservation or management plans that include mitigation measures to minimize impacts on the species (e.g., Bohne et al. 2007; Colorado Greater Sage-Grouse Steering Committee 2008; The Southwest Wyoming Local Sage-Grouse Working Group 2007; Uinta Basin Adaptive Resource Management Local Working Group 2006; UDNR 2002; WGFD 2003).

insect infestations, and predation; alterations in migrations and concentrations of wildlife; loss of diversity; reduced reproductive success and declining populations; increased competition with livestock; and increased potential for fires (IUCNNR 1998; UDWR 2006).

The presence of tar sands development projects and associated facilities could disrupt movements of wildlife, particularly during migration. Migrating birds would be expected to simply fly over the project and continue their migratory movement. However, herd animals, such as elk, deer, and pronghorn, could potentially be affected if the corridor segments transect migration paths between winter and summer ranges or in calving areas. The utility corridor segments would be maintained as areas of low vegetation that may hinder or prevent movements of some wildlife species. It is foreseeable that utility corridor segments may be used for travel routes by big game if they lead in the direction of normal migrations.

Migration corridors are vulnerable, particularly at pinch points where physiographic constrictions force herds through relatively narrow corridors (Berger 2004). Loss of habitat continuity along migration routes would severely restrict the seasonal movements necessary to maintain healthy big game populations (Sawyer and Lindsay 2001; Thomson et al. 2005). Any activity or landscape modification that prevents the use of migration corridor constrictions (migration bottlenecks or pinch points) could effectively reduce the use of habitats either above or below the constriction (BLM 2004b). As summarized by Strittholt et al. (2000), roads have been shown to impede the movements of invertebrates, reptiles, and small and large mammals. For large mammals, blockages of a route between foraging or bedding areas and watering areas could cause the animals to abandon a larger habitat area altogether (BLM 2004b). High snow embankments as a result of plowing can greatly influence the mobility of wildlife such as moose (*Alces alces*) (WGFD 2004). Barriers to movement that prevent snakes from accessing wintering dens or that isolate amphibian breeding pools from feeding areas could affect or even eliminate a population (BLM 2004b).

Larger and/or more mobile wildlife, such as medium-sized or large mammals and birds, would be most likely to leave an area that experiences habitat disturbance. Development of the site would represent a loss of habitat for these species, resulting in a long-term reduction in wildlife abundance and richness within the project area. A species affected by habitat disturbance may be able to shift its habitat use for a short period. For example, the density of several forest-dwelling bird species has been found to increase within a forest stand soon after the onset of fragmentation as a result of displaced individuals moving into remaining habitat (Hagan et al. 1996). However, it is generally presumed that the habitat into which displaced individuals move would be unable to sustain the same level of use over the long term (BLM 2004b). The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individual into the resident populations. If it is assumed that areas used by wildlife before development were preferred habitat, then an observed shift in distribution because of development would be toward less preferred and presumably less suitable habitats (Sawyer et al. 2006). Overcrowding of species such as mule deer in winter ranges can cause density-dependent effects such as increased fawn mortality (Sawyer et al. 2006).

Rather than being displaced, smaller animals such as small mammals, reptiles, and amphibians may be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and eggs or nestlings could be destroyed. Fossorial species could be crushed or buried by construction equipment.

The creation of edge habitat along the boundary between two habitats can (1) increase predation and parasitism of vulnerable forest or sagebrush interior animals in the vicinity of edges; (2) have negative consequences for wildlife by modifying their distribution and dispersal patterns; or (3) be detrimental to species requiring large undisturbed areas, because increases in edge are generally associated with concomitant reductions in habitat size and possible isolation of habitat patches and corridors (habitat fragmentation). Species that could benefit from the proposed utility or access road ROWs include those that prefer or require some open areas, edge habitat, and/or shrubs and small trees. Access roads through forested areas have been found to be positively correlated with bat activity because these areas can provide productive foraging areas and/or travel corridors (Zimmerman and Glanz 2000).

The utility and access road ROWs may hinder or prevent movements of some small mammals. In particular, species preferring heavy cover in forested areas may be adversely affected (Oxley et al. 1974; Forman and Alexander 1998). The degree to which roads serve as barriers to wildlife movement depends on traffic volume and speed, roadside vegetation, traditional movement patterns, and environmental factors motivating animal movement (e.g., predator avoidance).

Periodic removal of woody vegetation to maintain the ROW, particularly in forested areas, would maintain those sections of the ROW in an early stage of plant community succession that could benefit small mammals that use such habitats (e.g., hares) and their predators (e.g., bobcat [*Lynx rufus*]). Temporary growth of willows and other trees following brush cutting could benefit moose and other ungulates that use browse. Conversely, habitat maintenance would have localized adverse effects on species such as the red squirrel (*Tamiasciurus hudsonicus*), southern red-backed vole (*Myodes gapperi*), and American marten (*Martes americana*), which prefer late-successional or forested habitats (BLM 2002). Except where annual vegetation maintenance may be required over the pipelines to facilitate periodic corrosion and leak surveys, routine vegetation maintenance within a ROW segment conducted once every few years would lessen impacts on migratory bird species and other wildlife species that may make permanent use of the ROW segments. As ROWs become more densely vegetated toward the end of each maintenance cycle, bird species diversity would probably increase.

Overall, impacts on most wildlife species would be proportional to the amount of their specific habitat that was directly and indirectly lost and to the duration of the loss (BLM 2006d). For example, impacts on mule deer would proportionately increase with the amount of crucial winter habitat that was disturbed. Project development within the tar sands study area could impact crucial winter and summer ranges for mule deer and elk; crucial lambing and rutting grounds and water sources for bighorn sheep (*Ovis canadensis*); substantial-value habitat for pronghorn, black bear (*Ursus americanus*), and cougar (*Puma concolor*); portions of several wild horse and burro herds; year-long, nesting, or strutting grounds for greater sage-grouse; and foraging habitat for raptors (BLM 1984). Impacts on neotropical migrants that do not breed within the project area would be minor. Nonbreeders generally use riparian areas for feeding, and these areas would be minimally impacted by project construction and operation.

5.8.1.3.2 Wildlife Disturbance. Activities associated with construction and operation of a tar sands project may cause wildlife disturbance, including interference with behavioral activities. The response of wildlife to disturbance is highly variable and species specific. Intraspecific responses can also be affected by the physiological or reproductive condition of individuals; the distance from disturbance; and the type, intensity, and duration of disturbance. Wildlife can respond to disturbance in various ways, including attraction, habituation, and avoidance (Knight and Cole 1991). All three behaviors are considered adverse. For example, wildlife may cease foraging, mating, or nesting, or vacate active nest sites in areas where construction is occurring; some species may permanently abandon the disturbed areas and adjacent habitats. In contrast, wildlife such as bears, foxes, and squirrels readily habituate and may even be attracted to human activities, primarily when a food source is accidentally or deliberately made available. Human food wastes and other attractants in developed areas can increase the population of foxes, gulls, common ravens, and bears, which in turn prey on waterfowl and other birds.

Disturbance can reduce the relative habitat value for wildlife such as mule deer, especially during periods of heavy snow and cold temperatures. When wildlife are experiencing physiological stress, which requires higher levels of energy for survival and reproductive success, increased human presence can further increase energy expenditures that can lead to reduced survival or reproductive outcomes. Furthermore, disturbance could prevent access to sufficient amounts of forage necessary to sustain individuals (BLM 2006e). Hobbs (1989) determined that mule deer doe mortality during a severe winter period could double if they were disturbed twice a day and caused to move a minimum of 1,500 ft per disturbance.

The average mean flush distance for several raptor species in winter was 118 m (387 ft) due to walk disturbance and 75 m (246 ft) due to vehicle disturbance (Holmes et al. 1993). Bighorn sheep have been reported to respond at a distance of 500 m (1,640 ft) from roads with more than one vehicle per day, while deer and elk response occurs at a distance of 1,000 m (3,280 ft) or more (Gaines et al. 2003). Snowmobile traffic was found to affect the behavior of moose located within 300 m (984 ft) of a trail, and displaced them to less favorable habitats (Colescott and Gillingham 1998).

Mule deer will habituate to and ignore motorized traffic provided that the deer are not pursued (Yarmoloy et al. 1988). Harassment, an extreme type of disturbance caused by intentional actions to chase or frighten wildlife, generally causes the magnitude and duration of displacement to be greater. As a result, there is an increased potential for physical injury from fleeing and higher metabolic rates because of stress (BLM 2004b). Bears can be habituated to human activities, particularly moving vehicles, and these animals are more vulnerable to legal and illegal harvest (McLellan and Shackleton 1989). Wild horses and burros could also be impacted by increased encounters with vehicles. Noise and the presence of humans and vehicles could force herds to move to other areas. They would be most susceptible during spring foaling.

Disturbed wildlife can incur a physiological cost either through excitement (i.e., preparation for exertion) or locomotion. A fleeing or displaced animal incurs additional costs through loss of food intake and potential displacement to lower-quality habitat. If the disturbance becomes chronic or continuous, these costs can result in both reduced animal fitness and reproductive potential (BLM 2004b). Disturbance associated with a project would likely result in fewer nest initiations, increased nest abandonment and/or reproductive failure, and decreased productivity of successful nests (BLM 2006d). Factors that influence displacement distance include the following:

- Inherent species-specific characteristics,
- Seasonally changing threshold of sensitivity as a result of reproductive and nutritional status,
- Type of habitat (e.g., longer disturbance distances in open habitats),

- Specific experience of the individual or group,

- Weather (e.g., adverse weather such as wind or fog may decrease the disturbance),

- Time of day (e.g., animals are generally more tolerant during dawn and dusk), and

- Social structure of the animals (e.g., groups are generally more tolerant than solitary individuals) (BLM 2004b).

Regular or periodic disturbance could cause adjacent areas to be less attractive to wildlife and result in long-term reduction of wildlife use in areas exposed to a repeated variety of disturbances such as noise. Principal sources of noise would include vehicle traffic, operation of machinery, and blasting. The response of wildlife to noise would vary by species; physiological or reproductive condition; distance; and type, intensity, and duration of disturbance (BLM 2002). Wildlife response to noise can include avoidance, habituation, or attraction. Responses of birds to disturbance often involve activities that are energetically costly (e.g., flying) or affect their behavior in a way that might reduce food intake (e.g., shift away from a preferred feeding site) (Hockin et al. 1992). On the basis of a literature review by Hockin et al. (1992), the effects of disturbance on bird breeding and breeding success include reduced nest attendance, nest failures, reduced nest building, increased predation on eggs and nestlings, nest abandonment, inhibition of laying, increased absence from the nest, reduced feeding and brooding, exposure of eggs and nestlings to heat or cold, retarded chick development, and lengthening of the incubation period. The most adverse impacts associated with noise could occur if critical life-cycle activities were disrupted (e.g., mating and nesting). For instance, disturbance of birds during the nesting season can result in nest or brood abandonment. The eggs and young of displaced birds would be more susceptible to cold or predators. Construction noise could cause a localized disruption to wild horses and burros, particularly during the foaling season (BLM 2006c).

5.8.1.3.3 Noise. Much of the research on wildlife-related noise effects has focused on birds. This research has shown that noise may affect territory selection, territorial defense, dispersal, foraging success, fledging success, and song learning (e.g., Reijnen and Foppen 1994; Foppen and Reijnen 1994; Larkin 1996). Several studies have examined the effects of continuous noise on bird populations, including the effects of traffic noise, coronal discharge along electric transmission lines, and gas compressors. Some studies (e.g., Reijnen and Foppen 1994, 1995; Foppen and Reijnen 1994; Reijnen et al. 1995, 1996, 1997) have shown reduced densities of a number of species in forest (26 of 43 species) and grassland (7 of 12 species) habitats adjacent to roads, with effects detectable from 66 to 11,581 ft from the roads. On the basis of these studies, Reijnen et al. (1996) identified a threshold effect sound level of 47 dBA for all species combined and 42 dBA for the most sensitive species; the observed reductions in population density were attributed to a reduction in habitat quality caused by elevated noise levels. This threshold sound level of 42 to 47 dBA (which is somewhat below the EPA-recommended limit for residential areas) is at or below the sound levels generated by truck traffic that would likely occur at distances of 250 ft or more from the construction area or access roads, or the levels generated by typical construction equipment at distances of 2,500 ft or more from the construction site.

Blast noise has been found to elicit a variety of effects on wildlife (Manci et al. 1988; Larkin 1996). Brattstrom and Bondello (1983) reported that peak sound pressure levels reaching 95 dB resulted in a temporary shift in hearing sensitivity in kangaroo rats, and that they required at least 3 weeks for the hearing thresholds to recover. The authors postulated that such hearing shifts could affect the ability of the kangaroo rat to avoid approaching predators. A variety of adverse effects of noise on raptors have been demonstrated, but in many cases, the effects were temporary, and the raptors became habituated to the noise (Andersen et al. 1989; Brown et al. 1999; Delaney et al. 1999).

5.8.1.3.4 Mortality or Injury. Construction, operation, maintenance, and reclamation activities would result in mortality of wildlife that are not mobile enough to avoid these activities (e.g., reptiles and amphibians, small mammals, and the young of other wildlife), that utilize burrows (e.g., ground squirrels and burrowing owls [*Athene cunicularia*]), or that are defending nest sites (e.g., ground-nesting birds). More mobile species of wildlife, such as deer and adult birds, may avoid direct impacts by moving into habitats in adjacent areas. However, it can be conservatively assumed that adjacent habitats are at carrying capacity for the species that live there and could not support additional biota from impacted areas. The subsequent competition for resources in adjacent habitats would likely preclude the incorporation of the displaced individuals into the resident populations.

The presence of tar sands development projects and ancillary facilities (e.g., buildings, transmission lines, elevated portions of the pipelines, and other ancillary facilities) would create a physical hazard to some wildlife. In particular, birds may collide with transmission lines and buildings, while mammals may collide with fences. However, collisions with tar sands facilities would probably be infrequent, because human activity and project-related noise would discourage wildlife presence in the immediate project area. An open pipeline trench can trap small animals and injure larger wildlife trying to cross it, particularly at night. Artificial lighting can potentially affect birds by providing more feeding time (i.e., allowing nocturnal feeding) and by causing direct mortality or disorientation (Hockin et al. 1992). Areas of standing water (e.g., stormwater and liquid industrial waste ponds) could potentially provide habitat for mosquitoes that are vectors of West Nile virus, which is a significant stressor on sage-grouse and probably other at-risk bird species (Naugle et al. 2004).

Direct mortality from vehicle collisions would be expected to occur along new access roads, while increases in road mortality would occur along existing roads because of increased traffic volumes (e.g., associated with increased numbers of construction and operational personnel). Collision with vehicles can be a source of wildlife mortality, especially in wildlife concentration areas or travel corridors. When major roads cut across migration corridors, the effects can be dangerous for animals and humans. Between Kemmerer and Cokeville, Wyoming, hundreds of mule deer are killed during spring and fall migrations when they attempt to cross U.S. Highway 30 (Feeney et al. 2004). In unusual cases, mass casualties of wildlife occur from vehicular collision incidents, particularly in winter when animals may congregate near snow-free roads. Since 2003, there have been four vehicular incidents in which 7 to 21 pronghorn were killed or injured per incident in Wyoming. There was also an incident in which 41 pronghorn were killed by a train (Maffly 2007).

Being somewhat small and inconspicuous, amphibians are vulnerable to road mortality when they migrate between wetland and upland habitats, while reptiles are vulnerable because they will make use of roads for thermal cooling and heating. Greater sage-grouse are susceptible to road mortality in spring because they often fly to and from leks near ground level. They are also susceptible to vehicular collision along dirt roads because they are sometimes attracted to them to take dust baths (Strittholt et al. 2000). Utility ROWs and access roads increase use by recreationists and other public land users, which can increase the amount of human presence and the potential for harassment and legal or illegal harvesting of wildlife. This activity may include the collection of live animals, particularly reptiles and amphibians, for pets. Direct mortality from snowmobiles may occur because of crushing or suffocation of small mammals occupying subnivean spaces and from increased access to predators over compacted vehicular trails (Gaines et al. 2003).

No electrocution of raptors would be expected when they are perching on the transmission line structures because the spacing between the conductors and between a conductor and ground wire or other grounding structure would exceed the wing span of the largest raptors in the project area (i.e., bald and golden eagles [*Haliaeetus leucocephalus* and *Aquila chrysaetos*]). However, although a rare event, electrocution can occur to flocks of small birds that cross a line or when several roosting birds take off simultaneously because of current arcing. This occurrence is most likely in humid weather conditions (Bevanger 1998; BirdLife International 2003). Arcing can also occur by the excrement jet of large birds roosting on the crossarms above the insulators (BirdLife International 2003).

Electromagnetic field exposure can potentially alter the behavior, physiology, endocrine system, and the immune function of birds, which, in theory, could result in negative repercussions on their reproduction or development. However, the reproductive success of some wild bird species, such as ospreys (*Pandion haliaetus*), does not appear to be compromised by electromagnetic field conditions (Fernie and Reynolds 2005).

Any species of bird capable of flight can collide with power lines. Birds that migrate at night, fly in flocks, and/or are large and heavy with limited maneuverability are at particular risk (BirdLife International 2003). The potential for bird collisions with a transmission line depends on variables such as habitat, relation of the line to migratory flyways and feeding flight patterns, migratory and resident bird species, and structural characteristics of the line (Beaulaurier et al. 1984). Near wetlands, waterfowl, wading birds, shorebirds, and passerines are most vulnerable to colliding with transmission lines; in habitats away from wetlands, raptors and passerines are most susceptible (Faanes 1987). The highest concern for bird collisions is where lines span flight paths, including river valleys, wetland areas, lakes, areas between waterfowl feeding and roosting areas, and narrow corridors (e.g., passes that connect two valleys). A disturbance that leads to a panic flight can increase the risk of collision with transmission lines (BirdLife International 2003).

The shield wire is often the cause of bird losses involving higher voltage lines because birds fly over the more visible conductor bundles only to collide with the relatively invisible, thin shield wire (Thompson 1978; Faanes 1987). Young inexperienced birds, as well as migrants in unfamiliar terrain, appear to be more vulnerable to wire strikes than resident breeders. Also, many species appear to be most highly susceptible to collisions when alarmed, pursued, searching for food while flying, engaged in courtship, taking off, landing, when otherwise preoccupied and not paying attention to where they are going, and during night and inclement weather (Thompson 1978). Sage-grouse and other upland game birds are vulnerable to colliding with transmission lines because they lack good acuity and because they are generally poor flyers (Bevanger 1995).

Meyer and Lee (1981) concluded that, while waterfowl (in Oregon and Washington) were especially susceptible to colliding with transmission lines, no adverse population or ecological results occurred because all species affected were common and because collisions occurred in fewer than 1% of all flight observations. Stout and Cornwell (1976) reached a similar conclusion and suggested that fewer than 0.1% of all nonhunting waterfowl mortalities nationwide were caused by collisions with transmission lines. The potential for waterfowl and wading birds to collide with the transmission lines could be assumed to be related to the extent of preferred habitats crossed by the lines and the extent of other waterfowl and wading bird habitats within the immediate area.

Raptors have several attributes that decrease their susceptibility to collisions with transmission lines: (1) they have keen eyesight; (2) they soar or use relatively slow-flapping flight; (3) they are generally maneuverable while in flight; (4) they learn to use utility poles and structures as hunting perches or nests and become conditioned to the presence of lines; and (5) they do not fly in groups (like waterfowl), so their position and altitude are not determined by other birds. Therefore, raptors are not as likely to collide with transmission lines unless distracted (e.g., while pursuing prey) or when other environmental factors (e.g., weather) contribute to increased susceptibility (Olendorff and Lehman 1986).

Some mortality resulting from bird collisions with transmission lines is considered unavoidable. However, anticipated mortality levels are not expected to result in long-term loss of population viability in any individual species or lead to a trend toward listing as a rare or endangered species, because mortality levels are anticipated to be low and spread over the life of the transmission lines. A variety of mitigation measures, such as those outlined in *Avian Protection Plan (APP) Guidelines* (APLIC and USFWS 2005) and *Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances* (Romin and Muck 1999), would minimize impacts on birds.

5.8.1.3.5 Exposure to Contaminants. Wildlife may be exposed to accidental spills or releases of product, fuel, herbicides, or other hazardous materials. Exposure to these materials could affect reproduction, growth, development, or survival. Potential impacts on wildlife would vary according to the type of material spilled, the volume of the spill, the media within which the spill occurs, the species exposed to the spilled material, and the home range and density of the wildlife species. For example, as the size of a species' home range increases, the effects of a spill would generally decrease (Irons et al. 2000). Generally, small mammal species that have small home ranges and/or high densities per acre would be most affected by a land-based spill. A population-level adverse impact would only be expected if the spill was very large or contaminated a crucial habitat area where a large number of individual animals were concentrated. The potential for either event would be unlikely. Because the amounts of most fuels and other hazardous materials are expected to be small, an uncontained spill would affect only a limited area. In addition, wildlife use of the project area where contaminant spills may occur would be limited, thus greatly reducing the potential for exposure.

The potential effects on wildlife from a spill could occur from direct contamination of individual animals, contamination of habitats, and contamination of food resources. Acute (short-term) effects generally occur from direct contamination of animals; chronic (long-term) effects usually occur from such factors as accumulation of contaminants from food items and environmental media (Irons et al. 2000). Moderate to heavy contact with a contaminant is most often fatal to wildlife. In aquatic habitats, death occurs from hypothermia, shock, or drowning. In birds, chronic oil exposure can reduce reproduction, result in pathological conditions, reduce chick growth, and reduce hatching success (BLM 2002). Contaminated water could reduce emergent vegetation and invertebrate biomass that provide a food resource for wildlife such as waterfowl, amphibians, and bats. The reduction or contamination of food resources from a spill could also reduce survival and reproductive rates. Contaminant ingestion during preening or feeding may impair endocrine and liver functions, reduce breeding success, and reduce growth of offspring (BLM 2002).

A land-based spill would contaminate a limited area. Therefore, a spill would affect relatively few individual animals and a relatively limited portion of the habitat or food resources for large-ranging species (e.g., moose, mule deer, pronghorn, elk, and black bear). It would be unlikely that a land-based spill would cause significant impacts on movement (e.g., block migration) or foraging activities at the population (herd) level, largely because of the vast amount of surrounding habitat that would remain unaffected (BLM 2002).

Human presence and activities associated with response to spills would also disturb wildlife in the vicinity of the spill site and spill-response staging areas. In addition to displacing wildlife from areas undergoing contaminant cleanup activities, habitat damage could also occur from cleanup activities (BLM 2002). Avoidance of contaminated areas by wildlife during cleanup because of disturbance would minimize the potential for wildlife to be exposed to contaminants before site cleanup is completed.

Most herbicides used on BLM-administered lands pose little or no risk to wildlife or wild horses and burros unless they are exposed to accidental spills, direct spray, herbicide drift, or by consuming herbicide-treated vegetation. The licensed use of herbicides would not be expected to adversely affect local wildlife populations. Applications of these materials would be conducted by following label directions and in accordance with applicable permits and licenses. Thus, any adverse toxicological threat from herbicides to wildlife is unlikely. The response of wildlife to herbicide use is attributable to habitat changes resulting from treatment rather than direct toxic effects of the applied herbicide on wildlife. However, accidental spills or releases of these materials could impact exposed wildlife. Effects could include death, organ damage, growth decrease, and decrease in reproductive output and condition of offspring (BLM 2005).

Herbicide treatment reduced structural and floral complexity of vegetation on clear-cuts in Maine, resulting in lower overall abundance of birds and small mammals because of a decrease in invertebrate and plant foods and cover associated with decreased habitat complexity (Santillo et al. 1989a,b). However, some researchers have found increases in small mammal numbers because of increases in species that use grassy habitats (particularly microtine rodents). Nevertheless, small mammal communities rapidly returned to pretreatment numbers (e.g., within a 2-year period) because of regrowth of vegetation damaged by herbicides (Anthony and Morrison 1985). Moose tended to avoid herbicide-treated areas of clear-cuts because browse was less available for 2 years post-treatment. When they did feed in treated clear-cuts, they fed heavily in areas that were inadvertently skipped by spraying (Santillo 1994; Eschholtz et al. 1996). Selective herbicide use (e.g., cut-stump treatments) encourages the development of shrub habitat without negatively impacting birds nesting in such habitats (Marshall and Vandruff 2002).

Wildlife can be exposed to herbicides by being directly sprayed, inhaling spray mist or vapors, drinking contaminated water, feeding on or otherwise coming in contact with treated vegetation or animals that have been contaminated, and directly consuming the chemical if it is applied in granular form (DOE 2000). Raptors, small herbivorous mammals, medium-sized omnivorous mammals, and birds that feed on insects are more susceptible to herbicide exposure because they either feed directly on vegetation that might have been treated or feed on animals that feed on the vegetation. The potential for toxic effects would depend on the toxicity of the herbicide and the amount of exposure to the chemical. Generally, smaller animals are more at risk because it takes less substance for them to be affected (DOE 2000).

Indirect adverse effects on wildlife from herbicides would include a reduction in the availability of preferred forage, habitat, and breeding areas because of a decrease in plant diversity; a decrease in wildlife population densities as a result of limited vegetation regeneration; habitat and range disruption because wildlife may avoid sprayed areas following treatment; and an increase in predation of small mammals because of loss of ground cover (BLM 2005). However, population-level impacts on unlisted wildlife species are unlikely because of the limited size and distribution of treated areas relative to those of the wildlife populations and the foraging area and behavior of individual animals (BLM 2005).

Wildlife species that consume grass (e.g., deer, elk, rabbits and hares, quail, and geese) are at potentially higher risk from herbicides than species that eat other vegetation and seeds because herbicide residue concentrations tend to be higher on grass. However, harmful effects are not likely unless the animal forages exclusively within the treated area shortly after application. Similarly, bats, shrews, and numerous bird species that feed on herbicide-contaminated insects could be at risk (BLM 2005).

5.8.1.3.6 Erosion and Runoff. As described in Section 5.8.1.1, it is assumed that the potential for soil erosion and the resulting sediment loading of nearby aquatic or wetland habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, and the proximity to aquatic habitats. It is also assumed that areas being actively disturbed during mining or construction activities would have higher erosion potential than areas that are undergoing reclamation activities, and that areas being restored would become progressively less prone to erosion over time because of completion of site grading and the reestablishment of vegetated cover. Erosion and runoff from freshly cleared and graded sites could reduce water quality in aquatic and wetland habitats that are used by amphibians, thus potentially affecting their reproduction, growth, and survival. Any impacts on amphibian populations would be localized to the surface waters receiving site runoff. Although the potential for runoff would be temporary, pending completion of construction activities and stabilization of disturbed areas with vegetative cover, erosion could result in significant impacts on local amphibian populations if an entire recruitment class is eliminated (e.g., complete recruitment failure for a given year because of siltation of eggs or mortality of aquatic larvae). Implementation of measures to control erosion and runoff into aquatic and wetland habitats would reduce the potential for impacts from increased turbidity and sedimentation. Assuming that reclamation activities are successful, restored areas should eventually become similar to natural areas in terms of erosion potential.

5.8.1.3.7 Fugitive Dust. Little information is available regarding the effects of fugitive dust on wildlife; however, if exposure is of sufficient magnitude and duration, the effects may be similar to the respiratory effects identified for humans (e.g., breathing and respiratory symptoms). A more probable effect would be from the dusting of plants that could make forage less palatable. Fugitive dust that settles on forage may render it unpalatable for wildlife and wild horses and burros, which could increase competition for remaining forage. The highest dust deposition would generally occur within the area where wildlife and wild horses and burros would be disturbed by human activities (BLM 2004b). Fugitive dust generation during construction activities is expected to be short term and localized to the immediate construction area and is not expected to result in any long-term individual or population-level effects. Dusting impacts would be potentially more pervasive along unpaved access roads.

5.8.1.3.8 Invasive Vegetation. Utility corridors and access roads can facilitate the dispersal of invasive species by altering existing habitat conditions, stressing or removing native species, and allowing easier movement by wild or human vectors (Trombulak and Frissell 2000). Wildlife habitat could be impacted if invasive vegetation becomes established in the construction-disturbed areas and adjacent off-site habitats. The establishment of invasive vegetation could reduce habitat quality for wildlife and locally affect wildlife occurrence and abundance. The introduction or spread of non-native plants would be detrimental to wildlife such as neotropical migrants and sage-grouse by reducing or fragmenting habitat, increasing soil erosion, or reducing forage (BLM 2006b).

5.8.1.3.9 Fires. Increased human activity can increase the potential for fires. In general, the short-term and long-term effects of fire on wildlife are related to fire impacts on vegetation, which, in turn affect habitat quality and quantity, including the availability of forage shelter

(Hedlund and Rickard 1981; Groves and Steenhof 1988; Knick and Dyer 1996; Schooley et al. 1996; Watts and Knick 1996; Sharpe and Van Horne 1998; Lyon et al. 2000b; USDA 2008a–c).

While individuals caught in a fire could incur increased mortality, depending on how quickly the fire spreads, most wildlife would be expected to escape by either outrunning the fire or seeking underground or aboveground refuge within the fire (Ford et al. 1999; Lyon et al. 2000a). However, some mortality of burrowing mammals from asphyxiation in their burrows during fire has been reported (Erwin and Stasiak 1979).

In the absence of long-term vegetation changes, rodents in grasslands usually show a decrease in density after a fire; they often recover, however, to achieve densities similar to or greater than preburn levels (Beck and Vogel 1972; Lyon et al. 2000b; USDA 2008d). Long-term changes in vegetation from a fire (such as loss of sagebrush or the invasion or increase of non-native annual grasses) may affect food availability and quality and habitat availability for wildlife; the changes could also increase the risk from predation for some species (Hedlund and Rickard 1981; Groves and Steenhof 1988; Schooley et al. 1996; Watts and Knick 1996; Knick and Dyer 1997; Lyon et al. 2000b; USDA 2008b,c).

Raptor populations generally are unaffected by, or respond favorably to, burned habitat (Lyon et al. 2000b). In the short term, fires may benefit raptors by reducing cover and exposing prey; raptors may also benefit if prey species increase in response to post-fire increases in forage (Lyon et al. 2000b; USDA 2008d). Direct mortality of raptors from fire is rare (Lehman and Allendorf 1989), although fire-related mortality of burrowing owls has been documented (USDA 2008d). Most adult birds can be expected to escape fire, while fire during nesting (prior to fledging) may kill young birds, especially of ground-nesting species (USDA 2008d). Fires in wooded areas, such as pinyon-juniper woodlands, could decrease populations of raptors and other birds that nest in those habitats.

5.8.1.4 Threatened, Endangered, and Sensitive Species

The evaluation in this PEIS presents the potential for impacts on federally or state-listed threatened or endangered species, BLM-designated sensitive species, or species that are proposed or candidates for listing if tar sands development occurs. The discussion of impacts in this section presents the types of impacts that could occur if mitigation measures are not developed to protect listed and sensitive species. Project-specific NEPA assessments, ESA consultations, and coordination with state natural resource agencies would be conducted prior to leasing or development and would address project-specific impacts more thoroughly. These assessments and consultations would result in required actions to avoid or mitigate impacts on protected species.

The potential for impacts on threatened, endangered, and sensitive species by commercial tar sands development, including construction of ancillary facilities such as access roads and transmission systems, is directly related to the amount of land disturbance, the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects such as those resulting from the erosion of disturbed land surfaces and disturbance and harassment of animal species are also considered, but their magnitude is considered proportional to the amount of land disturbance.

Impacts on threatened and endangered species are fundamentally similar to or the same as those described for impacts on aquatic resources, plant communities and habitats, and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. However, because of their low population sizes, threatened, endangered, and sensitive species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development.

The potential magnitude of the impacts that could result from tar sands development is presented for different species types in Table 5.8.1-4. Unlike some projects where there are discrete construction and operation phases with different associated impacts, tar sands development projects include facility construction and extraction activities that would have similar types of impacts throughout the life of the project. Project construction and extraction activities would occur over a period of several decades. Reclamation that would occur after extraction activities are complete would serve to reduce or eliminate ongoing impacts by recreating habitats and ecological conditions that could be suitable for threatened, endangered, and sensitive species. The effectiveness of any reclamation activities would depend on the specific actions taken, but the best results would occur if site topography, hydrology, soils, and vegetation patterns were reestablished.

Post-lease land clearing and construction activities could remove potentially suitable habitat for threatened, endangered, and sensitive plant and animal species. Any plants present within the project areas would be destroyed, and plants adjacent to project areas could be affected by runoff from the site either through erosion or sedimentation and burial of individual plants or habitats. In addition, fugitive dust from site activities could accumulate in adjacent areas occupied by listed plants. Dust that accumulates on leaf surfaces can reduce photosynthesis and subsequently affect plant vigor. Disturbed areas could be colonized by non-native invasive plant species.

Larger, more mobile animals such as birds and medium-sized or large mammals would be most likely to leave the project area during site preparation, construction, and other project activities. Development of the site would represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. Smaller animals, such as small mammals, lizards, snakes, and amphibians, are more likely to be killed during clearing and construction activities. If land clearing and construction activities occurred during the spring and summer, bird nests and nestlings in the project area could be destroyed.

Operations could affect protected plants and animals as well. Animals in and adjacent to project areas would be disturbed by human activities and would tend to avoid the area while activities were occurring. Site lighting and operational noise from equipment would affect

TABLE 5.8.1-4 Potential Impacts of Commercial Tar Sands Development on Threatened, Endangered, and Sensitive Species

	Potential Magnitude of Impacts According to Species Type[a]					
Impact Category	Upland Plants	Wetland and Riparian Plants	Aquatic and Wetland Animals[b]	Terrestrial Amphibians and Reptiles	Terrestrial Birds	Terrestrial Mammals
Vegetation clearing	Large	Large	Large	Large	Large	Large
Habitat fragmentation	Moderate	Moderate	Moderate	Large	Large	Large
Blockage of movement and dispersal	Moderate	Moderate	Large	Moderate	Small	Moderate
Water depletions	Small	Large	Large	Small	Moderate	Moderate
Stream impoundment and changes in flow pattern	Large	Large	Large	Large	Large	Large
Alteration of topography and drainage patterns	Moderate	Large	Large	Small	Small	Small
Erosion	Large	Large	Large	Small	Small	Small
Sedimentation from runoff	Large	Large	Large	Small	Small	Small
Oil and contaminant spills	Moderate	Large	Large	Large	Small	Small
Fugitive dust	Moderate	Moderate	Small	Small	Small	Small
Injury or mortality of individuals	Large	Large	Large	Large	Large	Large
Human collection	Large	Large	Small	Moderate	Small	Small
Human disturbance/harassment	None	None	Large	Moderate	Large	Large
Increased human access	Moderate	Moderate	Moderate	Moderate	Large	Large
Increased predation rates	None	None	Moderate	Moderate	Moderate	Moderate
Noise	None	None	None	Small	Large	Large
Spread of invasive plant species	Large	Large	Moderate	Moderate	Moderate	Moderate
Air pollution	Moderate	Moderate	Small	Small	Small	Small
Disruption of groundwater flow patterns	Small	Moderate	Moderate	Small	Small	Small
Temperature increases in water bodies	None	Moderate	Moderate	None	None	None

[a] Potential impact magnitude (without mitigation) is presented as none, small, moderate, or large. A small impact is one that is limited to the immediate project area, affects a relatively small proportion of the local population (less than 10%), and does not result in a measurable change in carrying capacity or population size in the affected area. A moderate impact could extend beyond the immediate project area, affect an intermediate proportion of the local population (10 to 30%), and result in a measurable but moderate (not destabilizing) change in carrying capacity or population size in the affected area. A large impact would extend beyond the immediate project area, could affect more than 30% of a local population, and result in a large, measurable, and destabilizing change in carrying capacity or population size in the affected area.

[b] Aquatic and wetland animals include invertebrates (mollusks and arthropods), fish, amphibians, reptiles, birds, and mammals.

animals on and off the site, resulting in avoidance or reduction in use of an area larger than the project footprint. Runoff from the site during site operations could result in erosion and sedimentation of adjacent habitats. Fugitive dust during operations could affect adjacent plant populations.

For all potential impacts, the use of mitigation measures, possibly including predisturbance surveys to locate protected plant and animal populations in the area, erosion-control practices, dust suppression techniques, establishment of buffer areas around protected populations, and reclamation of disturbed areas using native species upon project completion, would greatly reduce or eliminate the potential for effects on protected species. The specifics of these practices should be established in project-specific consultations with the appropriate federal and state agencies. ESA Section 7 consultations between the BLM and the USFWS would be required for all projects prior to leasing and before leased areas could be developed, if ESA-listed species were present and would be affected by the lease.

Those consultations would identify conservation measures, allowable levels of incidental take, and other requirements to protect listed species. Conservation measures for oil shale and tar sands development have been recommended by the USFWS to avoid and minimize impacts of commercial oil shale and tar sands development on federally listed threatened and endangered species (Appendix F).

Tables 5.8.1-5 and 5.8.1-6 identify the federally and state-listed threatened, endangered, and sensitive species that could be affected by commercial tar sands development. The two tables consider separately the impacts on state-listed threatened and endangered species and species of special concern, federal candidates for listing, and BLM-designated sensitive species (Table 5.8.1-5), and on federally listed threatened, endangered, and proposed species (Table 5.8.1-6). For species in Table 5.8.1-5, a determination is made regarding the “potential for negative impact;” for species in Table 5.8.1-6, a similar determination is made but the terminology follows the ESA Section 7 convention of “adverse effect.” Potential for impact or effect was determined on the basis of conservative estimates of species distributions, and it is possible that impacts on some species would not occur because suitable habitat may not be present in project areas or impacts on those habitats could be avoided.

Federally listed species in study area counties that are not expected to be affected by development include the autumn buttercup, Barneby ridge-cress, Navajo sedge, and Utah prairie dog (Table 5.8.1-6). These species are not likely to be affected because known population distributions are clearly outside of the potential lease areas.

Federally listed plant species (including species that are being proposed for listing) that could occur in project areas and that could be affected by project activities include the Barneby reed-mustard, clay reed-mustard, Jones cycladenia, last chance townsendia, Maguire daisy, San Rafael cactus, shrubby reed-mustard, Uinta Basin hookless cactus, Ute ladies’-tresses, Winkler cactus, and Wright fishhook cactus. All but the Ute ladies’-tresses are upland species that could be affected by a variety of impacting factors, including vegetation clearing, habitat fragmentation, dispersal blockage, alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, fugitive dust, injury or mortality

TABLE 5.8.1-5 Potential Impacts of Commercial Tar Sands Development on BLM-Designated Sensitive Species, Federal Candidates for Listing, and State Species of Special Concern

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants				
Alcove bog-orchid	*Habenaria zothecina*	BLM-S	Emery, Garfield, Grand, San Juan, Uintah	**Potential for negative impact.** Possible occurrence in wetland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Tar Sands Triangle, and White Canyon STSAs.
Alcove rock-daisy	*Perityle specuicola*	BLM-S	Grand, San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle and White Canyon STSAs.
Basalt milkvetch	*Astragalus subcinereus* var. *basalticus*	BLM-S	Emery	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael STSA.
Bluff buckwheat	*Eriogonum racemosum* var. *nobilis*	BLM-S	San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of White Canyon STSA.
Bluff phacelia	*Phacelia indecora*	BLM-S	San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of White Canyon STSA.
Caespitose cat's-eye	*Cryptantha caespitosa*	BLM-S	Carbon, Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Raven Ridge, Pariette, P.R. Spring, and Sunnyside STSAs.
Canyonlands lomatium	*Lomatium latilobum*	BLM-S	Grand, San Juan	**No impact.** Populations occur outside STSAs under consideration.
Cataract gilia	*Gilia latifolia* var. *imperialis*	BLM-S	Emery, Garfield, San Juan, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael, Tar Sands Triangle, and White Canyon STSAs.
Cedar Breaks goldenbush	*Haplopappus zionis*	BLM-S	Garfield	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle STSA.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Chatterley onion	*Allium geyeri* var. *chatterleyi*	BLM-S	San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of White Canyon STSA.
Cisco milkvetch	*Astragalus sabulosus* var. *sabulosus*	BLM-S	Grand	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring STSA.
Claron pepperplant	*Lepidium montanum* var. *claronense*	BLM-S	Garfield	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle STSA.
Creutzfeldt-flower	*Cryptantha creutzfeldtii*	BLM-S	Carbon, Emery	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon, San Rafael, and Sunnyside STSAs.
Cronquist milkvetch	*Astragalus cronquistii*	BLM-S	San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of White Canyon STSA.
Cronquist's buckwheat	*Eriogonum corymbosum var. cronquistii*	BLM-S	Garfield, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle STSA.
Debris milkvetch	*Astragalus detritalis*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs.
Dolores River skeletonplant	*Lygodesmia doloresensis*	BLM-S	Grand	**Potential for negative impact.** Species could occur in upland habitats of P.R. Spring STSA.
Eastwood monkey-flower	*Mimulus eastwoodiae*	BLM-S	Garfield, Grand, San Juan	**Potential for negative impact.** Species could occur in wetland habitats of Tar Sand Triangle and White Canyon STSAs.
Entrada rushpink	*Lygodesmia grandiflora* var. *entrada*	BLM-S	Emery, Grand	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring and San Rafael STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Ephedra buckwheat	*Eriogonum ephedroides*	BLM-S	Uintah	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Ferron milkvetch	*Astragalus musiniensis*	BLM-S	Emery, Garfield, Grand, Wayne	**Potential for negative impact.** Species could occur in upland habitats of P.R. Spring, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs.
Fisher Towers milkvetch	*Astragalus piscator*	BLM-S	Garfield, Grand, San Juan, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Tar Sand Triangle and White Canyon STSAs.
Flat Top buckwheat	*Eriogonum corymbosum* var. *smithii*	BLM-S	Emery, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael and Tar Sands Triangle STSAs.
Goodrich cleomella	*Cleomella palmeriana* var. *goodrichii*	BLM-S	Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Goodrich's blazingstar	*Mentzelia goodrichii*	BLM-S	Duchesne	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon and Pariette STSAs.
Goodrich's penstemon	*Penstemon goodrichii*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Graham's beardtongue	*Penstemon grahamii*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Grand buckwheat	*Eriogonum contortum*	BLM-S	Grand	**Potential for negative impact.** Species could occur in upland habitats of P.R. Spring STSA.
Green River greenthread	*Thelesperma caespitosum*	BLM-S	Duchesne	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon and Pariette STSAs.
Hamilton's milkvetch	*Astragalus hamiltonii*	BLM-S	Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Hole-in-the-Rock prairie-clover	*Dalea flavescens* var. *epica*	BLM-S	Garfield, San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle and White Canyon STSAs.
Horse Canyon stickleaf	*Mentzelia multicaulis* var. *librina*	BLM-S	Carbon, Emery	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon, San Rafael, and Sunnyside STSAs.
Huber's pepperplant	*Lepidium huberi*	BLM-S	Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Jane's globemallow	*Sphaeralcea janeae*	BLM-S	Grand, San Juan, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring, Sunnyside, and White Canyon STSAs.
Jones blue star	*Amsonia jonesii*	BLM-S	Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Jones indigo bush	*Psorothamnus polydenius* var. *jonesii*	BLM-S	Emery	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael STSA.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Kachina daisy	*Erigeron kachinensis*	BLM-S	Garfield, San Juan	**Potential for negative impact.** Possible occurrence in wetland habitats Tar Sands Triangle and White Canyon STSAs.
Ligulate feverfew	*Parthenium ligulatum*	BLM-S	Wayne	**Potential for negative impact.** Species could occur in upland habitats of Tar Sand Triangle STSA.
Mussentuchit gilia	*Gilia tenuis*	BLM-S	Emery	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael STSA.
Narrow-stem gilia	*Gilia stenothyrsa*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, and Sunnyside STSAs.
Naturita milkvetch	*Astragalus naturitensis*	BLM-S	San Juan	**Potential for negative impact.** Species could occur in upland habitats of White Canyon STSA.
Northern twayblade	*Listera borealis*	BLM-S	Duchesne, San Juan	**No impact.** Suitable habitat not present within STSAs under consideration.
Nutall sandwort	*Minuartia nuttallii*	BLM-S	Duchesne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon and Pariette STSAs.
Osterhout cat's-eye	*Cryptantha osterhoutii*	BLM-S	Emery, Garfield, Grand, San Juan, Wayne	**Potential for negative impact.** Species could occur in upland habitats of P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs.
Ownbey's thistle	*Cirsium ownbeyi*	BLM-S	Uintah	**Potential for negative impact.** Species could occur in upland habitats of Raven Ridge STSA.
Paradox breadroot	*Pediomelum aromaticum*	BLM-S	Grand, San Juan	**Potential for negative impact.** Species could occur in upland habitats of White Canyon STSA.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Park rockcress	*Arabis vivariensis*	BLM-S	Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Peabody milkvetch	*Astragalus pubentissimus* var. *peabodianus*	BLM-S	Emery, Grand	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring and San Rafael STSAs.
Pinnate spring-parsley	*Cymopterus beckii*	BLM-S	San Juan, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle and White Canyon STSAs.
Psoralea globemallow	*Sphaeralcea psoraloides*	BLM-S	Emery, Grand, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring, San Rafael, and Tar Sands Triangle STSAs.
Rock hymenoxyz	*Hymenoxys lapidicola*	BLM-S	Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Rollins' cat's-eye	*Cryptantha rollinsii*	BLM-S	Duchesne, San Rafael, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, and Sunnyside STSAs.
Sandloving penstemon	*Penstemon ammophilus*	BLM-S	Garfield	**Potential for negative impact.** Possible occurrence in upland habitats of Tar Sands Triangle STSA.
San Rafael milkvetch	*Astragalus rafaelensis*	BLM-S	Emery, Grand	**Potential for negative impact.** Species could occur in riparian and upland habitats of P.R. Spring and San Rafael STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Shultz stickleaf	Mentzelia shultziorum	BLM-S	Grand	Potential for negative impact. Possible occurrence in upland habitats of P.R. Spring STSA.
Stagecoach milkvetch	*Astragalus sabulosus* var. *vehiculus*	BLM-S	Grand	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring STSA.
Strigose Easter-daisy	*Townsendia strigosa*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Thompson's talinum	*Talinum thompsonii*	BLM-S	Emery	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael STSA.
Trotter's oreoxis	*Oreoxis trotteri*	BLM-S	Emery, Grand	**Potential for negative impact.** Possible occurrence in upland habitats of P.R. Spring and San Rafael STSAs.
Tuhy's breadroot	*Pediomelum aromaticum* var. *tuhyi*	BLM-S	San Juan	**Potential for negative impact.** Possible occurrence in upland habitats of White Canyon STSA.
Uinta Basin spring-parsley	*Cymopterus duchesnensis*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Untermann's daisy	*Erigeron untermanii*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Utah gentian	*Gentianella tortuosa*	BLM-S	Emery, Garfield	**No impact.** Populations occur outside STSAs under consideration.
Utah phacelia	*Phacelia utahensis*	BLM-S	Carbon	**Potential for negative impact.** Possible occurrence in upland habitats of Argyle Canyon and Sunnyside STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Plants (Cont.)				
Utah spurge	*Euphorbia nephradenia*	BLM-S	Emery, Garfield, Wayne	**Potential for negative impact.** Possible occurrence in upland habitats of San Rafael and Tar Sands Triangle STSAs.
White River beardtongue	*Penstemon scariosus* var. *albifluvis*	ESA-C	Uintah	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Invertebrates				
Black Canyon pyrg	*Pyrgulopsis plicata*	BLM-S; UT-SC	Garfield	**No impact.** Populations occur outside STSAs under consideration.
Eureka mountainsnail	*Oreohelix eurekensis*	BLM-S; UT-SC	Duchesne, Grand	**No impact.** Populations occur outside STSAs under consideration.
Great Basin silverspot butterfly	*Speyeria nokomis nokomis*	BLM-S	Duchesne, Uintah	**Potential for negative impact.** Species could occur in wetland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Utah physa	*Physa utahensis*	BLM-S; UT-SC	Garfield	**No impact.** Populations occur outside STSAs under consideration.
Yavapai mountainsnail	*Oreohelix yavapai*	BLM-S; UT-SC	San Juan	**No impact.** Populations occur outside STSAs under consideration.
Fish				
Bluehead sucker	*Catostomus discobolus*	BLM-S; WY-SC	CO-Garfield, Rio Blanco; UT-Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah	**Potential for negative impact.** Species could occur in aquatic habitats of all STSAs.
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	BLM-S	Duchesne, Garfield, Uintah, Wayne	**Potential for negative impact.** Species could occur in aquatic habitats of Argyle Canyon STSA.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Fish (Cont.)				
Flannelmouth sucker	*Catostomus latipinnis*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in aquatic habitats of all STSAs.
Leatherside chub	*Gila copei*	BLM-S; UT-SC	Duchesne, Emery, Garfield, Wayne	**No impact.** Populations occur outside STSAs under consideration.
Roundtail chub	*Gila robusta*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in aquatic habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs.
Amphibians				
Arizona toad	*Bufo microscaphus*	BLM-S; UT-SC	Garfield, San Juan	**No impact.** Populations occur outside STSAs under consideration.
Boreal toad	*Bufo boreas*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Wayne, Uintah	**No impact.** Populations occur outside STSAs under consideration.
Canyon treefrog	*Hyla arenicolor*	BLM-S	Garfield, Grand, Wayne, San Juan	**Potential for negative impact.** Species could occur in aquatic and wetland habitats of Tar Sand Triangle and White Canyon STSAs.
Great basin spadefoot	*Spea intermontana*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in wetland and upland habitats of all STSAs under consideration.
Northern leopard frog	*Rana pipiens*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in aquatic and wetland habitats of all STSAs under consideration.
Reptiles				
Common chuckwalla	*Sauromalus ater*	BLM-S; UT-SC	Garfield, San Juan	**No impact.** Populations occur outside STSAs under consideration.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Reptiles (Cont.)				
Corn snake	*Elaphe guttata*	BLM-S; UT-SC	Grand, San Juan	**Potential for negative impact.** Species could occur in upland and wetland habitats of White Canyon STSA.
Desert night lizard	*Xantusia vigilis*	BLM-S; UT-SC	Garfield, San Juan	**Potential for negative impact.** Species could occur in upland habitats of Tar Sand Triangle and White Canyon STSAs.
Smooth greensnake	*Liochlorophis vernalis*	BLM-S; UT-SC	Carbon, Duchesne, Grand, San Juan, Uintah	**Potential for negative impact.** Species could occur in upland and wetland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, Sunnyside, and White Canyon STSAs.
Birds				
American peregrine falcon	*Falco peregrinus anatum*	BLM-S; CO-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
American white pelican	*Pelecanus erythrorhynchos*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**No impact.** Transient migrant through STSA project areas. Known breeding populations occur outside STSAs.
Black swift	*Cypseloides niger*	BLM-S; UT-SC	Duchesne, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Bobolink	*Dolichonyx oryzivorus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Burrowing owl	*Athene cunicularia*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Birds (Cont.)				
Ferruginous hawk	*Buteo regalis*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Greater sage-grouse	*Centrocercus urophasianus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs.
Lewis's woodpecker	*Melanerpes lewis*	BLM-S; UT-SC	Carbon, Duchesne, Emery Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Long-billed curlew	*Numenius americanus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in wetland and upland habitats of all STSAs.
Northern goshawk	*Accipiter gentilis*	BLM-S	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Short-eared owl	*Asio flammeus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Pariette, San Rafael, Tar Sand Triangle, and White Canyon STSAs.
Three-toed woodpecker	*Picoides tridactylus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Hill Creek, P.R. Spring, Sunnyside, Tar Sand Triangle, and White Canyon STSAs.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	ESA-C; BLM-S	Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in riparian habitats of Asphalt Ridge STSA.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Mammals				
Allen's big-eared bat	*Idionycteris phyllotis*	BLM-S; UT-SC	Garfield, Grand, San Juan, Wayne	**Potential for negative impact.** Species could occur in upland, aquatic, and wetland habitats of P.R. Spring, Tar Sand Triangle, and White Canyon STSAs.
Big free-tailed bat	*Nyctinomops macrotis*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs.
Fringed myotis	*Myotis thysanodes*	BLM-S; UT-SC	Duchesne, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, Tar Sand Triangle, and White Canyon STSAs.
Gunnison's prairie dog	*Cynomys gunnisoni*	ESA-C; BLM-S; UT-SC	Grand, San Juan	**No impact.** Populations occur outside STSAs.
Kit fox	*Vulpes macrotis*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Mogollon vole	*Microtus mogollonensis*	BLM-S; UT-SC	San Juan	**No impact.** Populations occur outside STSAs under consideration.
Pygmy rabbit	*Brachylagus idahoensis*	BLM-S; UT-SC	UT-Garfield, Wayne	**Potential for negative impact.** Species could occur in upland habitats of Tar Sand Triangle STSA.
Silky pocket mouse	*Perognathus flavus*	BLM-S; UT-SC	San Juan	**No impact.** Populations occur outside STSAs.
Spotted bat	*Euderma maculatum*	BLM-S; UT-SC	Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland, aquatic, and riparian habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs.

TABLE 5.8.1-5 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Impact[b]
Mammals (Cont.)				
Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for negative impact.** Species could occur in upland habitats of all STSAs.
Western red bat	*Lasiurus blossevillii*	BLM-S; UT-SC	Carbon, Emery, Grand, Garfield, San Juan, Wayne	**Potential for negative impact.** Species could occur in upland and riparian habitats of P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs.
White-tailed prairie dog	*Cynomys leucurus*	BLM-S; UT-SC	Carbon, Duchesne, Emery, Grand, Uintah	**Potential for negative impact.** Species could occur in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and San Rafael STSAs.

[a] Status categories: BLM-S = listed by the BLM as sensitive; ESA-C = candidate for listing under the ESA; UT-SC = species of special concern in Utah; CO-SC = species of special concern in Colorado.

[b] Potential impacts based on general habitat preference are presented in Table 5.1.8-3. Specific habitat preferences are presented in Appendix E.

of individual plants, human collection, increased human access, spread of invasive plant species, and air pollution (Table 5.8.1-4).

The Ute ladies'-tresses could occur in wetland habitats and along the Green River or White River. This species is dependent on a high water table and, in addition to the factors affecting upland plants, could be adversely affected by any water depletions from the Green River or White River basins associated with tar sands development.

Tar sands development in any of the STSAs could affect federally listed endangered Colorado River fishes (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) either directly, if projects are adjacent to occupied habitats, or indirectly, if project activities are located within occupied watersheds (e.g., Green River and White River). Direct and indirect effects could result from vegetation clearing, alteration of topography and drainage patterns, erosion, sedimentation from runoff, oil and contaminant spills, water depletions, stream impoundment and changes in streamflow, and disruption of groundwater flow patterns. Any activities within watersheds that affect water quality (e.g., land disturbance or water volume changes that affect sediment load, contaminant concentrations, TDS concentrations, and temperature of streams) or quantity (e.g., stream impoundments or withdrawals that affect base

TABLE 5.8.1-6 Potential Effects of Commercial Tar Sands Development on Federally Listed Threatened, Endangered, and Proposed Species

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Effect[b]
Plants				
Autumn buttercup	*Ranunculus aestivalis*	E	Garfield	**Not likely to adversely affect.** Populations occur outside STSAs under consideration.
Barneby reed-mustard	*Schoenocrambe barnebyi*	E	Emery, Wayne	**Potential for adverse effect.** Possible occurrence in upland habitats of San Rafael STSA.
Barneby ridge-cress	*Lepidium barnebyanum*	E	Duchesne	**Not likely to adversely affect.** Populations occur outside STSAs under consideration.
Clay reed-mustard	*Schoenocrambe argillacea*	T	Uintah	**Potential for adverse effect.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Jones cycladenia	*Cycladenia humilis* var. *jonesii*	T	Emery, Garfield, Grand, Uintah	**Potential for adverse effect.** Possible occurrence in upland habitats of Hill Creek, Pariette, P.R. Spring, and San Rafael STSAs.
Last chance townsendia	*Townsendia aprica*	T	Emery, Wayne	**Potential for adverse effect.** Possible occurrence in upland habitats of San Rafael STSA.
Maguire daisy	*Erigeron maguirei*	T	Emery, Garfield, Wayne	**Potential for adverse effect.** Possible occurrence in riparian and upland habitats of San Rafael STSA.
Navajo sedge	*Carex specuicola*	T	San Juan	**Not likely to adversely affect.** Populations occur outside STSAs under consideration.
San Rafael cactus	*Pediocactus despainii*	E	Emery, Wayne	**Potential for adverse effect.** Possible occurrence in upland habitats of San Rafael STSA.
Shrubby reed-mustard	*Schoenocrambe suffrutescens*	E	Duchesne, Uintah	**Potential for adverse effect.** Possible occurrence in upland habitats of Hill Creek, Pariette, P.R. Spring, and Sunnyside STSAs.

TABLE 5.8.1-6 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Effect[b]
Plants (Cont.)				
Uinta Basin hookless cactus	*Sclerocactus glaucus*	T	Carbon, Duchesne, Uintah	**Potential for adverse effect.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs.
Ute ladies'-tresses	*Spiranthes diluvialis*	T	Duchesne, Garfield, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in riparian and wetland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, and Raven Ridge STSAs.
Winkler cactus	*Pediocactus winkleri*	T	Emery, Wayne	**Potential for adverse effect** Possible occurrence in upland habitats of San Rafael STSA.
Wright fishhook cactus	*Sclerocactus wrightiae*	E	Emery, Wayne	**Potential for adverse effect.** Possible occurrence in upland habitats of San Rafael and Tar Sand Triangle STSAs.
Fish				
Bonytail	*Gila elegans*	E	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in aquatic habitats of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. All depletions from the Colorado River Basin are considered an adverse effect.
Colorado pikeminnow	*Ptychocheilus lucius*	E	Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in aquatic habitats of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. All depletions from the Colorado River Basin are considered an adverse effect.

TABLE 5.8.1-6 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Effect[b]
Fish (Cont.)				
Humpback chub	*Gila cypha*	E	Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in aquatic habitats of Asphalt Ridge, Hill Creek, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. All depletions from the Colorado River Basin are considered an adverse effect.
Razorback sucker	*Xyrauchen texanus*	E	Carbon, Emery Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in aquatic habitats of Asphalt Ridge, Hill Creek, Pariette, Raven Ridge, Sunnyside, Tar Sand Triangle, and White Canyon STSAs. All depletions from the Colorado River Basin are considered an adverse effect.
Birds				
California condor	*Gymnogyps californianus*	E	Grand	**Potential for adverse effect.** Possible occurrence in upland habitats of Tar Sand Triangle and White Canyon STSAs.
Mexican spotted owl	*Strix occidentalis lucida*	T	Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in upland habitats of Raven Ridge, Tar Sand Triangle, and White Canyon STSAs.
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	Carbon, Emery, Garfield, Grand, San Juan, Uintah, Wayne	**Potential for adverse effect.** Possible occurrence in wetland and riparian habitats of P.R. Spring, San Rafael, Tar Sand Triangle, and White Canyon STSAs.
Mammals				
Black-footed ferret	*Mustela nigripes*	XN	Carbon, Duchesne, Emery, Grand, San Juan, Uintah	**Potential for adverse effect.** Possible occurrence in upland habitats of Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, and Sunnyside STSAs.

TABLE 5.8.1-6 (Cont.)

Common Name	Scientific Name	Status[a]	Counties in Project Area Where Species Occurs	Potential for Effect[b]
Mammals (Cont.)				
Canada lynx	*Lynx canadensis*	T	Emery, Uintah; WY-Lincoln, Sublette, Uinta	**Potential for adverse effect.** Possible occurrence in upland habitats of Asphalt Ridge STSA.
Utah prairie dog	*Cynomys parvidens*	T	Garfield, Wayne	**Not likely to adversely affect.** Populations occur outside the STSAs under consideration.

[a] Status categories: E = listed under the ESA as endangered; PT = proposed for listing under the ESA as threatened; T = listed under the ESA as threatened; XN = experimental population, nonessential.

[b] Potential impacts based on general habitat preference are presented in Table 5.1.8-3. Specific habitat preferences are presented in Appendix E.

flow, peak flow magnitude, and seasonal flow pattern) could have effects in occupied areas far downstream. The Upper Colorado River Endangered Fishes Recovery Implementation Program considers any water depletions from the upper Colorado River Basin, which includes the watersheds of the Green River and White River, an adverse effect on endangered Colorado River fishes that requires consultation and mitigation. Water depletions for individual projects could be quite large and represent a significant adverse impact on these riverine fish.

On the basis of proximity of populations and critical habitat to potential lease areas, the greatest potential for direct impacts on endangered fishes is related to development in Utah, where the Green River and White River flow through tar sands areas. If these areas are made available for leasing, there is a relatively high probability that these species would be directly or indirectly affected by tar sands development.

Federally listed bird species that could be affected by commercial tar sands development include the California condor, Mexican spotted owl, and southwestern willow flycatcher. The California condor occurs in mountainous areas at low to moderate elevations, especially rocky and brushy areas near cliffs, while the Mexican spotted owl could occur year-round in steep forested canyons in Utah. The two species could be affected if these types of habitats are disturbed during tar sands development. Impacts on individual condors and owls could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

The southwestern willow flycatcher is most commonly found in riparian areas, especially along large rivers (e.g., Green River). These riparian habitats could be affected directly by surface disturbance or indirectly by activities in their watersheds that resulted in alteration of topography, changes in drainage patterns, erosion, sedimentation from runoff, and oil and contaminant spills. In addition, impacts on riparian habitats that support these species could result if the habitats were crossed by project transmission lines or roads. Impacts on individual birds could result from injury or mortality (e.g., collisions with transmission lines), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

Federally listed mammals that could be affected by tar sands development include the black-footed ferret and Canada lynx. The black-footed ferret occurs in grasslands and shrublands that support active prairie dog towns and may potentially occur near many of the tar sands project areas. The Canada lynx occurs in coniferous forests and potentially occurs near the Asphalt Ridge STSA. Impacts on these species could result from impacts on habitat (including vegetation clearing, habitat fragmentation, and movement/dispersal blockage) and individuals (injury or mortality [e.g., collisions with vehicles]), human disturbance or harassment, increased human access to occupied areas, increases in predation rates, and noise from facilities.

5.8.2 Mitigation Measures

Various mitigation measures would be required to reduce the impact of tar sands development on ecological resources during construction, operations, and reclamation. Existing guidance, recommendations, and requirements related to management practices are described in detail in the BLM Gold Book (DOI and USDA 2006), and BLM field office RMPs. The BLM has also developed a guidance document, *Hydraulic Considerations for Pipeline Crossing Stream Channels*, for construction of pipeline crossings of perennial, intermittent, and ephemeral stream channels. This guidance can be found at http://www.blm.gov/nstc/library/techno2.htm. BLM Manual 6840—*Special Status Species Management* describes BLM policy to protect species identified by BLM as sensitive (BLM 2001). In addition, BLM has developed a set of conservation measures in consultation with USFWS intended to minimize impacts of tar sands development on threatened and endangered species (see Appendix F).

In addition to the actions described in these guidance documents, the mitigation actions below could be used to reduce the potential for impacts on various ecological resources. Other mitigation measures may be identified by the BLM or USFWS prior to project development. Developing effective mitigation measures that avoid, reduce, or eliminate the impacts of tar sands development on ecological resources will represent a significant challenge because of the potentially large-scale, long operational time period, and reclamation difficulties that will be characteristic of many tar sands projects.

5.8.2.1 Aquatic Resources

- Protect wetlands, springs, seeps, ephemeral streams, and riparian areas on or adjacent to development areas through mitigation. This objective would be accomplished by conducting predisturbance surveys in all areas proposed for development following accepted protocols established by the USACE, BLM, or state regulatory agencies, as appropriate. If any wetlands, springs, seeps, or riparian areas are found, plans to mitigate impacts would be developed in consultation with those agencies and the local BLM field office prior to the initiation of ground disturbance. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats in which development activities would be excluded or modified, (2) using erosion-control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats.

- Minimize and mitigate changes in the function of the 100-year floodplain or flood storage capacity in accordance with applicable requirements. To achieve this, either no activities or limited activities within floodplains would be allowed, and floodplain contours could be restored to predisturbance conditions following short-term disturbances. The effectiveness of mitigation measures would be evaluated and modified, if necessary.

- Minimize and mitigate water quality degradation (e.g., chemical contamination, increased salinity, increased temperature, decreased dissolved oxygen, and increased sediment loads) that could result from construction and operation. Water quality in areas adjacent to or downstream of development areas would be monitored during the life of the project to ensure that water quality in aquatic habitats is protected.

- Minimize and mitigate the impacts on aquatic habitats (including springs, seeps, and ephemeral streams), wetlands, and riparian areas that could result from changes to surface or groundwater flows. Hydrologically connected areas would be monitored for changes in flow that are development related.

5.8.2.2 Plant Communities and Habitats

- Mitigate impacts on rare natural communities and remnant vegetation associations. Predisturbance surveys would be used to identify these communities in and adjacent to development areas. Examples of potential protective measures include (1) establishing buffer zones adjacent to these habitats and excluding or modifying development activities within those areas, (2) using erosion-control techniques to prevent sediment runoff into these habitats, (3) using runoff control devices to prevent surface water runoff into these areas, and (4) identifying and implementing spill prevention technologies that would prevent or reduce the potential for oil or other contaminants from entering these habitats. Mitigation could also include reclamation or establishment of similar habitats elsewhere as compensation.

- Reclaim excavated areas and disturbed areas following backfilling operations. Spent tar sands returned to mined areas would be covered with subsoil and then topsoil. Exposed soils would be seeded and revegetated as directed under applicable BLM requirements. Only locally native plant species would be used for the reclamation of disturbed areas to reestablish native plant communities.

- Prevent the establishment and spread of invasive species and noxious weeds, thus protecting developing plant communities on the project site from colonization by these species and increasing the potential for the successful development of diverse, mature native habitats in disturbed areas. Degradation of nearby habitats by invasive species colonization from project areas would also be avoided.

- Protect plant communities and habitats near all project areas from the effects of fugitive dust. This objective could be achieved by implementing dust abatement practices (e.g., mulching, water application, paving roads, and plantings) that would be applied to all areas of regular traffic or areas of exposed erodible soils.

5.8.2.3 Wildlife (Including Wild Horses and Burros)

- Identify important, unique, or high-value wildlife habitats in the vicinity of the project and design the project to mitigate impacts on these habitats. For example, project facilities, access roads, and other ancillary facilities could be located in the least environmentally sensitive areas (i.e., away from riparian habitats, streams, wetlands, drainages, and critical or crucial wildlife habitats). The lessee would consult with the BLM and state agencies to discuss important wildlife use areas in order to assist in the determination of facility design and location that would avoid or minimize impacts on wildlife species and their habitats to the fullest extent practicable. The lessee would, at a minimum, follow the *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (WGFD 2004).

- Habitat enhancement or in-kind compensatory habitat are options available when developing a wildlife management plan for a project.

- Evaluate the project site for avian use (particularly by raptors, greater sage-grouse, neotropical migrants, and birds of conservation concern), and design the project to mitigate the potential for adverse impacts on birds and their habitat. Conduct predisturbance surveys for raptor nesting in all areas proposed for development following accepted protocols and in consultation with the USFWS and state natural resource agencies. If raptor nests are found, an appropriate course of action would be formulated to mitigate impacts, as appropriate. For example, impacts could be reduced if project design avoided locating transmission lines in landscape features known to attract raptors. The lessee would also, at a minimum, follow guidance provided in the APP Guidelines prepared by the APLIC and USFWS (APLIC and USFWS 2005).

- Design facilities to discourage their use as perching or nesting sites by birds and minimize avian electrocutions.

- Any surface water body created for a project may be utilized to the benefit of wildlife when practicable; however, netting and fencing may be required when water chemistry demonstrates a need to prevent use by wildlife.

- Mitigate wildlife mortality from vehicle collisions. To achieve this objective, important wildlife habitats could be mapped and activities within them avoided (if possible) or mitigated. Education programs could be implemented to ensure that employees are aware of wildlife impacts associated with vehicular use. These would include the need to obey state- and county-posted speed limits. Carpooling, busing, or other means to limit traffic (and vehicle collisions with wildlife) would be emphasized.

- Develop a habitat restoration plan for disturbed project areas that includes the establishment of native vegetation communities consisting of locally native plant species. The plan would identify revegetation, soil stabilization, and erosion-reduction measures that would be implemented to ensure that all disturbed areas are restored. Restoration would be implemented as soon as possible after completion of activities to reduce the amount of habitat converted at any one time and to hasten the recovery to natural habitats.

- Minimize habitat loss and fragmentation due to project development. For example, habitat fragmentation could be reduced by consolidating facilities (e.g., access roads and utilities would share common ROWs, where feasible), reducing access roads to the minimum number required, and, where possible, locating facilities in areas where habitat disturbance has already occurred. Transportation management planning can be used as an effective tool to minimize habitat fragmentation to meet this performance goal.

- Protect wildlife from the negative effects of fugitive dust. Dust abatement practices include measures such as mulching, water application, road paving, and plantings.

- Avoid (to the extent practicable) human interactions with wildlife (and wild horses and burros). To achieve this objective, the following measures could be implemented: (1) instruct all personnel to avoid harassment and disturbance of wildlife, especially during reproductive (e.g., courtship and nesting) seasons; (2) make personnel aware of the potential for wildlife interactions around facility structures; (3) ensure that food refuse and other garbage are not available to scavengers (e.g., by use of covered dumpsters); and (4) restrict pets from project sites.

- Mitigate noise impacts on wildlife during construction and operation. This objective could be accomplished by limiting the use of explosives to specific times and at specified distances from sensitive wildlife areas, as established by the BLM or other federal and state agencies. Operators would ensure that all construction equipment was adequately muffled and maintained to minimize disturbance to wildlife.

- Protect wildlife from chronic and acute pesticide exposure. This objective could be accomplished by measures such as using pesticides of low toxicity, minimizing application areas where possible, and by using timing and/or spatial restrictions (e.g., do not use pesticide treatments in critical staging areas). All pesticides would be applied consistent with their label requirements and in accordance with guidance provided in the *Final Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (BLM 2007b).

- Construct wildlife- and wild-horse-friendly cattleguards for all new roads or the improvement of existing ways and trails that require passing through existing fences, fence-line gates, or new gates, in addition to standard wire gates alongside of them.

- Construct fencing (as practicable) to exclude livestock, wild horses, or wildlife from all project facilities, including all water sites built for the development of facilities and roadways.

- Mitigate existing water sources used by wildlife or wild horses in the vicinity of the project if adversely impacted during project construction or operation.

- Protect or avoid important big game habitat (e.g., crucial winter habitat and birthing areas) to the extent practicable.

5.8.2.4 Threatened and Endangered Species

The BLM, in consultation with the USFWS, developed a set of conservation measures to support the conservation of species listed under the ESA. These are provided in Appendix F. For purposes of the PEIS, these conservation measures are assumed to be generally consistent with existing conservation agreements, recovery plans, and completed consultations. It is the intent of the BLM and USFWS to ensure that the conservation measures are consistent with those currently applied to other land management actions where associated impacts are similar. However, it is presumed that potential impacts from development described in the PEIS are likely to vary in scale and intensity when compared with land management actions previously considered (e.g., oil and gas exploration and production, surface mining, and underground mining). Thus, final conservation measures would be developed for individual projects prior to leasing or ground-disturbing activities and would be consistent with agency policies. Current BLM guidance on similar actions (e.g., fluid mineral resources) requires that the least restrictive stipulation that effectively accomplishes the resource objectives or resource uses for a given alternative should be used while remaining in compliance with the ESA. Mitigation measures, generally applicable to all listed species, are presented below. Species-specific measures are listed in Appendix F.

- Protect federally listed and state-listed threatened and endangered species and BLM-designated sensitive species through siting and development decisions to avoid impacts. Conduct predisturbance surveys in all areas proposed for development following accepted protocols and in consultation with the USFWS and/or state agencies. If any federally listed species are found, and it is determined that the proposed development "may affect" the listed species or their critical habitat, the USFWS will be consulted as required by Section 7 of the ESA and an appropriate course of action developed to mitigate impacts and address any potential incidental take from the activity. If any state-listed or BLM-designated sensitive species are found, plans to mitigate impacts will be developed prior to construction consistent with guidance provided in BLM Manual 6840.

- Mitigate harassment or disturbance of federally listed threatened and endangered animals, BLM-designated sensitive animal species, and state-listed threatened and endangered animals and their habitats in or adjacent to project areas. This objective can be accomplished by identifying sensitive areas and implementing necessary protection measures based upon Section 7 consultation with the USFWS. Education programs could be developed to ensure that employees are aware of protected species and requirements to protect them. Prohibition of nonpermitted access and gating could be used to restrict access to sensitive areas.

- Mitigate impacts on federally listed and state-listed threatened and endangered species and BLM-designated sensitive species and their habitats during construction and operations. If deemed appropriate by the USFWS, activities and their effects on these species will be monitored throughout the duration of the project. To ensure that impacts are avoided, the effectiveness of mitigation measures will be evaluated and, if necessary, Section 7 consultation will be reinitiated.

- Protect federally listed and state-listed threatened and endangered species and BLM-designated sensitive species (especially plants) and their habitats from the adverse effects of fugitive dust. This objective could be achieved by implementing dust abatement practices near threatened and endangered species habitats or other special habitats of importance (to be determined at the local field office level). Dust abatement practices (e.g., mulching, water application, paving roads, and plantings) could be applied to all areas of regular traffic or areas of exposed erodible soils, especially in areas near occupied habitats.

- Avoid the release of oil to aquatic habitats in quantities that could result in subsequent adverse impacts on federally listed and state-listed threatened and endangered species and BLM-designated sensitive species. This objective could be accomplished by applying spill prevention technology to all oil pipelines that cross or are in close proximity to rivers or streams with threatened or endangered aquatic species. For example, pipelines crossing rivers with listed aquatic species could have remotely actuated block or check valves on both sides of the river; pipelines could be double-walled pipe at river crossings; and pipelines could have a spill/leak contingency plan that includes timely notification of the USFWS and/or state agencies.

5.9 VISUAL RESOURCES

5.9.1 Common Impacts

While visual impacts associated with the construction, operation, and reclamation of tar sands projects considered in the PEIS differ in some important aspects on the basis of the tar sands extraction and processing technologies employed, there are many impacts that are common to the development approaches. Direct visual impacts associated with construction, operation, and reclamation of commercial tar sands development can be divided into generally temporary impacts associated with activities that occur during the construction and reclamation phases of the projects, and long-term impacts that result from construction and operation of the facilities themselves. Impacts are presented below by tar sands extraction and processing technology approach. In some cases, visual impacts would be very similar to those expected for commercial oil shale development (Section 4.9), and in the following discussion, the reader is referred to the PEIS sections discussing oil shale development impacts as appropriate.

As is the case for commercial oil shale production, regardless of the technologies employed for tar sands extraction and processing, commercial production of tar sands would entail industrial processes eventually requiring more than 5,000 acres of land disturbance and the presence and operation of major industrial facilities and equipment. These activities would introduce major visual changes to natural-appearing landscapes and create strong visual contrasts in line, form, color, and texture. While mitigation measures might lessen some visual impacts associated with these projects (Section 5.9.2), in large part the visual impacts associated with the commercial tar sands projects analyzed in the PEIS could not be effectively mitigated.

While some of the lesser elements of a tar sands project might be compatible with VRM Class III or Class II objectives (see Section 4.9), the siting of the major facility elements would be expected to be compatible with Class IV objectives only, unless careful siting hid them from view. VRM Class II or Class III areas near major facilities where open lines of sight existed between the Class II or Class III lands and the major facilities would sometimes be subject to visual impacts from the strong visual contrasts that would result, particularly if the distance was within the foreground-middleground range, but possibly farther in some cases. These impacts might be incompatible with the VRM objectives for these areas.

5.9.1.1 Surface Mining with Surface Retorting

5.9.1.1.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and retorting would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.1.2 Operation. Potential visual impacts associated with operation of commercial tar sands projects utilizing surface mining and retorting would be similar to those expected for commercial oil shale production utilizing surface mining and retorting (see Section 4.9.1.1). There would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials; however, the general nature and extent of visual impacts would likely be similar. Rather than spent shale piles, tar sands projects would involve spent tar sands piles, which might be disposed of in pits and/or mounds. If stored in mounds, the form and line would likely be similar to spent shale piles, but the texture and color would likely be different, with spent tar sands being finer textured material and darker in color than spent shale. It is expected that up to 2,950 acres of land would be disturbed at a given time.

Figures 5.9.1-1 and 5.9.1-2 depict commercial surface mining activities for oil sands in Alberta, Canada. An oil sands processing facility is visible in the background in both figures. Figures 5.9.1-3 and 5.9.1-4 show closer views of an oil sands processing facility.

5.9.1.2 Surface Mining with Solvent Extraction

5.9.1.2.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be very similar to those anticipated for commercial oil shale production utilizing surface mines and surface retorts. These impacts are described in Section 4.9.1.1.

FIGURE 5.9.1-1 Large-Scale Commercial Oil Sands Surface Mining, North of Fort McMurray, Alberta, Canada (An oil sands processing plant is visible in the distant background.) (Image courtesy of Suncor Energy, Inc.)

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

FIGURE 5.9.1-2 Large-Scale Commercial Oil Sands Surface Mining Activity North of Fort McMurray, Alberta, Canada (The shovel bucket holds approximately 100 tons of oil sands ore. An oil sands processing plant is visible in the background.) (Image courtesy of Suncor Energy, Inc.)

5.9.1.2.2 Operation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing surface mining and solvent extraction would be similar to those expected for commercial oil shale production utilizing surface mining and retorting (see Section 4.9.1.1); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, buildings and structures for solvent extraction and related processes would be required. Spent tar sands, rather than spent oil shale, would be disposed of on the surface or in pits. It is expected that up to 2,950 acres of land would be disturbed at a given time. Figure 5.9.1-5 depicts an existing pilot-scale tar sands processing facility utilizing surface mining and solvent extraction on Asphalt Ridge near

FIGURE 5.9.1-3 Portion of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)

FIGURE 5.9.1-4 Close-up View of a Large-Scale Commercial Oil Sands Processing Plant near Fort McMurray, Alberta, Canada (Image courtesy of Suncor Energy, Inc.)

FIGURE 5.9.1-5 Photo Mosaic of Existing Pilot-Scale Tar Sands Processing Facility Utilizing Surface Mining and Solvent Extraction on Asphalt Ridge near Vernal, Utah

Vernal, Utah. The photo conveys a general sense of the appearance of the structures and layout for a tar sands processing facility. A commercial-scale facility, however, such as that analyzed in the PEIS, would be many times larger.

5.9.1.3 In Situ Steam Injection

5.9.1.3.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ steam injection would be very similar to those anticipated for commercial oil shale production utilizing in situ methods. These impacts are described in Section 4.9.1.3.

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.3.2 Operation. Potential visual impacts associated with operation of commercial tar sands projects utilizing in situ steam injection would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, steam-assisted gravity drainage of tar sands would be used. This technology requires large pieces of equipment to create steam and to recover, treat, and recycle condensate (cooling towers, holding ponds, treatment tanks, etc.). Buildings and structures associated with power generation and the transport of heat and cooling fluids, as well as numerous wells, well pads, and associated structures and equipment, would be present. The overall visual impacts, however, would be lower than those for projects utilizing mining and aboveground processing of tar sands. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a "rolling footprint" approach.

Figure 5.9.1-6 shows an in situ steam injection facility for oil sands extraction in Alberta, Canada.

5.9.1.4 In Situ Combustion

5.9.1.4.1 Construction and Reclamation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be very similar to those anticipated for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3). However, because there is no need for coolant and associated power generation and transport, there would be fewer aboveground structures, and, therefore, less construction and reclamation activity and associated visual impacts.

FIGURE 5.9.1-6 In Situ Steam-Assisted Gravity Drainage (SAGD) Facility near Fort McMurray, Alberta, Canada (SAGD technology uses underground wells to inject steam into the oil sands deposits and collect the bitumen released by the heat.) (Image courtesy of Suncor Energy, Inc.)

It is assumed that there would be one connecting transmission line and ROW serving each site that could be up to 140 mi long and 100 ft wide, with construction impacts up to 150 ft wide. It is assumed that there would be one pipeline and ROW serving each project site, up to 95 mi long and 50 ft wide, with construction impacting an area as wide as 100 ft (see Section 5.9.1.5 for a discussion of impacts associated with electric transmission line and pipeline construction).

5.9.1.4.2 Operation. Potential visual impacts associated with construction and reclamation of commercial tar sands projects utilizing in situ combustion would be similar to those expected for commercial oil shale production utilizing in situ methods (see Section 4.9.1.3); however, there would be some differences in the types of structures, buildings, and equipment used to extract and process the different materials. Rather than retorts, combustion of tar sands would require equipment to inject oxygen, but there would likely be fewer aboveground structures than would be required for in situ steam injection. While wells, well pads, and associated structures and equipment would be present, the overall visual impacts would likely be much lower than those for projects utilizing mining and aboveground processing of tar sands, and would likely be slightly lower than those for tar sands projects utilizing in situ steam injection. It is expected that 80 to 200 acres of land would be disturbed at a given time. Development would proceed utilizing a rolling footprint approach.

5.9.1.5 Other Associated Tar Sands Project Facilities

While many visual impacts expected from commercial tar sands development projects under consideration in the PEIS would be site- or technology-specific, the tar sands projects have some common elements that would be expected to create similar visual impacts regardless of location or the tar sands extraction or processing technologies employed. These elements include transmission lines and pipelines and employer-provided housing. The elements and related visual impacts are discussed here separately from impacts associated with specific tar sands extraction and processing technologies.

5.9.1.5.1 Electric Transmission Lines and Pipelines. Construction and operation of electric transmission lines and oil pipelines could be required for tar sands commercial development; the projected linear extent of the facilities, however, varies by project type and technology employed. Visual impacts associated with construction, operation, and reclamation of the electric transmission lines and pipeline facilities would be the same as those described for oil shale development projects discussed in Section 4.9.1.4. For a given tar sands project, up to 140 mi of transmission line and ROW might be required, and up to 95 mi of pipeline and ROW might be required.

5.9.1.5.2 Employer-Provided Housing. Employer-provided housing would be constructed for use by employees during the construction phase for tar sands projects. The locations of housing are unknown, but are not likely to be on public lands. Visual impacts associated with construction, operation, and reclamation of employer-provided housing are discussed in Section 4.9.1.4; however, for tar sands projects, an estimated 49 acres of land would be required for employer-provided housing during the construction phase for each project, and an estimated 13 acres of land would be required for employer-provided housing during the operations phase for each project.

5.9.2 Mitigation Measures

Development activities would implement visual impact mitigation measures to the extent applicable and practicable. Potential mitigation measures that may be applied to siting, development, and operation of tar sands leases, as warranted by the result of the lease-stage or plan of development–stage NEPA analyses, include the following. However, it should be noted that while mitigation measures might lessen some visual impacts associated with tar sands development, in large part the visual impacts associated with commercial tar sands projects could not be mitigated.

- Siting projects outside of the viewsheds of KOPs, or if this cannot be avoided, as far away as possible.

- Siting projects to take advantage of both topography and vegetation as screening devices to restrict views of projects from visually sensitive areas.

- Siting facilities away from and not adjacent to prominent landscape features (e.g., knobs and waterfalls).

- Avoiding placement of facilities on ridgelines, summits, or other locations such that they will be silhouetted against the sky from important viewing locations.

- Co-locating facilities to the extent possible, to utilize existing and shared ROWs, existing and shared access and maintenance roads, and other infrastructure, in order to reduce visual impacts associated with new construction.

- Siting linear facilities so that generally they do not bisect ridge tops or run down the center of valley bottoms.

- Siting linear features (aboveground pipelines, ROWs, and roads) to follow natural land contours rather than straight lines (particularly up slopes) when possible. Fall-line cuts should be avoided.

- Siting facilities, especially linear facilities, to take advantage of natural topographic breaks (i.e., pronounced changes in slope) to avoid siting facilities on steep side slopes.

- Where possible, siting linear features such as ROWs and roads to follow the edges of clearings (where they will be less conspicuous) rather than passing through the centers of clearings.

- Siting facilities to take advantage of existing clearings to reduce vegetation clearing and ground disturbance, where possible.

- Choosing locations for ROWs and other linear feature crossings of roads, streams, and other linear features to avoid KOP viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landform.

- Siting linear features (e.g., trails, roads, and rivers) to cross other linear features at right angles whenever possible to minimize viewing area and duration.

- Minimizing the number of structures required.

- Constructing low-profile structures whenever possible to reduce structure visibility.

- Siting and designing structures and roads to minimize and balance cuts and fills and to preserve existing rocks, vegetation, and drainage patterns to the maximum extent possible.

- Selecting and designing materials and surface treatments in order to repeat and/or blend with existing form, line, color, and texture of the landscape.

- Using appropriately colored materials for structures, or appropriate stains/coatings, to blend with the project's backdrop.

- Using nonreflective or low-reflectivity materials, coatings, or paints whenever possible.

- Painting grouped structures the same color to reduce visual complexity and color contrast.

- Designing and installing facility lighting so that the minimum amount of lighting required for safety and security is provided but not exceeded and that upward light scattering (light pollution) is minimized.

- Siting construction staging areas and laydown areas outside of the viewsheds of KOPs and visually sensitive areas, where possible, including siting in swales, around bends, and behind ridges and vegetative screens.

- Developing a site reclamation plan and implementing it as soon as possible after construction begins.

- Discussing visual impact mitigation objectives and activities with equipment operators prior to commencement of construction activities.

- Mulching slash from vegetation removal and spreading it to cover fresh soil disturbances or, if not possible, burying slash.

- If slash piles are necessary, staging them out of sight of sensitive viewing areas.

- Avoiding installation of gravel and pavement where possible to reduce color and texture contrasts with existing landscape.

- Using excess fill to fill uphill-side swales resulting from road construction in order to reduce unnatural-appearing slope interruption and to reduce fill piles.

- Avoiding downslope wasting of excess fill material.

- Rounding road-cut slopes, varying cut and fill pitch to reduce contrasts in form and line, and varying slope to preserve specimen trees and nonhazardous rock outcroppings.

- Leaving planting pockets on slopes where feasible.

- Providing benches in rock cuts to accent natural strata.

- Using split-face rock blasting to minimize unnatural form and texture resulting from blasting.

- Segregating topsoil from cut and fill activities and spreading it on freshly disturbed areas to reduce color contrast and aid rapid revegetation.

- If topsoil piles are necessary, staging them out of sight of sensitive viewing areas.

- Where feasible, removing excess cut and fill from the site to minimize ground disturbance and impacts from fill piles.

- Burying utility cables where feasible.

- Minimizing signage and painting or coating reverse sides of signs and mounts to reduce color contrast with existing landscape.

- Prohibiting trash burning during construction, operation, and reclamation; storing trash in containers to be hauled off-site for disposal.

- Controlling litter and noxious weeds and removing them regularly during construction, operation, and reclamation.

- Implementing dust abatement measures to minimize the impacts of vehicular and pedestrian traffic, construction, and wind on exposed surface soils during construction, operation, and reclamation.

- Undertaking interim restoration during the operating life of the project as soon as possible after disturbances.

- During road maintenance activities, avoiding blading existing forbs and grasses in ditches and along roads.

- Recontouring soil borrow areas, cut and fill slopes, berms, waterbars, and other disturbed areas to approximate naturally occurring slopes during reclamation.

- Randomly scarifying cut slopes to reduce texture contrast with existing landscape and to aid in revegetation.

- Covering disturbed areas with stockpiled topsoil or mulch, and revegetating with a mix of native species selected for visual compatibility with existing vegetation.

- Removing or burying gravel and other surface treatments.

- Restoring rocks, brush, and forest debris whenever possible to approximate preexisting visual conditions.

To mitigate visual impacts on high-value scenic resources in lands outside of, but adjacent to or near tar sands leasing areas, the following mitigation measures should be applied to siting, development, and operation of tar sands projects, as warranted by the result of lease-stage or plan of development–stage NEPA analyses:

- Tar sands-related development and operation activities within 5 mi of National Scenic Highways, All-American Roads, state-designated scenic highways, Wild and Scenic Rivers, and river segments designated as eligible for wild and scenic river status should conform to VRM Class II management objectives, with respect to impacts visible from the roadway/river. Beyond 5 mi but less than 15 mi from the roadway/river, development activities should conform to VRM Class III objectives.

- Development activities within 15 mi of high-potential sites and segments of National Trails, National Historic Trails, and National Scenic Trails should conform to VRM Class II management objectives, with respect to impacts visible from the adjacent trail high-potential sites and segments. Beyond 15 mi, development activities should conform to VRM Class III objectives.

- Development activities on BLM-managed public lands within 15 mi of KOPs (e.g., scenic overlooks, rest stops, and scenic highway segments) in National Parks, National Monuments, NRAs, and ACECs with outstandingly remarkable values for scenery should conform to VRM Class II management objectives, with respect to impacts visible from the KOPs. Beyond 15 mi, development activities will conform to VRM Class III objectives. KOPs for non-BLM-managed lands should be determined in consultation with the managing federal agency.

5.10 CULTURAL RESOURCES

5.10.1 Common Impacts

Significant cultural resources, listed or eligible for listing on the NRHP, could be affected by commercial tar sands leasing and development. The potential for impacts on cultural resources from commercial tar sands development, including ancillary facilities such as access roads, transmission lines, pipelines, and employer-provided housing, is directly related to the amount of land disturbance and the location of the project. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces and from increased accessibility to possible site locations, are also considered. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. However, the addition of stipulations to the leases would clarify the necessary requirements for historic properties present within a lease area.

Several impacts on cultural resources could occur, as described below.

- *Complete site destruction* could result from the clearing of the project area, grading, excavation, and construction of facilities and associated infrastructure if sites are located within the footprint of the project.

- *Site degradation and/or destruction* could result from the alteration of topography; alteration of hydrologic patterns; removal of soils; erosion of soils; runoff into and sedimentation of adjacent areas; and oil or other contaminant spills if sites are located near the project area. Such degradation could occur both within the project footprint and in areas downslope or downstream. While the erosion of soils could negatively impact sites downstream of the project area by potentially eroding materials and portions of sites, the accumulation of sediment could serve to protect some sites by increasing the amount of protective cover. Contaminants could affect the ability to conduct analyses of the material present at the site and thus the ability to interpret site components.

- *Increases in human access* and subsequent disturbance (e.g., looting, vandalism, and trampling) of cultural resources could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas. Increased human access (including OHV use) exposes archaeological sites and historic structures and features to a greater probability of impact from a variety of stressors.

- *Visual degradation of setting* associated with significant cultural resources could result from the presence of commercial tar sands development and associated land disturbances and ancillary facilities. This degradation could affect significant cultural resources for which visual integrity is a component of the sites' significance, such as sacred sites and landscapes, historic trails, and historic landscapes.

Cultural resources are nonrenewable; once they are damaged or destroyed, they are not recoverable. Therefore, if a cultural resource is damaged or destroyed during oil shale development, it would constitute an irretrievable commitment of this particular cultural location or object. For cultural resources that are significant for their scientific value, data recovery is one way in which some information may be salvaged should a cultural resource site be adversely impacted by development activity. Certain contextual data are invariably lost, but new cultural resources information is made available to the scientific community. Loss of value for education, heritage tourism, or traditional uses is less easily mitigated.

5.10.2 Mitigation Measures

For all potential impacts, the application of mitigation measures developed in consultation under Section 106 of the NHPA will avoid, reduce, or mitigate the potential for adverse impacts on significant cultural resources. Section 106 consultations between the BLM and the SHPOs, appropriate Tribes, and other consulting parties would be required at the lease stage and at the plan of development stage. The use of BMPs, such as training and education programs, could reduce occurrences of human-related disturbances to nearby cultural sites. The specifics of these BMPs would be established in project-specific consultations between the applicant and the BLM, as well as with the SHPO and Tribes, as appropriate. The addition of stipulations to specific leases would ensure that resulting decisions from project-specific consultations are applied to the resources present in the lease areas.

An ethnohistory and cultural resources overview were completed for the project area (Bengston 2007 and O'Rourke et al. 2007, respectively). The overviews synthesized existing information on cultural resources that had been previously identified. Also, Tribal consultation was initiated to further identify significant cultural resources. This phase of analysis did not identify geographical areas that would preclude moving areas forward for leasing. During the leasing phase, the overviews and ongoing Tribal consultation will be reviewed to help determine areas of sensitivity and appropriate survey and mitigation needs.

The BLM will conduct a phased approach to meet the agency's obligations under Section 106 of the NHPA. This approach is necessary for identification and evaluation efforts where alternatives under consideration consist of large land areas across a multistate region and when effects on historic properties cannot be fully determined prior to approval of leasing. Each phase of development will require an appropriate level of Section 106 analysis. Tar sands leasing may require additional consultation and information gathering (e.g., cultural resource inventories) prior to the lease sale. The final phase is that the lessee will then submit a plan of development for a site-specific project. Additional site-specific NEPA analyses and Section 106 review will be conducted on these individual project plans of development. The BLM will complete comprehensive identification (e.g., field inventory), evaluation, protection, and mitigation following the policies and procedures contained within the 1997 BLM National Programmatic Agreement and State Protocols (BLM 1997) and as indicated in any lease stipulations. Also, the BLM will continue to implement government-to-government consultation with Tribes and with other consulting parties on a case-by-case basis for plans of development.

The BLM does not approve any ground-disturbing activities that may affect any historic properties, sacred landscapes, and/or resources protected under the NHPA, American Indian Religious Freedom Act, NAGPRA, E.O. 13007 (U.S. President 1996), or other statutes and E.O.s until it completes its obligations under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated. The BLM attaches this language to all lease parcels.

In some instances, additional special stipulations to the leases may be required for protection of specific cultural resources on the basis of the ethnohistoric overview and cultural resource Class I overview (Bengston 2007 and O'Rourke et al. 2007, respectively), cultural resource inventories conducted prior to leasing, and information received from Tribal consultations, if it will not be possible to adequately avoid, minimize, or mitigate such resources under existing statutes, regulations, or BLM policy subsequent to lease issuance.

The BLM develops specific mitigation measures to implement the lease stipulations on a project-by-project basis. Mitigation for adverse effects on the most common resource type, archaeological sites significant for their scientific value, is data recovery. To protect portions of historic trails that are potentially eligible for listing on the NRHP from visual intrusion and to maintain the integrity of the historic cultural setting, the BLM would require that surface disturbance be restricted or prohibited within the viewshed of the trail along those portions of the trail for which eligibility is based on the viewshed.

5.11 SOCIOECONOMICS

The analysis of the socioeconomic impacts of tar sands development in Utah consists of two interdependent parts. The analysis of economic impacts estimates the impacts of tar sands facilities and associated housing on employment and personal income in an ROI in which tar sands resources are located. Because of the relative economic importance of tar sands developments in small rural economies and the consequent lack of local economic and community infrastructure, large-scale tar sands developments are likely to mean a large influx of temporary population. As population increases are likely to be rapid, local communities may be unable to quickly absorb new residents, resulting in impacts on local finances and public service infrastructure. Social and psychological disruption may also occur, together with the undermining of established community social structures. Given these considerations, the analysis of social impacts assesses the potential impacts of tar sands developments on housing, local government, finances, and employment in the ROI in each of the three states. The analysis also assesses the potential for social disruption that may be associated with rapid population growth in small rural communities hosting large resource development projects.

The assessment of the socioeconomic impact of tar sands development was undertaken on the basis of a number of key assumptions relating to tar sands local procurement, worker in-migration, housing requirements and housing construction, and annual impacts. These assumptions are the same as those used in the analysis of the impact of oil shale development and are outlined in Section 4.11. Methods used in the analysis of the economic and social impacts of tar sands developments are briefly described in the introduction to Section 4.11. Details of this methodology are presented in Appendix G. Underlying employment numbers are also presented in Appendix G.

5.11.1 Common Impacts

5.11.1.1 Economic Impacts

Construction and operation of tar sands facilities and the associated temporary employer-provided housing and housing provided by local communities in Utah for tar sands workers and family members would have relatively large impacts on the economy of the ROI.

A single tar sands facility would produce 1,831 jobs in the ROI (1,187 direct jobs at tar sands facilities and 644 indirect jobs in the remainder of the local economy) during the peak construction year, and $91.3 million in income in the ROI (Table 5.11.1-1). During commercial production, 747 employees (482 direct and 265 indirect) would be required in the ROI, producing $36.8 million in income. Construction employment for a tar sands development facility would represent an increase of 4.1% over the projected ROI employment baseline.

Temporary housing built for tar sands workers and families would create 552 jobs (432 direct and 119 indirect in the remainder of the local economy) and $9.9 million in income in the ROI (Table 5.11.1-1).

TABLE 5.11.1-1 ROI Economic Impacts of Tar Sands Development[a]

	Housing Construction		Tar Sands Development: Construction		Tar Sands Development: Operation	
	Employment	Income	Employment	Income	Employment	Income
Utah						
No specified technology						
Direct	432	7.3	1,187	78.3	482	31.8
Indirect	119	2.6	644	13.0	265	5.0
Total	552	9.9	1,831	91.3	747	36.8

[a] The direct employment data presented in this table are based on data provided in BLM (1984) and are extrapolated from data presented for construction and operation of a surface mine with a capacity of 190,000 bbl/day, and an in situ facility with a capacity of 175,000 bbl/day. Direct employment numbers and multiplier data from the IMPLAN model (Minnesota IMPLAN Group, Inc. 2007) were used to calculate total employment numbers; indirect employment numbers were then derived.

It is assumed that no new power plants or coal mines would be needed to facilitate development of tar sands resources in Utah.

5.11.1.2 Social Impacts

Construction and operation of tar sands facilities would have a large impact on population in the Utah ROI. The influx of tar sands workers and family members into local communities would have a relatively large impact on the housing market. The new residential population associated with the construction and operation of tar sands facilities would also require the hiring of additional local public service employees (police officers, fire personnel, local government employees, and teachers) in each ROI. Increases in ROI public service employment would also require increases in local revenues and expenditures to provide the necessary additional local public service provision.

In the peak year of construction of tar sands developments, 1,000 new residents are expected in ROI communities (Table 5.11.1-2). With commercial operation of tar sands development, 671 workers and family members would move into the local communities in the ROI. Population in-migration associated with tar sands construction would represent an increase of 1.0% over the projected ROI population baseline. During the peak year of construction, 289 housing units, or 3.2% of the projected vacant housing stock in the ROI, would be required (Table 5.11.1-2).

Construction of tar sands developments would require 25 new local government employees, with 17 required during operations (Table 5.11.1-3). The additional local public

TABLE 5.11.1-2 ROI Demographic and Housing Impacts of Tar Sands Development

	Tar Sands Development In-Migration in Local Communities		Housing Demand in Local Communities	
	Construction	Operation	Number of Units	Percent Vacant
Utah				
No specified technology	1,000	671	289	3.2

TABLE 5.11.1-3 ROI Community Impacts of Tar Sands Development

	Government Employees		Change in Local Government Expenditures (%)	
	Construction	Operation	Construction	Operation
Utah				
No specified technology	25	17	1.0	0.7

service provision would require an increase in 1.0% in local expenditures during the peak construction year, and 0.7% during operations.

Higher local government expenditures would mean the potential for better quality local public services and infrastructure in some communities. In addition to providing employment and higher wages for some occupational groups, oil companies may also provide funds to upgrade portions of the road system in each ROI, and fund school scholarships and vocational training in some communities. Financing needed to support increases in local public expenditures that would be required to facilitate expansion in local public services, education, and local infrastructure impacted by tar sands and associated facilities might come from a number of sources. In communities impacted by the oil and gas industry, increases in property tax revenues resulting from increases in assessed valuations with increased demand for employee housing have often provided local communities with funds to support local finances in each ROI, and have often occurred without the need to increases property tax rates (see Section 3.10.2). In addition, revenues from oil and gas severance taxes are currently distributed by state authorities to local communities to support local public service and infrastructure development using a range of different mechanisms, while payments in lieu of taxes are often made by federal agencies to support local community responses to energy developments on public land. Royalty bonus payments have also been provided to local communities with the leasing of public lands for energy development. Some communities might also receive increased sales tax revenues resulting from local energy development and consequent increases in economic activity that could be used to support local government expenditures.

With a relatively large in-migrant population expected in the Utah ROI during the construction and operation of tar sands facilities and the associated temporary housing, there is the potential for social disruption in communities in the ROI. The type and scope of impacts on social disruption are expected to be similar to those for oil shale development. Section 4.11.1.3 examines the experience of small rural communities in the Western states that would have rapid boomtown development associated with energy projects.

5.11.1.3 Agricultural Impacts

Since it is likely that tar sands technologies will require large quantities of water, water transfers from other industries may be required in each ROI. To facilitate new oil and gas development, historic water rights have often been purchased from agricultural landowners, primarily ranchers (see Section 3.10.2.2). Although the transfer of water rights to energy companies has not always meant that agricultural land is lost, the loss of water rights has often meant usually that irrigated agriculture is no longer possible and has led to the conversion of land to dryland farming and ranching activities. At higher levels of tar sands development, it is possible that water may be transferred into the ROI from other areas, which may limit the impact of reduced access by agriculture to water resources in some areas of the ROI. With restrictions on water use for irrigation, some agricultural land may consequently be sold and developed for second homes, condominiums, and other real estate types, which may create quality of life impacts in some farming communities (see Section 3.10.2.2.1). Water availability on agricultural land and land sales might also fragment wildlife habitat and affect the behavior of migratory big game species, such as elk and mule deer, which form an important basis for recreational activities in many parts of each ROI.

The impacts of substantial conversion of agricultural water rights could have large impacts on the economy of the ROI, the extent to which would depend on the amount of agricultural production lost, the extent of local employment in agriculture (see Section 3.10.2.1.2), the reliance of other industries in the ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local impact of spending of wages and salaries by farmers, ranchers, and farmworkers. In addition to income from agricultural activities, agricultural income comes from “agri-tourism,” including hunting and fishing; hiking and other farm and ranch-related experiences, may also be affected by losses of agricultural land or changes in agricultural land use. Oil shale and tar sands and ancillary facility development may fragment or destroy wildlife habitat and affect the behavior of migratory big game species, such as elk and mule deer, which form an important basis for recreational activities in many parts of each ROI. Loss of revenues from recreation activities may also affect wildlife and habitat agency management practices. The impact of losses in employment and income from a reduction in agriculture in the economy of the ROI likely would be more than offset in some parts of each ROI by increases in revenues coming from oil shale development; however, the impact would likely change the character of community life in the ROI. Changes in economic activity such as these would also likely produce social impacts associated with the loss of traditional quality of life and the adoption of a more urban lifestyle.

5.11.1.4 Recreation Impacts

Estimating the impact of tar sands development on recreation is problematic, as it is not clear how activities in the ROI would affect recreational visitation (use values) and passive use values (the value of recreational resources for potential or future visits). While it is clear that some federal land in the ROI would no longer be accessible for recreation, the majority of popular wilderness locations would be precluded from tar sands development. It is also possible that tar sands developments and associated transmission lines and transportation infrastructure elsewhere in the ROI would be visible from popular recreation locations (see Section 5.9), thereby reducing visitation and consequently impacting the economy of the ROI.

Because the impact of tar sands development on visitation is not known, this section presents two simple scenarios to indicate the magnitude of the economic impact of tar sands development on recreation: the impact of a 10% and a 20% reduction in ROI recreation employment in the state ROI. Impacts include the direct loss of recreation employment in the recreation sectors in the ROI, and the indirect effects, which represent the impact on the remainder of the economy in the ROI as a result of a declining recreation employee wage and salary spending, and expenditures by the recreation sector on materials, equipment, and services. Impacts were estimated by using IMPLAN data for the ROI (Minnesota IMPLAN Group, Inc. 2007). IMPLAN is an input-output modeling framework designed to capture spending flows among all economic sectors and households in the ROI economy.

In the Utah ROI, total (direct plus indirect) impacts of tar sands development on recreation would be the loss of 388 jobs and $3.2 million in income in the ROI as a whole as a result of a 10% reduction in recreation employment, and 776 jobs lost and $6.3 million in income lost with the 20% reduction (Table 5.11.1-4).

TABLE 5.11.1-4 Total ROI[a] Impacts of Reductions in Recreation Sector[b] Employment Resulting from Tar Sands Development

	10% Reduction		20% Reduction	
ROI	Employment	Income ($ million)	Employment	Income ($ million)
Utah	388	3.2	776	6.3

[a] The Utah ROI includes Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties.

[b] The recreation sector includes amusement and recreation services, automotive rental, eating and drinking places, hotels and lodging places, museums and historic sites, RV parks and campsites, scenic tours, and sporting goods retailers.

5.11.1.5 Property Value Impacts

There is concern that tar sands developments and their associated transmission lines and coal mines might affect property values in ROI communities located nearby. Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase because of access to employment opportunities associated with tar sands developments. The potential impacts of energy developments on property values are discussed in Section 4.11.1.6.

5.11.1.6 Transportation Impacts

Tar sands project development that could occur would lead to increases in traffic on any roads needed for access to project sites. In areas undergoing simultaneous oil and gas or other development at the same time, tar sands–related development would add to traffic volumes and maintenance needs. The amount of additional heavy vehicles associated with tar sands development is not large compared with the number of light vehicles transporting employees; however, such vehicles would add to the congestion and may require special consideration when designing or upgrading access roads and highways.

Providing adequate access roads to development sites may involve upgrading existing roads and road facilities or constructing completely new roads and facilities. Specifications for the access roads would be dictated by the expected volume and type of traffic. Significant increases in traffic loads would cause increased costs for maintenance and repair of roads and bridge structures.

Because some of the construction and processing equipment components are large, ROW clearances and minimum turning radii become critical parameters for road design. Typically, access roads would be a minimum of 10 ft (3 m) wide, but they may need to be as much as 30 ft (9 m) wide or more to accommodate continuous access needs. Depending on design requirements and local geology and soil characteristics, surface soils may need to be excavated, and road material may need to be imported to establish an adequate road base.

The majority of transportation-related environmental impacts would occur while creating access to development sites from existing public roads; existing public or private roadways may also need to be altered, however, to accommodate heavy and/or oversized transport vehicles or additional traffic volumes. It is reasonable to expect that special road transportation permits would be required for some vehicles. Excessive load weight may require fortification of existing bridges, and large loads may require the temporary removal of height or turning radius obstacles.

5.11.2 Mitigation Measures

Mitigation measures to reduce socioeconomic impacts will be required and could include the BLM working with state and local agencies to identify potential socioeconomic impacts and develop mitigations. In doing so, a suite of potential measures could be implemented, including but not limited to the following actions:

- Operators could be required to provide housing and basic services for all direct project hires and their families in order to minimize potential (1) social disruption associated with large numbers of in-migrants locating in small rural communities, (2) short-term adverse impacts on regional housing markets and overnight accommodation facilities, (3) adverse impacts on regional consumer products' availability and price, and (4) adverse impacts on public services provided by local communities in the surrounding region.

- Operators could work with state and local agencies to develop community monitoring programs that would be sufficient to identify and evaluate socioeconomic impacts resulting from commercial development. Monitoring programs should collect data reflecting economic, fiscal, and social impacts of the development at both the state and local level. Parameters to be evaluated could include impacts on local labor and housing markets, local consumer product prices and availability, local public services (police, fire, and public health), and educational services. Programs also could monitor indicators of social disruption (e.g., crime, alcoholism, drug use, and mental health) and the effectiveness of community welfare programs in addressing these problems.

It is possible that some community development programs, with participation from energy resource developers, and local, state, and federal governments, will be implemented proactively in each ROI to avoid, manage, or mitigate negative social, economic, and fiscal consequences of oil shale development, prior to development of oil shale.

Operators could work with state and local agencies to develop community outreach programs that would help communities adjust to changes triggered by commercial development. Such programs could include any of the following activities:

- Establishing vocational training programs for the local workforce to promote the development of skills required by the commercial development industries.

- Developing instructional materials for use in area schools to educate the local communities on the commercial development industries.

- Supporting community health screenings, especially those addressing potential health impacts related to commercial development activities.

- Providing financial support to local libraries for the development of information repositories on commercial development and processing, including materials on the hazards and benefits of commercial development. Electronic repositories established by the operators could also be of great value.

Additional impact mitigation strategies could be designed and implemented at the local and state level, notably market-based mitigation strategies to coordinate ecosystem management practices, and rotational schedules for direct workers once the location, timing, and magnitude of impacts of specific projects are known. The role of tax revenues in attempts to diversify local economies and reduce dependency on natural resource extraction industries, thereby reducing the susceptibility of local communities to the boom-and-bust economic cycle associated with energy development in rural areas, could also be considered. The BLM cannot direct that government funds be paid to state and local governments to mitigate impacts from oil shale development. The BLM can only show those impacts in NEPA documents and address how impacts were mitigated in the past by direction from Congress to use the bonus bids from the federal leases.

Mitigation measures that could be implemented to reduce transportation impacts include the following:

- Maintain and/or upgrade existing roads utilized for the proposed project, as necessary, to conditions equal to, or better, than those that existed prior to project-related use.

- Develop and maintain close working relationships with state and county highway departments during all phases of project construction and maintenance.

- Encourage employees and contractors to carpool to and from the site.

- Emphasize to contractors and employees the need to comply with all posted speed limits to prevent accidents as well as to minimize fugitive dust.

- Comply with county and state weight restrictions and limitations and overweight/size permitting requirements.

- Control dust along unsurfaced access roads and minimize the tracking of mud onto roads.

- Restore unsurfaced roads to equal or better condition than preconstruction levels after construction is completed.

- Develop measures to control unauthorized OHV use in cooperation with the BLM and interested landowners.

- Require all projects to develop transportation management plans; new road construction or road upgrades on BLM-administered public lands would be expected to follow minimum guidelines as provided in the BLM Gold Book (DOI and USDA 2006), including road maintenance requirements.

5.12 ENVIRONMENTAL JUSTICE

The construction and operation of tar sands developments and associated housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development were significantly high and if these impacts disproportionately affected minority and low-income populations. If health and environmental impacts are not significant, there can be no disproportionate impacts on minority and low-income populations. If the impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. Details of the methodology for assessing environmental justice issues are presented in Appendix G. The following sections describe impacts on various resources located in the tar sands resource areas within the ROI that would be impacted by tar sands development. Local demographic and social disruption impacts, property value impacts, land use, air and water quality and use, and visual impacts are described. This discussion is followed by a determination of the extent to which impacts of tar sands development would have a disproportionate effect on low-income and minority groups on the basis of the location of low-income and minority populations.

5.12.1 Common Impacts

5.12.1.1 Impact-Producing Factors

Rapid population growth in small rural communities hosting large tar sands development projects may produce social and psychological disruption, together with the undermining of established community social structures. Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15% (see Section 4.11.1.3).

Property value impacts on private land in the vicinity of tar sands development projects and associated transmission lines may affect minority and low-income populations. These impacts would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (e.g., visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (e.g., infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Construction activities would produce fugitive dust emissions and engine exhaust emissions from heavy equipment and commuting and delivery vehicles on paved and/or unpaved roads, and wind erosion from soil disturbed by construction activities or from soil stockpiles. Emissions associated with these activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Emissions during tar sands facility operations would consist of CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2. Construction of transmission lines and access roads required for the delivery of equipment and materials to project sites would produce fugitive dust impacts, the magnitude of which would depend, in part, on the terrain, road length, and the length of time that they would be used for construction traffic.

Water consumption and quality impacts on land in the vicinity of tar sands development projects and associated transmission lines might affect minority and low-income populations, both in terms of water used for domestic consumption and water that may be used to support wildlife populations used for subsistence agriculture and for cultural and religious purposes. The impact on water resources during construction would consist primarily of increases in surface runoff and, consequently, in dissolved solids and in the volumetric flow of nearby streams near the project sites. The amount of water used during the operation of tar sands development projects is expected to be large at higher levels of facility production and could potentially impact minority and low-income populations if there were shortages of drinking water or water that might be used for agriculture.

Construction and operation of tar sands and supporting facilities, housing, and transmission lines would produce noise impacts, and the operation of transmission lines could lead to EMF effects.

Tar sands facilities and associated transmission towers may potentially alter the scenic quality in areas of traditional or cultural significance to minority and low-income populations, depending on the facility's size and location. Construction would introduce contrasts in form, line, color, and texture, as well as a relatively high degree of human activity into existing landscapes with generally low levels of human activity.

Land used for tar sands facilities might affect certain types of animals or vegetation that were of cultural or religious significance to certain population groups or that formed the basis for subsistence agriculture. Similarly, land that was used for facilities that also has additional economic uses might affect access to resources by low-income and minority population groups.

5.12.1.2 General Population

Population in-migration would occur in each year of tar sands resource development. Workers would be required to move into the state for the construction and operation of tar sands facilities and to address the demand for goods and services resulting from the spending of tar sands and housing construction worker wages and salaries. It is projected that during the period in which a tar sands facility would be constructed in the ROI, population in the ROI would increase by 1.0%. In-migration associated with tar sands development would also require additional housing to be constructed in the ROI, with up to 3.2% of vacant housing units required during the peak year of construction.

Since tar sands development projects and the associated housing developments would lead to rapid population growth in many of the communities in each ROI, and given evidence presented in the literature (see Section 3.10.2.2), it is highly possible that some degree of social disruption would accompany these developments. In the absence of appropriate levels of local and regional planning, rapid demographic change may lead to the undermining of local community social structures by those among the local population and in-migrants with contrasting beliefs and value systems and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Partially offsetting some of these developments would be higher local government expenditures, with the potential for better quality local public services and infrastructure in some communities. In addition to providing employment and higher wages for some occupational groups, oil companies may also provide funds to upgrade portions of the road system in each ROI, and fund school scholarships and vocational training in some communities.

The precise nature of the impact of tar sands facility construction and operation on property values was not evaluated for this PEIS. The impact would depend on the range of alternate uses of specific land parcels by landowners, current property values, and the perceived value of costs (visual impacts, traffic congestion, noise and dust pollution, air quality impacts, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) from proximity to tar sands–related facilities to potential purchasers of property owned by minority and low-income individuals in local communities.

Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because all activities either conducted or approved by the BLM through use authorizations must comply with all applicable local, state, Tribal, and federal air quality laws, statutes, regulations, standards, and implementation plans, it is unlikely that future tar sands development would cause significant adverse air quality impacts.

Water from the Colorado River in Utah, plus the estimated sustainable groundwater yield, would likely be sufficient to support the amount of water needed for tar sands development, ancillary power and coal facilities, and associated population growth. It should be noted that prolonged drought conditions may occur and constrain water availability in Utah. Although discharges could have significant impacts on water quality if not properly controlled, water quality impacts of tar sands development are expected to be temporary and local, provided that mitigation measures are implemented, in part because of the dry climate where the sites are located. However, steep slopes in some areas may channel surface runoff and result in localized soil erosion.

Tar sands facilities might affect certain types of animals or vegetation that are of cultural or religious significance to certain population groups or form the basis for subsistence agriculture. Similarly, land that is used for these facilities that also has additional economic uses might affect access to resources by low-income and minority population groups.

Surface mine and surface retorting would involve the most surface disturbance and visible activity (including dust and emissions) and would be expected to generate the largest visual impacts relative to the other projects of similar size but using in situ processes. Visual impacts associated with reclamation also would likely be less than those for projects using surface mines because of the greatly reduced level of ground disturbance. Projects using in situ technologies would likely have the smallest level of visual impacts because of the absence of spent tar sands piles and other mining-related facilities and activities. These projects also would likely have the smallest reclamation impacts because of reduced surface disturbance and the absence of spent tar sands piles.

5.12.1.3 Environmental Justice Populations

The construction and operation of tar sands developments could impact environmental justice if the adverse health and environmental impacts resulting from either phase of development identified in the previous sections were significantly high and if these impacts disproportionately affected minority and low-income populations. Where impacts are significant, disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations.

A number of census block groups in the area potentially hosting tar sands development have low-income and minority populations in which the minority population exceeds 50% of the total population in each block group, and there are a number of block groups in which the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.11). Within 50 mi of the tar sands area, the minority population is located in the northeastern part of the state in the immediate vicinity of the tar sands resource area itself, in the southeastern portion of the Uintah and Ouray Indian Reservation, and in the north-central part of the state, to the east of Springville. The low-income population is centered in roughly the same area as the minority population, with five block groups in the southeastern portion of the Uintah and Ouray Indian Reservation, and one located in the vicinity of Price.

Given the location of environmental justice populations in each state, the construction and operation of tar sands facilities and employee housing required for the operation of tar sands development projects would produce impacts that may be experienced disproportionately by minority and low-income populations in a number of locations in each ROI. Of particular importance would be the social disruption impacts from large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region would also be important. Depending on their locations, impacts on low-income and minority populations may also occur with the development of transmission lines associated with power development and the supply of power to tar sands facilities in each state. Land use and visual impacts might be significant, depending on the location of land parcels impacted by tar sands projects and the associated housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses.

5.12.2 Mitigation Measures

Various procedures might be used to protect low-income and minority groups from high and adverse impacts of tar sands and associated facilities. Most important of these would be to develop and implement focused public information campaigns to provide technical and environmental health information directly to low-income and minority groups or to local agencies and representative groups. Included in these campaigns would be descriptions of existing air and groundwater monitoring programs; the nature, extent, and likelihood of existing and future airborne or groundwater releases from tar sands facilities; and the likely characteristics of environmental and health impacts. Key information would include the extent of any likely impact on air quality, drinking water supplies, and subsistence resources and the relevant preventative measures that could be taken.

Rapid population growth following the in-migration of construction and operation workers associated with tar sands and ancillary facilities into communities with low-income and minority populations could lead to the undermining of local community social structures where the in-migrants have beliefs and value systems that contrast with those of the local population. Consequently, a range of changes in social and community life, including increases in crime, alcoholism, and drug use, could result. In anticipation of these impacts, key information on the scale and time line of tar sands developments, and on the experience of other communities that have followed the same energy development path, together with information on planning activities that may be initiated to provide local infrastructure, public services, education, and housing, could be made available to low-income and minority populations.

5.13 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

5.13.1 Common Impacts

Impacts related to hazardous materials and wastes are generally independent of location. Such impacts would be derivatives of the technologies employed for resource recovery and for the subsequent processing of recovered products rather than of the locations at which these activities occur.

Hazardous materials and wastes are unique to the technology combinations used for tar sands development. However, hazardous materials and waste impacts are common for some of the ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing.

Hazardous materials impacts associated with construction or expansions of off-site support facilities would be minimal and limited only to the hazardous materials typically utilized in construction of such facilities. These would include the hazardous materials required to support construction equipment and vehicles (fuels, other vehicle and equipment fluids such as lubricating oils, hydraulic fluids, and glycol-based coolants) and miscellaneous hazardous materials typically associated with construction such as solvents, adhesives, and corrosion-control coatings. Construction-related wastes would include landscape wastes from clearing and grading of the construction sites and other wastes typically associated with construction, none of which are expected to be hazardous and all of which, except for landscape wastes, are expected to be disposed of in permitted sanitary landfills. Landscape wastes are expected to either be burned on-site or delivered to permitted off-site facilities for disposal or composting.

Once these support facilities become functional, different hazardous materials and waste impacts would result. It is expected that virtually no hazardous materials would be associated with employer-provided housing. However, wastes would include nonhazardous solid wastes and sanitary wastewaters. Solid wastes are expected to be containerized and hauled to permitted sanitary landfills or other appropriate waste disposal facilities. As conditions permit, sanitary wastewaters are expected to be treated on-site through such technologies as septic systems or active biological treatment; all such activities would be controlled by permits issued to state or local authorities. Depending on the location of the employer-provided housing and other circumstantial factors, it is also possible that sanitary wastewaters would be delivered by truck or sewer to existing or expanded municipal treatment works for treatment.

5.13.1.1 Surface Mining with Surface Retort

Hazardous materials associated with mining would primarily be used to support vehicles and equipment, most of which could not be easily transported to off-site maintenance and repair facilities. Hazardous materials would include fuels (primarily diesel fuel) and other engine and equipment fluids, such as lubricating oils, hydraulic fluids, glycol-based coolants, and battery electrolyte. Other miscellaneous hazardous materials used in the repair of mechanical equipment (cleaning solvents, welding gases, corrosion-control paints and coatings) would also likely be present in limited quantities. Explosives might also be used to support the mining activities; however, explosives are expected to be brought to the site on an as-needed basis rather than stored at the site. Limited amounts of herbicides would also be used on-site to manage vegetation in industrial areas for fire prevention and control. However, herbicides, like explosives, are not expected to be stored on-site but instead would be brought to the site on an as-needed basis.

Waste associated with surface mining operations also would be primarily associated with vehicle and equipment maintenance and would involve the spent hazardous materials described above. In addition, solid wastes (e.g., kitchen wastes, administrative wastes) and sanitary wastewater would result from the support of the workforce. Solid wastes would likely be containerized and hauled to an off-site permitted disposal facility. Sanitary wastes might be treated on-site by using septic systems or biological treatment as conditions dictate and operating permits allow, or alternatively, they might be delivered by truck or sewer to municipal treatment works. At the initial development of any given area, some landscape wastes could also result as the land surface was cleared and overburden removed. Landscape wastes would likely be burned on-site (under the authority of a state or local permit) or delivered to an off-site facility for disposal or composting. Stormwater runoff from stockpiled overburden could contain elevated amounts of suspended solids. Stormwater management is expected to be addressed by a sitewide SWPPP that is expected to be required by the site’s stormwater management permit.

Other than the commercial fuel consumed as a source of heat, no hazardous materials would be required to support operation of the surface retort.[5] The inorganic phase remaining after bitumen removal is composed primarily of sand and silt. At some Canadian oil sands developments, the sand that is recovered is a type (crystalline form) that makes it valuable for use in formation fracturing as part of enhanced recovery techniques for conventional crude oil. There is no evidence to suggest that sands recovered from retorting of U.S. tar sands would have similar value. Consequently, for the purpose of this analysis, the sand and silt that remain after bitumen removal are considered to be a solid waste. The most likely management strategies for this material involve either its use in reclamation of the mine site (to establish original contours prior to replacement of stockpiled overburden) or disposal in an on-site facility operating under a permit issued by state or local authorities. Residual sand and silt from retorting are not expected to exhibit any hazardous characteristics (although some residual bitumen may remain adsorbed to sand grains); nevertheless, they represent the potential for contaminating surface water runoff with high concentrations of suspended particulates, organic contaminants, and perhaps some dissolved minerals present in the tar sands formation. Proper design of waste sand disposal cells, appropriate vegetative covers, and other controls established under a solid waste disposal permit and/or a sitewide SWPPP should adequately address and mitigate this potential. Free water present in the formation is expected to be released during the retorting step. However, it is not expected to contain significant amounts of contamination and is likely to be of sufficient quality for beneficial use on-site for fugitive dust control.

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

5.13.1.2 Surface Mining with Solvent Extraction

Hazardous materials and waste impacts from surface mining discussed above would apply without change to this alternative. However, for the retorting step, a solvent in which the bitumen is soluble would be added as a means of bitumen separation rather than relying on heat, mechanical agitation, or phase separation to separate the bitumen from the inorganic fractions of tar sands. In this technique, additional hazardous materials would be introduced. A variety of solvents could be used. Those that have been used successfully for solvent extraction of oil sands

[5] For the purpose of this impact analysis, "retorting" means those actions conducted to separate the organic fraction, bitumen, from the inorganic materials contained in tar sands (primarily sand and silt). As it is used here, retorting implies only a separation of organic and inorganic fractions of tar sands and does not involve the chemical transformation of bitumen into other organic materials. As defined in Appendix B, a retort patterned after the Lurgi-Ruhrgas direct burn retort is considered to be representative of surface retorting.

in Canadian developments have included raw naphtha and raw gas oil (both condensate fractions from the distillation of conventional crude oil), hexane and cyclohexane (both chemicals produced in refineries or derived in petrochemical plants from secondary feedstocks), and ethanol. All of these materials have relatively high vapor pressures and low specific gravities, and all are extremely flammable.[6] When practiced correctly, solvent extraction will recover the majority of solvents for reuse, although some minor evaporative losses are expected. Some aromatic solvents (naphthenic derivatives) that could be used have moderately high water solubility. If used as extraction solvents, they can be expected to partition to some extent into the free formation water that would also be present during the extraction process. While this aqueous fraction is easily separated from the organic phase (the bitumen), it will likely need treatment to remove the polar organic contaminants before it can be released back to the environment or used for beneficial purposes on-site, such as fugitive dust control.

Obviously, the accidental release of any of the extraction solvents would represent a hazardous fire situation and a potential adverse impact on the environment. Prudent management procedures would prevent such accidental releases. For cost control, facilities are likely to be established for recovery and recycling of the extraction solvents. Alternatively, this mixture of extraction solvent and bitumen could also be sent directly to a refinery, eliminating on-site upgrading activities.[7]

Subsequent upgrading of recovered bitumen would be only that necessary to produce an upgraded product that could be accepted at refineries for additional processing. Hydrogen would be introduced to the site to support this upgrading (provided by commercial supplier on an as-needed basis and not generated on-site by steam reforming of natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

5.13.1.3 In Situ Steam Injection

For this technology, only bitumen is recovered from the formation, and spent sand is not generated. Steam is used to heat the bitumen, reducing its viscosity so that it can move through the formation and be recovered by a conventional production well. At the same time, steam condensates, as well as free formation water, are also recovered in the production well. Expected

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[6] Many of the chemical constituents typically found in refinery fractionator condensates, such as raw naphtha and raw gas oil, have been identified as known or possible carcinogens. See the discussions of potential health impacts in Section 5.14.

[7] It is common practice among some Canadian oil sands developers to mix bitumen with diluents (many of which are the same materials that would be used as extraction solvents) to create a less viscous mixture (known in the industry as “dil-bit”) that is delivered by conventional pipeline to refineries for processing, thereby eliminating mine site upgrading.

contaminants include suspended solids, dissolved minerals, and small amounts of polar organic constituents extracted from the bitumen. Typically, and especially in arid areas, these waters will be separated from the bitumen and recycled. Water sources for steam need to be of relatively high quality. Consequently, condensates require treatment to remove dissolved and suspended contaminants before being recycled. Such treatment is likely to produce sludge, which represents one of the primary wastes associated with this technology. Contaminants expected to be present in steam condensates include heavy metals and minerals dissolved from the formation, as well as small amounts of polar organic constituents extracted from the bitumen and partitioned into the aqueous phase. In addition to the primary steam cycle, secondary noncontact cooling systems may also be in operation. Water treatment chemicals are expected to be introduced into waters for primary steam loops as well as secondary cooling systems to control scale, corrosion, and bacteria, so blowdown water from both systems may also require treatment before release or beneficial use.

Bitumen recovered from steam injection is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by a commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities.

5.13.1.4 In Situ Combustion

Hazardous materials required to support in situ combustion would be limited to the conventional fuels (natural gas or propane) that would be introduced to initiate combustion. No solid wastes would result from in situ combustion. However, free formation water, as well as waters of combustion, would be recovered from the production wells used to extract the bitumen. This aqueous fraction is expected to contain some inorganic species (H_2S, NH_3) as well as organic species (e.g., carbonyl sulfide as well as polar organic constituents that formed from partial thermal destruction of bitumen and partitioned into the aqueous phase because of their moderate water solubility). Consequently, this wastewater would require some treatment on-site before being released to the environment or beneficially used on-site (e.g., for fugitive dust control).

The organic fraction recovered from in situ combustion (largely bitumen with lesser amounts of products of incomplete thermal destruction of bitumen) is expected to undergo some upgrading on-site. To support such upgrading, hydrogen would be present on-site (delivered by commercial vendor on an as-needed basis and not generated on-site through steam reforming of commercial natural gas). Periodic maintenance and repair of upgrading systems would result in spent catalysts (some of which might require management as hazardous waste) and sludge from the cleaning of storage tanks and reaction vessels, all of which would require characterization before waste management strategies could be determined. However, regardless of their character, the wastes resulting from upgrading operations are likely to be containerized and delivered to properly permitted off-site treatment or disposal facilities. Virtually all upgrading reactions occur at elevated temperatures and pressures. Therefore, additional fuels would likely be brought to the site to support upgrading heat and pressure requirements. Where steam would be generated to provide the needed heat, treatment of steam condensates to facilitate their recycling would result in sludge that would require characterization before disposal.

5.13.2 Mitigation Measures

Hazardous wastes will be present at a tar sands facility throughout construction, operation, and reclamation. During construction, hazardous wastes will be limited in both variety and volume, consisting mostly of wastes from the maintenance of construction equipment and the field applications of protective coatings. During operation, a greater variety of hazardous wastes can be expected with volumes generally proportional to the scale of the operation. Although facility owners/operators may elect to treat and even dispose of their hazardous wastes at the tar sands facility (with appropriate state-issued permits in place), it is reasonable to expect that most would adopt a strategy that minimizes the times and volumes of on-site storage of hazardous wastes, with expeditious transport to off-site, properly permitted TSDFs. Elementary neutralizations of strongly corrosive wastes, as well as preliminary treatment of wastes to stabilize them for storage and transport, might occur on-site but only to the extent that is minimally necessary.

Regulatory requirements to address hazardous materials and waste management already largely address the mitigation of impacts. To reinforce the regulatory requirements, additional mitigation measures and management plans could include the following:

- An individual, written management strategy for each hazardous waste anticipated;

- Written procedures for waste evaluations, containerization, on-site storage, and off-site disposal;

- Inspection procedures for hazardous material transportation vehicles and storage areas;

- Storage requirements for each hazardous material, including container type, required design elements and engineering controls for storage and handling areas (e.g., secondary containment for liquids, fire protection for areas where flammables are used), and chemical incompatibilities;

- Dedicated, restricted access areas for hazardous waste storage, including adequate separations of chemically incompatible wastes;

- Formal, routine inspections of hazardous waste storage and handling areas;

- In addition to HAZCOM training required for workers who handle hazardous materials, awareness training for all facility personnel, including an identification of explicit roles and responsibilities for each individual;

- Limitations on access to hazardous material storage and use areas to authorized personnel;

- A comprehensive inventory of all hazardous materials at the facility, including notations of incompatibilities;

- Formal, written standard operating procedures addressing “cradle-to-grave” management, including receipt, containerization, storage, use, emergency response, and management and disposal of spent materials for each hazardous material at the facility;

- “Just-In-Time” purchasing strategies to limit the amounts of hazardous materials present at the facility to just those quantities immediately needed to continue operations;

- Preventative maintenance on all equipment and storage vessels containing hazardous materials;

- Aggressive pollution prevention programs to identify less hazardous alternatives and other waste minimization opportunities;

- Establishment of comprehensive in-house emergency response capabilities to ensure expeditious response to accidental releases; and

- Documentation of all accidental releases of hazardous materials and corrective actions taken; conduct of root cause analyses; determination of the adequacy of response actions (making changes to response capabilities as necessary); assessment of long- and short-term impacts on the environment and public health; initiation of necessary remedial actions; and identification of policy or procedural changes that will prevent reoccurrence.

5.14 HEALTH AND SAFETY

Potential health and safety impacts from recovering oil from tar sands deposits can be associated with the following activities: (1) surface mining of the tar sands (underground mining is not considered at this time for tar sands deposits because of possible collapse of the sand deposits); (2) obtaining and upgrading of the product (primarily syncrude oil and some asphalt) through surface retorting, solvent extraction, in situ steam injection, or in situ combustion; (3) transport of construction and raw materials to the facility and transport of product from the facility; and (4) exposure to water and air contamination associated with tar sands development.

Hazards from tar sands development are similar to hazards from oil shale development and are summarized in Table 5.14-1.

For mining and upgrading activities, the primary health and safety impacts are to facility workers. These worker impacts include physical hazards from accidents (including heat stress or stroke, explosion, or injuries related to working around large, moving equipment); health risks from chemical exposures (usually inhalation or dermal) to hazardous substances present in tar sands, the products, other process chemicals, and wastes; and loss of hearing because of potentially high on-the-job noise levels. This section will mainly address worker physical hazards and worker chemical exposure risks. Noise risks are discussed in Section 5.7. Potential water and air contamination, which could lead to exposures for the general public, are discussed in Sections 5.5 and 5.6, respectively. Since, in general, water and air standards are set to be protective of public health, the discussion in those sections addresses potential impacts on the public.

A potential safety impact on the local off-site population that must be considered is risk due to an increased volume of vehicular traffic. The presence of construction and product transport trucks on narrow, two-lane roads could create unique hazards for children waiting at

TABLE 5.14-1 Potential Health Impacts Associated with Tar Sands Development[a]

Process or Product	Possible Hazard
Surface mining	Pneumoconiosis and/or increased cancer risk from inhalation of dust particles, tar sands particles, and/or diesel exhaust; physical hazards, including highwall collapse and explosions, heat stress, and noise.
Surface retorting, solvent extraction, and upgrading	Inhalation of or dermal contact with fumes or particles; noise; inhalation or dermal contact with contaminants in wastewater (e.g., hydrocarbons, phenols, trace elements, salts, suspended solids, oil, sulfides, ammonia, PAHs, and radionuclides).
In situ steam injection and in situ combustion	Physical hazards associated with well drilling, use of explosives, noise, and use of steam at high temperature and pressure; inhalation of or dermal contact with fumes or particles in product, recovered process water, or process chemicals.
Raw and spent tar sands storage	Exposure to contaminants in drinking water; concentrations of contaminants in edible aquatic organisms; inhalation of airborne particulates.
Products (syncrude, asphalt)	Potential cancers from dermal contact with or inhalation of volatile products.
Combustion products	Inhalation of HAPs from emissions of chemicals (e.g., criteria pollutants, trace elements, sulfur and nitrogen compounds, PAHs, and radionuclides).
All	Increased physical hazards and exposure risks from transportation of raw materials and products to and from the facility.

[a] Adapted from DOE (1988) and Brown (1979).

the roadside for their school bus. Additional transportation hazards would include exposure to particulate dusts created by the large trucks, as well as the increased potential for accidents. Transport of bitumen and other by-products is expected to occur by tractor trailer or by pipeline. Traffic accidents involving truck movements or accidents involving the pipelines could also impact public safety.[8]

5.14.1 Common Impacts

5.14.1.1 Surface Mining

Tar sands mining is generally surface mining, because the instability of tar sands does not allow underground mining. The hazards associated with surface mining tar sands would be similar to those associated with surface mining other materials. These include the following (Bhatt and Mark 2000; Speight 1990; Daniels et al. 1981):

- Injuries from highwall-spoilbank failures;
- Hazards associated with storage, handling, and detonation of explosives;
- Inhalation of dust and particulates, possibly containing bitumen or VOCs; inhalation of exhaust fumes from mining equipment;
- Accidents and injuries from working in close proximity to large equipment (e.g., shovels, trucks, and loaders) and equipment with moving parts;
- Injury hazards from lifting, stooping, and shoveling; exposure to climate extremes and sun while working outside; and
- Elevated noise levels (discussed in Section 5.7).

Highwall failures are very dangerous, often resulting in fatalities when the falling material hits workers. MSHA statistics show that there were 428 accidents caused by highwall instability in active coal and nonmetal surface mines from 1988 to 1997; 28 fatalities were recorded (Bhatt and Mark 2000). About one-half of the injuries occurred when the workers were hit directly with the failed highwall material; the other injuries involved the material hitting heavy or miscellaneous equipment. More than one-half of the accidents resulted in lost workdays.

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8 Waste tar sands (tar sand tailings) would be generated in large quantities in any surface processing technology. However, it is expected that disposal of these tailings would occur on the leased site. Consequently, little if any tar sand tailings would be transported to disposal areas over public roadways. However, other chemical wastes associated with the operation may not be acceptable for on-site disposal and would, therefore, be transported by truck to permitted treatment or disposal facilities.

Deaths and injuries from accidental ignition of explosives used to blast the formations and allow removal of the tar sands are a serious hazard in mining operations. Injuries and fatalities may also result from the high physical demands of surface mining. Large machinery could be used to remove the tar sands; a truck-and-shovel approach might also be used. This approach can be more efficient, but it also requires a larger number of employees to conduct the work. In Utah, where the water supplies are limited, making hydrotransport from the excavation site unattractive, it is most likely that excavated tar sands would either be trucked to the retorting or extraction facility or moved by conveyor. The degree of mechanization in the surface mining processes used would greatly influence the number of worker injuries. In general, more mechanization would be expected to result in a lower number of worker injuries, because fewer workers would be needed to conduct the mining (although the number of machinery-related injuries would increase).

Injury and fatality incidence from tar sands surface mining is likely to be lower than that from the mining industry as a whole, since the latter also includes the more hazardous underground mining accidents. However, as an indicator, the recent statistics for the mining industry as a whole are provided here. Statistics for work-related injuries and deaths show that mining is one of the most hazardous occupations, with approximately 28.3 deaths per 100,000 mine workers in the United States in 2004 (NSC 2006). Because of improved safety practices and the use of more advanced machinery, mining deaths have decreased since the 1970s. For example, the death rate in 1970 was 200 per 100,000 workers; the rate has decreased to about 30 deaths per 100,000 in recent years (DOL 2006). The number of work-related injuries for miners was 3.8 nonfatal injuries per 100 mine workers annually in 2004 (NSC 2006).

Inhalation of dusts generated during the mining process can cause disease. If these are tar sands dusts, they will likely contain PAHs, a carcinogenic component of the sands (further discussed in Section 5.14.1.2). Chronic inhalation of irritants such as mineral or metal particles causes pneumoconiosis or miner’s lung, a condition characterized by nodular fibrotic lung tissue changes. Prolonged inhalation of silica dusts causes a form of pneumoconiosis termed silicosis, which is a severe fibrosis of the lungs that results in shortness of breath. Both conditions can be fatal. Although concentrations of these dusts are lower for surface mining in comparison with underground mining, additive exposures may nonetheless result in these diseases.

5.14.1.2 Surface Retorting and Solvent Extraction

The composition and toxicity of tar sands, produced oils, the residual char or coke, and process chemicals partially determine the potential hazards of processing the materials. Tar sands are deposits of consolidated or unconsolidated sediments that have pore spaces saturated with heavy, viscous petroleum known as bitumen. In contrast to heavy oils, the bitumen in tar sands is semisolid and cannot be pumped and collected at a well bore (Daniels et al. 1981).

Bitumen is composed of a mix of hydrocarbons with a high carbon-to-hydrogen ratio, and it may contain elevated concentrations of sulfur, nitrogen, oxygen, and heavy metals. Fumes from heated bitumens contain PAHs, many of which have been classified as probable human carcinogens in the EPA’s Integrated Risk Information System (EPA 2006). According to the

IARC, there is inadequate evidence to classify bitumens alone as human carcinogens (IARC 1985). Several studies have shown an increased risk of several types of cancer in workers exposed to bitumens. However, these workers were also exposed to other carcinogenic materials such as coal tars. The refined bitumens have not been classified for human carcinogenicity.

For animals, there is sufficient evidence for the carcinogenicity of extracts of steam- and air-refined bitumens, limited evidence for the carcinogenicity of undiluted steam-refined bitumen and cracking-residue bitumen (char), and inadequate evidence for the carcinogenicity of air-refined bitumens. The possible increased cancer risk from inhalation of or dermal exposure to crude and processed bitumens is a primary chemical health concern for tar sands workers.

In addition to the array of organic chemicals that would be produced during bitumen recovery and processing, additional chemicals, including caustic agents, would be present during the treatment of steam condensates and raw water to allow for the recycling of steam, which would most likely be necessary to control costs.

The potential for hazardous exposures differs among the various retorting and separation processes (i.e., hot and cold water processes and thermal processes). The cold water process has a lower potential for exposure to volatile compounds. Potential chemical exposure pathways for workers include inhalation (especially for processes that take place at elevated temperatures) and dermal contact. At all facilities, worker exposures would be monitored and limited to stay within OSHA standard levels, by using engineered controls and also PPE if necessary.

Physical hazards to facility workers during retorting can be associated with equipment and systems. These include potential contact with hot pipes, fluids, and vapors; exposure to ruptured pipes and their contents; accidents from maintenance operations; and physical contact with chemical agents. Comprehensive facility safety plans and worker safety training can minimize these hazards.

Recovery of bitumen from mined tar sands through solvent extraction rather than through more conventional retorting presents many of the same hazards as discussed above for retorting, as well as additional hazards associated with exposure to the extraction solvent. Such solvents are typically naphthenic hydrocarbons (e.g., cyclohexane, raw naphtha) that pose both chemical and physical hazards. Many chemicals could be used successfully for solvent extraction. Since bitumen is soluble in a wide variety of organic solvents, the selection is based primarily on cost and availability rather than specific chemical or physical properties. Solvents could exhibit toxic properties through dermal, inhalation, or ingestion pathways (or through multiple pathways) as well as physical hazards such as volatility and flammability. Potential exposure pathways for workers include inhalation (especially for extractions that take place at elevated temperatures) and dermal contact.

5.14.1.3 In Situ Steam Injection and Combustion

The hazards for steam injection processes are similar to those for thermal retorting, although there is much less potential for exposure to the char or coke, since they will remain underground. Steam injection can occur without prior modification to the formation, or it may be preceded by explosive or hydraulic fracturing of the formation to enhance bitumen recovery. Hazards particularly associated with in situ steam injection processes include the following:

- Physical hazards associated with the high-pressure steam boilers and pumps and compressors used for injection;

- Hazards associated with the storage, handling, and detonation of explosives for modified in situ processes employing explosives to cause or enhance reservoir fracturing;

- Physical hazards associated with well drilling; and

- Exposures to hazardous substances in the recovered tar sands, in recovered process water, and in chemicals used to treat and recycle recovered water.

The hazards associated with explosives are the same as those discussed in Section 5.14.1.1 (surface mining). An additional hazard associated with in situ processes that is not applicable to mined tar sands is well drilling, in order to pump the mobilized bitumen to the surface. The phases of drilling wells include site preparation, drilling, well completion, servicing, and abandonment; each is associated with unique physical hazards (e.g., falling from heights, being struck by swinging equipment or falling tools, and burns from cutting and welding equipment or steam).

Health and safety procedures implemented at an in situ steam injection research facility (TS-1) near Vernal, Utah (Daniels et al. 1981) required that the workers (1) handle produced oil and recovered process water as toxic substances; (2) handle de-emulsifiers, water-treatment chemicals, oxygen scavengers, organic sequestering agents, and corrosion-control substances so as to prevent exposure; and (3) wear protective clothing and receive safety training.

Hazards associated with in situ combustion processes are similar to those associated with in situ steam injection processes; however, the hazards associated with high-temperature and high-pressure steam are eliminated and replaced with hazards associated with the storage and use of fuels used to initiate combustion and the hazards of potential exposures to combustion by-products (primarily CO as well as a wide variety of partial decomposition products of complex organic molecules). For most in situ combustion technologies, high-pressure sweeping gases may also be used to control the direction of the combustion front and to aid in product recovery. Sweeping gases such as CO_2 would introduce asphyxiant and toxic gas hazards.

5.14.2 Mitigation Measures

Regulatory requirements to address occupational health and safety issues already largely address the mitigation of impacts (e.g., OSHA standards under 29 CFR 1910 and 1926 [1910.109 is specific for explosives] and MSHA standards under 30 CFR Parts 1–99). Also, electrical systems must be designed to meet applicable safety standards (e.g., NEC and IEC).

To reinforce the regulatory requirements, additional mitigation measures could include the following:

- To address traffic safety, installation of appropriate highway signage and warnings should be carried out to alert the populace of increased traffic and to alert vehicle operators to road hazards and pedestrian traffic. Construction of safe bus stops for children waiting for school buses; these stops should be located well away from the roadway.

- To avoid highwall-spoilbank failure, use of benching, blasting patterns specifically designed for each mine site, adequate compacting of spoilbanks, and adequate miner training can allow for recognition and remediation of hazardous conditions (Bhatt and Mark 2000).

- The use of appropriate PPE can minimize some safety and exposure hazards.

- The risks from accidental explosions risk can be lowered by implementing applicable occupational standards and following general safety measures (e.g., good housekeeping for explosives storage areas; requiring safety training for all workers using explosives).

- Safety assessments for tar sands facilities should be conducted to describe potential safety issues and the means that could be taken to mitigate them.

- A comprehensive facility health and safety program should be developed to protect workers during all phases of a tar sands project. The program should identify all applicable federal and state occupational safety standards, establish safe work practices for each task, establish fire safety evacuation procedures, and define safety performance standards.

- A comprehensive training program and hazards communications program should be developed for workers, including documentation of training and a mechanism for reporting serious accidents or injuries to appropriate agencies.

- Secure facility access control should be established and maintained for all tar sands project facilities. Site boundaries should be defined with physical barriers, and site access should be restricted to only qualified personnel.

- Hazards from well drilling may be mitigated through the use of measures recommended by OSHA (2007).

5.15 REFERENCES

Note to Reader: This list of references identifies Web pages and associated URLs where reference data were obtained. It is likely that at the time of publication of this PEIS, some of these Web pages may no longer be available or their URL addresses may have changed.

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6 IMPACT ASSESSMENT FOR OIL SHALE AND TAR SANDS ALTERNATIVES

6.1 OIL SHALE ALTERNATIVES

This section presents the impacts associated with the three oil shale alternatives. Alternative A, the no action alternative, is discussed in Section 6.1.1. The impacts of Alternatives B and C are discussed in Sections 6.1.2 and 6.1.3, respectively. Section 6.1.4 presents a comparison of the oil shale alternatives. Discussions of the cumulative impacts and other NEPA considerations associated with Alternatives B and C are presented in Sections 6.1.5 and 6.1.6, respectively.

The reader should be aware there are several different types of information presented in Section 6.1 that are provided for different reasons. Section 6.1.1, Alternative A, the no action alternative, gives a summary of existing land allocation decisions in the current White River and Book Cliffs RMPs (BLM 1997a, 1985a) that are currently in effect. There is also a summary of information from environmental analyses of the existing oil shale RD&D projects that have been previously approved by the BLM. The purpose of this information is to provide a description of the types of impacts anticipated on the individual 160-acre RD&D lease parcels. Finally, there is an analysis of the potential impacts of commercial oil shale development on resources and resource uses on the lands currently identified as being available for commercial leasing. This latter information is comparable to the resource analyses of the potential impacts of commercial development in Sections 6.1.2 and 6.1.3 for Alternatives B and C. The purpose of this latter information is to allow a comparison of the potential impacts of future commercial development that might occur under the three alternatives.

Information contained in Sections 6.1.2 and 6.1.3 describes (1) the impact of the land allocation decisions proposed in the two programmatic alternatives, which is the focus of the PEIS, and (2) the potential impact of future commercial oil shale development on the public lands that could be made available for application for future leasing and development in each alternative. The bulk of the information provided in Sections 6.1.2 and 6.1.3 addresses the effects of potential future commercial development. However, as has been explained previously in the PEIS, commercial leasing and development are not being approved at this time. The information on potential impacts is being presented to help agency decision makers and the public form an impression of the effects of potential future development. Together with the information contained in Chapter 4, this analysis and comparison of potential impacts of future development associated with each of the alternatives, aids agency decision makers in making an informed decision regarding the relative merits of the three alternatives. It is also intended that these analyses will help identify information that will be needed to process future applications for commercial development.

On the basis of analyses contained in the PEIS, the BLM has determined that with the exception noted in the socioeconomic analysis regarding potential impacts on land values, the land use plan amendments contained in Alternatives B and C would not result in any impacts on the environment or socioeconomic setting. However, the future development of commercial oil shale projects that could be approved after subsequent NEPA analysis on lands identified in these alternatives as available for application for leasing would have impacts on the environment and the socioeconomic setting. The bulk of the information presented in Sections 6.1.2 and 6.1.3 identifies in a non-site-specific manner the potential impacts associated with future commercial oil shale development under each alternative. The magnitude of the impacts cannot be quantified at this time because key information about the location of commercial projects, the technologies that may be employed, the project size or production level, development time lines, and potential mitigation that might be employed are unknown.

6.1.1 Impacts of Alternative A, No Action Alternative, Continuation of Current Management

In this alternative, the 12 land use plans within the study area would not be amended. A complete impact analysis of the no action alternative is included in the land use plans. Oil shale commercial leasing and development in Alternative A would be authorized by existing decisions contained only in either the White River or Book Cliffs RMPs, not the PEIS (see Section 2.3.2 for a complete description of Alternative A). In this alternative, 352,780 acres of public land are available for leasing for commercial development of oil shale within Colorado and Utah, but there are no lands identified as available for leasing in Wyoming (see Figures 2.3.2-1 and 2.3.2-2). In both of these RMPs, additional NEPA analysis is required prior to leasing. Future leasing and development would be subject to mitigating measures or resource stipulations included in the RMPs or that are developed through the NEPA analysis. These lands include 294,680 acres in Colorado and 58,100 acres in Utah (Table 2.3.2-1). Within Colorado, 223,860 acres could be mined by underground methods, and 39,410 of these acres could be surfaced mined. An additional 70,820 acres located within the identified Multimineral Zone could be developed for oil shale if other minerals were not harmed (Figure 2.3.3-1). Within Utah, 42,000 acres are classified as priority management areas for underground mining; 6,000 acres are priority management areas for in situ development; and 10,100 acres are areas that have been previously leased for oil shale development (Figure 2.3.2-2).

Included within these areas, as discussed in Section 2.3.2, are the six 160-acre RD&D projects leased by the BLM in 2007. These include five projects in Rio Blanco County, Colorado, evaluating in situ processes, and one project in Duchesne County, Utah, evaluating underground mining with surface retort (see Figure 2.3-2). A total of 960 acres are involved in the six projects.

The BLM evaluated the environmental and socioeconomic impacts of the RD&D activities on the six leases prior to issuance of the leases through the preparation of EAs. Four separate EAs were prepared and Findings of No Significant Impact (FONSIs) were issued for each project. These include separate documents for the Chevron project (BLM 2006a,b), EGL project (BLM 2006c,d), three Shell projects (BLM 2006e–h), and OSEC project (BLM 2007a,b). These EAs assess only the RD&D activities at each project site and do not examine the potential impacts of future commercial development on the associated PRLAs.

Because the RD&Ds are part of the current situation, this section contains a summary of the impacts associated with the RD&D activities at each of the six project sites (including the impacts associated with the establishment of their utility ROWs for electric transmission lines and pipelines and the construction of access roads). As described in Section 2.3 of the PEIS, the RD&D leases are prior existing rights and are common to all three alternatives. To avoid unnecessary duplication, the impacts of the RD&Ds are not repeated in Sections 6.1.2 and 6.1.3, but the effects of the RD&Ds under each of these alternatives would be the same as under Alternative A. Unless otherwise noted, the information on the RD&Ds is summarized from the individual EAs and more detailed information is contained in the EAs. The EAs and FONSIs identify a number of terms, conditions, and stipulations that will be applied to mitigate the potential impacts of the RD&D projects.

Future leasing and development of commercial oil shale projects on the public lands that are currently identified as available for leasing in Alternative A would affect the environment and socioeconomic setting in Colorado and Utah. The following sections describe the potential impacts of Alternative A on the environment and on the socioeconomic setting.

In general, potential impacts of future development on specific resources located within the 352,780 acres cannot be quantified at this time because key information about the location of commercial projects, the technologies that will be employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of project development, it is possible to make observations and draw conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following subsections identify, by resource or program area, the potential impact that could arise from future development under Alternative A. Many of the potential impacts might be successfully avoided or mitigated, depending upon site- and project-specific factors and future regulations that will guide leasing actions.

6.1.1.1 Land Use

In the Piceance Basin area, the five Colorado RD&D lease areas are located within 15 mi of each other in Rio Blanco County, Colorado. They are all located between 25 and 30 mi southwest of the town of Meeker and 20 to 30 mi southeast of the town of Rangely. The region in which these lease areas are located is rural and relatively undeveloped. Existing land uses include open rangeland; ranching; oil and gas development; utility corridors; historic nahcolite and oil shale mining, as well as more recent sodium solution mining; seasonal recreation, including big-game hunting; and wild horse herd management (primarily at Shell Sites 1 and 3, within the Piceance–East Douglas Creek HMA). Land use on adjacent parcels of land should be largely unaffected by the RD&D activities, except that noise and human activity could alter the quality of hunting and other recreational experiences in the area and impact wild horses (see Section 6.1.1.7.3 for more information about the impact on wild horses under Alternative A). Land use along the new utility ROWs and access roads will be impacted during the construction phases, but these impacts will be largely short term. Although these lease areas are located in the same general area and will be undergoing RD&D activities during the same period of time, they are dispersed enough so that cumulatively, their impacts on land use will be relatively minor.

One of the five Colorado lease areas, Shell Site 2, is located within the Multimineral Zone. The Shell Site 2 RD&D activities are focused on evaluating the practicability of combining already developed nahcolite extraction methods with Shell's in situ hydrocarbon extraction technology. Although the Chevron RD&D lease area is outside the Multimineral Zone, this project also will include an assessment of the development potential for nahcolite and dawsonite in the project area and the potential conflicts between oil shale development using Chevron's in situ technology and the development of these resources.

By the terms of the existing RD&D leases, the operations could covert into commercial facilities (see Section 1.4.1 for a description of the terms and conditions). Within the Piceance Basin, this could lead to a relatively dense development complex of approximately 25,000 acres, which could dramatically affect existing land uses within the area.

The OSEC RD&D project is located at the White River Mine site in Uintah County, Utah. This 160-acre lease area is located within the Ua Tract of the 1974 Federal Prototype Oil Shale Leasing Program. Current land use within the RD&D lease and on adjacent lands includes oil and gas development, gilsonite mining, wildlife habitat, recreational use, and livestock grazing. The project site does not coincide with any wild horse or burro HMAs. OSEC plans to conduct RD&D activities in three phases. On-site construction activities will not begin until Phase 2, and construction of the utility ROWs will not begin until Phase 3. Because this project is located at an existing mine site, the RD&D activities will not substantively change the existing land use within the leased area. Land use on adjacent parcels of land should be largely unaffected by the RD&D activities, except that noise and human activity could alter the quality of hunting and other recreational experiences. These impacts will not occur until the start of Phase 2 activities. Land use along the new infrastructure ROWs will be impacted during the construction phases, but these impacts will be largely short term.

Impacts could result from construction and operation of oil shale facilities that could occur following future approval of commercial leases and development on the 352,780 acres currently available for commercial leasing. Impacts of that leasing and subsequent development action would be considered in project-specific NEPA analyses prior to approval of any leases and/or development. The specific impacts on land use and the magnitude of those impacts will depend on project location; project size, technology employed, and scale of operations; and proximity to roads, transmission lines, and pipelines. Impacts on various land uses that could be caused by commercial development of oil shale are discussed in Section 4.2 and are summarized below.

- Commercial oil shale development, using any technology, is largely incompatible with other mineral development activities because each dominates the lease area in which it is located. Oil and gas development is ongoing in many parts of the study area, and conflict between oil shale projects and oil and gas projects may occur. Oil and gas leases issued between 1968 and 1989 contained a stipulation that drilling of wells will only occur if the oil and gas lessee can establish that such drilling will not interfere with the mining and recovery of oil shale deposits. Oil and gas leases issued after January 27, 1989, do not contain this stipulation. While it is possible that undeveloped portions of an oil shale lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company is developing multiple resources. A possible exception is being investigated as part of two of the RD&D projects where nacholite mining is being conducted in advance of oil shale production. Existing leases for oil and gas or other mineral development may preclude oil shale development for some period of time.

In the Book Cliffs RMP area, the two oil shale areas totaling 6,000 acres classified for in situ development overlap with the P.R. Spring STSA. Although no development of either oil shale or tar sands resources has occurred in this area, it is possible that at some point development of these resources may conflict with one another.

- Where existing agricultural water rights are acquired to support oil shale development, existing irrigation-based agricultural uses of the land from which the water is acquired would be modified to support lower value dry land use of the lands and/or may result in a complete loss of agricultural uses. Some areas could be converted to nonfarm uses, depending upon local zoning decisions.

- Grazing activities could be precluded by commercial oil shale development in those portions of the lease area that were (1) undergoing active development; (2) being prepared for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as production facilities, office buildings, laboratories, retorts, and parking lots. Depending on conditions unique to the individual grazing allotment, temporary reductions in authorized grazing use may be necessary because of loss of a portion of the forage base. It is possible, depending upon how commercial leases would be developed, that grazing uses might be accommodated on parts of the leases during the lease period.

  The level of impact of the removal of acreage from individual grazing leases would be dependent upon site-specific factors regarding the grazing allotment(s) affected. There is a large variation in size and productivity of BLM grazing allotments across the PEIS study area, and the loss of up to 5,120 acres for individual oil shale leases from larger allotments would not be as significant as from smaller allotments. Some allotments could become completely unavailable for use. Others would lose varying percentages of grazing area that might affect their overall economic viability.

- Commercial oil shale development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird-watching, OHV use, and camping). Recreational uses, including OHV use, would be precluded from those portions of commercial lease areas involved in ongoing development and restoration activities. Impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial oil shale projects. The impact of displacement of recreation uses from oil shale development lease areas would be highly dependent upon site-specific factors, especially the nature of existing uses on the site.

- Specially designated areas, including all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are currently closed to mineral development, are not available for commercial development and would not be directly affected. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial oil shale development on adjacent lands or on areas within the general vicinity. Section 4.9 discusses impacts on visual resources in greater detail.

- ACECs that are not closed to mineral leasing include approximately 4,842 acres and are shown in Table 6.1.1-1. The current RMP prescription for management of these ACECs is to maintain the environmental quality of the ACECs to prevent undue degradation to the values that make the sites unique. The prescription would allow for multiple uses as long as the special values present are maintained.

- Lands classified as available for oil shale leasing contain all or portions of areas that have been recognized by the BLM in Utah as having one or more characteristics of wilderness. Table 6.1.1-2 lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the

TABLE 6.1.1-1 ACECs in the Study Area Not Closed to Mineral Leasing, Alternative A

ACEC Name/Field Office	Acres in Alternative A
White River Field Office, Colorado	
Duck Creek	3,414
Ryan Gulch	1,428
Trapper Creek	11
Total	4,853

TABLE 6.1.1-2 Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives A, B, and C and the Amount of Overlap[a,b]

Name of Area with Wilderness Characteristics	Amount of Overlap (acres) Alternative A	Alternative B	Alternative C
Price Field Office, Utah			
Desolation Canyon	0	85	85
Vernal Field Office, Utah			
Bitter Creek	0	1,218	669
Desolation Canyon	0	29,261	25,313
Lower Bitter Creek	0	11,417	10,125
White River	6,972	17,642	17,642
Rawlins Field Office, Wyoming			
Adobe Town fringe	NA[c]	NA	NA
Rock Springs Field Office, Wyoming			
Buffalo Hump	0	6,118	0
Kinney Rim North	0	33,511	11,456
Kinney Rim South	0	70,007	44,952
Sands Dunes	0	37	0
Total	6,972	169,298	110,244

[a] The key characteristics of wilderness that may be considered in land use planning include an area's appearance of naturalness and the existence of outstanding opportunities for solitude or primitive and unconfined types of recreation.

[b] Totals may be off due to rounding. Acreage estimates were derived from GIS data compiled to support the PEIS analyses.

[c] NA = data not available.

developed areas would be lost. Alternative A includes approximately 170,000 acres of these lands that are subject to potential development.

- Primarily in the Vernal Field Office, there are areas that have been identified as being potentially eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities. Table 6.1.1-3 lists the areas and the number of acres of overlap that are available for commercial oil shale leasing by alternative. If oil shale development occurs on these lands, depending on the nature of resources present on the lands, these resources could be lost. The decisions regarding ACEC designation of these lands will be made at the BLM field office level. Should designation as ACEC be made, these lands may not be available for commercial oil shale leasing.

TABLE 6.1.1-3 Potential ACECs That Overlap with Lands Made Available for Application for Commercial Oil Shale Leasing under Alternatives A, B, and C and the Amount of Overlap[a]

	Amount of Overlap (acres)		
Potential ACEC	Alternative A	Alternative B	Alternative C
Price Field Office, Utah			
Nine Mile Canyon	0	85	85
Vernal Field Office, Utah			
Bitter Creek	0	7,917	3,814
Bitter Creek/P.R. Spring	0	2,856	1,471
Coyote Basin–Coyote Basin	0	19,270	19,201
Coyote Basin–Kennedy Wash	0	8,692	8,626
Coyote Basin–Myton Bench	0	25,403	19,135
Four Mile Wash	0	32,569	30,128
Lower Green River	0	9,588	1,042
Main Canyon	6,211	17,134	14,217
Pariette Wetlands	0	6,523	0
White River	20,520	55,423	38,906
Total	26,731	185,461	136,624

[a] Totals may be off due to rounding. Acreage estimates were derived from GIS data compiled to support the EIS analyses.

6.1.1.2 Soil and Geologic Resources

In combination, the six RD&D projects are expected to result in up to 960 acres of disturbed land at the lease sites, plus additional disturbed land for access roads and utilities. Soil erosion impacts, including potential related impacts on surface water salinity and overall water quality (see Section 6.1.1.4), are of concern. The erosion hazard of the soils at each of the sites is variable. The Chevron site is composed of soil with moderate to very high erosion potential. The erosion potential at the EGL site ranges from moderate to very high for water erosion and slight to moderate for wind erosion; the revegetation potential is fair to very poor for site soils. Shell Site 1 is mostly moderately to highly erodible, but some areas are severely erodible by water and wind. At Shell Site 2, a small portion of the site is slightly erodible, but the bulk of it is moderately to highly erodible, including some severely erodible areas. Shell Site 3 has a wide range of erosion hazard levels, from slight to high, and also includes a portion that is severely erodible. At the OSEC RD&D site, the soils are slightly to moderately erodible by water, but have wind erodibility ranging from none to moderate. Phase 3 of the OSEC project will involve construction of a ROW to the site, which will add to the overall amount of disturbed land. Along this ROW, many soil types are present, ranging in water erodibility from none to very severe and ranging in wind erodibility from none to high. The erodibility of soils is variable at other Alternative A lands in Colorado (294,680 acres) and in Utah (58,100 acres).

Each of the Colorado RD&D projects will entail extensive drilling activities. Proper management of drill cuttings is important because they can be susceptible to water and wind erosion and have a subsequent effect on water quality. At the Chevron site, drilling cuttings will be generated at approximately 5 injection or production wells, 20 groundwater monitoring wells, and 20 to 25 boreholes for tiltmeters, for collection of fracture data. At the EGL site, drill cuttings will be produced by approximately 4 to 8 dewatering wells, 2 water injection wells, 5 boreholes for heating, 4 producer wells, and additional groundwater monitoring wells. Anticipated drilling waste from each of the Shell sites will include cuttings from approximately 150 boreholes for freeze-wall construction, 10 producer boreholes, 30 heater boreholes, and additional boreholes for groundwater monitoring wells. Drilling activities at other locations included under Alternative A would depend on the choice of technology and site-specific factors.

Each of the RD&D projects will have impacts on other mineral development activities. Chevron's in situ combustion technique could lead to the loss of other mineral resources, such as any economically extractable nahcolite or dawsonite, in or near the treated area. Because of the flammability of natural gas, gas wells will not be allowed within some distance of an in situ combustion site, likely including any directionally drilled wells targeting gas beneath the oil shale treatment zone. Producing gas wells are within 0.1 mi of the Chevron lease boundary. This site is located in the KSLA of the Piceance Basin. The nahcolite and dawsonite content beneath the site is to be determined through a drilling program. Coal is too deep to be technologically accessible.

The EGL site also is within the KSLA, although the EA does not describe the sodium minerals present at the site. The EGL site targets a zone above nahcolite, presumably leaving this mineral resource unaffected. The heating process could potentially lead to heaving and subsidence, with possible effects on nearby gas or oil wells. A producing gas well is within 0.4 mi of the EGL lease boundary.

As part of the RD&D activities, nahcolite solution mining will occur at Shell Site 2, which is located in the Multimineral Zone. The naturally occurring nahcolite at Sites 1 and 3 has been leached away by naturally circulating groundwater. Dawsonite, which is not soluble in groundwater, is present at Site 2 at an average of 5% by weight and at Site 3 at an average of 4% by weight across certain intervals. Natural gas wells, including producing wells and permitted locations awaiting drilling, are within 5 mi of Sites 1 and 3, and several are within 0.5 mi of Site 2. Directional drilling will be necessary for accessing gas beneath the RD&D sites, although technological constraints may prevent this. Coal is present at technologically infeasible depths.

Tar sands resources are not present on the OSEC RD&D site, although they do occur 10 mi to the south. Coal bed methane is present in the region, though no production takes place nearby the RD&D site. Coal is too deep to be mineable, and no other minerals are present at the site. Two gilsonite veins are present along the intended ROW. OSEC will coordinate ROW construction with the gilsonite mining company. Natural gas leases are present at the site; OSEC will also coordinate with the oil and gas lessees.

Soil impacts, occurring during construction and reclamation, are expected to be local in extent. Overall impacts will be minimized through a series of conditions identified in the EAs and FONSIs. To mitigate impacts on nahcolite and dawsonite, the proposed actions for the Colorado sites call for either avoiding oil shale zones with substantial deposits of sodium minerals, recovering the nahcolite before recovering the oil resources, or isolating the formations to avoid destruction of the nahcolite and dawsonite. The proposed actions will not adversely affect the future recovery of oil shale outside the retorted zones or of other minerals in the project area.

Under Alternative A, impacts on soil and geologic resources as described in Section 4.3 could occur wherever individual projects are located within the 352,780 acres identified as available for application for leasing in the two existing land use plans.

6.1.1.3 Paleontological Resources

There is a potential for impact on paleontological resources at all six RD&D locations, and within areas available for oil shale development under existing White River and Vernal RMPs, consistent with those impacts discussed in Section 4.4 for commercial oil shale operations. All five of the RD&D project sites in the Piceance Basin are underlain by the Uinta Formation. As presented in Section 3.3, Table 3.3-1, the Uinta Formation is categorized as a Condition 1 area in which significant paleontological resources are known to occur and will need to be considered. At the Chevron and EGL sites, there were no bedrock exposures from which paleontological potential could be determined. Impacts on paleontological resources were determined to be possible at both sites, and to mitigate possible damage to these potential resources, it was indicated in the EAs that each site will be monitored during the RD&D activities. The monitor will be present to identify paleontological resources during ground-disturbing activities, and those activities will need to be stopped if paleontological resources are discovered. The BLM Authorized Officer will be contacted by the operator. The find will be evaluated, and if it is considered significant, mitigation measures will be established by the BLM. The operator will not be allowed to resume activities until mitigation is completed. If the find is not considered significant, the activity will be allowed to continue. Chevron and EGL also indicated that they will inform and train their personnel to not disturb or collect paleontological materials. Shell Sites 1 and 3 have been surveyed for paleontological resources (Paleontological Investigations 2003; Young 2005). No paleontological resources were found during the survey at Site 1, but it was indicated in the EA that a BLM paleontologist will be notified prior to any excavation into the underlying rock formation. Significant plant fossil remains were encountered in an unnamed tongue of the Uinta Formation in an area adjacent to Site 3. This unnamed tongue is also exposed in drainages incised on the site, and additional plant fossils could possibly be present there; impacts on significant paleontological resources are “probable” at Site 3. Shell Site 2 has not been surveyed; there is a potential for significant paleontological resources to be present at the site. Possible mitigation that was presented in the EA included site avoidance, quarrying to recover a sampling of fossils present at the site (Site 3), and monitoring (similar to that described above for EGL and Chevron).

The OSEC RD&D site in the Uinta Basin and proposed utility line ROWs are underlain by the Uinta and Green River Formations, both classified as Condition 1 areas for paleontological resources. The OSEC site was previously mined for oil shale, and no fossils were previously reported in existing shale ore stockpiles at the site. It is possible that any new excavation at the site could impact paleontological resources. Construction of power lines and pipelines in support of the RD&D project has less potential to impact paleontological resources because of the limited areas of bedrock near the construction location for the proposed pipeline and the limited amounts of ground disturbance associated with power pole placement. Possible mitigation presented in the EA to reduce negative impacts included the preparation of a "project-specific unanticipated discovery and monitoring plan for paleontological resources." Monitoring, stop-work instructions for suspected fossil discoveries, informing personnel that it is illegal to collect or excavate fossil materials without a permit, and curation of any significant fossil specimens that are discovered during the project were also mentioned.

Under Alternative A, within the areas available for oil shale development under existing RMPs, approximately 97% of the area in Colorado and 99% of the area in Utah are considered as having high potential for containing significant paleontological resources (i.e., conditional Potential Fossil Yield Classification 4/5). Development in those areas could occur once leasing regulations are promulgated, and site-specific NEPA analyses are conducted and approvals are issued.

6.1.1.4 Water Resources

Water resource impacts can be divided into water quality and water quantity issues. The former are particularly important to surface water, in keeping with the federal Colorado River Water Quality Improvement Program (CRWQIP) (P.L. 92-500) to maintain Lower Colorado Basin water salinity at or below certain levels. The latter are related to the water allocation under the Upper Colorado River Basin Compact, stream and river flows, and their effect on sediment erosion and deposition in channels. The water quality in the Upper Colorado River Basin, where the six RD&D sites are located, is closely related to stream and river flows. Because water will not be withdrawn from surface water bodies near the sites and wastewater will be shipped off-site for disposal under this alternative, the impacts on surface water quantity and quality originate primarily from surface runoff, including potential spills. For the groundwater, potential impacts come from groundwater dewatering, reinjection (if used), permeability enhancement in oil shale productive zones, and release of contaminants in the subsurface. Natural groundwater discharge from seeps and springs in stream valleys will also be affected. Mitigation measures identified in the EAs and FONSIs focus extensively on limiting impacts on water resources.

During the construction phase for the RD&D sites, most of the surface water impacts are related to soil and vegetation disturbance that will occur as a result of clearing, excavation, and grading activities. These activities occur at project sites, along utility line ROWs, newly constructed stormwater drainage systems, spent shale disposal areas, and access roads, and will result in temporary increases in sediment load carried to nearby surface water bodies by surface runoff. Because the soils and underlying sedimentary rocks near the RD&D sites have a high salt content, increased surface runoff also is likely to produce higher dissolved salts in the surface runoff. Construction activities may cause some natural drainages to be diverted or modified, and new drainage channels may be created near access roads and other specific sites. These changes could result in increased runoff velocity and increased peak discharge. An indirect consequence of drainage changes could be increased rates of surface soil erosion, especially in sloped areas. If drill cuttings are not contained or otherwise managed properly, they could represent another source of increased sediment and salinity loads to surface water. The impacts on surface water during the construction phase can be mitigated by many of the actions identified in the EAs for the projects.

At the OSEC site, mitigation of impacts from runoff and treated process water from retorting will likely be through collection in ponds or behind a retention dam. Depending on the quality of the water and the permeability of the soil underneath the retention dam area, water infiltrated to the subsurface could migrate to nearby surface water bodies and impact the surface water. At other RD&D sites, lined ponds will be used to hold and evaporate stormwater and process water; infiltrated water from the ponds will be withheld, resulting in insignificant impacts on the water resources.

During development of the five RD&D facilities employing in situ technologies, single or multiple zones of oil shale will be fractured using different fracturing technologies (e.g., water, steam, CO_2, or thermal) to enhance the extraction of hydrocarbon products during in situ retorting (such as at the Chevron and EGL sites). The fractures could permanently increase the permeability of the source rock in the productive zones. At the Chevron RD&D site, where horizontal fracturing will be conducted, the fracturing will be limited to individual production zones. The groundwater aquifers below and above the production zone will be closely monitored to detect inadvertent vertical fracturing. If cross-flows between the two aquifers are detected, fracturing intervals will be adjusted or other measures may be implemented to correct this problem. Similarly, at the EGL site, a zone of oil shale adjacent to an aquifer will be preserved, allowing the production zone to remain hydraulically isolated from the aquifer.

In the case of the Shell’s ICP sites, fractures could also form vertically in rocks within the freeze wall, resulting in cross-flow between aquifers after the freeze wall is allowed to dissipate. The permeability in the retorted zone likely will be increased, allowing for greater groundwater flow, and could become a groundwater discharge zone for the shallower aquifers and a groundwater recharge zone for the deeper aquifers. Increased porosity (and permeability) will occur where kerogen, nahcolite, and other soluble minerals are removed from the rock. Such alteration of permeability will promote vertical as well as horizontal flow and transport of groundwater, as well as any residual hydrocarbons, chemicals used to enhance the hydrocarbon extraction, salts, and metals.

The withdrawal of groundwater will lower the water table and potentiometric surface of the affected aquifers. During RD&D operations, the activities that will result in groundwater withdrawal include (1) dewatering operations in mines or in retorted zones to prevent groundwater from entering work areas or production zones, and (2) drilling operations that could create conduits between aquifers if precautions and appropriate drilling technologies are not used. The withdrawals will create a cone of depression of the potentiometric surface or water table around each pumping well. If existing water supply wells were within the cone of depression, the yield of the wells could decline or the wells could go dry. In the Piceance Basin where the five in situ sites are located, the upper and lower aquifers (totaling 1,100 ft in thickness) are present above and below the Mahogany Zone of the Parachute Creek Member.

The drawdown of water levels in the upper Parachute Creek Unit could reduce the streamflows in Yellow or Piceance Creeks. According to a modeling study presented in the EA for the Shell projects, 1 ft of groundwater drawdown could extend up to 2 mi from a dewatering well. At the OSEC site, the dewatering involves the Bird's Nest Aquifer (about 115 ft thick), which is above the target oil shale (the Parachute Creek Member). At Shell's ICP sites, drawdown of water levels will be limited inside the freeze wall, and impacts of the withdrawal on local surface water will be minimized. At the OSEC site, the dewatering could reduce the flows of springs in Bitter Creek that receive groundwater discharge from the connected Bird's Nest Aquifer.

Groundwater injection may have the opposite effect on hydrologically connected surface water bodies, if underground injection is used to dispose of formation water or wastewater. Injection will raise the groundwater level of the recharged aquifer near recharge wells and, depending on the target depth of the injection wells, may increase the flows of the seeps and springs or create new seeps and springs in valleys that are hydrologically connected to the affected aquifer. At the RD&D sites, the injected fluids will originate from different activities, including disposal of formation water from the production zone and water injection to create fractures (hydrofracturing) in oil shale layers. The hot-water injection to recover dawsonite and nahcolite (used in Shell's two-step ICP) is accompanied by extraction wells and is less likely to cause a rise of water levels outside the production zone.

Impacts from groundwater–surface water interaction are primarily attributed to groundwater-related activities, including groundwater withdrawal and injection. Surface water bodies that are connected to and replenished by surficial and confined aquifers could consequently be affected. Because of the connectivity of the aquifer and the surface water bodies, the lowering of the water table could reduce or prevent the replenishment of the water bodies by the aquifers, thereby reducing the flow of the affected seeps, springs, and streams. The magnitude and the areal extent of the impact will depend on the drop or rise of the water level, the areal extent of the zone of influence, and seasonal factors. During low-flow periods, many seeps, springs, and streams in the study areas rely on groundwater discharge.

The surface water quality near an injection well may be adversely affected if the injection zone is hydraulically connected to a surface water body. During the dewatering operations, water from the lower aquifer will be mixed with the water from the upper aquifer. Because the water quality of the deeper aquifer is typically lower than that of the upper aquifer, the mixed water will result in decreased water quality compared with the water of the upper aquifer as well as the surface water bodies. The reinjection could, therefore, decrease the quality of hydraulically connected surface water through groundwater discharge at seeps and springs.

Once RD&D activities end at the in situ project sites and engineering controls such as the freeze wall are suspended, groundwater will reenter and flow through the retorted zone. Because the porosity of the source rock in the retorted zone (and the nahcolite and dawsonite mining zone, for the cases in which they are mined) will have been increased by the in situ retorting process, residual hydrocarbons and salts in the source rock may be readily leached and moved by the groundwater. The retorted zone is likely to become a potential subsurface contamination source for hydrocarbons, various kinds of salts, and metals. Any downgradient groundwater users could, therefore, have decreased water quality. If the contaminated groundwater is discharged to surface water bodies directly or through seeps and springs, the quality of the surface water will be adversely affected. If the underground injection method is used to dispose of “rinse” water from the retorted zones (e.g., the EGL site or Shell’s ICP sites in Colorado), the injection will cause environmental impacts similar to those described above. The magnitude of the impacts on groundwater and surface water will depend on the injection rate, locations of the injection wells, quality of injected water, and the target geologic formation. Reinjection of groundwater and treated process water will be done under permits managed by the affected states. Both the standards for treatment for reinjected water and/or designation of the aquifer into which injection will be permitted could minimize the potential for adverse effects on uses downgradient from the reinjection sites.

Retention ponds will be used in all RD&D sites to capture runoff from the sites and to minimize sediment input to surface streams. Discharge of captured runoff to surface water bodies will be managed through stormwater management plans and NPDES permits. The impacts of the discharge on the surface water quality should be minor.

The water sources for the six RD&D sites vary. At the Chevron and EGL sites, water use will be limited because of using in situ combustion technologies. Water will be trucked in or derived from on-site groundwater sources. Process wastewater will be trucked off-site or placed in evaporation ponds for disposal. The water use is not likely to cause a significant impact on water resources. At Shell’s ICP sites, water for drilling, dust control, soil compaction, and drinking will be trucked in. During the operation and reclamation phase, groundwater and treated process water will be used. The amount of water to be consumed is unlikely to affect the groundwater resource. At the OSEC site, water used in Phases 1 and 2 will be trucked in. In Phase 3, groundwater from the alluvial aquifer connected to the White River is likely to be used. The amount of water to be withdrawn is small relative to the streamflow of the river so that the impact on the White River will be insignificant.

Under Alternative A, about 152 mi of perennial streams (or about 76% of the total perennial streams in the Piceance Basin, including a 2-mi buffer) are within the areas identified for oil shale leasing in Colorado. In Utah, about 57 mi of perennial streams (or about 22% of the total streams in the Uinta Basin) are within Alternative A areas. Seventeen acres of protected floodplains, wetlands, and riparian areas occur within Alternative A in Colorado and Utah. If the technologies tested at RD&D sites could be commercialized and would not pose any environmental or social risks unacceptable to the BLM, oil shale could be developed in these areas. The streams and protected floodplains, wetlands, and riparian areas still could be affected. Depending on the technologies that are tested to be successful and restrictions on existing management plans, the oil shale development could use underground mining, surface mining, or in situ processing to obtain the oil shale. The mining and oil shale processing operations and the construction of supportive infrastructures could impact the water quality and streamflows in the vicinity of project sites, primarily through surface disturbance; drainage modification; surface water and/or groundwater withdrawals; construction of ponds or reservoirs; leaching of overburden material, mine tailings, and spent shale; traffic dust; unwanted-water discharges (may be treated before the discharges); alteration of the hydrologic properties of affected subsurface bedrock; and modification of the interaction between groundwater and surface water. These types of impacts are discussed in Section 4.5.1 and are not repeated here.

6.1.1.5 Air Quality

Construction and operation activities associated with each of the six 160-acre RD&D projects have the potential to affect local air quality as a result of PM releases generated during construction activities (e.g., clearing and grading of facility areas, shale excavation, operation of graders and dump trucks), as well as exhaust gases (SO_2, CO, and NO_x) from construction equipment, while operational releases (e.g., smokestack emissions from processing activities) have the potential to affect regional air quality. The EAs prepared for the RD&D projects (BLM 2006a,c,e; 2007a) identified proposed construction and operations activities, quantified potential air pollutant emissions levels, predicted potential air quality impacts using atmospheric dispersion modeling methods, and compared potential impacts with appropriate significance threshold levels. The air quality analyses presented in the EAs indicate that no significant adverse, direct, or cumulative air quality impacts are likely to occur. The existing White River (Colorado) and Vernal (Utah) RMPs allow for oil shale development once leasing regulations are promulgated. In addition, individual RD&D lessees may also apply to convert their 160-acre leases (plus 4,960 adjacent acres) to a 20-year commercial-scale lease once specific requirements are met.

6.1.1.6 Noise

Ambient noise levels may be affected as a result of RD&D activities at the six project sites during the construction and operations phases. The EAs prepared for the RD&D projects (BLM 2006a,c,e; 2007a) provide some quantification of the expected noise levels and, along with the FONSIs, identify measures that will be taken to mitigate noise impacts. Specifically, at the five in situ projects in Colorado, noise impacts could occur as a result of construction activities (e.g., clearing, excavation, grading, paving, and building construction); drilling wells; use of pumps, generators, and transformers; flaring; vehicular traffic; and, at the EGL project site, use of a steam boiler. No sensitive human receptors are located within 0.5 mi of the Chevron and Shell project sites and 1 mi of the EGL project site. At OSEC’s underground mine and surface retort project in Utah, noise impacts could occur as a result of construction activities; mining activities; use of a crusher and conveyor belt system, operation of a horizontal rotary kiln; use of pumps, generators, and transformers; and vehicular traffic. Noise impacts elsewhere in the 352,780 acres currently available for leasing would be the same as those described in Section 4.7, and their effects would be highly location dependent.

6.1.1.7 Ecological Resources

6.1.1.7.1 Aquatic Resources. Under Alternative A, 352,780 acres of land in Colorado and in Utah have already been allocated for commercial oil shale development. There are no impacts on aquatic habitats associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.1.
These impacts will be considered in project-specific NEPA analyses that will be conducted at the lease and development phases of projects.

Potential impacts on aquatic resources from oil shale development could result primarily from increased turbidity and sedimentation, changes to water table levels, degradation of surface water quality (e.g., alteration of water temperature, salinity, and nutrient levels), release of toxic substances to surface water, and increased public access to aquatic habitats as described in Section 4.8.1.1. As described in Section 4.8.1.1, there is a potential for activities in upland areas to affect surface water and groundwater beyond the area where surface disturbance or water withdrawals are occurring. Consequently, the analysis here considers the potential for impacts on waterways up to 2 mi beyond the boundary of the lands that could be allocated for potential leasing under this alternative. However, as project development activities become more distant from waterways, the potential for negative effects on aquatic resources are reduced. For the analysis of potential impacts under each of the alternatives considered in the PEIS, it was assumed that the potential for negative impacts on aquatic resources increases as the area potentially affected (i.e., the area that could be considered for leasing) increases and as the number and extent of waterways within a 2-mi zone surrounding those areas increase.

Under Alternative A, there are 17 perennial streams, and about 67 mi of perennial stream habitat within the Piceance and Uinta Basins that are directly overlain by areas that are potentially available for oil shale development. When an additional 2-mi zone surrounding these areas is considered, there are 19 perennial streams and about 209 mi of perennial stream habitat that could be affected by future development activities (Table 6.1.1-4). Because no areas are currently allocated for potential oil shale development in the Green River or Washakie Oil Shale Basins of Wyoming, aquatic resources within those areas would not be affected by oil shale development under this alternative. The types of aquatic habitats and organisms that could be impacted by future development in the vicinity of the Piceance and Uinta Basins are described in Section 3.7.1, although specific impacts would depend upon the locations and methods of extraction. Project-specific NEPA analyses would be conducted prior to any future leasing decisions.

In addition to the lands that could be developed for commercial oil shale development in the future, six RD&D projects that have already been initiated within the Piceance and Uinta Basins would continue to operate under this alternative. Potential impacts on aquatic resources from those projects, derived from information provided in previously prepared NEPA documents (BLM 2006a,c,e; 2007a), are summarized here. The potential impacts on aquatic resources discussed in Section 4.8.1.1 potentially could occur at each of the RD&D project sites, although the magnitude of the impacts would be less than those discussed for full-scale commercial operations. No perennial streams occur immediately within the 160-acre tracts where the RD&D projects are sited. Within the Uinta Basin, the White River (perennial) and Evacuation Creek (intermittent tributary of the White River) are located more than 0.75 mi from the OSEC project area. The five RD&D projects planned within the Piceance Basin are located 0.25 mi or more from the nearest perennial water bodies (Hunter Creek, Black Sulphur Creek, Corral Gulch, Ryan Gulch, and Willow Creek). A combined ROW for a power line, communication lines, and a natural gas pipeline will be constructed across Hunter Creek as part of the Chevron RD&D project, while no such stream crossings are included as part of the remaining RD&D projects within the Piceance Basin. While portions of Black Sulphur Creek may have habitat suitable for cutthroat trout, such areas are located upstream from the proposed RD&D sites, and no erosion

TABLE 6.1.1-4 Streams and Approximate Miles of Each Stream in the Geologically Prospective Areas of the Oil Shale Basins and in the Vicinity[a] of Areas To Be Considered for Leasing under Each of the Alternatives

Stream	Geologically Prospective Area	Alternative A	Alternative B	Alternative C
Colorado—Piceance Oil Shale Basin				
Black Sulphur Creek	18.8	18.2	18.2	12.9
Clear Creek	11.3	3.8	3.8	1.3
Corral Gulch	10.8	10.8	10.8	4.2
Dry Fork Piceance Creek	10.1	1.7	10.1	8.1
East Fork Parachute Creek	12.3	–[b]	12.0	–
East Willow Creek	6.5	6.5	6.5	4.1
Fawn Creek	7.0	7.0	7.0	4.3
Hunter Creek	8.3	8.3	8.3	6.4
Parachute Creek	6.8	–	5.8	3.8
Piceance Creek	37.7	36.5	37.3	24.4
Ryan Gulch	15.0	15.0	15.0	6.8
West Fawn Creek	6.9	6.9	6.9	6.0
West Fork Parachute Creek	11.5	7.2	11.5	7.2
West Fork Spring Creek	5.6	–	5.6	–
West Hunter Creek	7.2	7.2	7.2	5.2
Willow Creek	8.3	8.3	8.3	6.3
Yellow Creek	14.9	14.9	14.9	14.4
Piceance Basin totals	**199.1**	**152.0**	**189.4**	**115.4**
Utah—Uinta Oil Shale Basin				
Asphalt Wash	5.2	5.2	5.2	5.2
Bitter Creek	29.4	7.0	29.4	29.4
Center Fork	13.9	4.0	13.9	13.9
Duchesne River	2.4	–	2.2	–
Green River	48.8	–	48.8	39.4
Nine Mile Creek	3.6	–	3.6	2.8
Pariette Draw	9.5	–	9.5	9.1
Petes Wash	17.7	–	17.7	17.7
Sand Wash	24.7	7.8	24.7	24.7
Sweetwater Canyon	9.5	–	9.5	5.7
Tabyago Canyon	19.0	–	19.0	8.6
Wells Draw	3.5	–	3.5	3.0
White River	63.3	33.0	63.3	48.7
Willow Creek	11.1	–	11.1	11.1
Uinta Basin totals	**261.7**	**57.1**	**261.5**	**219.3**
Wyoming Green River Oil Shale Basin				
Big Sandy River	37.6	–	31.6	7.5
Bitter Creek	9.3	–	9.0	4.3
Blacks Fork	48.9	–	18.3	9.4
Bone Draw	3.6	–	3.6	–
Currant Creek	14.7	–	14.7	–
Dry Muddy Creek	3.1	–	3.1	1.5

TABLE 6.1.1-4 (Cont.)

Stream	Geologically Prospective Area	Alternative A	Alternative B	Alternative C
Wyoming Green River Oil Shale Basin (Cont.)				
Green River	63.7	–	42.0	21.1
Hams Fork	9.9	–	9.9	–
Henrys Fork	9.1	–	9.1	9.0
Killpecker Creek	2.8	–	–	–
Little Bitter Creek	1.8	–	1.8	–
Little Sandy River	8.1	–	8.1	7.2
Pacific Creek	4.2	–	3.8	2.3
Sage Creek	15.2	–	15.2	–
Simpson Gulch	19.9	–	19.9	4.8
Slate Creek	0.7	–	–	–
Green River Basin totals	**252.7**	**0.0**	**190.0**	**67.0**
Wyoming—Washakie Oil Shale Basin				
Alkali Creek	20.2	–	20.2	16.1
Bitter Creek	3.3	–	3.2	2.7
Canyon Creek	3.7	–	3.7	–
Vermillion Creek	11.6	–	11.6	5.0
Washakie Basin totals	**38.8**	**0.0**	**38.7**	**23.8**
All basins combined	752.2	209.1	679.6	425.5

[a] Stream lengths for alternatives include portions of streams within each potential allocation area and a 2-mi zone surrounding the potential allocation area.

[b] A dash = the stream does not fall within a potential allocation area or within a 2-mi buffer surrounding the potential allocation area under this alternative.

or sedimentation impacts on cutthroat trout habitats are anticipated under Alternative A. The use of mitigation measures identified in the EAs and FONSIs, including erosion-control practices, dust-suppression techniques, limiting of the length of time for completing stream crossings, use of horizontal directional drilling to install pipelines under perennial streambeds, and restoration of disturbed areas upon project completion, will greatly reduce or eliminate the potential for effects on aquatic habitats and species from erosion or sedimentation. The relatively small amount of land surface affected by the RD&D projects (160 acres per project) further reduces the potential for large amounts of erosion or sedimentation to occur in specific watersheds.

Any changes in the elevation of the water table or in the quality of discharged groundwater that occur as a result of RD&D operations could negatively affect nearby aquatic habitats and the species they support. Dewatering activities could result in drawdown of surrounding water tables, while reinjection of water could result in localized increases in the elevation of the water table. Preliminary groundwater modeling results for the Shell RD&D sites indicate that up to 1 ft of aquifer drawdown could extend for up to 2 mi from the dewatering well locations in the Piceance Basin. It is anticipated that such a drawdown will have a relatively minor effect on water quantity in nearby perennial streams. Very small amounts of depletion are expected (about 19 ac-ft/yr at each of the three Shell test sites), and during some phases of operations an increase in flow may be realized. No depletions are expected for the EGL or Chevron projects. It is anticipated that dewatering or recharge at well sites associated with the RD&D projects under Alternative A will have minor effects on water quantity in perennial stream habitats.

Dewatering and reinjection wells have a potential to inadvertently allow connection between aquifers with differing water quality parameters (Section 4.5). In addition, groundwater passing through the retorted zone associated with in situ oil shale operations could pick up residual hydrocarbons, various salts, and metals and discharge this contaminated water into nearby stream systems (Section 4.5). Depending upon the level of changes to water quality or the concentrations of specific contaminants, aquatic organisms in receiving streams could be adversely affected. The potential for impacts from contaminated groundwater could be mitigated, in some cases, by pumping water out of the retorted zone and treating it before reinjecting it into the portion of the aquifer located downgradient of the retorted zone. This approach is proposed for the EGL RD&D site in the Piceance Basin, and impacts on aquatic organisms are expected to be minor, assuming that well locations, treatment procedures, and withdrawal and reinjection rates are properly selected. Similar treatment operations have not been proposed for the remaining RD&D sites in the Piceance Basin, and it is anticipated that some impacts on aquatic organisms could occur at these remaining locations. In situ retorting will not occur in the Uinta Oil Shale Basin under Alternative A. Rather, surface retorting will be implemented, and spent oil shale will be disposed of either off-site or in an engineered surface impoundment that will be designed to prevent off-site discharge of contaminated runoff. Contaminated water will be temporarily stored in aboveground storage tanks prior to being sent off-site for treatment and disposal.

A potential exists for toxic materials (e.g., fuel, lubricants, and herbicides) to be accidentally introduced into waterways during construction and maintenance activities or as the result of leaks or spills from pipelines and on-site fuel and material storage areas. The mitigation measures identified in the EAs and FONSIs will effectively minimize the risk for such releases and resulting impacts.

In addition to the potential for the direct impacts identified above, indirect impacts on fisheries could occur as a result of increased public access to remote areas via newly constructed access roads and utility corridors. However, as described in Section 4.8.1.1, it is anticipated that impacts on fishery resources from increased access associated with oil shale development would be minor.

6.1.1.7.2 Plant Communities and Habitats. Under Alternative A, 352,780 acres of land in Colorado and in Utah have already been allocated for commercial oil shale development. There are no impacts on plant communities and habitats associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Land areas allocated for commercial oil shale development under Alternative A support a wide variety of plant communities and habitats (see Section 3.7.2). These areas include approximately 17 acres that are currently identified in BLM land use plans for the protection of wetlands, riparian habitat, and floodplains. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 4.8.1.2). Some impacts, such as habitat loss, could continue beyond the termination of oil shale production.

Direct impacts could include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, employer-provided housing, and new power plants would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well as the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within the construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction occurs and where facilities are located, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

The area available for lease application under Alternative A includes locations that support oil shale endemic plant species. Local populations of oil shale endemics, which typically occur as small scattered populations on a limited number of sites, could be reduced or lost as a result of oil shale development activities. The establishment and long-term survival of these species on reclaimed land may be difficult.

Within the area available for lease application under Alternative A, the six RD&D project sites encompass a total of 960 currently leased acres, 800 acres in the Piceance Basin (the Chevron, EGL, and three Shell sites) and 160 acres in the Uinta Basin (the OSEC site). The PRLAs associated with each of the RD&D sites could potentially be available, and potentially developed, under Alternative A.

Impacts on vegetation, wetlands and riparian areas, and ephemeral streams will vary among the RD&D project sites. On the Chevron site, about 100 acres of sagebrush steppe community will be cleared. The sagebrush steppe at this site is composed of Wyoming big sagebrush and associated shrubs, herbaceous species, and scattered pinyon pine and juniper. The impacts will extend throughout the duration of the project, with the cleared area remaining unvegetated for up to 10 years. Following site reclamation, herbaceous vegetation will likely become reestablished in 1 to 2 years, while sagebrush will take about 20 years to return, and pinyon at least 50 years. Indirect impacts could include increased soil erosion and the invasion of noxious weeds, invasive, or non-native species, which could reduce restoration success, introduce invasive species into nearby undisturbed areas, and reduce biodiversity, with the decline and possible eventual replacement of native species by non-natives. In addition, the replacement of native species by noxious weeds could result in an increase in the intensity and frequency of fires and a change in soil nutrient regimes. Plant community structure could also be impacted by creating, eliminating, or changing the density of vegetation layers or canopy cover. No wetlands or riparian areas occur on the Chevron RD&D project site. However, the ROW for the electric transmission line, communications lines, and natural gas pipeline will cross approximately 0.1 mi of Hunter Creek, a perennial stream, resulting in disturbance of the wetland and riparian vegetation communities along Hunter Creek, including mature pinyon-juniper woodland. Herbaceous species will likely become reestablished in 1 to 3 years; however, the loss of pinyon-juniper woodland will be a long-term impact. Indirect impacts could include lower recruitment of native species resulting from mixing of topsoil and subsoil, alteration of the hydrology of the wetland and riparian areas, inhibition of seed germination, and an increase in the potential for siltation because of soil compaction and rutting.

At the EGL RD&D project site, up to 35 acres will be cleared of vegetation, with an additional acre cleared along the utility ROW. A total of 28 acres of sagebrush shrubland and 8 acres of pinyon-juniper woodland will be removed. Some vegetation, primarily grasses and small shrub species, will be allowed to reestablish on portions of the site during operations. Pinyon-juniper woodland, however, will be lost until reclamation of the site is completed. Restoration of vegetation communities similar to those existing on the sites will likely require 1 to 2 years for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodland. Potential indirect impacts from vegetation removal could include increased soil erosion and the invasion of noxious weeds and non-native plant species. Effects of the invasion of noxious weeds and non-native species could include the decline and possible eventual replacement of native species by non-natives, increased soil erosion, and reduction or fragmentation of habitat. The EGL RD&D project site does not contain wetlands or riparian areas, and no wetlands will be permanently filled or drained as a result of proposed construction activities. Dewatering and reinjection of formation groundwater will be conducted during operation of the EGL project and could possibly affect groundwater fluctuations or discharges to surface water in the vicinity. Wetland and riparian areas along Black Sulphur Creek, a perennial stream, or Ryan Gulch, an intermittent stream, located 1 and 2 mi from the site, respectively, could be indirectly affected if they are hydrologically connected with the groundwater units involved and if changes in groundwater levels or discharges to surface water occur.

The majority of the vegetation on the three Shell RD&D project sites will be cleared. Potential indirect impacts from vegetation removal may include increased soil erosion, invasion of noxious weeds and non-native plant species, habitat fragmentation, and generation of fugitive dust. Effects of invasion of noxious weeds and non-native species could include reduced biodiversity, with the decline and possible eventual replacement of native species by non-natives. Plant community structure could also be impacted by creating, eliminating, or changing the density of vegetation layers or canopy cover. Replacement of native species by noxious weeds could also result in an increase in the frequency and intensity of fires and a change in soil nutrient regimes. Impacts on vegetation will extend throughout the duration of the Shell projects, including the reclamation phase, covering a period of 20 years or longer. Restoration of vegetation communities similar to those existing on the sites will require 1 to 2 years for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodland.

On Shell Site 1, 80% of the vegetation will be cleared for construction and operations; vegetation not cleared will be lightly disturbed. Approximately 96 acres of pinyon-juniper woodland, 49 acres of upland sagebrush shrubland, and 2 acres of bottomland sagebrush shrubland will be cleared. Thirteen acres of the site were previously impacted by the construction of well pads and associated access roads. Construction of the site access road will also impact upland sagebrush shrubland and pinyon-juniper woodland. About 110 acres will be cleared on Shell Site 2. Fifty acres of the site were previously disturbed and will not be used for in situ testing. Vegetation clearing will primarily impact upland sagebrush shrubland composed of Wyoming big sagebrush and associated shrubs and grasses, and will include 85 acres of shrubland with mixed pinyon pine and Utah juniper, 23 acres of shrubland, and 2 acres of pinyon-juniper woodland. Vegetation on 75% of Shell Site 3 will be removed; vegetation not cleared will be lightly disturbed. Vegetation clearing will impact approximately 103 acres of upland sagebrush shrubland, 48 acres of pinyon-juniper woodland, and 9 acres of bottomland sagebrush shrubland.

No wetlands or riparian habitats occur on the three Shell project sites or proposed routes for access roads. No streams were identified on Shell Test Site 1. On Test Site 2, approximately 2,000 ft of intermittent stream channels are present and could be impacted by construction and operation activities associated with the project. These streams are tributaries of Stake Springs Draw, an intermittent stream with segments of perennial flow in association with springs and seeps. About 2,100 ft of an intermittent stream, a tributary of Big Duck Creek, is located on Site 3 and could be impacted by project activities. About 1,200 ft of the stream channel will be located in the immediate area of major facilities.

At the OSEC project site in Utah, in addition to development of the site, ROWs for an access road, transmission line, and pipeline will be constructed. Vegetation on the site and along the ROWs includes sagebrush shrubland, pinyon-juniper shrubland, greasewood flats, saltbush shrublands, and grassland communities with scattered shrubs. Approximately 134 acres of upland habitat will be disturbed by activities associated with the project. The greatest impact (63%) will occur in big sagebrush shrubland. Approximately 82 acres of the 160-acre site have been previously disturbed by development of an underground mining operation and surface storage of mined shale. No wetlands or riparian areas occur on the OSEC site; however, ephemeral streams are present. The proposed electric transmission line and pipeline routes will cross the White River, a perennial stream, as well as a number of ephemeral streams. The transmission line will also cross Evacuation Creek, an intermittent stream. Riparian and wetland areas occur along the White River and Evacuation Creek at the crossing locations. Wetlands and riparian areas will be avoided to the extent practicable; however, impacts on riparian habitat near the water supply wells will occur. The transmission line and pipeline will cross the White River 100-year floodplain, and the water supply wells will be located near the White River, within the 100-year floodplain. Cottonwood, Russian olive, and tamarisk are common species in White River riparian areas.

6.1.1.7.3 Wildlife. Under Alternative A, 352,780 acres of land in Colorado and Utah have already been allocated for commercial oil shale development. There are no impacts on wildlife associated with this land use designation. Impacts could occur, however, from post-lease construction and operations as described in Section 4.8.1.3. These impacts will be considered in greater detail in project-specific NEPA analyses that will be conducted at the lease and development phases of projects. The areas identified as available for leasing support a diverse array of wildlife and habitats (see Section 3.7.3). Important areas identified for protection (in BLM land use plans) within these areas include greater sage-grouse nesting and lek areas, raptor nests, and big game species winter and summer range areas (Table 6.1.1-5).

The Alternative A areas identified as available for leasing also overlap areas identified by state natural resource agencies as important for greater sage-grouse and big game species. These areas include greater sage-grouse habitat (Figure 6.1.1-1) and mule deer and elk winter and summer ranges (Figures 6.1.1-2 and 6.1.1-3). Table 6.1.1-6 gives the amounts of these habitats, identified by state, that occur in the Alternative A lease areas and could be impacted by potential future commercial oil shale development in these areas.

The Piceance-East Douglas Creek wild horse HMA in Colorado overlaps the lands that would be available for application for leasing (about 52,250 acres) (Figure 6.1.1-4).

Impacts on wildlife from commercial oil shale projects (see Section 4.8.1.3) could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement of biota; (3) mortality; (4) exposure to hazardous materials; and (5) increase in human access. These impacts can result in changes in species distribution and abundance; habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

At each of the six RD&D sites, the majority of the wildlife habitat will be initially eliminated (i.e., by vegetation clearing): 100 acres at the Chevron site; 36 acres at the EGL site; 160 acres at Shell Site 1, including 13 acres that were previously impacted by construction of well pads and associated access roads; 110 acres at Shell Site 2; 160 acres at Shell Site 3; and 100 acres at the OSEC site, of which 82 acres were previously disturbed by underground mining

TABLE 6.1.1-5 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans That Are Present in the Alternative A Oil Shale Lease Allocation Areas

Wildlife Habitat	Colorado	Utah
Birds		
Sage grouse lek sites	2,644 (3,563)[a,b]	–[c]
Sage grouse nesting habitat	33,960 (40,243)	–
Sage grouse nesting and lek habitat	–	0 (599)
Raptor nests	11,507 (19,976)	–
Raptor habitat/nesting area	–	0 (3,436)
Waterfowl (in Pariette Wetlands)	–	0 (79)
Goose nest sites (in Pariette Wetlands)	–	0 (80)
Big Game		
Big game severe winter range	46,446 (90,088)	–
Deer and elk summer range	155,372 (169,172)	–
Pronghorn crucial kidding habitat	–	47 (25,815)
Elk crucial winter habitat	–	0 (1,607)
Other		
Wild horses	55,829 (66,091)	–

[a] Acreage may be overestimated because of unknown degree of habitat overlap among species or habitat types for a species. For these reasons, columns should not be totaled.

[b] Numbers in parentheses are the wildlife habitat acreage identified for protection within the most geologically prospective lands.

[c] A dash = not identified for protection, or identified otherwise for protection within the state.

and surface storage of mined shale. Section 6.1.1.7.2 describes the types of habitats that will be impacted at each RD&D project. Generally, the habitats present include pinyon-juniper woodlands, sagebrush shrublands, and disturbed/grassland areas.

Construction will impact 160 acres and 36 acres of elk and mule deer year-round, summer, and winter ranges at the Chevron and EGL RD&D project sites, respectively. Construction and operation of the Shell Sites 1 and 2 will each result in the loss and fragmentation of 160 acres of mule deer winter range and elk summer and winter ranges, while Shell Site 3 is within the year-round range for both species. At the OSEC site, construction will impact 100 acres of mule deer winter and year-round ranges. Construction of Shell Sites 1 and 3 will eliminate 320 acres of land within the Piceance/East Douglas HMA for wild horses. This will result in a minimal loss of forage and cover for the herd (i.e., 0.2% of the HMA).

The relatively small amount of land surface affected at each RD&D site (up to 160 acres per project plus the area encompassed by access roads and corridors) reduces the potential for population-level impacts for any wildlife species. For example, for the Chevron RD&D project, nearly 7.9 acres will be disturbed for the combined power, communications, and gas pipeline

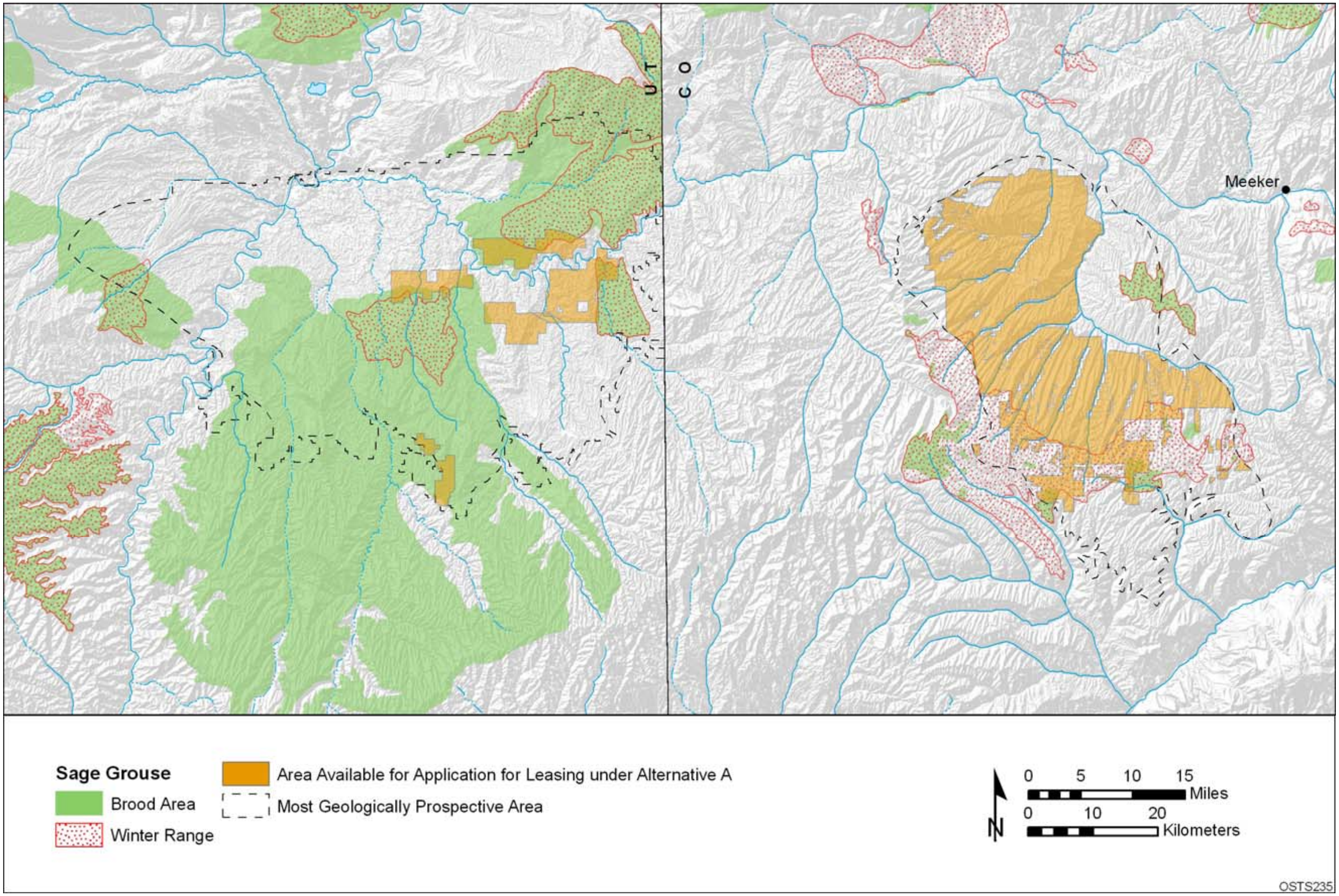

FIGURE 6.1.1-1 Overlap of Lands Available for Leasing under Alternative A with the Known Distribution of the Greater Sage-Grouse

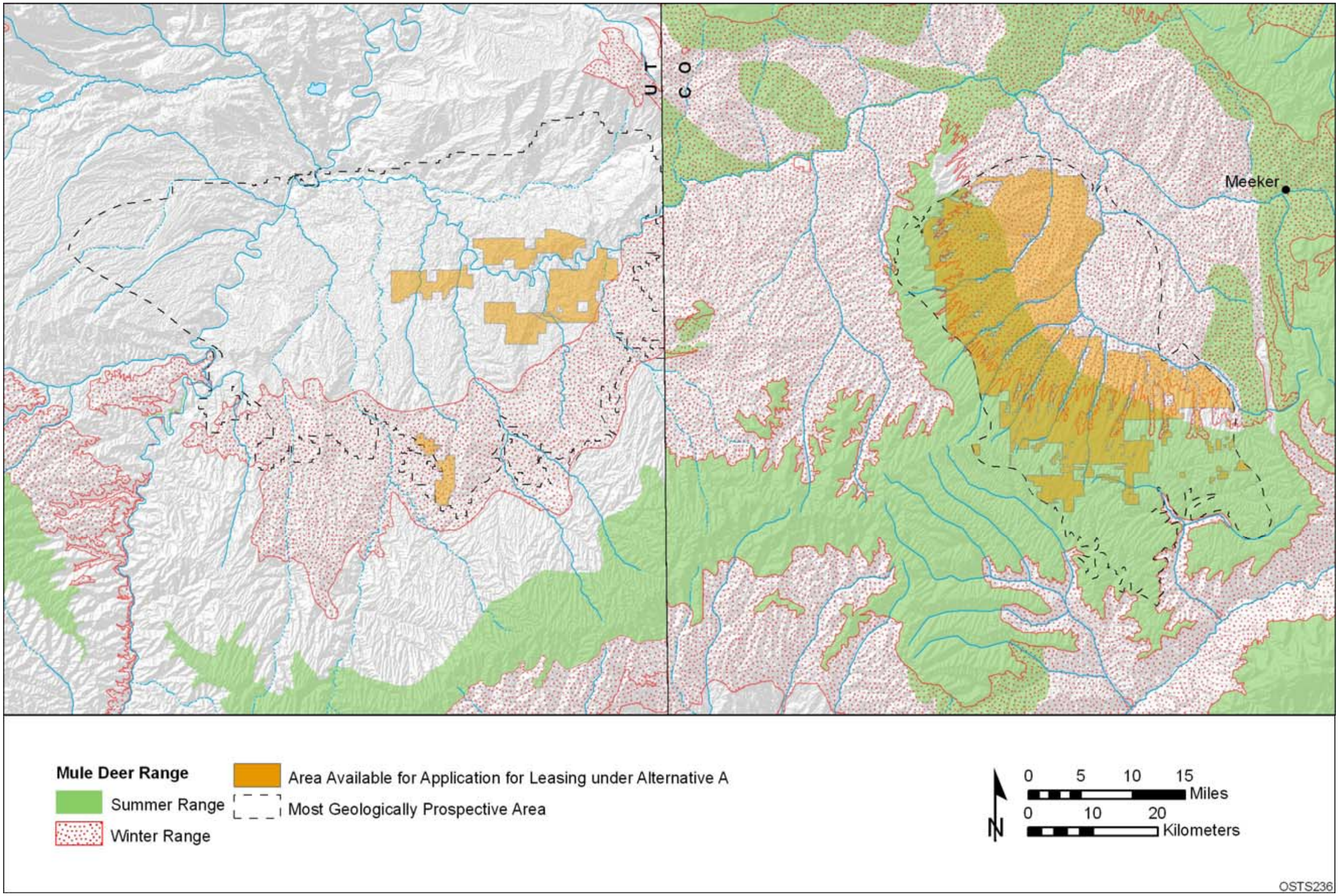

FIGURE 6.1.1-2 Overlap of Lands Available for Leasing under Alternative A with the Summer and Winter Ranges of the Mule Deer

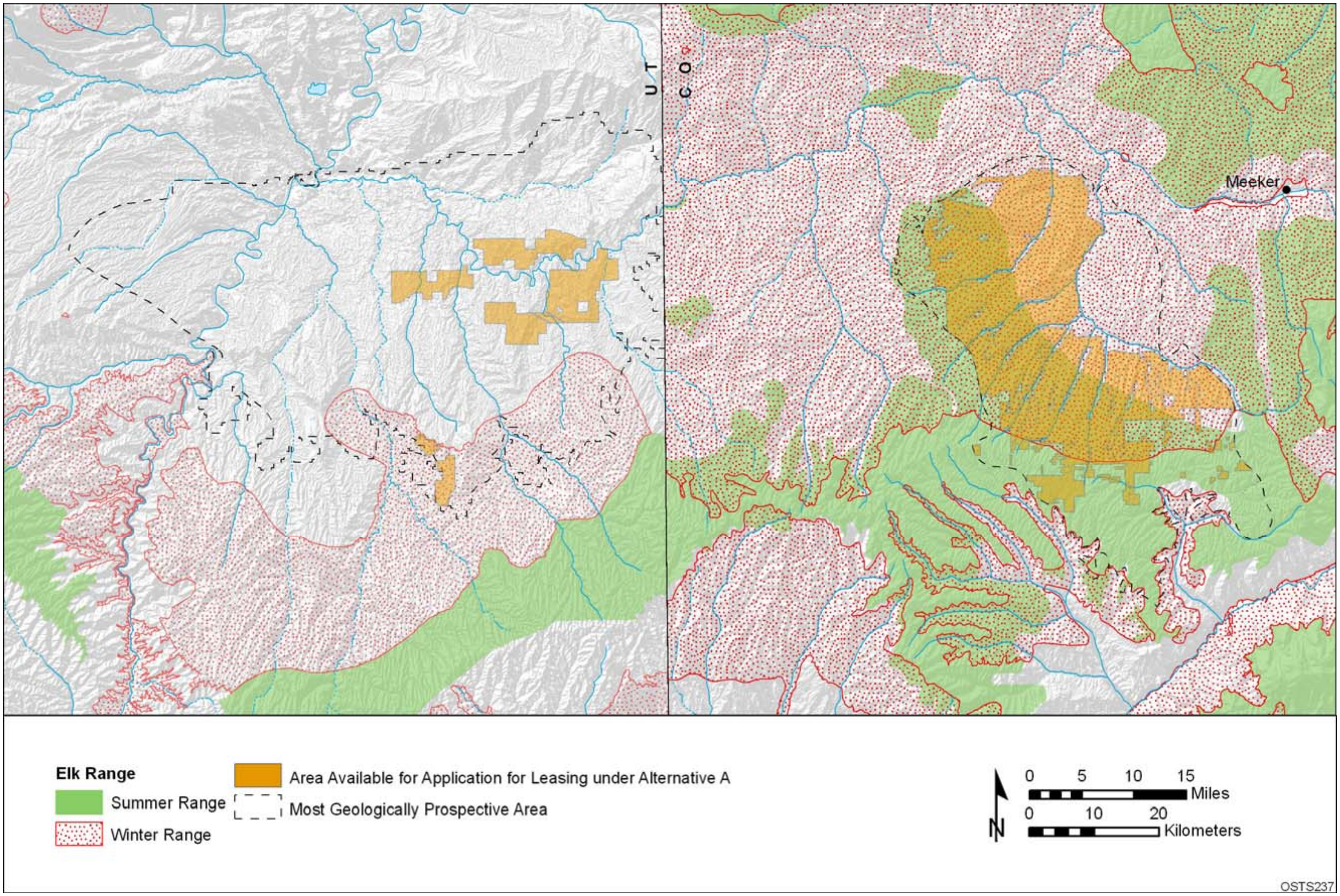

FIGURE 6.1.1-3 Overlap of Lands Available for Application for Leasing under Alternative A with the Summer and Winter Ranges of the Elk

TABLE 6.1.1-6 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in Alternative A Available for Leasing

Wildlife Resource	Colorado	Utah	Total
Sage grouse habitat	3,327	29,927	33,255
Mule deer winter habitat	177,543	6,637	184,180
Mule deer summer habitat	158,496	0	158,496
Elk winter habitat	245,127	6,131	251,258
Elk summer habitat	158,510	0	158,510

ROW. The 1,750-ft-long, 25-ft-wide ROW for the EGL project will disturb at least 1 acre of habitat outside the 160-acre tract boundary. This assumes that only the 25-ft-wide corridor will be disturbed during construction. However, construction disturbance usually occurs within an area wider than the final ROW by about 50 to 100%; therefore, construction may end up disturbing about 2 acres of habitat. For the OSEC project, an additional 100 acres will be disturbed to accommodate the required access road and electric power, gas, and water ROWs. Specified limits on surface disturbance will be applied for big game parturition areas, raptor nesting areas, and greater sage-grouse winter concentration areas and leks. Construction restrictions (e.g., buffer zones and seasonal restrictions) will lessen the potential for inadvertent loss of migratory bird nests during the avian breeding season.

The time required for the restoration of original wildlife habitats impacted by the RD&D projects will depend on the type of vegetation communities present at the time of disturbance. For example, 1 to 2 years will be required for herbaceous vegetation, 20 to 75 years for big sagebrush communities, and 100 to 300 years for pinyon-juniper woodlands.

Wildlife could also be affected by human activities not directly associated with the oil shale project or its workforce, but instead associated with the potentially increased human access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, (2) an increase in the incidence of fires, and (3) increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

6.1.1.7.4 Threatened and Endangered Species. Under Alternative A, approximately 353,000 acres of land in Colorado and in Utah have already been identified, in existing BLM land use plans, as available for leasing for commercial oil shale development. There are no impacts on threatened and endangered species associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.4. These impacts would be considered in project-specific NEPA analyses and ESA consultations that would be conducted at the lease and development phases of projects.

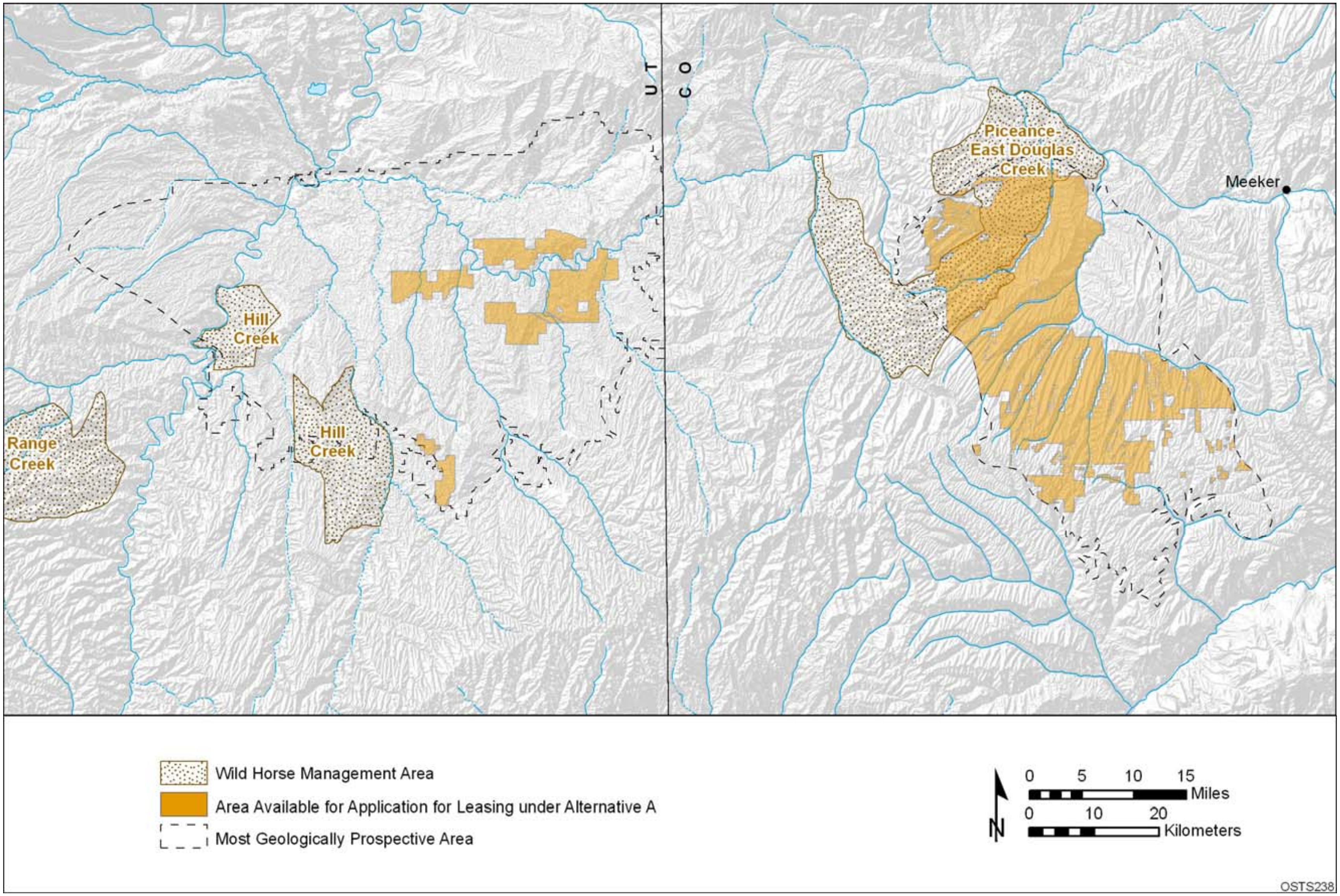

FIGURE 6.1.1-4 Overlap of Lands Made Available for Application for Leasing under Alternative A with Wild Horse Herd Management Areas

Under Alternative A, 68 of the 172 federal candidate, BLM-designated sensitive, and state-listed species listed in Table 4.8.1-4, and 14 of the 16 federally listed threatened or endangered species listed in Table 4.8.1-5 could occur in areas that are available for leasing (based on records of occurrence in Uintah County, Utah, and Garfield and Rio Blanco Counties, Colorado). Potential lease areas include about 1.5 mi of critical habitat for Colorado River endangered for leasing fishes in Colorado and Utah (Figure 6.1.1-5). The areas that are available for application for leasing under Alternative A also include about 61,000 acres for which lease stipulations have been established in existing RMPs to protect federally listed and candidate species, BLM-designated sensitive species, and other special status species. All of these lands with existing lease stipulations are in Colorado.

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by commercial oil shale development is directly related to the amount of land disturbance that could occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, surface or groundwater depletions, the accidental release of contaminants, and disturbance and harassment of animal species are also considered, but their relative magnitude is considered proportional to the amount of land disturbance.

Potential impacts on threatened and endangered species (see Section 4.8.1.4) under Alternative A are similar to or the same as impacts on aquatic resources, plant communities and habitats, and wildlife described in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable to impact than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific assessments and consultations conducted prior to leasing and development.

Included under Alternative A are the six RD&D projects on the 160-acre leases issued by the BLM in 2007. The EAs prepared for these leases include descriptions of anticipated impacts on federally listed and state-listed threatened and endangered species as well as BLM-designated sensitive species. Protected species that occur in these two counties and that could occur on or adjacent to project areas are presented in Tables 6.1.1-7 and 6.1.1-8. Habitats typically occupied by these species are presented in Table E-1 of Appendix E.

Activities at each of the RD&D project sites have the potential to affect listed species. Land clearing and construction activities on each project site will remove potentially suitable habitat for listed plant and animal species. Any plants present within the project areas will be destroyed. Plants adjacent to project areas could be affected by runoff from the site either through erosion of occupied areas or sedimentation and burial of individual plants or habitats. In addition, fugitive dust from site activities could accumulate in adjacent areas occupied by listed

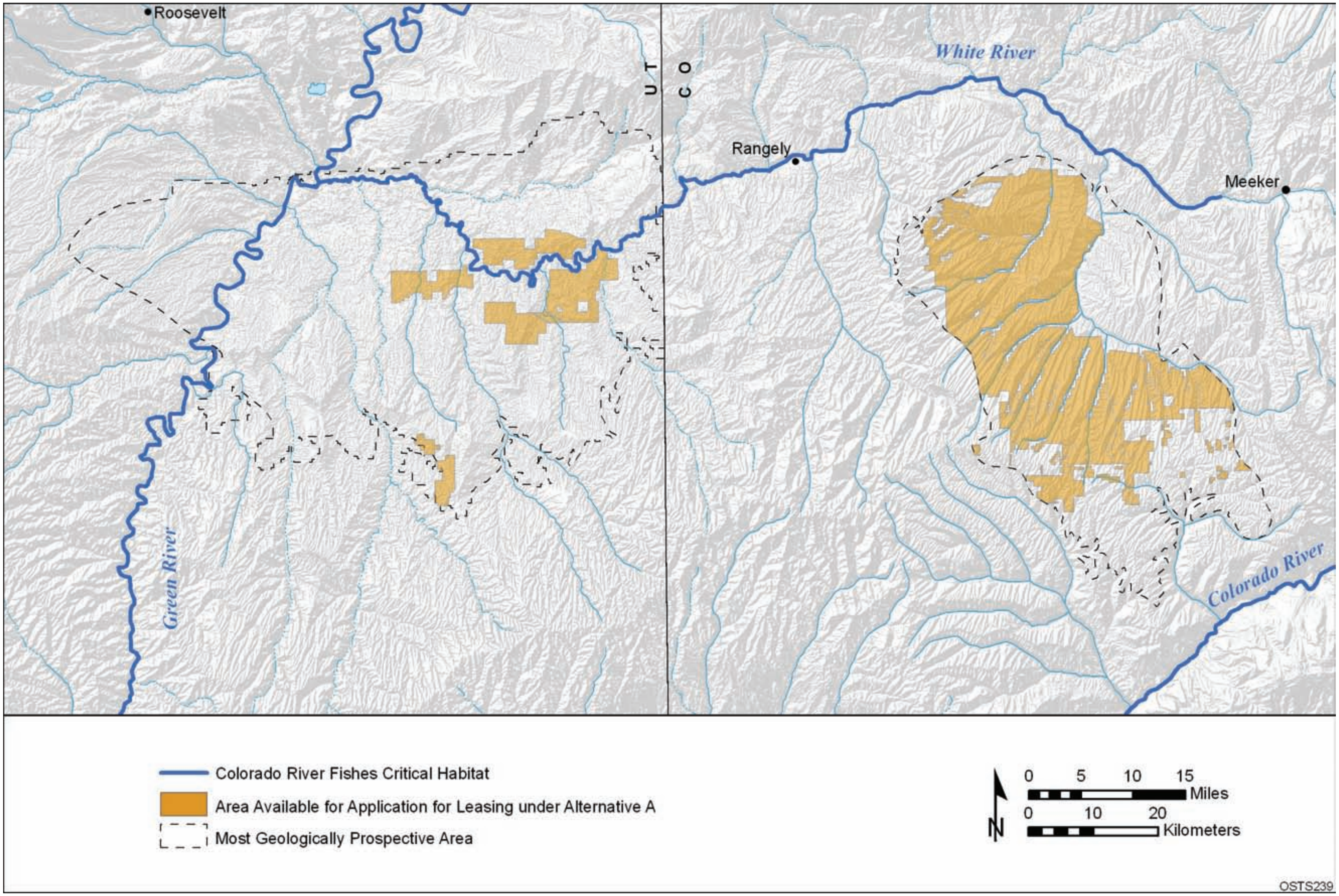

FIGURE 6.1.1-5 Designated Critical Habitat of Endangered River Fishes That Cross Lands Made Available for Application for Leasing under Alternative A

TABLE 6.1.1-7 Potential Impacts of RD&D Projects on State-Listed Threatened and Endangered Species and Species of Special Concern, Federal Candidates for Listing, and BLM-Designated Sensitive Species

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Impact[c]
Plants				
Caespitose cat's-eye	*Cryptantha caespitosa*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Debris milkvetch	*Astragalus detritalis*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas.
Ephedra buckwheat	*Eriogonum ephedroides*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas.
Graham's beardtongue	*Penstemon grahamii*	BLM-S	OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area.
Jones blue star	*Amsonia jonesii*	BLM-S	OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area.
Ligulate feverfew	*Parthenium ligulatum*	BLM-S	Shell (3), EGL, Chevron	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas.
Narrow-stem gilia	*Gilia stenothyrsa*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Northern twayblade	*Listera borealis*	BLM-S	OSEC	**No impact.** Suitable habitat does not exist in the project area.
Nuttall sandwort	*Minuartia nuttallii*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Piceance bladderpod	*Lesquerella parviflora*	BLM-S	Shell (3), EGL, Chevron	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas.

TABLE 6.1.1-7 (Cont.)

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Impact[c]
Plants (Cont.)				
Rollins' cat's-eye	*Cryptantha rollinsii*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas.
Strigose Easter-daisy	*Townsendia strigosa*	BLM-S	OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area.
Uinta Basin spring-parsley	*Cymopterus duchesnensis*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Utah gentian	*Gentianella tortuosa*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. Suitable habitat does not exist in OSEC project area.
White River beardtongue	*Penstemon scariosus* var. *albifluvis*	ESA-C	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area. No known occurrences within Piceance Basin; therefore, unlikely to occur in Shell, EGL, or Chevron project areas.
Invertebrates				
Great Basin silverspot butterfly	*Speyeria nokomis Nokomis*	BLM-S	OSEC	**No impact.** Suitable habitat not present in project area.
Fish				
Colorado River cutthroat trout	*Oncorhynchus clarkia pleuriticus*	BLM-S; CO-SC	Shell (3), EGL, Chevron, OSEC	**No impact.** Suitable habitat not present in project areas.
Flannelmouth sucker	*Catostomus latipinnis*	BLM-S	OSEC	**Potential for negative impact.** Occurs in White River near utility line crossing for OSEC project area.

TABLE 6.1.1-7 (Cont.)

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Impact[c]
Fish (Cont.)				
Roundtail chub	*Gila robusta*	BLM-S; CO-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Suitable habitat not present in Shell, EGL, or Chevron project areas. Occurs in White River crossed by OSEC utilities.
Amphibians				
Boreal toad	*Bufo boreas*	BLM-S; CO-E	Shell (3), EGL, Chevron	**No impact.** Suitable habitat not present in project areas.
Great basin spadefoot	*Spea intermontana*	BLM-S	Shell (3), EGL, Chevron	**Potential for negative impact.** Suitable habitat present in Shell and Chevron project areas. Suitable habitat does not exist in EGL project area.
Northern leopard frog	*Rana pipiens*	BLM-S	OSEC	**No impact.** Suitable habitat does not exist in project area.
Reptiles				
Longnose leopard lizard	*Gambelia wislizenii*	BLM-S; CO-SC	Shell (3), EGL, Chevron	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas.
Midget faded rattlesnake	*Crotalus oreganus concolor*	BLM-S; CO-SC	Shell (3), EGL, Chevron	**Potential for negative impact.** Suitable habitat present in Shell, EGL, and Chevron project areas.
Smooth greensnake	*Liochlorophis vernalis*	UT-SC	OSEC	**Potential for negative impact.** Possible occurrence along White River crossed by OSEC utilities.
Birds				
American peregrine falcon	*Falco peregrinus anatum*	BLM-S; CO-SC	Shell (3), EGL, Chevron	**Potential for negative impact.** May forage in Shell, EGL, and Chevron project areas.
American white pelican	*Pelecanus erythrorhynchos*	BLM-S; UT-SC	OSEC	**Potential for negative impact.** Possible occurrence along White River crossed by OSEC utilities.
Bald eagle	*Haliaeetus leucocephalus*	NL	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** May forage in project areas. May roost and forage along White River crossed by OSEC utilities.

TABLE 6.1.1-7 (Cont.)

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Impact[c]
Birds (Cont.)				
Barrow's goldeneye	*Bucephala islandica*	BLM-S	Shell (3), EGL, Chevron	**No impact.** Suitable habitat not present in project areas.
Black swift	*Cypseloides niger*	CO-SC; UT-SC	Shell (3), EGL, Chevron, OSEC	**No impact.** May forage over project areas.
Bobolink	*Dolichonyx oryzivorus*	BLM-S; UT-SC	OSEC	**No impact.** Suitable habitat not present in project area.
Burrowing owl	*Athene cunicularia*	BLM-S; CO-T; UT-SC	Shell (3), EGL, Chevron, OSEC	**No impact.** Suitable habitat not present in project areas.
Ferruginous hawk	*Buteo regalis*	BLM-S; CO-SC; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Suitable habitat does not exist in Shell or EGL project areas. Possible occurrence in Chevron and OSEC project areas.
Greater sandhill crane	*Grus canadensis tabida*	CO-SC	Shell (3), EGL, Chevron	**No impact.** Suitable habitat does not exist in project areas.
Lewis's woodpecker	*Melanerpes lewis*	BLM-S; UT-SC	OSEC	**No impact.** Suitable habitat does not exist in project area.
Long-billed curlew	*Numenius americanus*	BLM-S; CO-SC; UT-SC	Shell (3), EGL, Chevron, OSEC	**No impact.** Suitable habitat does not exist in project areas.
Mountain plover	*Charadrius montanus*	BLM-S; CO-SC	Shell (3), EGL, Chevron	**Potential for negative impact.** Suitable habitat does not exist in Shell or EGL project areas. Possible occurrence in Chevron project area.
Northern goshawk	*Accipiter gentilis*	BLM-S	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Potential occurrence in Shell, EGL, and Chevron project areas. Suitable habitat does not exist in OSEC project area.
Sage grouse	*Centrocercus urophasianus*	BLM-S; CO-SC; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas. Species not present in OSEC project area.
Short-eared owl	*Asio flammeus*	BLM-S; UT-SC	OSEC	**Potential for negative impact.** Possible occurrence in OSEC project area.

TABLE 6.1.1-7 (Cont.)

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Impact[c]
Birds (Cont.)				
Three-toed woodpecker	*Picoides tridactylus*	UT-SC	OSEC	**No impact.** Suitable habitat does not exist in project area.
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	ESA-C; BLM-S	OSEC	**No impact.** Suitable habitat does not exist in project area.
White-faced ibis	*Plegadis chihi*	BLM-S	Shell (3), EGL, Chevron	**No impact.** Suitable habitat not present in project areas.
Mammals				
Big free-tailed bat	*Nyctinomops macrotis*	BLM-S; UT-SC	OSEC	**No impact.** Suitable habitat does not exist in project area.
Fringed myotis	*Myotis thysanodes*	BLM-S; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Kit fox	*Vulpes macrotis*	BLM-S; CO-E; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
Spotted bat	*Euderma maculatum*	BLM-S; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in Shell, EGL, and Chevron project areas.
Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	BLM-S; CO-SC; UT-SC	Shell (3), EGL, Chevron, OSEC	**Potential for negative impact.** Possible occurrence in all project areas.
White-tailed prairie dog	*Cynomys leucurus*	BLM-S; UT-SC	OSEC	**No impact.** Does not occur in project area.
Wolverine	*Gulo gulo*	CO-E	Shell (3), EGL, Chevron	**No impact.** Suitable habitat does not exist in project areas.

[a] Federal listings: BLM-S = listed by the BLM as sensitive; ESA-C = candidate for listing under the ESA. State listings: CO = Colorado, UT = Utah; E = listed as endangered; NL = not listed; T = listed as threatened; SC = listed as species of special concern.

[b] Based on counties in which species has been recorded or could occur.

[c] Based on information provided in BLM (2006a,c,e; 2007a).

TABLE 6.1.1-8 Potential Effects of RD&D Projects on Federally Listed Threatened, Endangered, and Proposed Species

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Effect[c]
Plants				
Clay reed-mustard	*Schoenocrambe argillacea*	T	OSEC	**No effect.** Suitable habitat does not exist in project area.
Dudley Bluffs bladderpod	*Lesquerella congesta*	T	Shell (3), EGL, Chevron	**May adversely affect.** Possible occurrence in Shell, EGL, and Chevron project areas.
Dudley Bluffs twinpod	*Physaria obcordata*	T	Shell (3), EGL, Chevron	**May adversely affect.** Possible occurrence in Shell, EGL, and Chevron project areas.
Shrubby reed-mustard	*Schoenocrambe suffrutescens*	E	OSEC	**No effect.** Suitable habitat does not exist in the project area.
Uinta Basin hookless cactus	*Sclerocactus glaucus*	T	OSEC	**May adversely affect.** Possible occurrence in OSEC project area.
Ute ladies'-tresses	*Spiranthes diluvialis*	T	OSEC	**May adversely affect.** Although species does not occur in project areas, water depletions from the White River Basin could result in adverse impact.
Fish				
Bonytail	*Gila elegans*	E	OSEC	**May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact.
Colorado pikeminnow	*Ptychocheilus lucius*	E	Shell (3), EGL, Chevron, OSEC	**May adversely affect.** Although species does not occur in project areas, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact.
Humpback chub	*Gila cypha*	E	OSEC	**May adversely affect.** Although species does not occur in project area, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact.
Razorback sucker	*Xyrauchen texanus*	E	Shell (3), EGL, Chevron, OSEC	**May adversely affect.** Although species does not occur in project areas, water depletions from Colorado River Basin (Shell and OSEC projects) could result in adverse impact.

TABLE 6.1.1-8 (Cont.)

Common Name	Scientific Name	Status[a]	Project Areas within Species Range[b]	Potential Effect[c]
Birds				
Mexican spotted owl	*Strix occidentalis lucida*	T	OSEC	**No effect.** Suitable habitat does not exist in project area.
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	Shell (3), EGL, Chevron, OSEC	**No effect.** Suitable habitat does not exist in project areas.
Mammals				
Black-footed ferret	*Mustela nigripes*	E	Shell (3), EGL, Chevron, OSEC	**No effect.** Suitable habitat does not exist in project areas.
Canada lynx	*Lynx canadensis*	T	Shell (3), EGL, Chevron, OSEC	**No effect.** Suitable habitat does not exist in project areas.

[a] Listing status: E = listed as endangered under the ESA; T = listed as threatened under the ESA.

[b] Based on counties in which species has been recorded or could occur.

[c] Based on information provided in BLM (2006a,c,e).

plants. Dust that accumulates on leaf surfaces can reduce photosynthesis and subsequently affect plant vigor. Disturbed areas could be colonized by non-native invasive plant species.

Larger, more mobile animals such as birds and medium-sized or large mammals will be most likely to leave the project area during site preparation, construction, and other project activities. Development of the site will represent a loss of habitat for these species and potentially a reduction in carrying capacity in the area. Smaller animals such as small mammals, lizards, snakes, and amphibians are more likely to be killed during clearing and construction activities. If land clearing and construction activities occur during the spring and summer, bird nests and nestlings in the project area could be destroyed.

Operations of the RD&D facilities could affect protected plants and animals as well. Animals in and adjacent to project areas will be disturbed by human activities and will tend to avoid the area while activities are occurring. Site lighting and operational noise from equipment will affect animals on and off the site, resulting in avoidance or reduction in use of an area larger than the project footprint. Runoff from the site during site operations could result in erosion and sedimentation of adjacent habitats occupied by plants. Fugitive dust during operations could affect adjacent plant populations.

For all of these potential impacts, the use of the mitigation measures identified in the EAs and FONSIs, including predisturbance surveys to locate protected plant and animal populations in the area, erosion-control practices, dust-suppression techniques, establishment of buffer areas around protected populations, and restoration of disturbed areas using native species upon project completion, will greatly reduce or eliminate the potential for effects on protected species. In addition, the relatively small amount of land surface affected (160 acres per project) reduces the possibility for local extinctions of any protected plant or animal species.

Federally listed species (including species that are candidates or have been proposed for listing) that are not expected to be affected by the RD&D projects because they or their habitats are not present within the RD&D project areas or vicinities include the clay reed-mustard, shrubby reed-mustard, Mexican spotted owl, black-footed ferret, and Canada lynx (Table 6.1.1-8).

Listed plant species (including species that are candidates or have been proposed for listing) that could occur in the R&D project areas and that could be affected by project activities include Dudley Bluffs bladderpod, Dudley Bluffs twinpod, Ute ladies'-tresses, Uinta Basin hookless cactus, and White River beardtongue. On the basis of reviews of soils and habitats present in project areas, it is considered unlikely that any of these species will actually occur within or adjacent to project areas. However, predisturbance surveys for these species will be conducted, and if any individuals are found, protection strategies will be developed in consultation with the USFWS. BLM lease stipulations and mitigation measures adopted by the applicants will serve to greatly reduce the chance of adverse impacts on listed plant species. The Ute ladies'-tresses could occur along the White River. This species is dependent on a high water table and could be adversely affected by any water depletions from the White River Basin associated with the OSEC project. The amount of water depletion expected for the OSEC project is not expected to have a measurable effect on Ute ladies'-tresses.

Any water depletions from the Upper Colorado River Basin are considered an adverse effect on the endangered Colorado River fishes that exist in the major rivers of the basin. These species include the bonytail, Colorado pikeminnow, humpback chub, and razorback sucker. Operations will not directly affect these fish or their habitats, but pumping of groundwater could have indirect effects. Water will be used in drilling, operational, and reclamation phases of the project. The pumping of groundwater could affect aquifers underlying project areas, which will in turn reduce groundwater discharge to nearby creeks. No depletions are expected for the EGL or Chevron projects. Very small amounts of depletion are expected (about 19 ac-ft/yr at each of the three Shell test sites), and during some phases of operations an increase in flow may be realized.

6.1.1.8 Visual Resources

Under Alternative A, visual impacts are associated with:

1. The construction, operation, and reclamation of the RD&D projects, and the construction, operation, and reclamation of oil shale facilities that might be developed on the PRLAs for the RD&D projects if RD&D operators are granted use of the PRLA for commercial development; and

2. The construction, operation, and reclamation of oil shale facilities that might be developed in the oil shale priority management areas (Utah) and the lands available for oil shale leasing under the White River RMP in Colorado.

6.1.1.8.1 Impacts Associated with the Existing RD&D Lease Areas. Under this alternative, it is assumed that the six RD&D projects would proceed on the 160-acre leases (see Table 2.3-2 and Figure 2.3-2). Direct visual impacts associated with construction and operation of the RD&D projects, and subsequent reclamation can be divided into short-term impacts associated with activities that occur during the construction and reclamation phases of the projects, and longer-term impacts that result from construction and operation of the facilities themselves. Major construction activities that will have a visual impact include vegetation clearing; recontouring of landforms; road building and/or upgrading; pad, building, and tank construction; and utility ROW construction. Other construction activities will include digging of drilling reserve pits and possibly retention ponds, construction of berms around some tanks, and the addition of fencing around some or all of the lease sites. These various construction activities will require work crews, vehicles, and equipment that will add to visual impacts during construction. Traffic movement, associated fugitive dust emissions, and temporary parking resulting from workers' vehicles and large equipment (trucks, graders, excavators, and cranes) will also result in visual impacts. Construction equipment might produce emissions and visible exhaust plumes. In addition, piles of building materials as well as brush piles and soil piles, will be visible at times.

Visual impacts from the operation of the various RD&D projects will be associated with vegetation clearing; the presence of the project facilities and associated infrastructure; and the presence and activities of workers, vehicles, and equipment. These impacts will occur to some degree throughout the operational life of the projects, and some impacts might occur beyond the operational life of the projects. Project components and activities that will likely be associated with each of the RD&D projects and that could result in visual impacts include the following:

- Vegetation clearing (ranging between 35 acres and 160 acres cleared, depending on the project) with associated debris;
- Recontouring of landforms;
- New or upgraded roads;
- Pads for structures and or equipment (e.g., well pads);
- Buildings (generally of sheet metal construction), such as offices and laboratories;
- Groundwater monitoring wells;
- Flare stacks;

- Utilities, such as electric transmission lines, pipelines, and communication data lines (with associated rows and structures) within and/or outside the 160-acre lease boundaries depending on the project, and with ROWs 25 to 65 ft in width and up to 1 mi long, depending on the project;

- Communication towers;

- Storage tanks for water, syncrude, fuel, and other liquids associated with oil shale processing;

- Retention ponds and runoff-control structures;

- Earthen berms around some storage tanks;

- Mounds of stored soil;

- Fencing around all or part of the lease site;

- Vehicular, equipment, and worker presence and activity, and associated vegetation and ground disturbances;

- Dust and emissions; and

- Light pollution, resulting from facilities operating at night or from security lighting.

The in situ technology projects also are expected to have extensive numbers of production and injection wells and drilling reserve pits, which could result in visual impacts. Similarly, the OSEC RD&D project involving underground mining with surface retort processes will have additional visual impacts associated with the surface retorts, ore-crushing facilities, spent-shale handling facilities, processing buildings and associated structures, and piles of raw and spent shale.

Construction activities and the presence of the visible site components described above will introduce contrasts in form, line, color, texture, and a relatively high degree of human activity into what are generally natural-appearing landscapes (although the OSEC site currently has significant existing visual intrusions from previous development activity). In general, visual impacts associated directly with construction activities will be temporary, but because of the phased nature of the RD&D projects, construction activities will occur several times during the course of the project, giving rise to brief periods of intense construction activity (and associated visual impacts) followed by periods of inactivity. Much of the contrast will be associated with vegetation removal and the presence of buildings and other structures with strong geometric lines, spatial symmetry, and flat, monochromatic surfaces. These man-made industrial facilities will draw visual attention because of their size, color, and shape. Removal of vegetation and recontouring during construction will introduce unnatural-appearing linear features into the landscape and might create contrasting soil and vegetation colors and patterns. Soil scars, exposed slope faces, eroded areas, and areas of compacted soil could result from recontouring and equipment and vehicle movement, and could introduce noticeable color contrasts, depending on soil type. Invasive species might colonize disturbed and stockpiled soils and compacted areas. These species might be introduced naturally, in seeds, plants, or soils introduced for intermediate restoration, or by vehicles. The presence of workers and construction activities could also result in litter and debris that could create negative visual impacts within and around work sites.

The five in situ technology projects are generally similar in nature and extent of the visual impacts that are expected, although the three Shell projects will involve more vegetation clearing than the other in situ projects, prior to exercising of the preferential leases. The Chevron site will be the most prominent in its proposed location on Hunter Ridge adjacent to County Road 69. Because of the presence of a mine and associated buildings and structures, one or more retorts, and raw and spent shale piles, the OSEC project will have somewhat different impacts than the in situ technology projects; it will have more and potentially larger structures and eventually a large spent shale pile, covering 38 acres.

As portions of the RD&D project sites are reclaimed, visual impacts will be similar to those encountered during construction, but likely of shorter duration. Reclamation likely will be an intermittent or phased activity persisting over extended periods of time and will include the presence of workers, vehicles, and temporary fencing at the work site. Restoring an area to preproject conditions could also entail recontouring, grading, scarifying, seeding and planting, and perhaps stabilizing disturbed surfaces, but might not be possible in all cases (i.e., the contours of restored areas might not always be identical to preproject conditions). Newly disturbed soils might create visual contrasts that could persist for several seasons before revegetation will begin to disguise past activity. Invasive species might colonize reclaimed areas, likely producing contrasts of color and texture.

Should the existing RD&D developments prove successful, if the terms of the existing leases are met, commercial development could proceed on adjacent PRLA acreages totaling 24,800 acres in the Piceance Basin and on 4,960 acres adjacent to the OSEC site in Utah. The general nature of visual impacts associated with commercial development in the PRLAs would be similar to impacts noted above for the six RD&D projects. However, the scale of the impacts would be larger, as the disturbed land area would be larger, buildings and other structures more numerous and, in some cases, considerably larger, spent soil and/or shale piles (for mining-based projects) much larger, and with more employees and vehicles present. Greater volumes of smoke, dust, and other impacts associated with oil shale processing would be visible, and in general, the level of activity visible would be greater. The impacts associated with the project would also be experienced for a longer duration, because of the relatively long period of operation of the facility and longer times required for construction and decommissioning of the developments.

6.1.1.8.2 Impacts Associated with Potential Future Commercial Oil Shale Development in the Oil Shale Priority Management Areas (Utah) and Lands Available for Oil Shale Leasing under the White River RMP in Colorado. Common visual impacts associated with commercial oil shale development are described in detail in Section 4.9.1.

Acreages and applicable technologies for potential commercial oil shale development under Alternative A are described in Chapter 2. Impacts associated with commercial oil shale development in the oil shale priority management areas in Utah could include those associated with underground mining and/or in situ methods, which are described in Sections 4.9.1.2 and 4.9.1.3, respectively. Impacts associated with commercial oil shale development in the lands available for oil shale leasing under the White River RMP in Colorado could include those associated with surface mining using open pit methods, underground mining, and/or in situ methods, which are described in Sections 4.9.1.1, 4.9.1.2 and 4.9.1.3, respectively.

The RD&D leases and the lands made available for application for leasing under Alternative A support a variety of visual resources (Section 3.8). These resources are not affected by the identification of these lands as available for application for commercial leasing. However, visual resources in and around these potential lease areas could be affected by subsequent commercial development of oil shale.

Several scenic resource areas are located in Utah and Colorado within the area that is available for application for commercial leasing under Alternative A. Specifically, these areas include the Main Canyon and White River proposed ACECs, the Winter Ridge Wilderness Study Area, and segments of Evacuation Creek and White River eligible for designation as Wild and Scenic Rivers in Utah, and Duck Creek and Ryan Gulch ACECs in Colorado.

Scenic resource areas are also located within 5 or 15 mi of the RD&D leases and areas that are available for application for commercial leasing under Alternative A (Figures 6.1.1-6 and 6.1.1-7) in both Utah and Colorado. These 5-mi and 15-mi zones correspond to the BLM's VRM foreground-middleground and background distance limits, respectively. Assuming an unobstructed view of a commercial oil shale project, viewers in these areas would be likely to perceive some level of visual impact from a commercial oil shale project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for those areas within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.1.1-9 presents the scenic resource areas that fall within these zones under Alternative A.

Visual resources could be affected at and near Alternative A lease areas where RD&D or commercial oil shale projects are developed and operated, and at areas where supporting infrastructure (e.g., plants and utility and pipeline ROWs) could be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 4.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as shale-processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

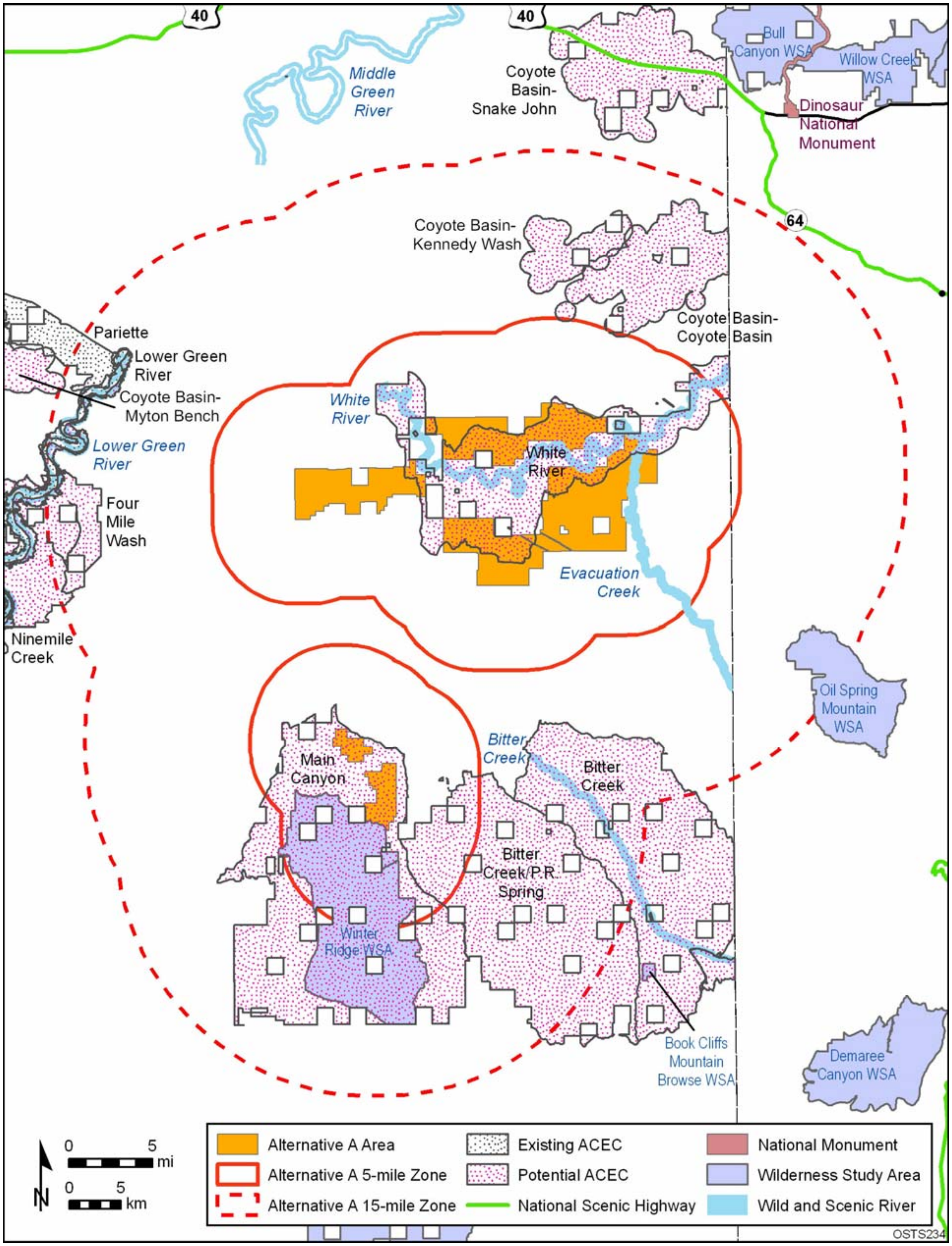

FIGURE 6.1.1-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Utah

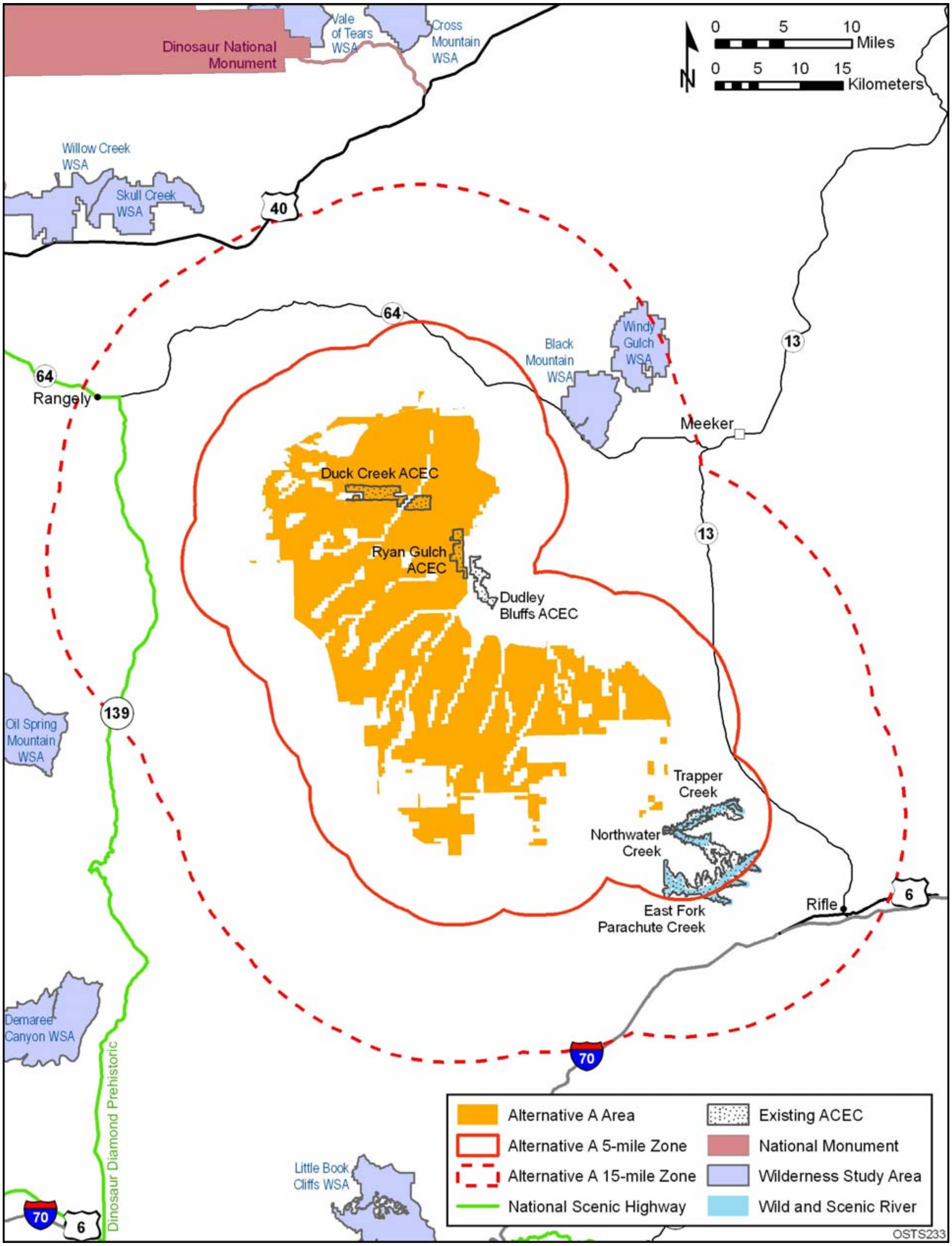

FIGURE 6.1.1-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Colorado

TABLE 6.1.1-9 Visually Sensitive Areas That Could Be Affected by Oil Shale Projects Developed in the Alternative A Lease Areas

State	Scenic Resources within 5 mi of Alternative A Lease Areas	Scenic Resources between 5 and 15 mi of Alternative A Lease Areas
Utah	Bitter Creek/P.R. Spring Proposed ACEC Coyote Basin–Coyote Basin Proposed ACEC Main Canyon Proposed ACEC White River Proposed ACEC Segments of Evacuation Creek determined to be eligible for WSR designation. Segments of White River determined to be eligible for WSR designation. Winter Ridge WSA	Lower Green River ACEC Pariette ACEC Bitter Creek potential ACEC Bitter Creek/P.R. Spring potential ACEC Coyote Basin–Coyote Basin potential ACEC Coyote Basin–Kennedy Wash potential ACEC Coyote Basin–Myton Bench potential ACEC Four Mile Wash potential ACEC Lower Green River potential ACEC Main Canyon potential ACEC White River potential ACEC Segments of Bitter Creek determined to be eligible for WSR designation. Segments of Evacuation Creek determined to be eligible for WSR designation. Segments of Lower Green River determined to be eligible for WSR designation. Segments of White River determined to be eligible for WSR designation. Winter Ridge Wilderness Study Area
Colorado	Duck Creek ACEC Dudley Bluffs ACEC East Fork Parachute Creek ACEC Northwater Creek ACEC Ryan Gulch ACEC Trapper Creek ACEC Segments of Trapper Creek determined to be eligible for WSR designation. Segments of East Fork Parachute Creek determined to be eligible for WSR designation.	Duck Creek ACEC Dudley Bluffs ACEC East Fork Parachute Creek ACEC Northwater Creek ACEC Ryan Gulch ACEC Trapper Creek ACEC Dinosaur Diamond Prehistoric National Scenic Highway Segments of Trapper Creek determined to be eligible for WSR designation. Segments of East Fork Parachute Creek determined to be eligible for WSR designation. Black Mountain WSA Windy Gulch WSA Oil Spring Mountain WSA

6.1.1.9 Cultural Resources

The existing White River and Vernal RMPs allow for oil shale development on more than 353,000 acres of land in Colorado and Utah once leasing regulations are promulgated. In addition, individual RD&D lessees may also apply to convert their 160-acre leases (plus 4,960 adjacent acres) to a 20-year commercial-scale lease once specific requirements are met.

Therefore, under Alternative A, commercial-scale oil shale development could occur after additional site-specific NEPA analyses are conducted and approvals are issued.

The lands made available under Alternative A overlap with lands that have been specifically identified as having cultural resources. Approximately 19% of public lands that are available under Alternative A for application for leasing in the Piceance Basin have been surveyed for cultural resources; approximately 45% are in the Uinta Basin. More than 1,000 sites have been identified in these surveyed areas. Additional cultural resources are likely to exist in the unsurveyed portions of the proposed lease areas. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), about 240,000 acres (83%) in the Piceance Basin, and about 58,000 acres (100%) in the Uinta Basin within the Alternative A footprints have been identified as having a medium or high sensitivity for containing cultural resources.

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to have an impact on cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts from development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resource from looting or vandalism to resources as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting (see Section 4.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested tribes.

Adverse impacts on significant cultural resources are possible in association with the RD&D activities, particularly at Shell Site 3 and the OSEC site. Avoidance of the resources and/or additional testing and possible data recovery will be needed to mitigate these impacts.

The 160-acre Chevron lease tract and associated utility line route were surveyed for cultural resources in March and April 2006. No cultural resources were identified, and the potential for subsurface remains is considered low in this area on the basis of results of previous surveys in the area and the north-sloping terrain (Connor 2006a,b). The proposed development of oil shale resources for RD&D activities on the Chevron lease tract will, therefore, not impact any known significant cultural resources.

The 160-acre EGL lease tract and associated utility line route were surveyed for cultural resources in April and May 2006, respectively (Hoefer and Greenberg 2006a,b). Two previously reported prehistoric sites were relocated, and two prehistoric isolated finds were encountered during the survey of the 160-acre lease tract. An isolated find is either a single artifact (that could be broken in several pieces, like a ceramic cup) or a small collection, typically fewer than five items, of the same type of artifact, such as four small pieces of chipped stone flakes. Two additional isolated finds dating to the historic period were encountered during the utility ROW survey. Of the six cultural resource locations identified during the surveys, none meet the eligibility criteria for listing on the NRHP; five of the sites have a field recommendation of "not eligible," and one of the previously recorded sites has an official determination of not eligible.

The proposed development of oil shale resources for RD&D activities on the EGL lease tract will, therefore, not impact any known significant cultural resources.

The three 160-acre lease tracts that Shell proposes to develop under the RD&D program have all undergone cultural resource surveys. Shell Site 1, the Oil Shale Test Site, was surveyed previously as part of two different surveys in 2004 and 2005. The total acreage previously surveyed was 1,368 acres, and 7 prehistoric sites, 1 historic site, and 10 isolated finds were recorded (Connor et al. 2004, 2005). None of these sites or isolated finds were encountered in the 160-acre lease tract of Site 1. Shell Site 2, the Nahcolite Test Site, was surveyed in 2006, and no cultural resources were recorded (Darnell 2006). The proposed development of oil shale resources for RD&D activities on the Shell Sites 1 and 2 lease tracts will, therefore, not impact any known significant cultural resources.

Shell Site 3, the Advanced Heater Test Site, was surveyed previously in 2001. The total acreage previously surveyed was 3,507 acres, and 9 prehistoric sites, 7 historic sites, and 23 prehistoric isolated finds were encountered (Connor and Davenport 2001). One site, 5RB4296, a prehistoric open camp, is located within the Site 3 lease tract. There are insufficient data regarding the eligibility of the site; therefore, the site must be treated as eligible until further testing of the site can be completed. Adverse impacts on this site will occur without the application of mitigation actions. In the Shell EA, it is stated that this site will be avoided, including any necessary erosion-control measures, and that conditions of approval will be added to the lease to ensure that the site will be safeguarded until eligibility of the site is determined.

The 160-acre OSEC lease tract has undergone previous land disturbance because it was previously mined for oil shale. In the OSEC EA, it is indicated that 28 separate cultural resource investigations have been conducted in the vicinity of the lease tract. The initial archaeological survey of the area was conducted in 1975 for oil shale lease areas Ua and Ub. The total acreage previously surveyed was 27,200 acres (Berry and Berry 1975). No additional survey of the lease tract was conducted for the RD&D activities specifically. On the basis of the results of previous surveys, 5 prehistoric sites and 1 historic site have been determined to be located within areas affected by the proposed development. None of these sites have been evaluated for eligibility, and they must be treated as eligible until a determination of eligibility is made. Adverse impacts on these sites will occur without the application of mitigation actions. In addition, a survey was completed for the associated utility line route in June 2006 to supplement coverage of the corridor by previous surveys. During this survey, eight isolated finds were recorded, none of which are eligible for listing on the NRHP. However, of the sites recorded in the previous surveys covering the corridor, 10 prehistoric and historic sites and 7 isolated finds are located within the area of the proposed utility ROW. Two sites within the area of potential impact have been determined eligible for listing on the NRHP, and 4 sites do not have sufficient data to determine their eligibility status. The remaining 4 sites and the 7 isolated finds have been recommended not eligible. On the basis of data presented in the EA, 3 of the sites with undetermined eligibility are possibly located outside of the ROW and will, therefore, not be impacted by the present proposed configuration of the utility line. However, the two eligible sites and at least one site with undetermined eligibility will be adversely impacted. It is stated in the EA that the applicant will avoid these sites during construction, if possible. Mitigation measures identified in the EA also include additional archaeological investigation when sites cannot be avoided.

It is recognized in each of the EAs that responsibility for protecting cultural resources does not end with the cultural resources surveys identified above. In the event that unanticipated cultural resources are discovered during development activities, the potential impact on these resources will need to be mitigated by stopping work and contacting the BLM Authorized Officer immediately for further instruction prior to proceeding. If human remains are encountered during project operations, the BLM Authorized Officer must be notified by telephone with written confirmation immediately upon the discovery. All activities must stop in the vicinity of the discovery, and the discovery must be protected for 30 days or until the operator is notified to proceed by the BLM Authorized Officer. Pursuant to 43 CFR 10.4, this process must be followed upon the discovery of Native American human remains, funerary items, sacred objects, or objects of cultural patrimony. All employees of the operator and any subcontractors must be informed by the operator before commencement of operations that any disturbance to, defacement of, or removal of archaeological, historical, or sacred material will not be permitted. Violation of the laws that protect these resources will be treated as law enforcement/administrative issues. The operator will be held accountable for the conduct of employees and subcontractors in this regard.

6.1.1.10 Socioeconomics

6.1.1.10.1 Projections. In addition to analysis of impacts under the no action alternative, this section includes projected baseline data for a number of economic and social variables used in the analysis of impacts under each alternative, namely, employment, personal income, population, housing, and fiscal conditions. Projections are presented for 2009, 2012, 2016, 2022, and 2027, the years likely to produce the largest impacts associated with construction and commercial operation of oil shale facilities.

Although the extent of the impact of the current natural gas and oil development on employment in each ROI over the next 30 years is not known, growth is expected to be rapid, with energy-related employment in northwestern Colorado projected to reach almost 8,900 jobs by 2020, and almost 9,300 by 2035 (BBC Research and Consulting 2008).

Employment. Wage and salary employment projections based on county population forecasts indicate that employment will grow at a relatively modest pace in each ROI from 2004 through 2027 (Table 6.1.1-10). In the Colorado ROI, employment is expected to reach 171,200 by 2027, with an average annual growth rate of 2.5%, while employment in the state is expected to grow at 1.9% over the same period. In the Utah ROI, a growth rate of 1.1% is expected over the 2004 through 2027 period, with growth in state employment higher at 1.8%. At these rates, by 2027, employment is expected to reach approximately 53,900 in the Utah ROI. Employment is expected to stand at about 53,900 in the Wyoming ROI in 2027, with a growth rate of 0.8% in both the ROI and in the state.

TABLE 6.1.1-10 Total Employment[a] (Number of Employees) Comparing Each ROI and State

	Year					
Parameter	2004	2009	2012	2016	2022	2027
Colorado ROI	97,755	110,382	118,739	130,887	151,510	171,189
Colorado	2,317,759	2,545,143	2,692,146	2,901,442	3,246,285	3,564,763
Utah ROI	42,318	44,585	46,008	47,984	51,122	53,909
Utah	1,165,695	1,272,576	1,341,353	1,438,872	1,598,604	1,745,178
Wyoming ROI	45,101	48,472	49,712	50,795	52,414	53,910
Wyoming	269,651	285,020	292,200	300,462	313,013	324,141

[a] Projections for Wyoming are based on forecasted growth rates in population for the ROI and state.

Sources: U.S. Bureau of the Census (2006a); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007); U.S. Department of Commerce (2006).

Forecasts recently completed for the Associated Governments of Northwest Colorado indicate that employment is likely to grow from 110,683 in 2005 to 184,978 over the period 2005 to 2025, at an average annual rate of 2.6%, in the four-county area comprising Garfield, Mesa, Moffat, and Rio Blanco Counties (BBC Research and Consulting 2008).

Personal Income. On the basis of ROI county population projections, by 2027, personal income is expected to reach $12.0 billion in the Colorado ROI, $2.9 billion in the Utah ROI, and $3.5 billion in the Wyoming ROI (Table 6.1.1-11).

Population. County and state projections indicate that population will grow at a relatively modest rate in the Colorado and Utah ROIs between 2000 and 2027. In the Colorado ROI, population is expected to reach 416,120 by 2027 at an average annual growth rate of 2.6%, while population in the Utah ROI is expected to reach 124,383 by 2027, growing at an annual rate of 0.8% over the period 2000 through 2027. In Wyoming, relatively low annual growth rates are expected in the ROI (0.7%) between 2000 and 2027, with population expected to stand at 105,925 in 2027. Fairly rapid annual population growth is expected in Utah as a whole (3.0%), with lower annual rates of growth expected for Colorado (1.8%) and Wyoming (0.8%) (Table 6.1.1-12).

Forecasts recently completed for the Associated Governments of Northwest Colorado indicate that the population is likely to grow from 200,835 in 2005 to 345,699 over the period 2005 to 2025, at an average annual rate of 2.8%, in the four-county area comprising Garfield, Mesa, Moffat, and Rio Blanco Counties (BBC Research and Consulting 2008).

TABLE 6.1.1-11 Total Personal Income Comparing Each ROI and State ($ billions 2005)[a]

	Year					
Parameter	2004	2009	2012	2016	2022	2027
Colorado ROI	6.5	7.4	8.0	9.1	10.7	12.0
Colorado	177.9	195.3	207.0	223.0	247.2	267.4
Utah ROI	2.3	2.4	2.5	2.6	2.7	2.9
Utah	68.9	77.3	85.9	100.4	120.6	138.8
Wyoming ROI	2.9	3.2	3.2	3.3	3.4	3.5
Wyoming	18.6	19.6	20.1	20.7	21.5	22.3

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources: U.S. Department of Commerce (2006); U.S. Bureau of the Census (2006a); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007).

TABLE 6.1.1-12 Total Population[a] Comparing Each ROI and State

	Year					
Parameter	2000	2009	2012	2016	2022	2027
Colorado ROI	207,050	255,815	279,194	314,582	370,492	416,120
Colorado	4,301,261	5,109,928	5,414,641	5,835,139	6,467,978	6,995,491
Utah ROI	101,019	103,123	105,796	110,409	117,785	124,383
Utah	2,233,169	2,769,656	3,078,370	3,598,737	4,322,043	4,972,573
Wyoming ROI	87,567	94,900	97,350	99,550	102,858	105,925
Wyoming	493,782	534,720	548,190	563,690	587,238	608,115

[a] Projections are based on forecasted growth rates in population for each of the states and for each ROI county.

Sources: U.S. Bureau of the Census (2006a,c); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2007); Wyoming Department of Administration and Information (2006).

Housing. On the basis of ROI county population forecasts, the number of housing units in the Colorado ROI is expected to reach 177,190 in 2027. Of the total number of units, 16,088 housing units are expected to be vacant in the ROI in 2027, of which 4,632 are expected to be rental units. In the Utah ROI, the number of housing units is expected to reach 52,913 in 2027 (Table 6.1.1-13). The number of vacant housing units expected in the county in 2027 is

TABLE 6.1.1-13 ROI Housing Units by Type[a]

	Year					
Parameter	2000	2009	2012	2016	2022	2027
Colorado ROI						
Owner-occupied	57,685	71,026	77,345	86,931	102,097	114,535
Rental	22,714	28,209	30,874	34,895	41,237	46,386
Vacant units	6,228	10,210	11,060	12,358	14,405	16,088
Total units	86,627	109,585	119,424	134,337	157,906	177,190
Utah ROI						
Owner-occupied	26,187	26,698	27,395	28,598	30,522	32,245
Rental	6,929	7,038	7,206	7,495	7,954	8,362
Vacant units	8,853	9,139	9,446	9,961	10,797	11,556
Total units	42,469	43,422	44,620	46,670	49,959	52,913
Wyoming ROI						
Owner-occupied	24,356	26,437	27,133	27,765	28,716	29,598
Rental	7,967	8,567	8,770	8,941	9,164	9,431
Vacant units	6,747	7,292	7,476	7,646	7,904	8,147
Total units	39,070	42,296	43,378	44,351	45,814	47,176

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources: U.S. Bureau of the Census (2006a,c); Colorado State Demography Office (2007); Utah Governor's Office of Planning and Budget (2006); Wyoming Department of Administration and Information (2006).

11,556, of which 2,337 are expected to be rental units. In the Wyoming ROI, the number of housing units is expected to reach 47,176 in 2027. Of these, 8,147 are expected to be vacant housing units in the county in 2027, of which 1,969 are expected to be rental units.

Fiscal Conditions. On the Colorado ROI, public service expenditures are expected to reach $751.4 million by 2027 at an average annual growth rate of 2.6%, while public service expenditures in the Utah ROI are expected to reach $264.3 million by 2027, growing at an annual rate of 0.9% over the period 2000 through 2027. In Wyoming, relatively low annual growth rates are expected in the ROI (0.8%) between 2000 and 2027, with expenditures expected to stand at $319.0 million in 2027. Fairly rapid public service expenditure growth is expected in Utah as a whole (3.0%), with lower annual rates of growth expected for Colorado (1.7%) and Wyoming (0.8%) (Table 6.1.1-14).

6.1.1.10.2 Impacts of No Action. Construction and operation of RD&D oil shale facilities and the associated temporary housing will impact the economies of each ROI. On the basis of employment numbers presented in the EAs and the IMPLAN model results (Minnesota

TABLE 6.1.1-14 Annual State and ROI Public Service Expenditures Comparing Each ROI and State ($ millions 2005)[a]

Parameter	Year					
	2005	2009	2012	2016	2022	2027
Colorado ROI	416.8	461.9	504.2	568.1	699.0	751.4
Colorado	39,481	42,720	45,267	48.783	54.073	58,483
Utah ROI	215.4	219.1	224.8	234.6	250.3	264.3
Utah	19,455	21,307	23,682	27,685	33,250	38,255
Wyoming ROI	268.8	285.8	293.2	299.8	309.8	319.0
Wyoming	5,638	5,919	6,068	6,240	6,501	6,732

[a] Projections are based on forecasted growth rates in population for each ROI and state.

Sources:

Colorado—City of Craig (2003); City of Delta (2004); City of Fruita (2005); City of Glenwood Springs (2004); City of Grand Junction (2004); City of Rifle (2004); Colorado State Demography Office (2007); Delta County (2005); Garfield County (2004); Mesa County (2003); Moffat County (2005); Rio Blanco County (2005); Town of Meeker (2005); Town of Parachute (2005); Town of Rangely (2004); Town of Silt (2005).

Utah—Carbon County (2004); City of Moab (2005); Duchesne County (2004); Emery County (2004); Garfield County (2004); Grand County (2004); Price Municipal Corporation (2005); Roosevelt City Corporation (2005); San Juan County (2004); Uintah County (2004); Utah Governor's Office of Planning and Budget (2006); Vernal City Corporation (2005); Wayne County (2004).

Wyoming—Carbon County (2006); City of Evanston (2005); City of Green River (2004); City of Kemmerer (2005); City of Rawlins (2005); City of Rock Springs (2005); Lincoln County (2006); Sweetwater County (2005); Uinta County (2005); Wyoming Department of Administration and Information (2006).

Overall—Standard and Poor's (2006); U.S. Bureau of the Census (2006a,b).

IMPLAN Group, Inc. 2007; see discussion of the socioeconomic assessment methodology in Section 4.11), construction of the five in situ projects will create 1,544 jobs (810 direct jobs at oil shale facilities and 734 indirect jobs in the remainder of the local economy) in the Colorado ROI and $91.3 million in income during the peak year of construction. Operation of the in situ RD&D projects will result in 1,016 additional jobs (535 direct and 481 indirect jobs, thus producing $59.7 million in income (Table 6.1.1-15). In situ construction employment represents an increase of 1.4% over the projected ROI employment baseline for 2008 (see Section 3.10.2). Construction of the one underground mining and surface retort project in Utah will create 180 jobs (120 direct and 60 indirect jobs) and $9.1 million in income during the peak construction year, and 180 jobs (120 direct and 60 indirect) and $9.1 million in income during the first year of operation.

TABLE 6.1.1-15 Estimated ROI Economic Impacts of Oil Shale Development under Alternative A[a]

	Housing Construction		Oil Shale Development: Construction		Oil Shale Development: Operation	
	Employment	Income ($ million)	Employment	Income ($ million)	Employment	Income ($ million)
Colorado						
In situ processing (5 RD&D projects)						
Direct	251	6.0	810	72.0	535	47.6
Indirect	83	2.3	734	19.3	481	12.1
Total	334	8.3	1,544	91.3	1,016	59.7
Utah						
Underground mining with surface retorting (1 RD&D project)						
Direct	16	0.3	120	7.9	120	7.9
Indirect	4	0.1	60	1.2	61	1.2
Total	19	0.3	180	9.1	181	9.1

[a] Totals may be off due to rounding. The direct employment data presented in this table for the construction and operation of the RD&D projects are based on information contained in the final EAs prepared for the six RD&D projects. Direct employment numbers and multiplier data from the IMPLAN model (Minnesota IMPLAN Group, Inc. 2007) were used to calculate indirect employment numbers for each ROI. The direct employment numbers for the construction of the in situ projects are based on the assumption that only three projects will be under construction simultaneously (EGL, Chevron, and one Shell project). For operation of the in situ projects, it is assumed that all five projects will be under operation simultaneously.

Temporary housing built for workers at the five in situ projects will create 334 jobs (250 direct and 83 indirect) and $8.3 million in income in the Colorado ROI (Table 6.1.1-14). Construction of housing for the one underground mine project will produce employment of 19 (16 direct and 4 indirect jobs) and $0.3 million in income in the Utah ROI.

Population increases associated with the construction of the in situ RD&D projects under Alternative A will represent a 0.4% increase over the ROI baseline population for the peak construction year of 2008 (see Section 3.10.2). In Utah, increases in population during the peak construction year of an underground mine in 2010 will lead to an increase of 0.2% in population in the ROI (see Section 3.10.2). Given the relatively small direct labor force requirements for each project, population in-migration in Colorado and Utah is likely to be small, with minor impacts on local social disruption in each ROI expected.

Given the relatively small scale of the RD&D projects under Alternative A, any property value impacts in the vicinity of federal land are likely to be local and temporary. In the ROI in Colorado and Utah, in general, few workers are expected to in-migrate. Individual projects are not expected to produce large increases in local employment and economic activity, meaning that property value impacts will be small.

Under Alternative A, 352,780 acres of land in Colorado and in Utah have been allocated for commercial oil shale development. The White River and Book Cliffs RMPs both authorize leasing for oil shale development. Within the White River RMP area, there are approximately 294,680 acres that are available for application for commercial oil shale leasing. In the Book Cliffs RMP area, there are 58,100 acres available for application for leasing that are classified for underground or in situ processes. Impacts could result from post-lease construction and operation of commercial oil shale projects as described in Sections 4.11 and 5.11. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Impacts on transportation systems and infrastructure could result from post-lease construction and operation as described in Section 4.11. Impacts of subsequent leasing and development actions would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

6.1.1.11 Environmental Justice

Environmental and human health impacts on the general population from the RD&D projects under the no action alternative are expected to be low. No significant, adverse air quality impacts are likely to occur during construction and operation of the RD&D projects. Land use impacts associated with the RD&D projects are likely to be relatively small given the small amount of land disturbed and the relative remoteness of locations in each state. Noise effects during energy project operation will also likely be minimal. In general, visual impacts associated with construction activities under Alternative A will be small, and temporary in nature, although some construction activities will occur several times during the course of the project, which will give rise to brief periods of intense construction activity and the associated visual impacts. Providing that mitigation measures are implemented as described in the EAs and FONSIs, water quality impacts of the RD&D projects are expected to be temporary and local, while water use during oil shale facility operations under Alternative A is expected to be low and within the capacity of regional water suppliers.

Construction and operation of the six RD&D projects will have minor disproportionate impacts on minority and low-income populations, primarily associated with changes in quality of life and social disruption caused by rapid in-migration of population into some rural communities, changes in air and water quality, and the impact of water diversions on agriculture. There may be property value and visual impacts depending on the locations of land parcels impacted by oil shale projects, their importance for subsistence, their cultural and religious significance, and possible alternate economic uses.

Under Alternative A, 352,780 acres of land in Colorado and in Utah have already been allocated for commercial oil shale development. Environmental justice impacts could result from post-lease construction and operation as described in Sections 4.12 and 5.12. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

6.1.1.12 Hazardous Materials and Waste Management

With few exceptions, the hazardous materials associated with the six RD&D projects will be very similar. Commercially available fuels to support equipment and/or provide for comfort heating (natural gas, propane, diesel fuel, and gasoline) are expected to represent the largest category of hazardous materials present on-site. As stated in Section 4.1, it is assumed that on-site upgrading of recovered products will not take place at the RD&D project sites; therefore, hazardous materials and wastes specifically associated with upgrading activities will not be present at the RD&D facilities.

The products of oil shale development efforts will exhibit hazardous properties. Whether it is the raw shale oil recovered from the one RD&D project utilizing an aboveground retort or the recovered upgraded products that are anticipated at any of the five in situ RD&D projects, the research nature of each of these projects suggests that the resulting products will exhibit characteristics unique to the particular recovery and retorting schemes that created them. Consequently, each of the RD&D products will need careful characterization (i.e., creation of a Material Safety Data Sheet [MSDS]) before appropriate management protocols can be established. However, despite the research nature of these ventures, developers still have responsibilities under the General Duty Clause of OSHA or the regulations promulgated at 29 CFR 1910.1200 (Hazard Communication Standard) to protect their workers against the hazards of the products being created. It is assumed that those responsibilities will be met expeditiously and effectively in all cases.

Execution of some of the resource recovery techniques to be employed at the RD&D facilities will require the use of hazardous materials, sometimes in substantial amounts. Examples include the anhydrous ammonia that will be used as a refrigerant in each of the three Shell in situ RD&D projects and explosives that may be used in underground mining associated with the OSEC project. Small amounts of herbicides will also be used at each facility for vegetation management within industrial areas for fire safety. Neither explosives nor herbicides are expected to be stored on-site but, instead, will be brought to the site on an as-needed basis.

During RD&D operations, limited volumes of waste streams are expected to be generated. Those associated with similar activities will be virtually the same for each project. At the quantities likely to be generated, it is reasonable to expect that all of the solid and hazardous wastes will be containerized and delivered to off-site facilities for treatment and disposal. The largest volume solid waste stream that can be anticipated is the spent shale that will be generated in the later RD&D phases of the OSEC project. OSEC anticipates producing 8,000 tons of spent shale during Phase 2 and 1.2 million tons during Phase 3; these spent shales will be disposed of either in the underground mine or in an on-site facility. At these amounts, disposal at on-site facilities will likely be conducted under the auspices of permits issued by state or local authorities. Well drilling activities at the Shell projects and at the EGL project will generate cuttings; however, such cuttings are expected to be nonhazardous and will be disposed of on-site.

Both sanitary and industrial wastewater streams will be generated at each of the RD&D projects. In most instances, volumes will be small. However, for each of the three Shell projects and the EGL project, substantial quantities of well drilling fluids will be generated. It is expected that drilling fluids will be captured in temporary sediment ponds and recycled to a great extent. Management schemes for other wastewater streams vary among the six projects and involve combinations of surface discharge, recycling, disposal by subsurface injection, on-site storage and treatment, and off-site disposal at permitted facilities. In all instances, however, the management and disposal of these wastewaters will be subject to regulatory agency approval and, in some cases, permit requirements.

In addition, one of the by-products of aboveground retorting is water (sometimes referred to as pyrolysis water). This water will often contain hydrocarbon pyrolysis products that have enough polar character to be water soluble; however, the quality of pyrolysis water will vary. Shell anticipates that pyrolysis water from its projects will be initially collected in lined ponds and treated before being released. Others plan to containerize pyrolysis water in aboveground tanks prior to shipment off-site for treatment. Pyrolysis water that is free of hydrocarbon and heavy metal contamination may be suitable for use in dust control of spent shale disposal piles or as a wetting agent for the spent shale to promote adequate compaction in the disposal cell. Pyrolysis water is also created in all in situ retorting technologies and recovered from production wells, together with hydrocarbon pyrolysis products. Here, too, the quality of pyrolysis water can vary. Water with little to no contamination can be put to beneficial uses on the site such as for fugitive dust control on on-site roads or reinjected downgradient of the retort zone to help the groundwater contours reequilibrate. Contaminated pyrolysis water will require treatment before discharge, either to surface water or to groundwater downgradient of the retort zone.

Potentially adverse health and environmental impacts could result from improper management of hazardous materials and waste streams. In general, impacts will result from the release of hazardous materials to the environment as a result of accident or improper storage and use practices. Likewise, impacts can result from accidental release from temporary storage facilities or improper management and control of on-site waste disposal or water treatment facilities. Direct impacts of such releases could include contamination of vegetation, soil, and surface and groundwater; indirect impacts on the public and on flora and fauna populations could subsequently result. If all applicable regulations governing the use, storage, and disposal of hazardous materials and regulations and permits governing the management of wastes are complied with and appropriate management practices are implemented, the adverse impacts associated with hazardous materials and most of the anticipated wastes are expected to be minimal to nonexistent. Concerns exist, however, for the potential of spent shale disposed of at the OSEC RD&D project to cause environmental damage. As documented in the project EA, however, OSEC intends to design and construct a spent shale disposal site equipped with adequate engineering features to ensure the capacity both to identify such impacts as they develop and to mitigate them to minor consequence.

Under Alternative A, 352,780 acres of public land are available within Colorado and Utah for application for leasing for commercial development of oil shale. Impacts related to hazardous materials and wastes could occur during future development of commercial oil shale projects within the Alternative A lease areas. Such impacts are generally independent of location and would be unique to the technology combinations used for oil shale development. However, hazardous materials and wastes are similar for some of the ancillary support activities that would be required for development of any oil shale facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing and power plants.

Hazardous materials and wastes could be used and generated during both the construction and operation of commercial oil shale facilities and supporting infrastructure (e.g., power plants). Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, and corrosion control coatings. Construction-related wastes could include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 4.13.1).

During project operations, hazardous materials could be utilized, and a variety of wastes (some hazardous) could be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations will depend on the specific design of the commercial oil shale project (surface or subsurface mining, surface retorting, or in situ processes). Waste materials produced during operations may include spent shale, waste engine fuels and lubricants, pyrolysis water, flammable gases, volatile and flammable organic liquids, and heavier-molecular-weight organic compounds (Section 4.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial oil shale project, it is not possible to quantify project-related impacts of these materials. Under Alternative A, individual facilities could be located anywhere within the area identified as available for leasing, pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Section 4.14) at locations wherever the individual projects are sited within the Alternative A lease areas.

6.1.1.13 Health and Safety

For the in situ RD&D projects, chemical and physical hazards associated with mining will not be applicable. The types of health hazards discussed in Section 4.14 (Table 4.14-1) that may be of concern for workers at the in situ RD&D facilities are mainly injuries and hearing loss. Workers at the OSEC underground mine facility and construction workers could be exposed to respirable dusts and thus be at risk of developing lung disease. The inhalation hazard will be lower for workers at the in situ projects, because emissions will be lower. For all the RD&D projects, the number of cases of lung disease will likely be small (if any) given the small scale of RD&D operations, the low number of employees, and required adherence to occupational health and safety standards.

A rough estimate of the numbers of injuries and fatalities that will be expected under Alternative A can be made using the numbers of direct jobs estimated (see Section 6.1.1.10.2) and published fatality and injury rates for construction and mining (NSC 2006). The 2004 fatality and injury rates for construction are 11.6 per 100,000 full-time equivalents (FTEs) and 6.4 per 100 FTEs, respectively; the rates for mining are 28.3 per 100,000 FTEs and 3.8 per 100 FTEs, respectively. For this assessment, construction rates are used to estimate impacts for all phases of in situ projects.

For all 6 RD&D projects, the estimated total number of direct construction jobs is 930 (810 in Colorado and 120 in Utah), and the number of direct operations jobs is 655 (535 in Colorado and 120 in Utah). Using these employment numbers and appropriate fatality and injury rates, the estimated numbers of annual fatalities under Alternative A are as follows: during construction, 0.14; during operations, 0.09. The estimated numbers of annual injuries under Alternative A are as follows: during construction, 75; during operations, 39. For all RD&D projects, a comprehensive facility health and safety plan and worker safety training will be required as part of the plan of development.

Under Alternative A, 352,780 acres of land in Colorado and in Utah have already been allocated for commercial oil shale development. Impacts could result from post-lease construction and operation as described in Section 4.14. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

6.1.2 Impacts of Alternative B, the Proposed Plan Amendment

Under Alternative B, the BLM would amend nine BLM land use plans to make 1,991,222 acres of public land available for application for leasing for commercial development of oil shale within Colorado, Utah, and Wyoming (see Figures 2.3.3-1, 2.3.3-2, and 2.3.3-3). (See Sections 2.3.3 and 2.3.3-1 for a complete description of Alternative B.) These lands include about 359,798 acres in Colorado, 630,971 acres in Utah, and 1,000,453 acres in Wyoming (Table 2.3.3-1) and are composed of 1,865,542 acres of BLM-administered lands and 125,681 acres of split estate lands. The nine land use plans that would be amended are as follows:

- Colorado
  - Glenwood Springs RMP (BLM 1988, as amended by the 2006 Roan Plateau Plan Amendment [BLM 2006i, 2007c, 2008a])
  - Grand Junction RMP (BLM 1987)
  - White River RMP (BLM 1997a, as amended by the 2006 Roan Plateau Plan Amendment [BLM 2006i, 2007c, 2008a])

- Utah
  - Book Cliffs RMP (BLM 1985a)
  - Diamond Mountain RMP (BLM 1994a)
  - Price River Resource Area MFP, as amended (BLM 1989)

- Wyoming
  - Great Divide RMP (BLM 1990)
  - Green River RMP (BLM 1997b, as amended by the Jack Morrow Hills Coordinated Activity Plan [BLM 2006j])
  - Kemmerer RMP (BLM 1986a).

As discussed in Section 2.3.3.1, these land use plans would be amended under Alternative B specifically to (1) identify the most geologically prospective oil shale resources within each planning unit, (2) designate lands within these most geologically prospective areas available for application for leasing, (3) identify any technology restrictions, (4) stipulate requirements for future NEPA analyses and consultation activities, and (5) specify that the BLM will consider and give priority to the use of land exchanges to facilitate commercial oil shale development pursuant to Section 369(n) of the Energy Policy Act of 2005. Specific land use plan amendments are provided in Appendix C.

On the basis of the analysis in this PEIS, the BLM has determined that there is no environmental impact associated with amending land use plans to make lands available for application for commercial leasing in three-state study area, but there may be impacts on land values. However, the future development of commercial oil shale projects on lands identified as available for application for commercial leasing could affect these resources. In addition, Alternative B would include the same level of development of the RD&D projects as described in Section 6.1.1 for Alternative A. The following sections describe the impacts of Alternative B on the environment and on the socioeconomic setting. The sections also describe the potential impact of subsequent commercial development that might occur on the lands identified as available for leasing.

In general, potential impacts of future commercial development on specific resources located within the 1,991,222 acres cannot be quantified at this time because key information about the location of projects, the technologies that will be employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of project development, it is possible to make observations and draw conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following sections identify the potential impacts, many of which might be successfully avoided or mitigated, depending upon site- and project-specific factors and future regulations that will guide leasing actions.

6.1.2.1 Land Use

The identification of 1,991,222 acres of public land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale (approximately 87% of the study area) is expected to have no impacts on other land uses, although there may be some effect on land values. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect these land uses; however, existing land uses could be adversely affected by future commercial oil shale development on these lands.

As discussed in Section 3.1, lands within the three-state study area where future commercial oil shale development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial oil shale development could have a direct effect on these uses, displacing them from areas that are being developed for oil shale production.

Future indirect impacts of oil shale development could be associated with changing existing off-lease land uses, including conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families that move to the region in support of commercial oil shale development. Increases in traffic, increased access to previously remote areas, and development of oil shale facilities in currently undeveloped areas would continue the change in the overall character of the landscape that has already begun as a result of oil and gas development. The value of private ranches and residences in the area affected by oil shale developments or associated ROWs either may be reduced because of perceived noise, traffic, human health, or aesthetic concerns or may be increased by additional demand.

Oil shale development will require off-lease construction and operation of certain infrastructure, such as electric power plants. Such structures and activities would most directly impact uses of nonfederal lands, but could have indirect impacts on some uses of federal lands. The BLM does not decide the location of electric power plants on nonfederal land. It would be too speculative to attempt to analyze where any such electric power plant would be located, but it is possible that additional generation capacity could be constructed within the socioeconomic ROI.

Transmission and pipeline ROWs associated with commercial oil shale development would not preclude other land uses but could result in both direct and indirect impacts. Direct impacts, such as the loss of lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW, would last as long as the transmission lines and pipelines were in place. Indirect impacts of ROW development could include the introduction of new or increased recreational use to an area because of improved access, avoidance of the area for residential or recreational use for aesthetic reasons, and increased traffic.

The specific impacts on land use and the magnitude of those impacts would depend on project location; project size, technology employed, and scale of operations; and proximity to roads, transmission lines, and pipelines. Impacts on various land uses that could be caused by commercial development of oil shale are discussed in Section 4.2 and are summarized below.

- Commercial oil shale development, using any technology under consideration in this PEIS, is largely incompatible with other mineral development activities because each of the technologies would dominate the lease area on which it is located. Oil and gas development is ongoing in many parts of the study area, and conflict between oil shale projects and oil and gas projects may occur. While it is possible that undeveloped portions of an oil shale lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company is developing multiple resources. A possible exception is being investigated as part of one of the RD&D projects where nahcolite mining is being conducted in advance of oil shale production.

- Where existing agricultural water rights are acquired to support oil shale development, existing irrigation-based agricultural uses of the land from which the water is acquired will be modified to support lower-value dry land use of the lands and/or may result in a complete loss of agricultural uses in some areas. Some areas could be converted to nonfarm uses depending upon local zoning decisions.

- Grazing activities would be precluded by commercial oil shale development in those portions of the lease area that were (1) undergoing active development; (2) being prepared for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as production facilities, office buildings, laboratories, retorts, and parking lots. Depending on conditions unique to the individual grazing allotment, temporary reductions in authorized grazing use may be necessary because of loss of a portion of the forage base. It is possible, depending upon how commercial leases would be developed, that some grazing uses might be accommodated on parts of the leases at various times during the lease period.

  The impact of the removal of acreage from individual grazing leases would be dependent upon site-specific factors regarding the grazing allotment(s) affected. There is a large variation in size and productivity of BLM grazing allotments across the PEIS area, and the loss of up to 5,760 acres for individual oil shale facilities from larger allotments would not be as significant as from smaller allotments. Some allotments could become completely unavailable for use. Others would lose varying percentages of grazing area that might affect their overall economic viability.

- Commercial oil shale development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird-watching, OHV use, and camping). Recreational uses, including OHV use, would be precluded from those portions of commercial lease areas involved in ongoing development and restoration activities. Impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial oil shale projects. The impact of displacement of recreation uses from oil shale development lease areas would be highly dependent upon site-specific factors, especially the nature of existing uses on the site.

- Specially designated areas, including all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails), and existing ACECs that are currently closed to mineral development, would not be available for application for commercial development and would not be directly affected. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial oil shale development on adjacent lands or on areas within the general vicinity. Section 4.9 discusses impacts on visual resources in greater detail.

- ACECs that are not closed to mineral leasing include approximately 23,000 acres and are shown in Table 6.1.2-1. Should oil shale development occur in these areas, the R&I values within these designated ACECs could be lost.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah and Wyoming as having one or more characteristics of wilderness. Table 6.1.1-2 lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative B includes approximately 170,000 acres of these lands that could be subject to potential development.

  In Utah, there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this PEIS is published. Table 6.1.1-3 lists the areas and the number of acres of overlap by field office that would be available for application for commercial oil shale leasing. If oil shale development occurs on these lands, depending on the nature of resources present on the lands, it is likely that these resources would be lost. The decisions regarding designation of these lands will be made at the BLM field office level and not in this PEIS. Should designation as ACEC be completed before this PEIS is complete, these lands may not be available for lease. If this PEIS is completed before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial oil shale development. Alternative B includes approximately 185,000 acres of these lands that could be available for commercial development.

- A portion of the land within the PRLA established for the OSEC RD&D project would not be available for application for leasing under Alternative B by an applicant other than the OSEC RD&D leaseholder because a segment of a potentially eligible WSR, Evacuation Creek, runs through the area (see Figure 2.3.3-2) that is excluded from leasing. As discussed in Section 2.4.3, the BLM has determined that a corridor extending at least 0.25 mi from the high water mark on either side of this river segment would be excluded from commercial leasing under all alternatives. Although a power line will cross

TABLE 6.1.2-1 ACECs in the Study Area Not Closed to Mineral Leasing and Available for Leasing under Alternative B

ACEC Field Office	Acres in Alternative B
White River Field Office, Colorado	
Duck Creek	3,414
Dudley Bluffs	1,605
Ryan Gulch	1,428
Glenwood Springs Field Office, Colorado	
Northwater Creek	698
E. Fork Parachute Creek	988
Trapper Creek	110
Vernal Field Office, Utah	
Lower Green River	7,683
Nine Mile Canyon	531
Pariette Wetlands	6,523
Rock Springs/Kemmerer Field Office, Wyoming	
Special status plant species	140
Total	23,070

Evacuation Creek at two locations as part of the RD&D project development, OSEC would not be able to locate other surface facilities within 0.25 mi of the creek during commercial operations if the creek has been determined to be suitable for designation as a WSR at the time the commercial lease is issued.

Under the terms of the RD&D program, the federal government has a commitment to grant the RD&D companies leases for commercial development within the PRLAs, provided all conditions of the program are met (see Section 1.4.1; includes the provision that BLM finds that the environmental impacts identified in site-specific analyses for the proposed lease are acceptable). As a result, all lands within the PRLA will be available for issuance of a commercial lease to OSEC under Alternative B if OSEC meets all conditions of the program. If OSEC does not meet the conditions of the RD&D lease, the lands would not otherwise be available for application for commercial development.

- Under this alternative, the 30,720 acres, including the existing RD&D leases, will be available for future leasing if the current leaseholders relinquish their existing leases.

6.1.2.2 Soil and Geologic Resources

The identification of 1,991,222 acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale and the amendment of land use plans to incorporate these lease areas would not have direct impacts on soil and geologic resources in these areas. The identification of these lands does not authorize or approve any ground-breaking activities that could affect these resources. Soil and geologic resources could, however, be affected by future commercial oil shale development on these lands.

Soil and geologic resources could be affected during project construction as a result of removal or compaction (e.g., during site clearing and grading, foundation excavation and preparation, and pipeline trenching) and by erosion during project construction and operation (e.g., erosion of exposed soils in construction areas or of topsoil stockpiles [see Section 4.3.1]). Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas could remain susceptible to erosion until completion of construction, mining, oil shale processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (e.g., access roads, utility ROWs, and power plants) would be located. For any project, the erosion potential of the soils would be a direct function of the lease and project location and also the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

Under Alternative B, impacts on soil and geologic resources could occur wherever individual projects are located within the 1.991.222 acres identified as available for application for leasing. Under this alternative, Wyoming would have the most land (1,000,453 acres) and Colorado the least (359,798 acres) where commercial oil shale development could affect soil and geologic resources.

6.1.2.3 Paleontological Resources

The identification of 1,991,222 acres of public land for application for leasing for commercial development of oil shale and the amendment of land use plans to incorporate these lease areas would not have direct effects on paleontological resources. Of the 1,991,222 acres identified under Alternative B as being available within the four oil shale basins, a total of 1,793,480 acres (approximately 90%) have been identified as having potential to contain important paleontological resources (Murphey and Daitch 2007). Approximately 343,820 of these acres are in the Piceance Basin; 592,620 acres are in the Uinta Basin; and 857,040 acres are in the Green River and Washakie Basins. Paleontological resources within these areas could be adversely impacted if leasing and subsequent commercial development occur. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resource from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 4.4).

6.1.2.4 Water Resources

The identification of 1,991,222 acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale (approximately 87% of the study area) and amendment of land use plans to incorporate these lease areas would not impact water resources in these areas. Both surface and groundwater resources could, however, be affected by subsequent commercial oil shale development on these lands. The amount of water that may be required for future commercial development and the potential mix among surface water, groundwater, and treated process water is unknown.

The inability to predict specific locations for potential future commercial development and the lack of information regarding the type of technology that might be employed make it very difficult to predict the specific impacts on water resources that could occur with commercial development. Quantification of such impacts would depend on the specific location of the lease area being developed, as well as the design of the project and associated infrastructure. Future climate conditions may also affect streamflows and create another uncertainty in water availability.

Section 4.5 of this PEIS provides a generic description of the potential impacts on water resources. These impacts could occur anywhere within the 1,991,222 acres available for application to lease in this alternative. The following is a summary of these generic impacts:

- Accidental chemical spills or product spills and/or leakage could potentially contaminate surface water and/or groundwater.

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;

- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;

- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;

- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;

- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;

- Construction of reservoirs that might alter natural streamflow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;

- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Spent shale piles and mine tailings that might be sources of salt, metal, and hydrocarbon contamination for both surface and groundwater;

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected;

- Degradation of groundwater quality resulting from the injection of lower quality water, from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased, and from spent shales replaced in either surface or underground mines; and

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses.

As noted in Section 6.1.2.2, the lands made available for application for leasing under Alternative B include lands that have been identified in BLM land use plans as having high potential for erosion due to steep slopes and/or highly erosive soils. Surface water quality could be adversely impacted by erosion that could contribute to increases in sediment and salinity loads from these and similar lands throughout the area that would be open for application for leasing under this alternative.

In addition, lands made available for application for leasing under Alternative B overlap with sensitive hydrologic areas identified by the BLM, including about 7,900 acres of identified riparian areas and wetlands in Colorado; about 6,100 acres of watershed, floodplains, and other sensitive water resources in Utah; and about 31,000 acres of identified floodplains, wetlands, and riparian areas in Wyoming. Disturbance of these areas could occur either by direct manipulation or through indirect effects, including increased sedimentation and runoff of contaminated water from project sites.

The total stream miles within the four oil shale basins is approximately 753 mi. Alternative B contains approximately 680 mi of these perennial streams that could be affected either directly or indirectly by commercial oil shale development (see Table 6.1.2-2).

TABLE 6.1.2-2 Perennial Streams Occurring within the Lease Areas with a 2-mi Buffer

	Alternative A		Alternative B		Alternative C	
	Number of Perennial Streams	Length of Streams (mi)	Number of Perennial Streams	Length of Streams (mi)	Number of Perennial Streams	Length of Streams (mi)
Colorado	14	152	17	189	15	115
Utah	5	57	24	262	13	219
Wyoming			20	229	12	91
Total	19	209	61	680	40	425

6.1.2.5 Air Quality

Air resources in the three states would not be affected by the identification of 1,991,222 acres of public land as available for application for commercial leasing, or by the amendment of land use plans to identify these potential lease areas. However, air resources in and around these 1,991,222 acres could be affected by potential future commercial development of oil shale. Under Alternative B, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust, diesel exhaust) during construction activities, such as site clearing and grading in preparation for facility construction, and (2) exhaust emissions (SO_2, CO, and NO_x) from construction equipment (see Section 4.6). These potential impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations, such as mining and processing of the oil shale. Processing activities could also result in regional impacts on air quality that could extend beyond the boundaries of the lease areas in each state. These regional impacts would be associated with operational releases of CO, NO_x, PM, and other pollutants (VOCs and SO_2) during oil shale excavation and processing (see Section 4.6). Operational releases of certain HAPs (e.g., benzene, toluene, formaldehyde, and diesel PM) could also affect on-site workers and nearby residences (if any are present); but these impacts, however, would be localized to the immediate project location and subject to further analyses prior to implementation.

If development of oil shale requires expansion of capacity of existing electric power plants, or the construction and operation of new electric power plants off-lease, those would also have longer-term impacts on regional air quality. Table 6.1.5-3 gives a summary of the emissions from coal-fired electric power plants.

6.1.2.6 Noise

Under Alternative B, 1,991,222 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. Ambient noise levels in these areas would not be affected by the identification of these lands for application for leasing, or by the amendment of land use plans to incorporate these lease areas. However, ambient noise levels could be affected by the future commercial development of oil shale. Under Alternative B, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of oil shale projects (see Section 4.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in Sections 4.8.1 and 4.2.1.4, respectively. Noise levels could be affected as a result of the operation of construction equipment (graders, excavators, and haul trucks) and as a result of any blasting activities. Increases in ambient noise levels during operations would be associated with mining and oil shale–processing activities and would be more long term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump stations, and by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA and Colorado guidelines (there are currently no state guidelines for Utah or Wyoming). Similarly, operational noise associated with mining and retort activities may, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed either EPA or Colorado guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the 1,991,222 acres identified for application for leasing under Alternative B.

6.1.2.7 Ecological Resources

Under Alternative B, land use plans would be amended to identify 1,991,222 acres of public land as available within Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. These lands support a wide variety of biota and their habitats (Section 3.7). However, ecological resources in and around these 1,991,222 acres could be affected by the future commercial development of oil shale. The following sections describe the potential impacts on ecological resources that may result from commercial oil shale development within the areas identified as available for application for commercial leasing under Alternative B.

The magnitude of potential impacts on specific ecological resources that could occur from commercial oil shale development would depend on the specific location of the commercial oil shale projects as well as on the specific project design.

6.1.2.7.1 Aquatic Resources. Under Alternative B, land use plans would be amended to identify 1,991,222 acres of land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. There would be no impacts on aquatic habitats associated with this action. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Potential impacts on aquatic resources from oil shale development could result primarily from increased turbidity and sedimentation, changes to water table levels, degradation of surface water quality (e.g., alteration of water temperature, salinity, and nutrient levels), release of toxic substances to surface water, and increased public access to aquatic habitats as described in Section 4.8.1.1. As described in Section 4.8.1.1, there is a potential for development and production activities in upland areas to affect surface water and groundwater beyond the area where surface disturbance or water withdrawals are occurring. Consequently the analysis here considers the potential for impacts in waterways up to 2 mi beyond the boundary of the lands that would be allocated for potential leasing under this alternative. However, as project development activities become more distant from waterways, the potential for negative effects on aquatic resources could be reduced. For the analysis of potential impacts on each of the alternatives considered in this PEIS, it was assumed that the potential for negative impacts on aquatic resources increases as the area potentially affected (i.e., the area that would be considered for leasing) increases and as the number and extent of waterways within a 2-mi zone surrounding those areas increases.

Under Alternative B, there are 33 perennial streams, and about 251 mi of perennial stream habitat within the Piceance, Uinta, Green River, and Washakie Basins that are directly overlain by areas that would be potentially available for oil shale development. When an additional 2-mile zone surrounding these areas is considered, there are 49 perennial streams and about 680 mi of perennial stream habitat that could be affected by future development activities (Table 6.1.1-1). The development of commercial oil shale projects in the areas identified under Alternative B could affect aquatic biota and their habitats during project construction and operations, thereby resulting in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. As described in Section 4.1.1.1, impacts from water quality degradation and water depletions could affect not only resources in areas within or immediately adjacent to leased areas, but also in areas farther downstream in affected watersheds. The nature and magnitude of impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

The types of aquatic habitats and organisms that could be impacted by future development in the vicinity of the Piceance, Uinta, Green River, and Washakie Basins are described in Section 3.7.1, and some of these aquatic habitats are known or likely to contain federally listed endangered fish, state-listed or BLM-designated sensitive species (Section 3.7.4), and other native fish and invertebrate species that could be negatively affected by development. Specific impacts would depend greatly upon the locations and methods of extraction used by future projects. Project-specific NEPA analyses would be conducted prior to any future leasing decisions to evaluate potential impacts in greater detail.

6.1.2.7.2 Plant Communities and Habitats. Under Alternative B, land use plans would be amended to identify 1,991,222 acres of land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. There would be no impacts on plant communities or habitat associated with this action. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.4. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Areas identified as available for application for commercial leasing under Alternative B support a wide variety of plant communities and habitats (see Section 3.7.2). These areas include approximately 41,000 acres that are currently identified in BLM land use plans for the protection of wetlands, riparian habitats, and floodplains. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 4.8.1.2). Some impacts (e.g., habitat loss) could continue beyond the termination of shale oil production.

Direct impacts could include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, employer-provided housing, and new power plants would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

The area available for application for leasing under Alternative B includes locations that support oil shale endemic plant species. Local populations of oil shale endemics, which typically occur as small scattered populations on a limited number of sites, could be reduced or lost as a result of oil shale development activities. Establishment and long-term survival of these species on reclaimed land may be difficult.

6.1.2.7.3 Wildlife. Under Alternative B, land use plans would be amended to identify 1,991,222 acres of lands in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. There would be no impacts on wildlife species associated with this action. Impacts could result, however, from post-lease construction and operations as described in Section 4.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The areas available for application for leasing support a diverse array of wildlife and habitats (see Section 3.7.3). Important areas identified for protection (in BLM land use plans) within the lease areas include greater sage-grouse nesting and lek areas, raptor nests, and big game species winter and summer ranges and calving areas. Table 6.1.2-3 identifies the amount of each of these habitats available for application for leasing in Alternative B and that could be impacted by subsequent commercial oil shale development in these areas.

Areas identified in Alternative B as available for application for commercial leasing overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include greater sage-grouse habitat and lek sites (Figure 6.1.2-1) and mule deer and elk winter and summer ranges (Figures 6.1.2-2 and 6.1.2-3). Table 6.1.2-4 presents the amounts of these habitats, identified by the states, that occur in the Alternative B areas available for application for leasing and that could be impacted by potential future commercial oil shale development in these areas. In addition, 38 current and historic sage grouse leks in Wyoming have been identified in areas overlapped by the Alternative B lease areas available for application for leasing in that state (Figure 6.1.2-1).

Several wild horse HMAs overlap with the lands that would be available for application for leasing, including the Piceance–East Douglas Creek HMA in Colorado (nearly 59,700 acres); the Hill Creek HMA in Utah (more than 29,800 acres); and the Adobe Town (more than 65,100 acres), Little Colorado (about 208,700 acres), Salt Wells Creek (more than 119,750 acres), and White Mountain (nearly 170,800 acres) HMAs in Wyoming (Figure 6.1.2-4).

Impacts on wildlife from commercial oil shale projects (see Section 4.8.1.3) could occur in a number of ways and could be related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement of biota; (3) mortality; (4) exposure to hazardous materials; and (5) increase in human access. These impacts can result in changes in species distribution and abundance; habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

TABLE 6.1.2-3 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative B Oil Shale Lease Areas

Wildlife Habitat	Colorado	Utah	Wyoming
Birds			
Sage grouse lek sites	3,562 (3,563)[a,b]	–[c]	15,624 (27,329)
Sage grouse nesting habitat	40,031 (40,243)	–	264,359 (437,705)
Sage grouse nesting and lek habitat	–	598 (599)	–
Raptor nests	19,560 (19,976)	–	81,705 (143,242)
Raptor habitat/nesting area	–	3,435 (3,436)	–
Waterfowl (in Pariette Wetlands)	–	79 (79)	–
Goose nest sites (in Pariette Wetlands)	–	80 (80)	–
Big Game			
Big game severe winter range	89,312 (90,088)	–	–
Deer and elk summer range	163,654 (169,172)	–	–
Pronghorn crucial kidding habitat	–	25,814 (25,815)	–
Pronghorn crucial winter habitat	–	–	269,453 (566,031)[d]
Elk crucial winter habitat	–	1,606 (1,607)	77,973 (91,320)[d]
Mule deer crucial winter habitat	–	–	87,564 (113,194)
Other			
Wild horses	65,615 (66,091)	–	–

[a] Acreage may be overestimated because of unknown degree of habitat overlap among species or habitat types for a species. For these reasons, columns should not be totaled.

[b] Numbers in parentheses are the wildlife habitat acreage identified for protection within the most geologically prospective lands.

[c] A dash = not identified for protection, or identified otherwise for protection within the state.

[d] Crucial winter habitat may be overestimated because it includes areas labeled as simply winter habitat for one or more field offices.

Wildlife could also be affected by human activities not directly associated with the oil shale project or its workforce but instead associated with the potentially increased human access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation; an increase in the incidence of fires; and increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

The potential for impacts on wildlife and their habitats from commercial oil shale development is directly related to the amount of land disturbance that would occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitat affected by development (i.e., the location of the project). Indirect effects, such as impacts

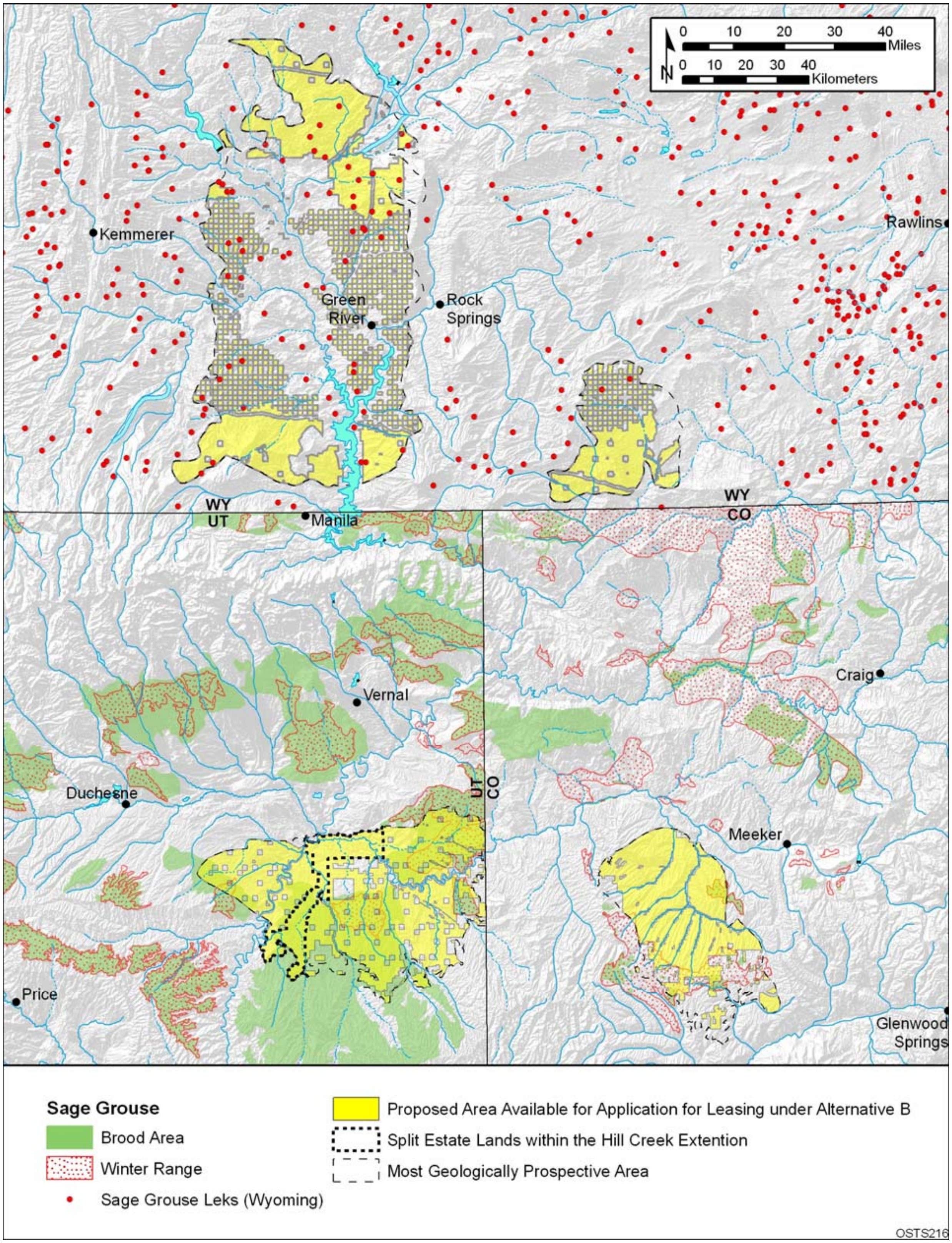

FIGURE 6.1.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse

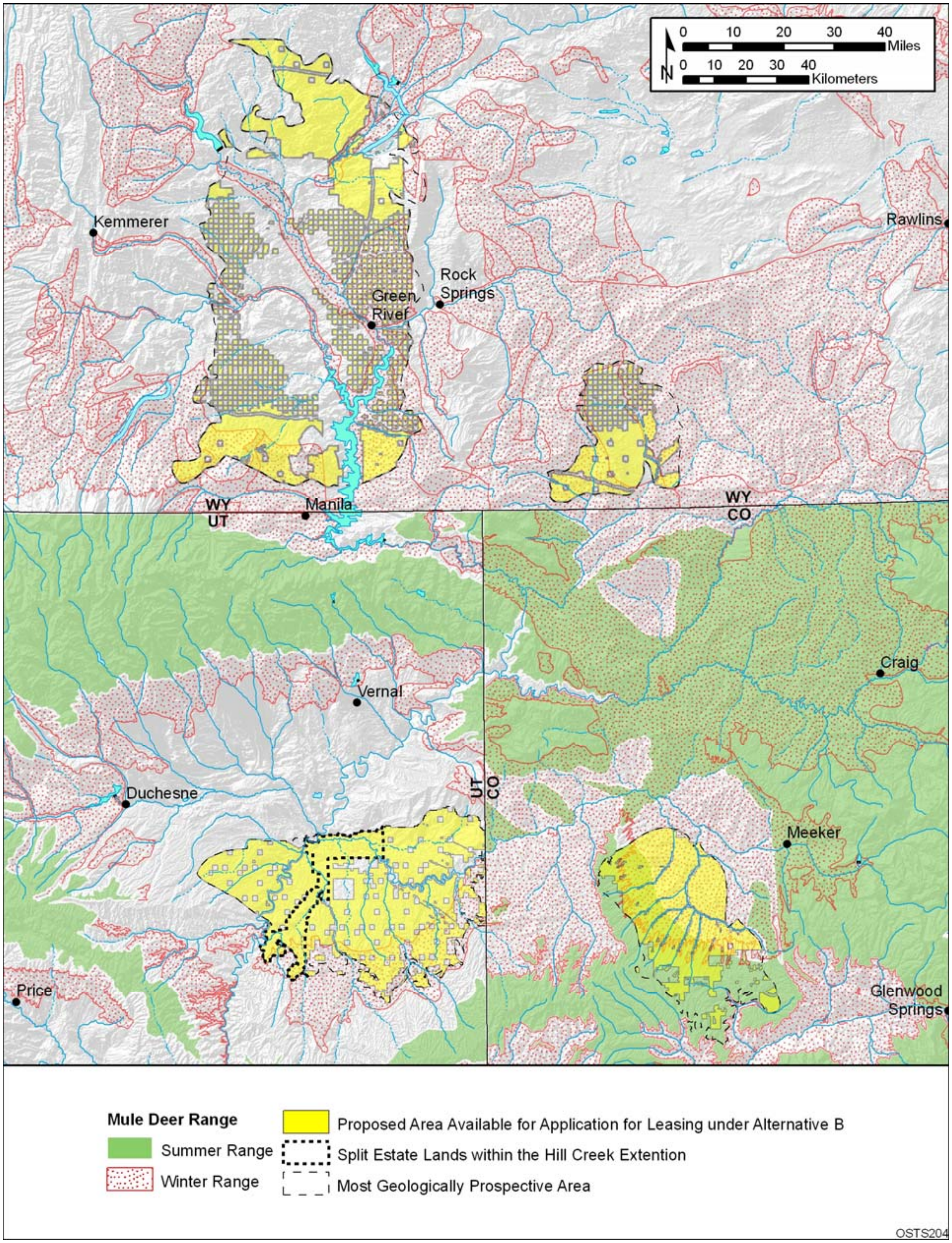

FIGURE 6.1.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer

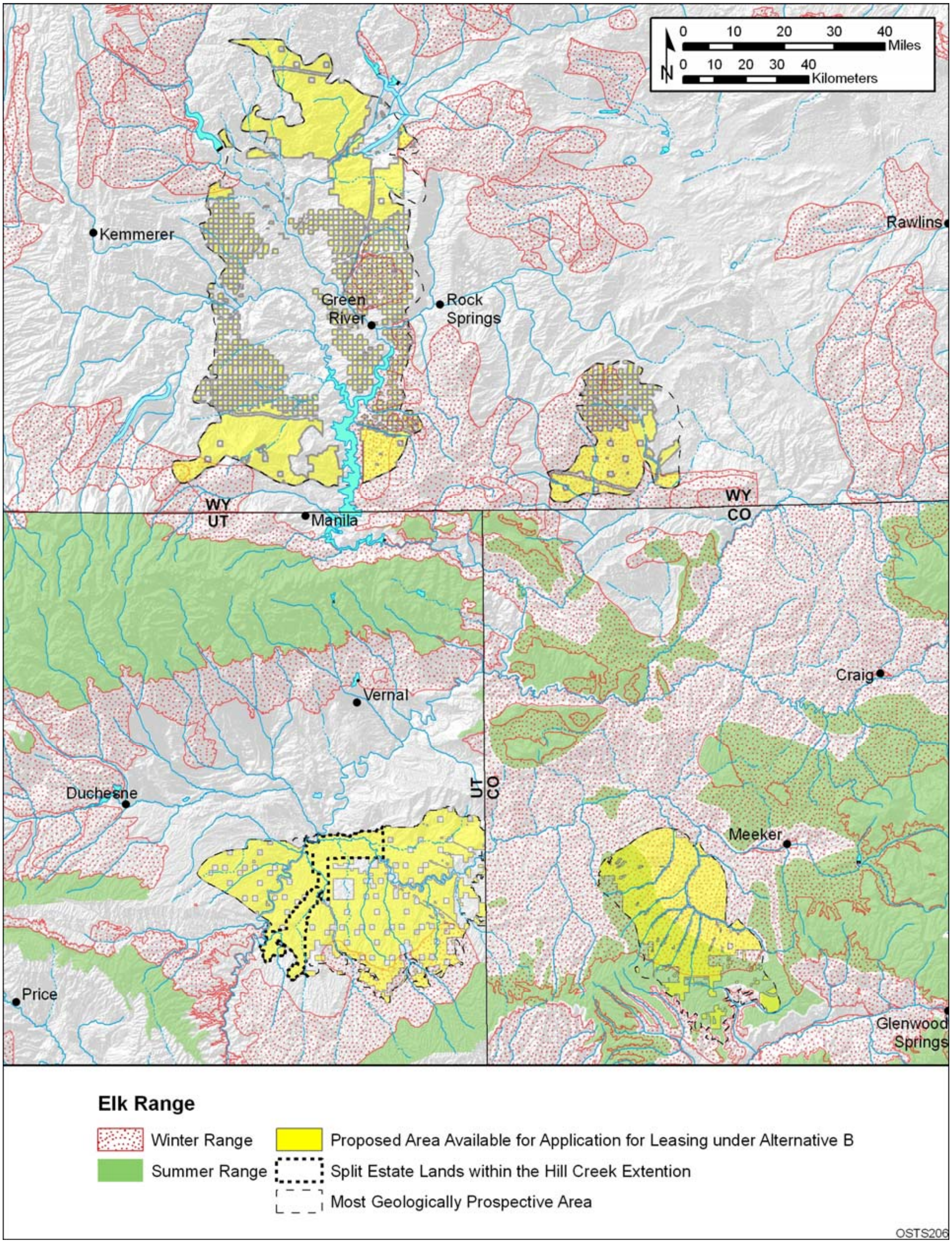

FIGURE 6.1.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk

TABLE 6.1.2-4 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas

Wildlife Resource	Colorado	Utah	Wyoming	Total
Sage grouse habitat	69,216	432,287	NA[a]	501,503
Mule deer winter habitat	245,640	127,068	362,792	735,500
Mule deer summer habitat	181,476	0	NA	181,476
Elk winter habitat	320,288	67,139	262,273	649,700
Elk summer habitat	181,216	0	NA	181,216

[a] NA = data not available.

resulting from the erosion of disturbed land surfaces, water depletions, contamination, and disturbance and harassment, are also considered. Their magnitude of these impacts is also considered to be proportional to the amount of land disturbance.

6.1.2.7.4 Threatened and Endangered Species. Under Alternative B, land use plans would be amended to identify 1,991,222 acres of land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. There would be no impacts on threatened and endangered species associated with this action. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Under Alternative B, 170 of the 172 federal candidate, BLM-designated sensitive, and state-listed species listed in Table 4.8.1-4, and 14 of the 16 federally listed threatened or endangered species listed in Table 4.8.1-5 could occur in areas that are available for application for commercial leasing (based on records of occurrence in project counties of Colorado, Utah, and Wyoming). Potential lease areas include about 99 mi of critical habitat for Colorado River endangered fishes in Colorado and Utah (Figure 6.1.2-5). The areas that are available for application for leasing under Alternative B also include about more than 382,000 acres for which lease stipulations have been established in existing RMPs to protect federally listed and candidate species, BLM-designated sensitive species, and other special status species.

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by commercial oil shale development is directly related to the amount of land disturbance that could occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, surface or groundwater depletions, contamination, and disturbance and harassment of animal species, are also considered, but their relative magnitude is considered proportional to the amount of land disturbance.

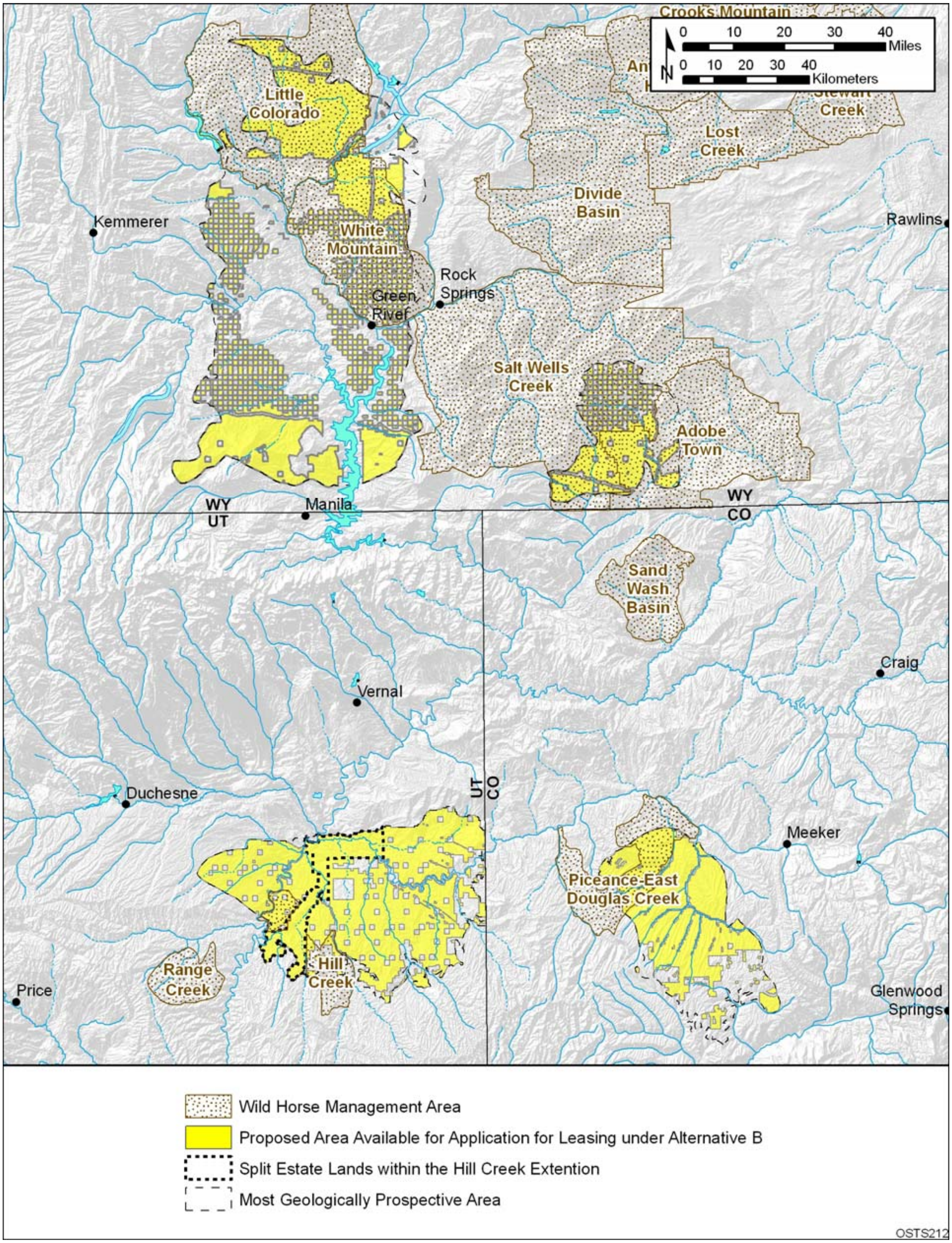

FIGURE 6.1.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas

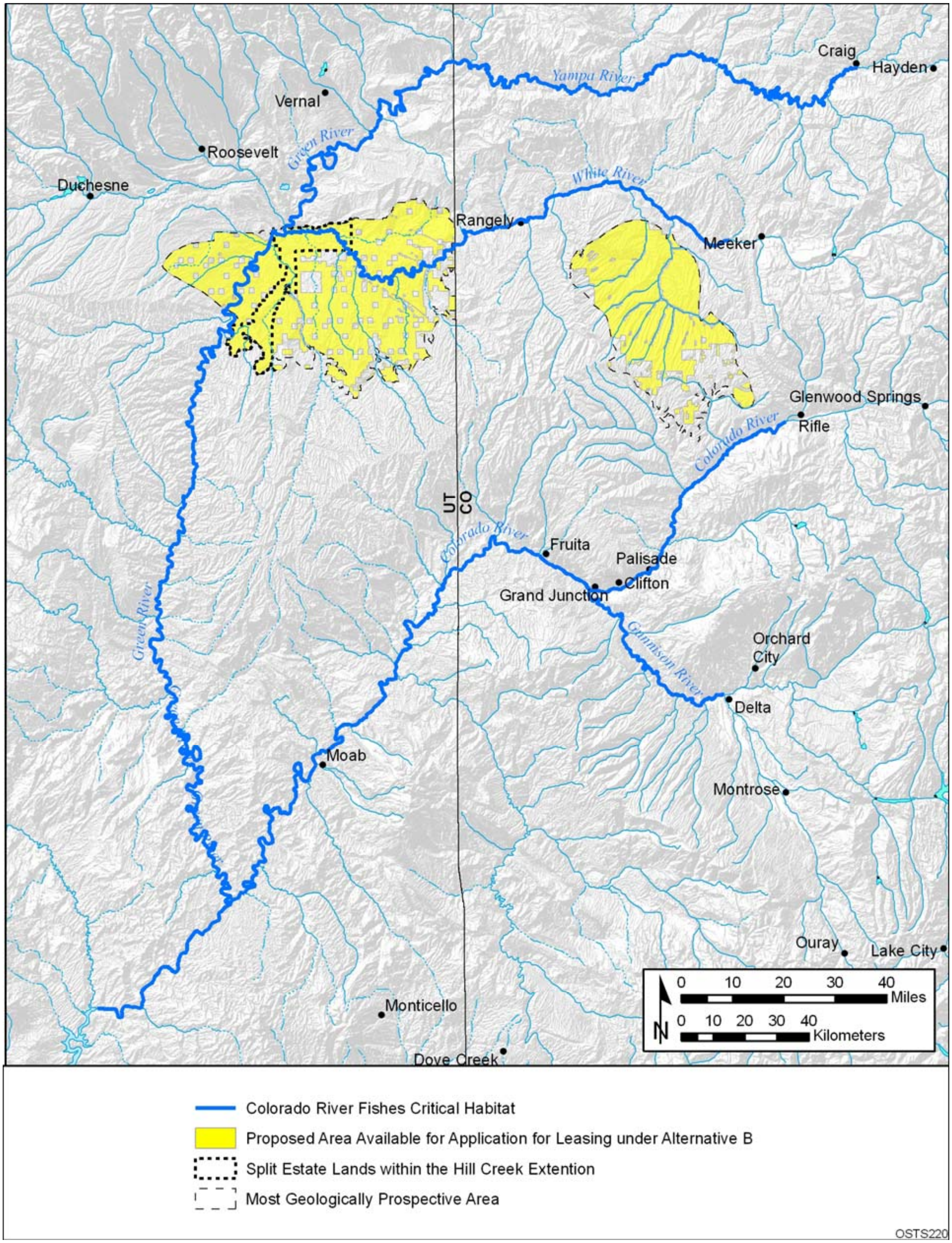

FIGURE 6.1.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B

Potential impacts on threatened and endangered species (see Section 4.8.1.4) under Alternative B are fundamentally similar to or the same as impacts on aquatic resources, plant communities and habitats, and wildlife described in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific assessments and consultations conducted prior to leasing and development.

6.1.2.8 Visual Resources

Under Alternative B, land use plans would be amended to identify 1,991,222 acres of public land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale. These lands support a wide variety of visual resources (Section 3.8). These resources would not be affected by the amendment of land use plans to identify the lands as available for application for commercial leasing. However, visual resources in and around these 1,991,222 acres could be affected by future commercial development of oil shale.

Certain scenic resource areas are located within the lease areas identified under Alternative B (Figures 6.1.2-6, 6.1.2-7, and 6.1.2-8). These include the following:

- Colorado: Duck Creek, Dudley Bluffs, Ryan Gulch, East Fork–Parachute Creek, Northwater Creek, and Trapper Creek ACECs;

- Wyoming: Sage Creek and Currant Creek portions of Greater Red Creek ACEC; and

- Utah: Lower Green River, Nine Mile Canyon, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, and White River potential ACECs; and segments of the Green River and Lower Green River determined to be eligible for WSR designation.

Additional scenic resource areas are located within 5 or 15 mi of the Alternative B proposed lease areas (Figures 6.1.2-6, 6.1.2-7, and 6.1.2-8). The 5-mi zone corresponds to the BLM's VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM's background distance limit. Assuming an unobstructed view of the project, viewers in these areas would be likely to perceive some level of visual impact from a commercial oil shale project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for resources within the background distance. Beyond the background

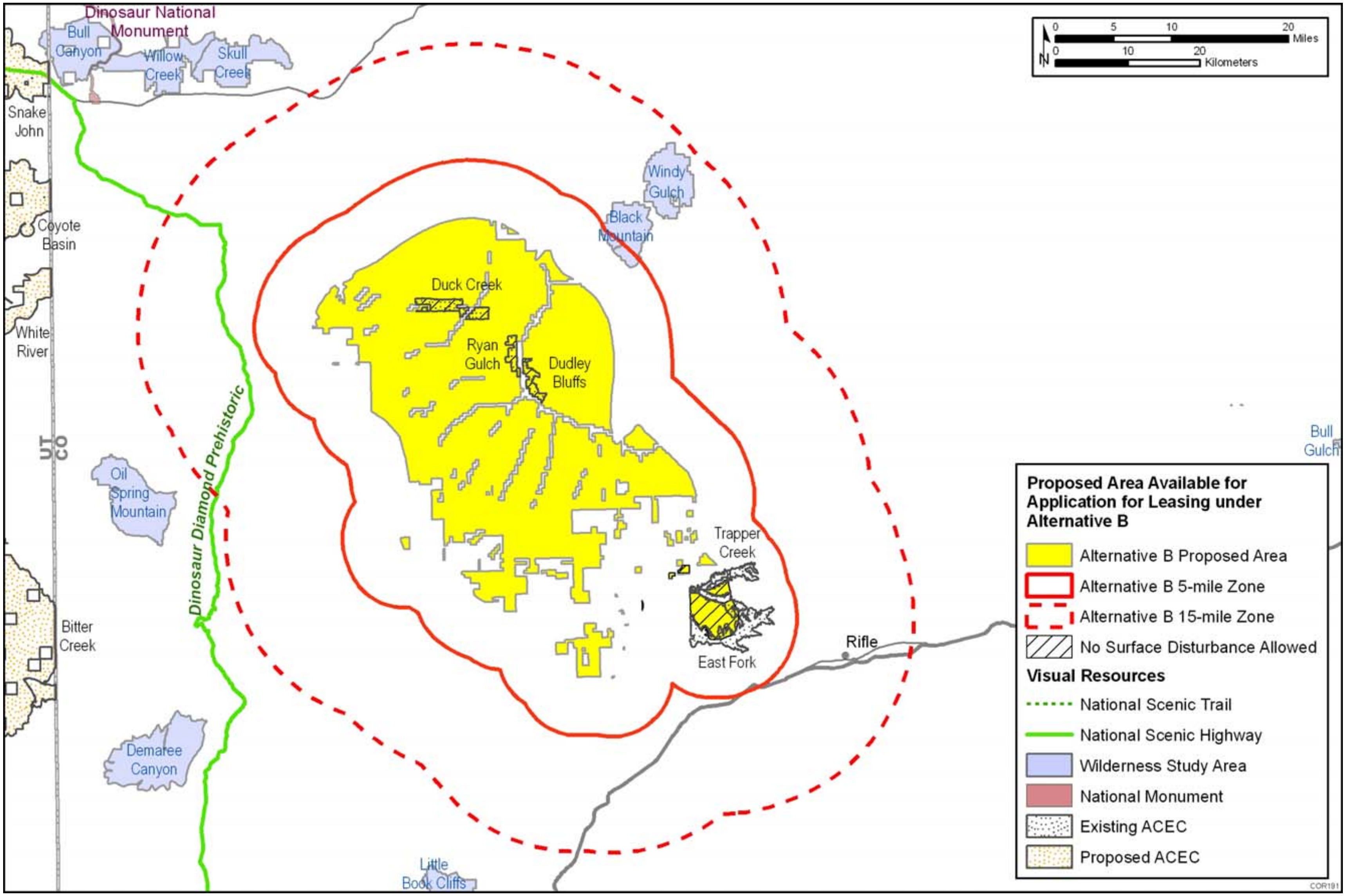

FIGURE 6.1.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Colorado

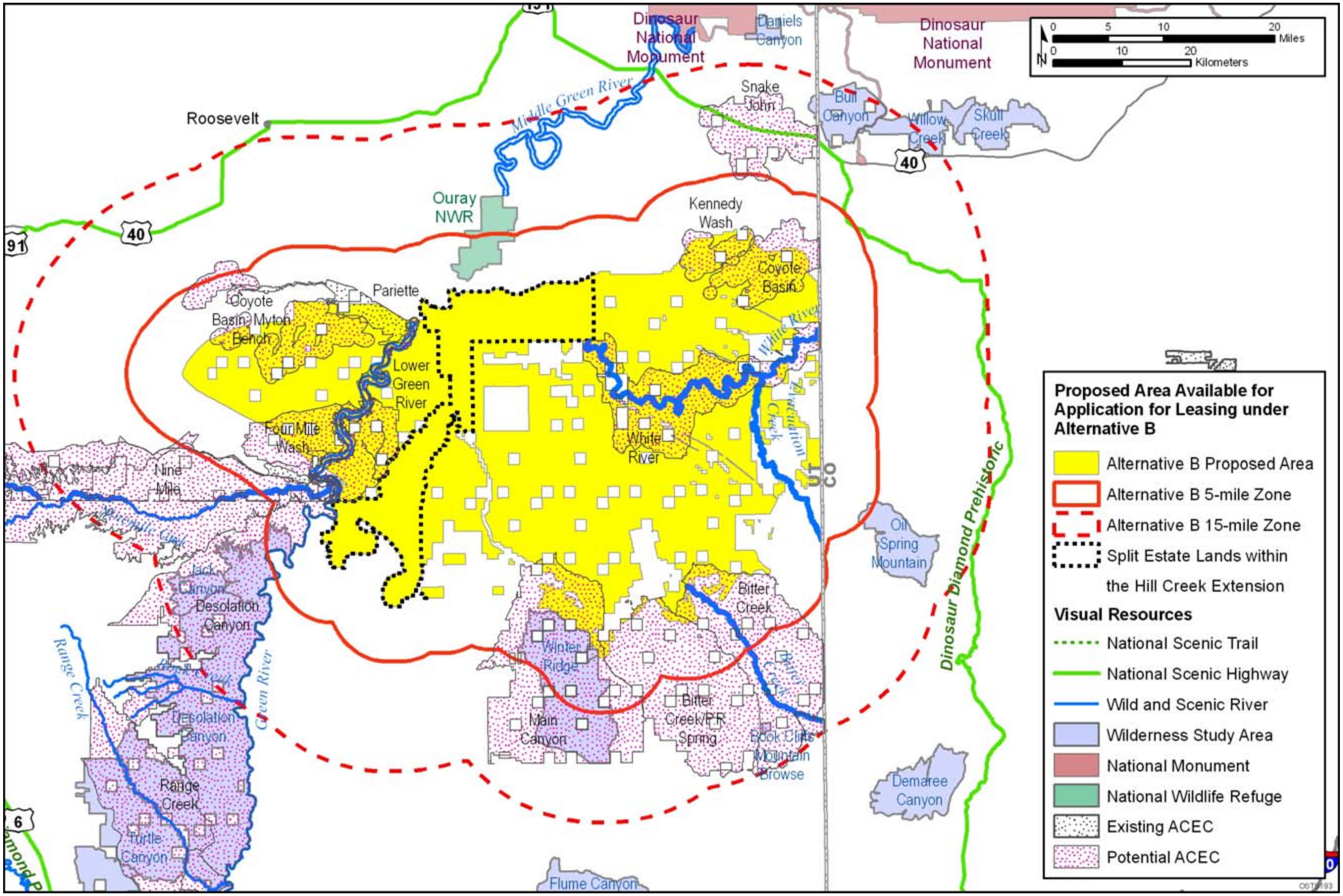

FIGURE 6.1.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Utah

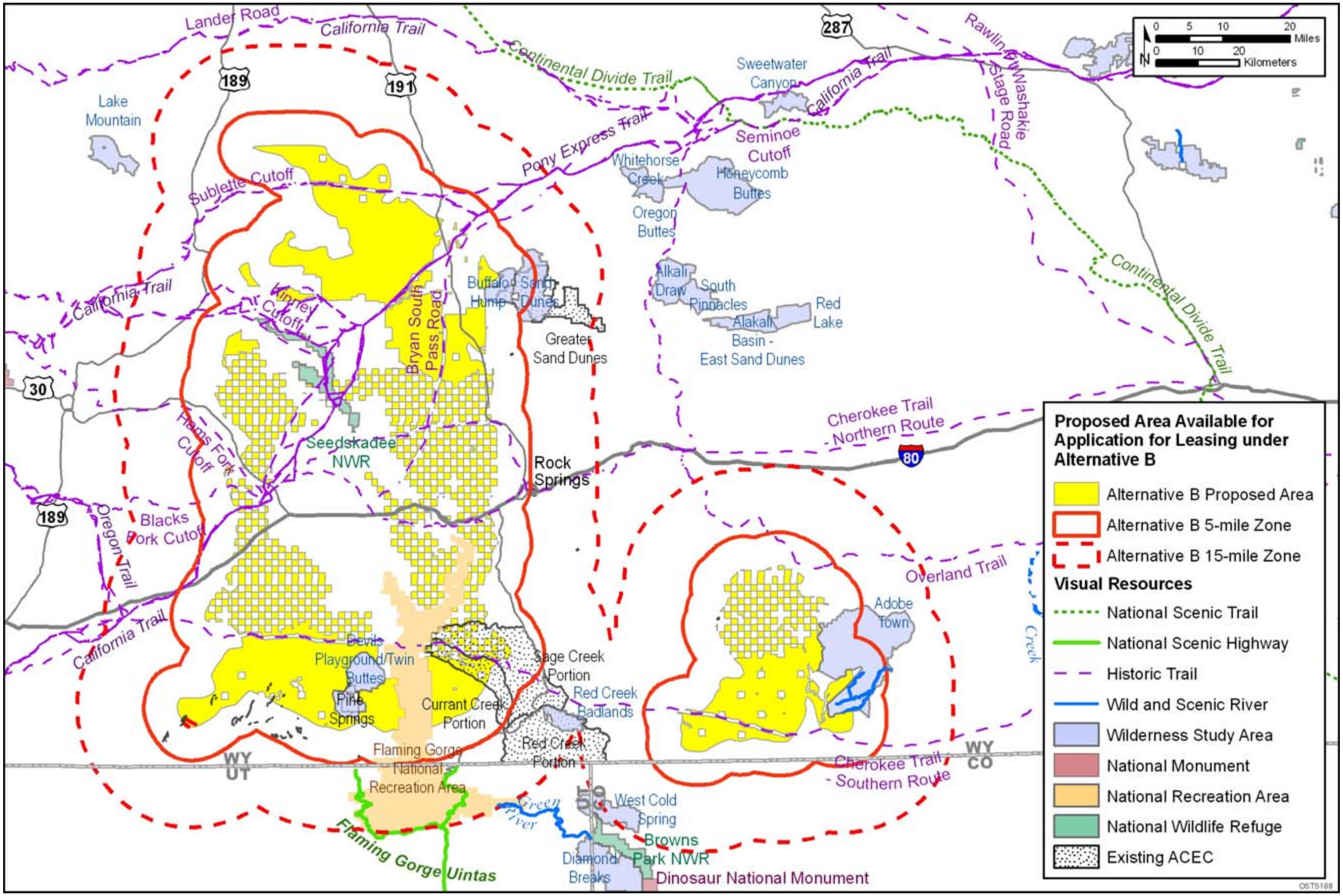

FIGURE 6.1.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Wyoming

distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.1.2-5 presents the scenic resource areas that fall within these zones.

Visual resources could be affected at and near the lease areas where commercial oil shale projects would be developed and operated, and at areas where supporting infrastructure (such as power and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 4.9.1). Potential impacts could be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components, such as shale-processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

6.1.2.9 Cultural Resources

Under Alternative B, the amendment of land use plans to identify 1,991,222 acres of public land as available for application for commercial oil shale leasing would not result in impacts on cultural resources. The lands made available under Alternative B overlap with lands that have been specifically identified as having cultural resources. Approximately 18% of public lands that would be made available under Alternative B for application for leasing in the Piceance Basin have been surveyed for cultural resources; approximately 21% in the Uinta Basin; and approximately 7% in the Green River and Washakie Basins. Nearly 3,000 sites have been identified in these surveyed areas. Additional cultural resources are likely to exist in the unsurveyed portions of the proposed lease areas. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), about 270,207 acres (75%) in the Piceance Basin, 513,233 acres (81%) in the Uinta Basin, and 881,669 acres (88%) in the Green River and Washakie Basins within Alternative B have been identified as having a medium or high sensitivity for containing cultural resources.

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to have an impact on cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development to cultural properties. Impacts from development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resource from looting or vandalism to resources as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting (see Section 4.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested Tribes.

6.1.2.10 Socioeconomics

Under Alternative B, land use plans would be amended to identify 1,991,222 acres of public land in Colorado, Utah, and Wyoming as available for application for leasing for

TABLE 6.1.2-5 Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects within the Lease Areas Identified under Alternative B

Location	Scenic Resources within 5 mi of Alternative B Lease Areas	Scenic Resources between 5 and 15 mi of Alternative B Lease Areas
Colorado	Black Mountain WSA; East Fork–Parachute Creek, Northwater Creek, and Trapper Creek ACECs; and segments of East Fork–Parachute Creek and Trapper Creek determined to be eligible for WSR designation.	Black Mountain and Windy Gulch WSAs; and Dinosaur Diamond Prehistoric National Scenic Highway.
Utah	Oil Spring Mountain, Winter Ridge, and Desolation Canyon WSAs; Lower Green River, Nine Mile, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, Nine Mile–Canyon Expansion, and White River potential ACECs; and segments of the Green River, Lower Green River, Ninemile Creek, Bitter Creek, Evacuation Creek, and White River determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway.	Bull Canyon, Willow Creek, Oil Spring Mountain, Jack Canyon, Winter Ridge, Desolation Canyon, and Book Cliffs Mountain Browse WSAs; Nine Mile ACEC; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Main Canyon, Nine Mile, and Nine Mile–Canyon Expansion potential ACECs; segments of the Green River, Middle Green River, Ninemile Creek, Rock Creek, and Bitter Creek determined to be eligible for WSR designation; Dinosaur National Monument, managed by the NPS; and Dinosaur Diamond Prehistoric National Scenic Highway.
Wyoming	Sand Dunes, Devils Playground/Twin Buttes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species, Sage Creek and Currant Creek portions of Greater Red Creek ACEC, Greater Sand Dunes, Pine Springs, and White Mountain Petroglyphs ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; and segments of Skull Creek determined to be eligible for WSR designation.	Red Creek Badlands, Sand Dunes, Adobe Town, and West Cold Spring (Colorado) WSAs; Special Status Protected Species, Sage Creek and Currant Creek portions of Greater Red Creek ACEC, and Greater Sand Dunes ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; segments of Skull Creek and Upper Green River (Utah) determined to be eligible for WSR designation; and Flaming Gorge Uintas National Scenic Highway.

commercial development of oil shale. With the possible exception of an impact on property values, there is no socioeconomic impact of this action. The socioeconomic impacts described in Section 4.11 and summarized in this section are for hypothetical individual commercial oil shale projects. These represent the types of impacts that could occur as a result of commercial development on lands identified as available for commercial leasing. The specific socioeconomic impacts of future commercial oil shale projects would be dependent upon the technologies employed, the project size or production level, and development time lines and mitigation measures.

- Oil shale developments and their associated ancillary facilities might affect property values in ROI communities located nearby. Furthermore, it is possible that there will be property value impacts simply from designating land as available for application for leasing; these impacts could result in either decreased or increased property values (see Section 4.11.1.6). Property values might decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values might increase as a result of new access to employment opportunities associated with oil shale developments.

- Under Alternative B, surface mining with surface retorting could produce about 2,200 total (direct plus indirect) jobs in the three ROIs in the peak year of construction, with between 2,900 and 3,000 jobs during operations. Underground mining could create between 2,200 and 2,600 jobs, with between 2,900 and 3,300 jobs created during the operating period. Construction of an in situ processing facility could create between 2,300 and 2,900 jobs, producing between 780 and 950 jobs during operations. Income produced by each technology could be between $40 million and $169 million during construction and operations in the three ROIs, and peak construction employment could represent an increase of between 1.5% and 4.6% over the projected peak year employment in the three ROIs.

- Construction of power plants in association with in situ facilities (if needed) could produce between 2,800 and 3,100 total jobs in the three ROIs during the peak construction year, and between 300 and 330 jobs during operations. The construction and operation of these ancillary power plants could produce between $160 million and $220 million in income in the three ROIs, and peak construction employment would represent an increase of between 2.4% and 5.6% over the projected ROI employment baseline in the peak year. Ancillary coal mine development in each ROI, also possibly associated with in situ facilities, could produce between 200 and 1,300 jobs during construction, while operations could require between 210 and 960 employees. Coal mine construction and operation could produce between $12 million and $56 million in income in the three ROIs, and peak construction employment for the coal mines would represent an increase of between 0.4% and 2.3% over the projected peak year employment in the three ROIs.

- Construction of housing provided for oil shale workers and their families could create between 560 and 620 jobs and between $10 million and $15 million in income in the ROIs. Construction of housing for power plant workers and families (associated with in situ facilities only) could create between 760 and 820 jobs, while construction of housing for coal mine workers (if needed) could produce between 52 and 320 jobs. Income of $14 million to $19 million could be produced during construction of housing for power plant workers and between $1 million and $7 million during construction of coal mine worker housing.

- Population increases associated with the construction of an underground mine project would represent an increase of between 0.6% and 1.4% over the ROI baseline population during construction and between 1% and 3.2% during operations, with similar increases expected for a surface mine. If additional power and coal are needed in association with in situ facilities, population increases associated with the construction of power plants would represent increases of between 0.8% and 1.7% during construction and between 0.1% and 0.3% during operations; and coal mine construction would increase ROI population by between 0.1% and 0.4%, with operations adding between 0.2% and 0.3% to the baseline population in each ROI.

- In-migrating population associated with oil shale facilities could absorb between 2.9% and 6.2% of vacant housing units. For a power plant (if needed), population increases associated with project construction could require between 3.8% and 6.4% of the vacant housing stock in the ROIs, while coal mine development (if needed) could require between 0.5% and 2.9% of vacant units in the ROIs.

- Construction of a surface mine facility could require an increase of between 1.1% and 1.7% in local expenditures, with increases of between 2.5% and 3.8% during operations (Table 4.11.1-5). Construction of an underground mine would require an increase in local public service provision of between 1.0% and 1.7% in expenditures during construction and between 1.8% and 3.9% during operations. Construction of an in situ facility could require an increase in local public service provision of between 1.2% and 1.9% in expenditures during construction and between 0.5% and 1.1% during operations. Construction of a power plant (if needed) could require an increase in local public service provision, requiring an increase of between 1.1% and 1.9% in expenditures during construction and between 0.2% and 0.4% during operations (Table 4.11.1-6). Coal mine development (if needed) could require an increase in local government expenditures of between 0.2% and 0.6% during construction and of between 0.3% and 0.5% during operations.

- The number of new residents from outside the producing regions and the pace of population growth associated with the commercial development of oil shale resources, including large-scale production facilities and ancillary power plants, coal mines, and housing developments, would likely lead to substantial demographic and social change in small rural communities. These communities would likely be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity, and increasing dependence on formal social relationships within the community.

- Substantial changes in access to water by agriculture could have large impacts on the economy of each ROI, which would depend on the amount of agricultural production lost, the extent of local employment in agriculture, the reliance of other industries in each ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local spending of wage and salaries by farmers, ranchers, and farmworkers. Loss of property tax revenues on agricultural land could also have an impact on local government expenditures and, consequently, on the provision of public services in local communities in each ROI. Changes in agricultural activity could change the character of community life in each ROI, with a movement away from activities that historically represent small rural communities.

- The impact of each oil shale technology on recreational visitation in the Colorado ROI would be the loss of 1,415 jobs if there were a 10% reduction in recreation employment, and 2,830 jobs if recreation employment were to decline by 20%. In the Utah ROI, 388 jobs would be lost as a whole as a result of a 10% reduction in recreation employment, and 776 jobs would be lost with a 20% reduction. In the Wyoming ROI, 1,360 jobs would be lost under the 10% scenario, and 2,719 jobs lost under the 20% scenario.

The identification of 1,991,222 acres of public land in Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale is expected to have no impacts on transportation systems and infrastructure or on traffic use levels. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect transportation infrastructure or traffic use levels; however, future commercial oil shale development on these lands could have impacts. Any future leasing or development activities would be subject to NEPA analysis, which would assess impacts of the proposed action(s). Transportation impacts would be similar to those described in Section 4.11.3.

6.1.2.11 Environmental Justice

The potential environmental justice impacts described in Section 4.12 and summarized in this section are for hypothetical individual commercial oil shale projects. These represent the types of impacts that could occur as a result of development on lands identified as available for application for commercial leasing under Alternative B. As with the environmental impacts discussed elsewhere in Section 6.1.2, the specific environmental justice impacts of future commercial oil shale projects would depend on specific project locations, the technologies employed, the project size or production level, development time lines, and mitigation measures.

Since oil shale development projects and ancillary power plant and housing developments would lead to rapid population growth in many of the communities in each ROI, it is possible that social disruption could occur, leading to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts on property values of property owned by minority and low-income individuals would depend on the range of alternate uses of specific land parcels, current property values, and the perceived value of costs (traffic congestion; noise and dust pollution; and visual, air quality, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) associated with proximity to oil shale–related facilities.

Each technology would produce surface disturbance, fugitive dust, vehicle emissions, and visible activity that could generate visual impacts. Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because of the limited surface water and groundwater, the amount of water needed in commercial oil shale projects, power plants and coal mines (if needed), and associated population growth would mean that additional water resources would be needed. Oil shale facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups or that form the basis for subsistence agriculture. Similarly, land used for these facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

Given the location of environmental justice populations in each state, construction and operation of oil shale facilities, power plants and coal mines (if needed), and employer-provided housing could produce impacts that could be experienced disproportionately by minority and low-income populations. Of particular importance would be social disruption impacts of large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Land use and visual impacts might be significant depending on the location of land parcels for oil shale projects and the associated power plant and housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses. Depending on the locations of low-income and minority populations, impacts could also occur with the development of transmission lines associated with power development and the supply of power to oil shale facilities in each state.

6.1.2.12 Hazardous Materials and Waste Management

Under Alternative B, 1,991,222 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. There would not be any hazardous material or waste management concerns associated with this action. Impacts related to hazardous materials and wastes could occur during future development of commercial oil shale projects within areas identified in Alternative B as available for application for commercial leasing. Such impacts are generally independent of location but would be unique to the technology combinations used for oil shale development. However, hazardous materials and wastes are similar for some of the ancillary support activities that would be required for development of any oil shale facility regardless of the technology used. These include the impacts from development or expansions of support facilities such as employer-provided housing and power plants.

Hazardous materials and wastes could be used and generated during both the construction and operation of commercial oil shale facilities and supporting infrastructure (e.g., power plants). Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, and corrosion control coatings. Construction-related wastes could include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 4.13.1).

During project operations, hazardous materials could be utilized, and a variety of wastes (some hazardous) could be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations will depend on the specific design of the commercial oil shale project (surface or subsurface mining, surface retorting, in situ processes). Waste materials produced during operations may include spent shale, waste engine fuels and lubricants, pyrolysis water, flammable gases, volatile and flammable organic liquids, and heavier-molecular-weight organic compounds (Section 4.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial oil shale project, it is not possible to quantify project-related impacts of these materials. Under Alternative B, individual facilities could be located anywhere within the area identified as available for leasing, pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Section 4.14) at locations wherever the individual projects are sited within the Alternative B lease areas.

6.1.2.13 Health and Safety

The identification of 1,991,222 acres of public land as being available for application for leasing and the amendment of land use plans to identify these areas would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of oil shale projects within the areas in Alternative B that are identified as available for commercial leasing. The level of health and safety impacts would be mainly dependent on the extent of oil shale development, the extent of health and safety precautions imposed by the operators, and the design of each project (as related to the level of air and water emissions associated with a facility).

Potential health and safety impacts from the construction and operation of commercial oil shale projects could be associated with the following activities: (1) constructing project facilities and associated infrastructure, (2) mining (if processing is not in situ) the oil shale; (3) obtaining and upgrading of the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposing the general public to water and air contamination associated with oil shale development. Hazards from oil shale development (summarized in Table 4.14-1) could include physical injury from construction, oil shale processing, and vehicle transportation accidents and exposure to fugitive dust and hazardous materials, such as retort emissions and industrial chemicals (Section 4.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public who could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Workers could be exposed to different hazards depending on the type of jobs they do. Workers at all types of oil shale development facilities could be exposed to high noise levels, resulting in hearing loss. The health and safety of miners could be impacted by injuries or deaths due to accidents (e.g., highwall bank failures or cave-ins, uncontrolled explosions, accidents involving heavy machinery), or heat exposures. Workers operating surface retorts also could be injured or die due to accidental explosions, heat stress, or accidents involving heavy machinery. Physical hazards from well-drilling, the use of explosives, and the operation of heavy equipment would be present for in situ workers.

Serious and often fatal lung disease in miners has been associated with inhalation of particulates and volatile compounds containing carcinogenic PAHs; such exposures could be limited by adherence to applicable occupational health and safety standards. Lung disease caused by inhalation of emissions from the retorting process would also be of concern for retort operators, although these exposures are generally lower than those associated with mining. For workers at facilities using in situ recovery techniques, hazards associated with inhalation of emissions would also be expected to be lower than those associated with mining.

Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. Based on the numbers of employees projected to be needed for construction and operation of oil shale facilities, there would statistically be less than 1 death and about 125 injuries per year expected per facility during construction activities, and less than 1 death and less than 100 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training will be required as part of the plan of development for every proposed commercial oil shale project.

Health and safety concerns are largely independent of the location of oil shale development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions, and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

6.1.3 Impacts of Alternative C

Under Alternative C, the BLM would amend the same nine BLM land use plans that would be amended under Alternative B (Section 6.1.2), but would designate only 830,296 acres of public land as available for application for leasing for commercial development of oil shale within the most geologically prospective oil shale areas in Colorado, Utah, and Wyoming (see Figures 2.3.3-4, 2.3.3-5, and 2.3.3-6). (See Sections 2.3.3 and 2.3.3.2 for a complete description of Alternative C.) These include 40,325 acres in Colorado, 490,460 acres in Utah, and 299,511 acres in Wyoming (Table 2.3.3-2). These public lands comprise 795,986 acres of BLM-administered lands and 34,311 acres of split estate lands. Specific land use plan amendments are provided in Appendix C.

On the basis of the analysis in this PEIS, the BLM has determined that there is no environmental impact associated with amending land use plans to make lands available for application for commercial leasing in the three-state study area, but there may be impacts on land values. However, the development of commercial oil shale projects on lands made available for application for commercial leasing by these land use plan amendments would have impacts on these resources. In addition, Alternative C could include the same level of development of the RD&D projects as described in Section 6.1.1 for Alternative A. The following sections describe the impacts of Alternative C on the environment and the socioeconomic setting of the areas identified as available for application for leasing under this alternative.

In general, potential impacts of future commercial development on specific resources located within the 830,296 acres cannot be quantified at this time because key information about the location of projects, the technologies employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of future project development, it is possible to make observations and draw conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following sections identify the potential impacts that could accompany subsequent commercial oil shale leasing, many of which might be successfully avoided or mitigated depending on site- and project-specific factors and future regulations that would guide leasing actions.

6.1.3.1 Land Use

Alternative C would amend the same nine land use plans as Alternative B but would identify 830,296 acres of public land in Colorado, Utah, and Wyoming as available for application for leasing for commercial development of oil shale (approximately 36% of the study area). The amendment of the land use plans is expected to have no direct impacts on land uses, although there may be some impact on land values. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect existing land uses. Existing land uses could, however, be adversely affected by future commercial oil shale development on these lands.

The nature of the impacts of Alternative C on land uses would be the same as those listed under Alternative B above, with exceptions that are included below. Although Alternative C makes approximately 1.2 million less acres available for application for commercial leasing, it does not provide for less potential development of commercial oil shale than does Alternative B. Alternative C does remove from consideration for leasing lands with sensitive resources that have been identified in current BLM land use plans, including all existing ACECs.

The following are areas where the impacts of Alternative C could differ from those described for Alternative B in Section 6.1.2.1:

- In the Piceance Basin, Alternative C would likely have less of an impact on oil and gas operations because considerably fewer acres of potentially valuable oil and gas deposits in a rapidly developing area would be available for application for commercial oil shale development.

- Alternative C removes from application for leasing approximately 23,000 acres of land identified as ACECs.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah and Wyoming as having one or more characteristics of wilderness. Table 6.1.2-1 lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative C includes approximately 110,000 acres of these lands that could be subject to development.

- In Utah there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this PEIS is published. Table 6.1.1-2 lists, by field office, the areas and the number of acres of overlap that would be available for application for commercial oil shale leasing. If oil shale development occurs on these lands, depending on the nature of resources present on the lands, it is likely that these resources would be lost. The decisions regarding designation of these lands will be made at the field office level and not in this PEIS. Should designation as an ACEC be completed before this PEIS is complete, these lands may not be available for lease. If this PEIS is completed before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial oil shale development. Alternative C includes approximately 137,000 acres of these lands that could be subject to development.

- A portion of the land within the PRLA established for the five Colorado RD&D projects and the OSEC RD&D project in Utah would not be available for application for leasing under Alternative C by applicants other than the existing RD&D leaseholders. These lands would be excluded in order to provide maximum protection to sensitive resources identified in these areas (see Figure 2.3.3-4). Specifically, portions of the areas associated with the Chevron, EGL, and Shell Site 2 RD&D projects would be excluded. In addition, the entire PRLAs for Shell Sites 1 and 3 would be excluded. As with Alternative B, a portion of the land within the PRLA established for the OSEC RD&D project also may not be available for application for leasing under Alternative C, depending on whether a portion of Evacuation Creek is designated as a WSR.

  Under the terms of the RD&D program, the federal government has a commitment to grant the RD&D companies leases for commercial development within the PRLAs, provided all conditions of the program are met (see Section 1.4.1, which includes the provision that the BLM finds the environmental impacts identified in site-specific analyses for the proposed lease are acceptable). As a result, all lands within the PRLAs would be available for issuance of commercial leases to the RD&D companies under Alternative C if they meet all conditions of the program. The federal government is not under an obligation to grant leases for commercial development within these areas to any other applicants.

- Under this alternative, of the 30,720 acres included in the existing RD&D leases, if current leaseholders relinquished those leases, only 8,025 acres would be available for future leasing. The 8,025 acres that would be available are those identified within the RD&D lease boundaries in Figures 2.3.3-4 and 2.3.3-5.

6.1.3.2 Soil and Geologic Resources

Under Alternative C, 830,296 acres of public land in Colorado, Utah, and Wyoming would be identified as available for application for leasing for commercial oil shale development. This action would not affect soil and geologic resources in these lands. Development of commercial oil shale projects could, however, affect soil and geologic resources in these lands. Construction-related activities could directly disturb surface and subsurface soils during clearing and grading activities and construction of project facilities and infrastructure. This disturbance could include soil disturbance, removal, and compaction, and disturbed areas would be more susceptible to the effects of precipitation and wind-driven erosion (see Section 4.3.1). Surface and subsurface mining activities during project operations would directly disturb geologic resources. Erosion of exposed soils could lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust. Soils in project areas would remain susceptible to erosion until completion of construction, mining, and oil shale-processing activities, and site stabilization and reclamation (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-lease infrastructure (such as access roads, utility ROWs, and power plants) would be located. For any project, the erosion potential of the soils will be a direct function of the lease and project location, and the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

Under Alternative C, project-related impacts could occur wherever individual projects are located within the 830,296 acres identified for application for leasing under this alternative. Utah would have the most land (490,460 acres) and Colorado the least land (40,325 acres) where commercial oil shale development could affect soil and geologic resources.

6.1.3.3 Paleontological Resources

Under Alternative C, 830,296 acres in the four oil shale basins would be identified as being available for application for leasing and potential future commercial development. The identification of these lands as available for leasing, as well as the amendment of land use plans to incorporate these areas, would not affect paleontological resources because these actions do not authorize or approve any ground-disturbing activities. All existing ACECs, some of which have been identified for their paleontological values, would not be made available for application for leasing under this alternative, and, therefore, the paleontological resources present in these areas would not be impacted under this alternative. However, the lands that are made available for application for leasing also overlap with some lands known to be potentially rich in paleontological resources. Of the acreage identified as available for application for leasing under Alternative C, a total of 749,920 acres (approximately 90%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Approximately 38,030 of these high potential acres are present in the Piceance Basin; 444,160 acres are present in the Uinta Basin; and 267,730 acres are present in the Green River and Washakie Basins. Resources within these areas could potentially be adversely impacted if leasing and subsequent commercial development occur. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development areas, and increased potential for loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 4.4).

6.1.3.4 Water Resources

Under Alternative C, 830,296 acres of public land (about 36% of the study area) would be made available for application for leasing for commercial development of oil shale within Colorado, Utah, and Wyoming. The acreage available for application for leasing in this alternative specifically excludes lands identified in BLM land use plans as sensitive for numerous different resources (see Table 2.2.3-3). Excluding these lands from application for leasing would provide complete protection from direct impacts from oil shale development for the resources found on these lands. However, indirect effects are still possible. In those areas that are available for application for leasing in both Alternatives B and C, the potential impacts would be the same as described in Section 6.1.2.4 of this PEIS.

The total stream miles within the four oil shale basins is approximately 753 mi. Alternative C contains approximately 425 mi of these perennial streams (see Table 6.1.2-2).

The assessment of impacts on water resources under Alternative C has the same limitations as referenced under Alternative B. Without site-specific information regarding location and type of technology to be employed, it is not possible to assess the overall impacts of this alternative.

6.1.3.5 Air Quality

Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. Air resources in the three states would not be affected by this action. Air resources in and around these areas could, however, be affected by potential future commercial oil shale development within the basin areas. Under Alternative C, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust, diesel exhaust) during construction activities such as site clearing and grading in preparation of facility construction, and (2) exhaust emissions (SO_2, CO, and NO_x) from construction equipment (see Section 4.6). These potential impacts would be largely limited to specific project locations and the immediately adjacent areas. Similar short-term impacts could also occur in other areas where project-related electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer term impacts on local air quality could occur during normal project operations such as mining and processing of the oil shale. Processing activities could also result in regional impacts on air quality that could extend beyond the lease areas identified under Alternative C. These regional impacts would be associated with operational releases of CO, NO_x, PM, and other pollutants (VOCs and SO_2) during oil shale processing (Section 4.6). Operational releases of certain HAPs (e.g., benzene, toluene, and formaldehyde) as well as diesel PM could also affect on-site workers and nearby residences, but these impacts would be localized to the immediate project location and subject to further analysis prior to implementation.

If development of oil shale requires expansion of capacity of existing electric power plants, or the construction and operation of new electric power plants off-lease, those would also have longer-term impacts on regional air quality. Table 6.1.5-3 gives a summary of the emissions from coal-fired electric power plants.

6.1.3.6 Noise

Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. Ambient noise levels would not be affected by this action. However, ambient noise levels could be affected by future commercial development of oil shale. Under Alternative C, local, short-term changes in ambient noise levels could be incurred during the construction, operation, and reclamation of oil shale projects (see Section 4.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Noise impacts on wildlife and recreational users are discussed in Sections 4.8.1 and 4.2.1.4, respectively.

Increased noise levels could result from the operation of construction equipment (graders, excavators, and haul trucks) and from any blasting activities that might occur. Increases in noise levels during operations could be associated with mining and oil shale–processing activities and could be more long term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could increase in the immediate vicinity of any pipeline pump stations and be affected by project-related vehicular traffic at the project site and related locations (such as access roads to the site).

Construction-related noise levels could exceed EPA and Colorado guidelines at some distances from the construction sites (there are currently no state guidelines for Utah or Wyoming). Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed either EPA or Colorado guideline levels except for short durations and in areas close to roads or traffic.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes in ambient noise levels due to project development could occur wherever a project is located within the 830,296 acres identified for application for leasing under Alternative C.

6.1.3.7 Ecological Resources

Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. These lands support a wide variety of biota and their habitats (Section 3.7). Ecological resources in these areas would not be affected by the identification of future lands available for application for leasing or by amendment of land use plans to incorporate these lease areas. However, ecological resources in and around these areas could be affected by future commercial development of oil shale in these areas. The following sections describe the potential impacts on ecological resources that may result from commercial oil shale development within the areas identified as available for application for commercial leasing under Alternative C.

The magnitude of the impact on specific ecological resources that could be affected by commercial oil shale development in areas identified as available for application for commercial leasing in Alternative C would depend on the specific location of the commercial oil shale projects as well as on specific project design.

6.1.3.7.1 Aquatic Resources. Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. There are no impacts on aquatic habitats associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Potential impacts on aquatic resources from oil shale development could result primarily from increased turbidity and sedimentation, changes to water table levels, degradation of surface water quality (e.g., alteration of water temperature, salinity, and nutrient levels), release of toxic substances to surface water, and increased public access to aquatic habitats as described in Section 4.8.1.1. As described in Section 4.8.1.1, there is a potential for development and production activities in upland areas to affect surface water and groundwater beyond the area where surface disturbance or water withdrawals are occurring. Consequently, the analysis here considers the potential for impacts in waterways up to 2 mi beyond the boundary of the lands that would be allocated for potential leasing under this alternative. However, as project development activities become more distant from waterways, the potential for negative effects on aquatic resources is reduced. For the analysis of potential impacts on each of the alternatives considered in the PEIS, it was assumed that the potential for negative impacts on aquatic resources increases as the area potentially affected (i.e., the area that would be considered for leasing) increases and as the number and extent of waterways within a 2-mi zone surrounding those areas increases.

Under Alternative C, there are 17 perennial streams, and about 65 mi of perennial stream habitat within the Piceance, Uinta, Green River, and Washakie Basins that are directly overlain by areas that would be potentially available for oil shale development. When an additional 2-mi zone surrounding these areas is considered, there are 40 perennial streams and about 426 mi of perennial stream habitat that could be affected by future development activities (Table 6.1.1-1). The development of commercial oil shale projects in the areas identified under Alternative C could affect aquatic biota and their habitats during project construction and operations, thereby resulting in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. As described in Section 4.1.1.1, impacts from water quality degradation and water depletions could affect not only resources in areas within or immediately adjacent to leased areas, but also in areas farther downstream in affected watersheds. The nature and magnitude of impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

The types of aquatic habitats and organisms that could be impacted by future development in the vicinity of the Piceance, Uinta, Green River, and Washakie Basins are described in Section 3.7.1, and some of these aquatic habitats could contain federally listed endangered fish, state-listed or BLM-designated sensitive species (Section 3.7.4), and other native fish and invertebrate species that could be negatively affected by development. However, because most of the areas within the oil shale basins that contain known sensitive aquatic habitats and species would be excluded from consideration for leasing via land use plan amendments under this alternative, the potential impacts on aquatic resources are likely considerably smaller under Alternative C than under the other alternatives considered. Specific impacts would depend greatly upon the locations selected, methods of extraction used, and mitigation measures implemented by future projects. Project-specific NEPA analyses would be conducted prior to any future leasing decisions to evaluate potential impacts in greater detail.

6.1.3.7.2 Plant Communities and Habitats. Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. There would be no impacts on plant communities and habitats associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Areas identified as available for application for commercial leasing under Alternative C support a wide variety of plant communities and habitats (see Section 3.7.2). Direct and indirect impacts on plant communities and habitats could be incurred on these areas during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 4.8.1.2). Some impacts, such as habitat loss, may continue beyond the termination of shale oil production.

Direct impacts would include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities, such as access roads, pipelines, transmission lines, employer-provided housing, and new power plants, would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

The areas identified as available for application for commercial leasing under Alternative C potentially include locations outside of ACECs that support oil shale endemic plant species. Local populations of oil shale endemics, which typically occur as small scattered populations on a limited number of sites, could be reduced or lost as a result of oil shale development activities. Establishment and long-term survival of these species on reclaimed land may be difficult.

6.1.3.7.3 Wildlife. Under Alternative C, 830,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. There would be no impacts on wildlife species associated with the identification of lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The areas available for application for leasing support a diverse array of wildlife and habitats (see Section 3.7.3). While important areas (such as big game wintering areas and greater sage-grouse habitat) are identified for protection in current BLM land use plans, none of these identified areas occur on the Alternative C areas available for application for leasing.

Areas identified in Alternative C as available for application for commercial leasing do overlap with areas identified by state natural resource agencies as important for greater sage-grouse and big game species. These areas include greater sage-grouse habitat and lek sites (Figure 6.1.3-1), and mule deer and elk winter and summer ranges (Figures 6.1.3-2 and 6.1.3-3). Table 6.1.3-1 presents the amounts of these habitats (as identified by state resource agencies) that occur in the Alternative C lease areas and that could be impacted by future commercial oil shale development in these areas. In addition, four current and historic sage grouse leks have been identified in Wyoming in areas overlapped by the Alternative C lease areas in that state (Figure 6.1.3-1).

Several wild horse HMAs overlap with the lands that are identified as available for application for commercial leasing, including the Piceance–East Douglas Creek HMA in Colorado (nearly 9,300 acres); the Hill Creek HMA in Utah (more than 23,600 acres); and the Adobe Town (nearly 40,900 acres), Little Colorado (over 87,350 acres), Salt Wells Creek (nearly 48,300 acres), and White Mountain (nearly 38,100 acres) HMAs in Wyoming (Figure 6.1.3-4).

Impacts on wildlife from commercial oil shale projects (see Section 4.8.1.3) in Alternative C lease areas could occur in a number of ways and would be related to (1) habitat loss, alteration, or fragmentation; (2) disturbance and displacement of biota; (3) mortality; (4) exposure to hazardous materials; and (5) increase in human access. These could result in changes in species distribution and abundance; habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

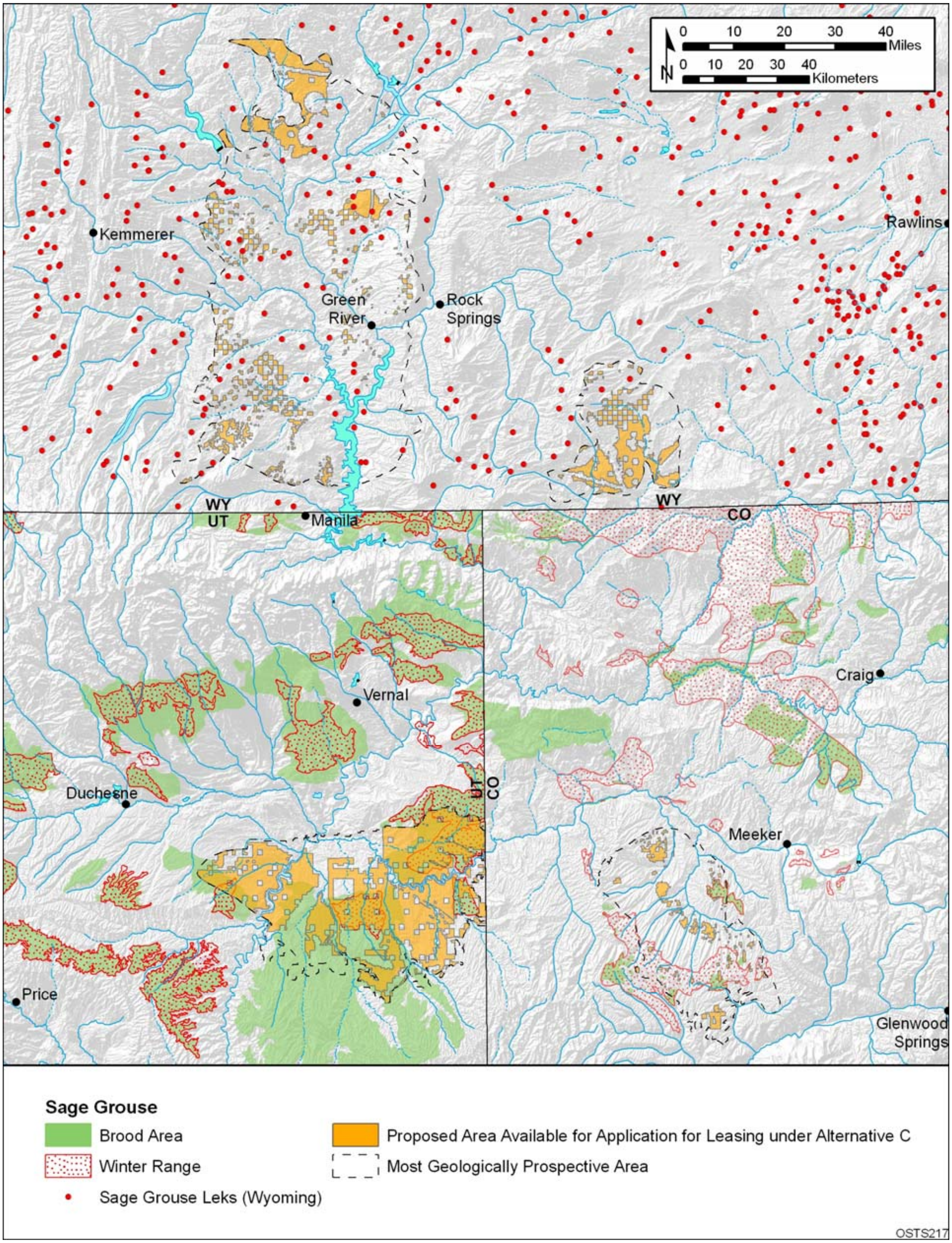

FIGURE 6.1.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse

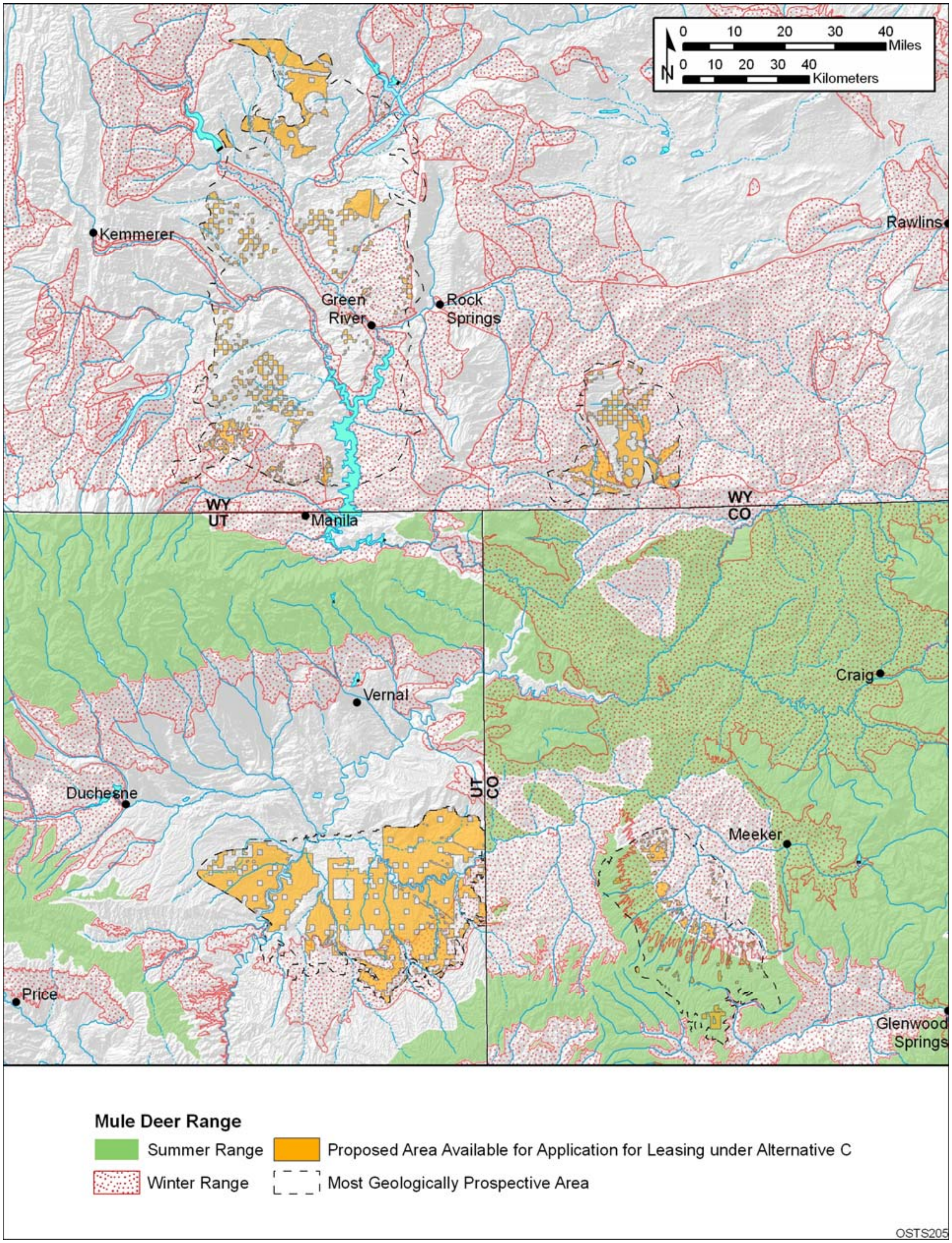

FIGURE 6.1.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer

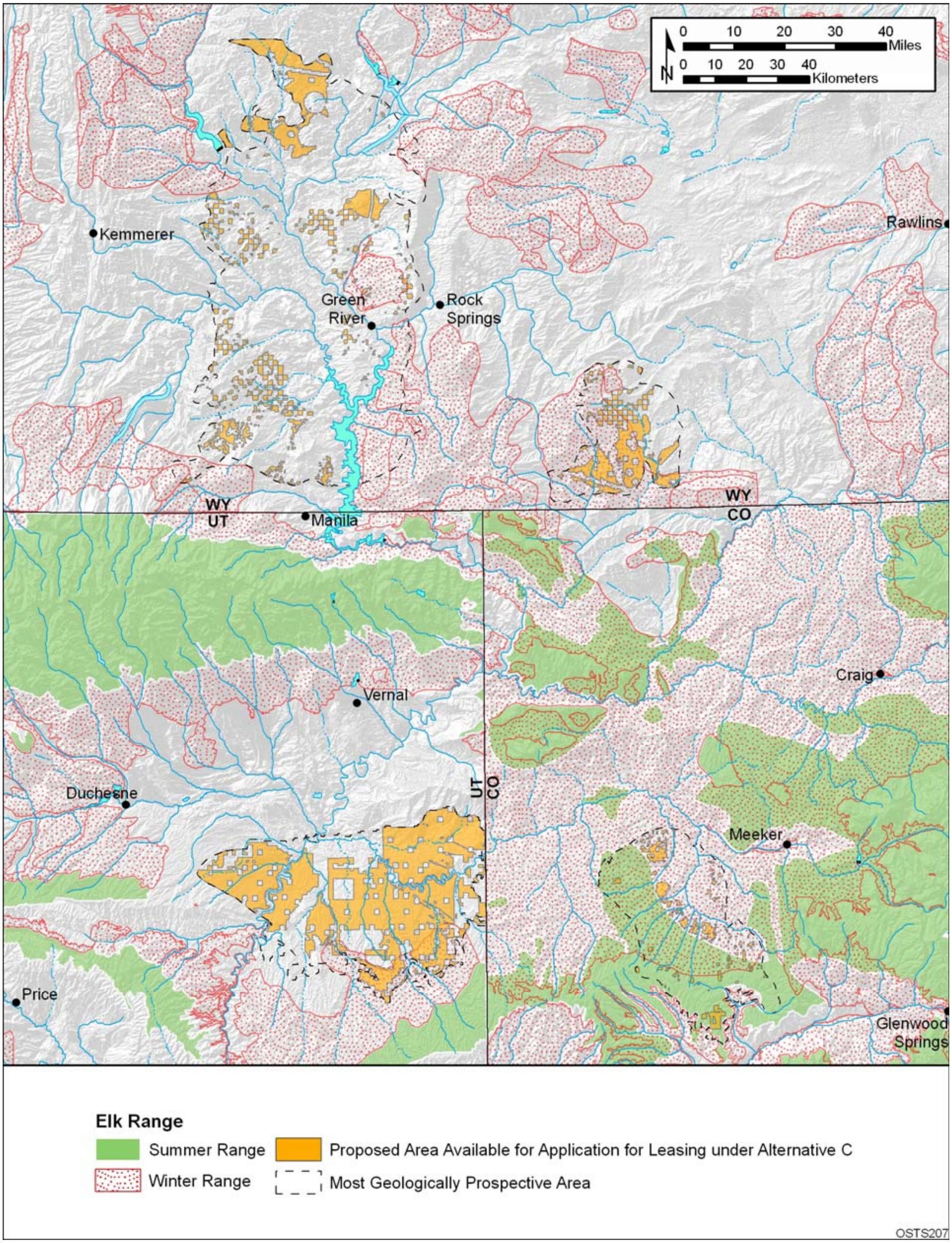

FIGURE 6.1.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk

TABLE 6.1.3-1 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Lease Areas Identified under Alternative C

Wildlife Resource	Colorado	Utah	Wyoming	Total
Sage grouse habitat	10,078	345,714	NA[a]	355,792
Mule deer winter habitat	25,862	87,037	67,301	180,200
Mule deer summer habitat	12,339	0	NA	12,339
Elk winter habitat	29,406	51,999	63,795	145,200
Elk summer habitat	12,335	0	NA	12,335

[a] NA = data not available.

Wildlife could also be affected by human activities that are not directly associated with the oil shale project or its workforce but that are instead associated with the increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads could lead to increased human access into the area. Potential impacts associated with increased access include (1) the disturbance of wildlife from human activities, including an increase in legal and illegal take and an increase of invasive vegetation, (2) an increase in the incidence of fires, and (3) increased runoff that could adversely affect riparian or other wetland areas that are important to wildlife.

The potential for impacts on wildlife and their habitats from commercial oil shale development is directly related to the amount of land disturbance that would occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitat affected by development (i.e., the location of the project). Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, water depletions, contamination, and disturbance and harassment, are also considered. Their magnitude is also considered to be proportional to the amount of land disturbance.

6.1.3.7.4 Threatened and Endangered Species. Under Alternative C, 800,296 acres of public land would be made available within Colorado, Utah, and Wyoming for application for leasing for commercial development of oil shale. There would be no impacts on threatened and endangered species associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.4. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Under Alternative C, 170 of the 172 federal candidate, BLM-designated sensitive, and state-listed species listed in Table 4.8.1-4, and 14 of the 16 federally listed threatened or endangered species listed in Table 4.8.1-5 could occur in areas that are available for application for leasing (based on records of occurrence in project counties of Colorado, Utah, and

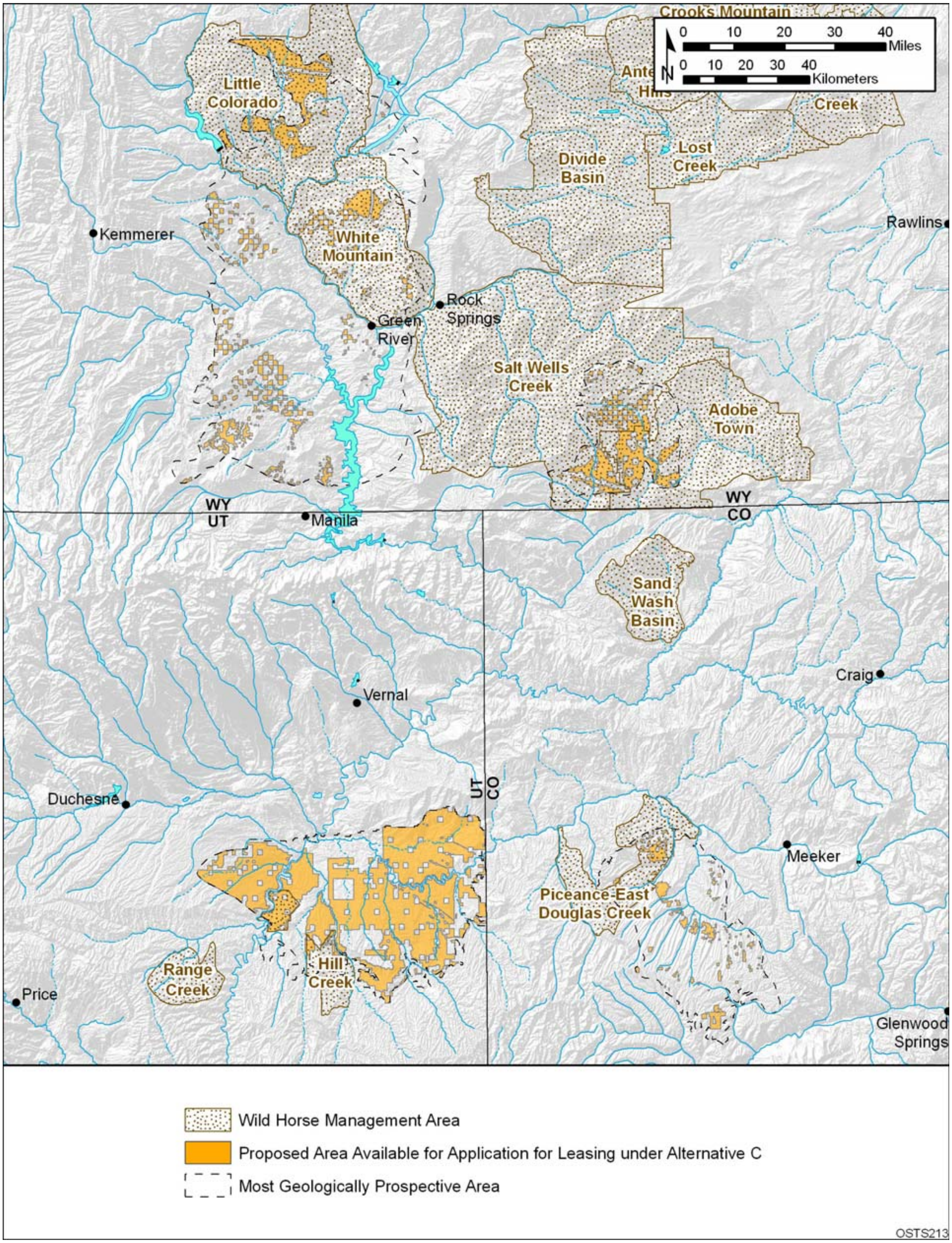

FIGURE 6.1.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas

Wyoming). Potential lease areas include about 71 mi of critical habitat for Colorado River endangered fishes in Colorado and Utah (Figure 6.1.3-5). Those areas for which lease stipulations have been established in existing RMPs to protect federally listed and candidate species, BLM-designated sensitive species, and other special status species would not be available for lease application under Alternative C.

The potential impacts on threatened, endangered, and sensitive species (and their habitats) by commercial oil shale development are directly related to the amount of land disturbance that could occur with a commercial project (including ancillary facilities such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development (i.e., the location of the project). Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, surface water or groundwater depletions, contamination, and disturbance and harassment of animal species, would be proportional to the amount of land disturbance.

Potential impacts on threatened and endangered species under Alternative C (Section 4.8.1.4) are similar to or the same as impacts on aquatic resources; plant communities and habitats; and wildlife described in Sections 4.8.1.1, 4.8.1.2, and 4.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of the low population sizes of threatened and endangered species, they are far more vulnerable than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific assessments and consultations conducted prior to leasing and development.

6.1.3.8 Visual Resources

The lands made available for application for leasing under Alternative C support a wide variety of visual resources (Section 3.8). These resources would not be affected by the amendment of land use plans or by the identification of these lands as available for application for commercial leasing. However, visual resources in and around these potential lease areas could be affected by subsequent commercial development of oil shale.

Several scenic resource areas are located in Utah within the area that would be available for application for commercial leasing under Alternative C. Specifically, these areas (shown in Figures 6.1.3-6, 6.1.3-7, and 6.1.3-8) include the following potential ACECs: Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, and White River.

Scenic resource areas are also located within 5 or 15 mi of the areas that would be made available for application for commercial leasing under Alternative C (Figures 6.1.3-6, 6.1.3-7, and 6.1.3-8). These 5-mi and 15-mi zones correspond to the BLM's VRM foreground-middleground and background distance limits, respectively. Assuming an unobstructed view of a

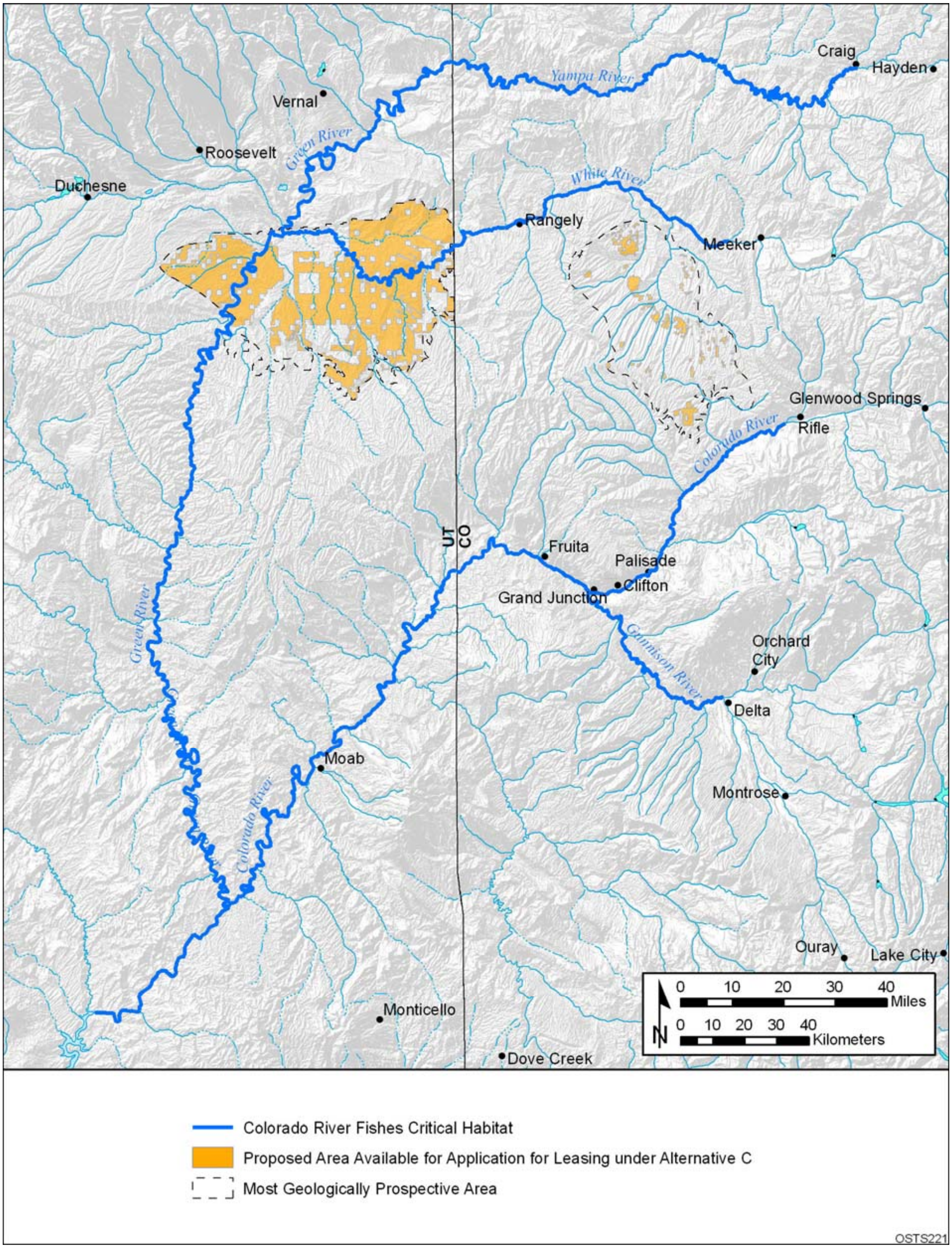

FIGURE 6.1.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C

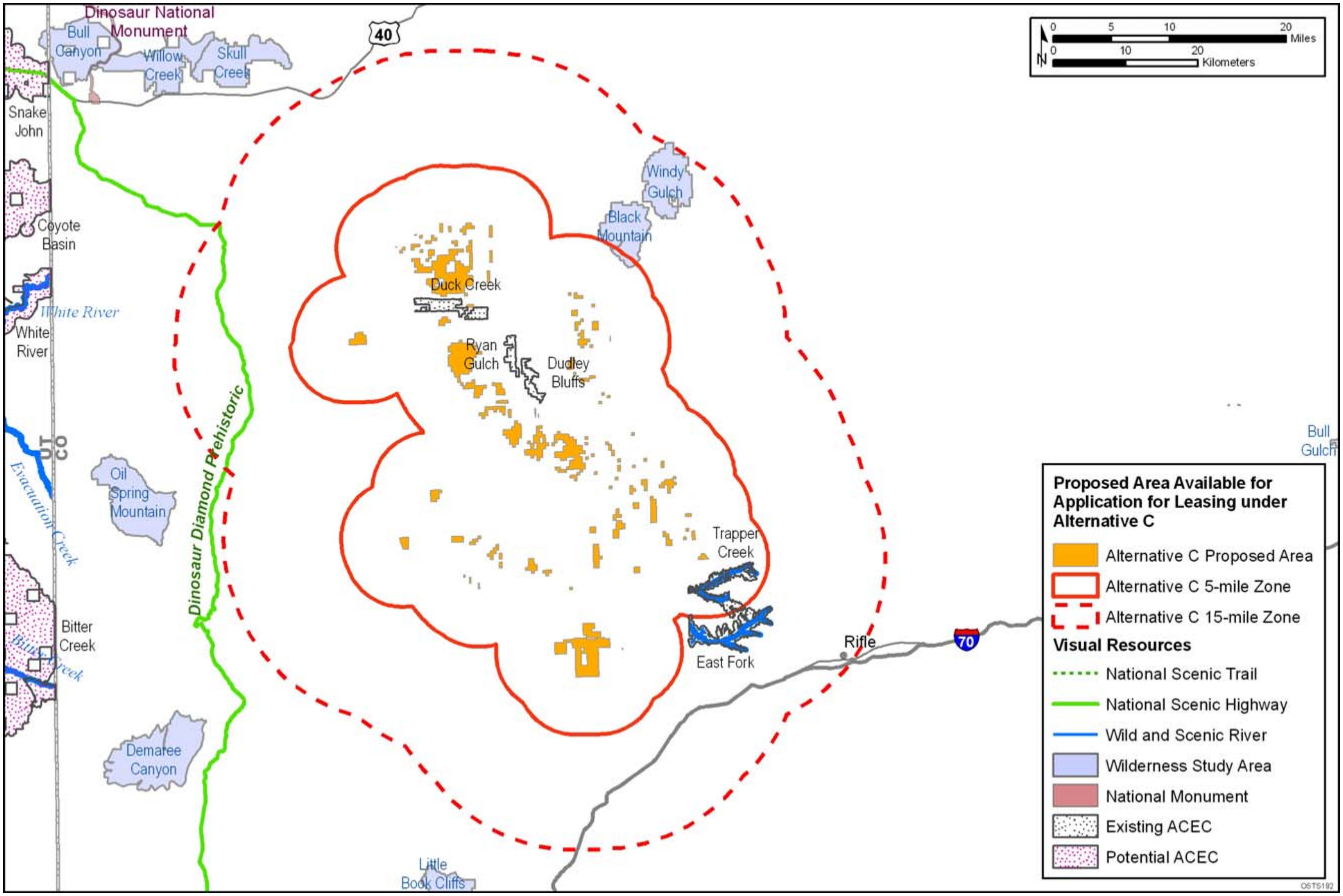

FIGURE 6.1.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Colorado

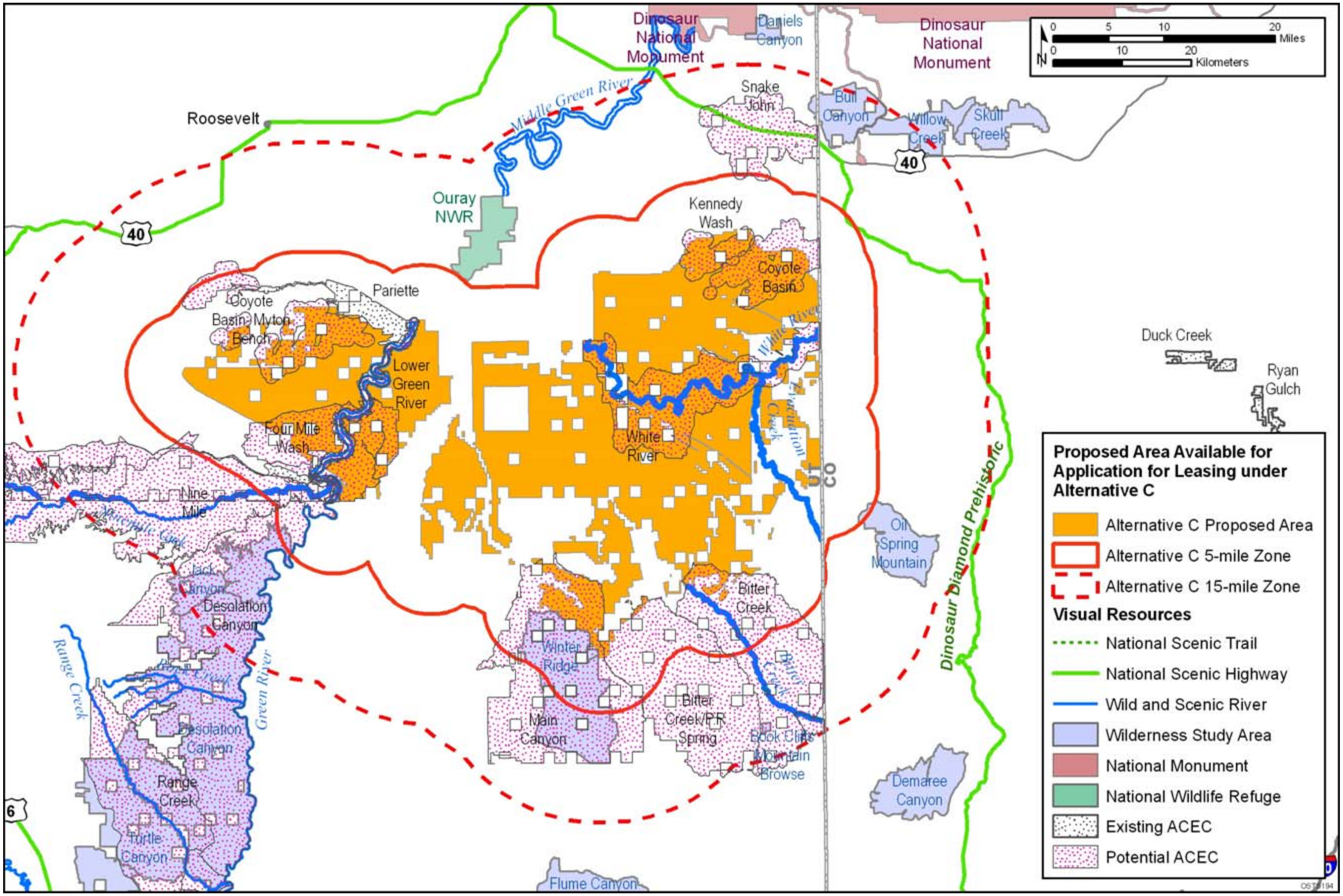

FIGURE 6.1.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Utah

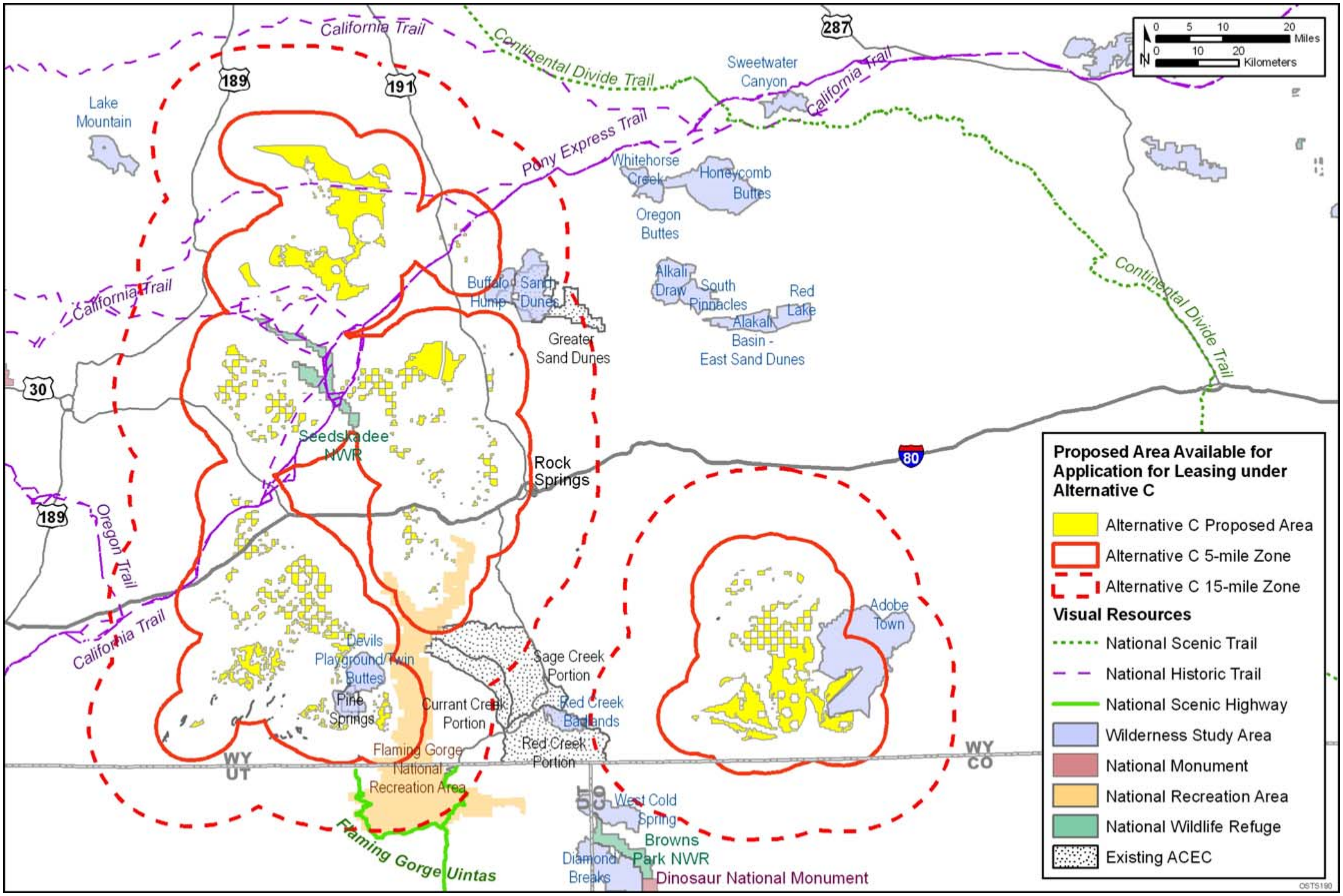

FIGURE 6.1.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Wyoming

commercial oil shale project, viewers in these areas would be likely to perceive some level of visual impact from a commercial oil shale project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for those areas within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.1.3-2 presents the scenic resource areas that would fall within these zones under Alternative C.

Visual resources could be affected at and near the Alternative C lease areas where commercial oil shale projects are developed and operated, and at areas where supporting infrastructure (e.g., plants and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 4.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as shale-processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

6.1.3.9 Cultural Resources

Under Alternative C, the amendment of land use plans to identify 830,296 acres of public land as available for commercial oil shale development would not result in impacts on cultural resources. Existing ACECs, some of which have been identified for their cultural values, including about 7,300 acres in Wyoming (the West Sand Dunes Archaeological District), will not be made available for application for leasing under this alternative, and, therefore, the cultural resources present in these areas would not be directly impacted under this alternative. The remaining lands made available for application for leasing overlap with some lands identified as having cultural resources present. Approximately 10% of public lands that would be made available for application for leasing in the Piceance Basin under Alternative B have been surveyed for cultural resources; approximately 21% in the Uinta Basin; and approximately 8% in the Green River and Washakie Basins. In these areas that have been surveyed, nearly 1,200 sites have been identified. Additional resources are likely in unsurveyed portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), 35,440 acres (88%) of the Piceance Basin, 409,382 acres (84%) of the Uinta Basin, and 274,233 acres (92%) of the Green River and Washakie Basins Alternative C footprints have been identified as having a medium or high sensitivity for containing cultural resources.

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to have an impact on cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts of development could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas, and visual degradation of cultural setting

TABLE 6.1.3-2 Visually Sensitive Areas That Could Be Affected by Commercial Oil Shale Projects Developed in the Alternative C Lease Areas

Location	Scenic Resources within 5 mi of Alternative C Lease Areas	Scenic Resources between 5 and 15 mi of Alternative C Lease Areas
Colorado	Black Mountain WSA; East Fork–Parachute Creek, Northwater Creek, Ryan Gulch, Trapper Creek, Dudley Bluffs, and Duck Creek ACECs; and segments of Trapper Creek and Northwater Creek determined to be eligible for WSR designation.	Black Mountain and Windy Gulch WSAs; East Fork-Parachute Creek and Northwater Creek ACECs; segments of East Fork–Parachute Creek and First Anvil Creek determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway.
Utah	Oil Spring Mountain, Winter Ridge, and Desolation Canyon WSAs; Lower Green River, Nine Mile, and Pariette ACECs; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Four Mile Wash, Lower Green River, Main Canyon, Nine Mile, Nine Mile–Canyon Expansion, and White River potential ACECs; segments of the Green River, Lower Green River, Bitter Creek, Evacuation Creek, Nine Mile Creek, and White River determined to be eligible for WSR designation; and Dinosaur Diamond Prehistoric National Scenic Highway.	Bull Canyon, Willow Creek, Oil Spring Mountain, Jack Canyon, Winter Ridge, Desolation Canyon, and Book Cliffs Mountain Browse WSAs; Nine Mile ACEC; Bitter Creek–P.R. Spring, Bitter Creek, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Main Canyon, Nine Mile, and Nine Mile–Canyon Expansion potential ACECs; segments of the Green River, Middle Green River, Bitter Creek, and Nine Mile Creek determined to be eligible for WSR designation; Dinosaur National Monument, managed by the NPS; and Dinosaur Diamond Prehistoric National Scenic Highway.
Wyoming	Devils Playground/Twin Buttes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species, Sage Creek Portion of Greater Red Creek ACEC, Pine Springs, and White Mountain Petroglyphs ACECs; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; and segment of Skull Creek determined to be eligible for WSR designation.	Sand Dunes, Adobe Town, and Buffalo Hump WSAs; Special Status Protected Species and Greater Sand Dunes ACECs, and the Red Creek, Sage Creek and Currant Creek portions of Greater Red Creek ACEC; Overland Trail, Bryan South Pass Road, Cherokee Trail–Northern Route, Cherokee Trail–Southern Route, Blacks Fork Cutoff, Hams Fork Cutoff, Kinney Cutoff, Slate Creek Cutoff, and Sublette Cutoff National Historic Trails; segment of Skull Creek determined to be eligible for WSR designation; and Flaming Gorge Uintas National Scenic Highway.

(see Section 4.10). Special lease stipulations could be developed for specific lease parcels based on this information and consultation with interested Tribes.

6.1.3.10 Socioeconomics

Socioeconomic and transportation impacts of Alternative C would be dependent on the exact locations of future development, the types of impacts that could occur would be the same as those described in Section 4.11 and summarized in Section 6.1.2.10 for Alternative B. The specific impacts would be dependent upon the technologies employed, the project size or production level, development time lines, mitigation measures, and the location of employee housing.

Under Alternative C, it is possible that there will be property value impacts simply from designating land as available for application for leasing; these impacts could result in either decreased or increased property values (see Section 4.11.1.6).

6.1.3.11 Environmental Justice

Although the environmental justice impacts of Alternative C would be dependent on the exact locations of specific developments, the types of impacts that could occur as a result of development on lands identified as available for application for leasing under Alternative C would be the same as those described in Section 4.12 and summarized in Section 6.1.2.11. As with the environmental impacts discussed in Section 6.1.3, the specific environmental justice impacts would be dependent upon the technologies employed, the project size or production level, and development time lines and mitigation measures.

6.1.3.12 Hazardous Materials and Waste Management

The amendment of land use plans under Alternative C to identify 830,296 acres of land as available for application for leasing for commercial oil shale development would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during future development of commercial oil shale projects within the areas identified in Alternative C as available for application for commercial leasing. Such impacts are generally independent of location and would be unique to the technology combinations used for oil shale development. However, hazardous materials and wastes are similar for some of the ancillary support activities that would be required for development of any oil shale facility regardless of the technology used. These include the impacts from development or expansions of support facilities, such as employer-provided housing and power plants.

Hazardous materials and wastes would be used and generated during both the construction and operation of commercial oil shale facilities and supporting infrastructure (e.g., power plants). Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, and corrosion control coatings. Construction-related wastes could include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 4.13.1).

During project operations, hazardous materials would be utilized, and a variety of wastes (some hazardous) would be generated. Hazardous materials would include fuels, solvents, corrosion-control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations will depend on the specific design of the commercial oil shale project (surface or subsurface mining, surface retorting, in situ processes). Waste materials produced during operations may include spent shale, waste engine fuels and lubricants, pyrolysis water, flammable gases, volatile and flammable organic liquids, and heavier-molecular-weight organic compounds (Section 4.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial oil shale project, it is not possible to quantify project-related impacts of these materials. Under Alternative C, individual facilities could be located anywhere within the area identified as available for leasing pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Sections 4.14 and 6.1.3.13) at locations wherever the individual projects are sited within the Alternative C lease areas.

6.1.3.13 Health and Safety

The amendment of land use plans to identify 830,296 acres of land as available for application for leasing for commercial oil shale development would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of oil shale projects within the areas in Alternative C identified as available for application for commercial leasing. For commercial oil shale development in Alternative C, potential health and safety impacts from the construction and operation of commercial oil shale projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure, (2) mining (if processing is not in situ) the oil shale; (3) obtaining and upgrading the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposing the general public to water and air contamination associated with oil shale development. Hazards from oil shale development (summarized in Table 4.14-1) could include physical injury from construction, oil shale processing, and vehicle transportation accidents and exposure to fugitive dust and hazardous materials, such as retort emissions and industrial chemicals (Section 4.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public who could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Hazards for workers at oil shale development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. Based on the numbers of employees projected to be needed for construction and operation of oil shale facilities, statistically there would be less than 1 death and about 125 injuries per year expected per facility during construction activities, and less than 1 death and less than 100 injuries per year expected per facility during operations (NSC 2006). As a measure to decrease worker injuries, a comprehensive facility health and safety plan and worker safety training could be recommended to be included in the plans of development for proposed commercial oil shale projects.

Health and safety concerns are largely independent of the location of oil shale development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

6.1.4 Comparison of Oil Shale Alternatives

Alternative A, the no action alternative, maintains current land use designations in the White River and Book Cliffs RMPs that allow commercial oil shale leasing on 352,780 acres of BLM-administered lands, subject to additional NEPA analysis and subject to other land use plan decisions that affect lands within the areas designated for leasing (e.g., designated ACECs). No other lands within the study area are currently designated for commercial oil shale leasing. The six existing RD&D leases were issued based on the land use decisions in these two plans, and the development and operation of the RD&D leases are common to all of the alternatives being considered. By the terms of the existing RD&D leases, the operations could transform into commercial facilities. Within the Piceance Basin, this could lead to a relatively dense development complex of 24,800 acres, which could dramatically affect existing land uses within the area. This would be common to all alternatives.

The two programmatic alternatives, Alternatives B and C, would amend nine BLM land use plans in Colorado, Utah, and Wyoming to (1) identify the most geologically prospective oil shale areas within each planning unit; (2) designate lands within the most geologically prospective areas available for application for leasing; (3) identify any technology restrictions; (4) stipulate requirements for future NEPA analyses and consultation activities; and (5) specify that the BLM would consider and give priority to land use exchanges, where appropriate and feasible, to consolidate land ownership and mineral interests within the oil shale basins. These alternatives are described in detail in Sections 2.3.2 and 2.3.3; specific land use plan amendments to implement Alternatives B and C are provided in Appendix C. The analyses of potential impacts associated with each alternative are presented in Sections 6.1.1, 6.1.2, and 6.1.3 of this chapter.

As noted in the preceding impact analysis sections for Alternatives B and C, with the exception noted in the socioeconomic analysis regarding potential impacts on land values, these land use plan amendments would not result in any impacts on the environment or socioeconomic setting. However, the future development of commercial oil shale projects that could be approved after subsequent NEPA analysis identified in both of these alternatives would have impacts on these resources. The types of impacts that could be associated with future commercial oil shale development are described in Chapter 4. The magnitude of the impacts cannot be quantified at this time because key information about the location of commercial projects, the technologies that may be employed, the project size or production level, development time lines, and mitigations are unknown.

6.1.4.1 Land Use

Under Alternative A, both the White River and Book Cliffs RMPs authorize leasing for oil shale development. Within the White River RMP area, there are 294,680 acres that are potentially available for oil shale leasing. Approved extraction methods could include surface and underground mining and in situ processes. In the Book Cliffs RMP area, there are 58,100 acres potentially available for leasing that are classified for underground or in situ processes. Commercial leases issued subsequent to the existing land use plan decisions could have the same impacts as described in Chapter 4 of the PEIS.

Decisions implementing Alternatives B and C would neither grant rights to third parties nor approve any ground-disturbing activities; however, it is the intent of these alternatives to create a program that will facilitate future leasing and development of oil shale resources. The future development of commercial oil shale projects that could be approved after subsequent NEPA analysis identified in both alternatives would have the same impacts as those described in Chapter 4. It is important to note that none of the alternatives impose a cap on the level of development that may occur; that is, only the areas available for potential development are prescribed.

Table 6.1.4-1 summarizes the acreages available for potential development by alternative.

The following is a summary of the principal differences in potential impact on land uses among Alternatives A, B, and C:

TABLE 6.1.4-1 Acreages Available for Potential Development under Alternatives A, B, and C

	Total Acres	Colorado	Utah	Wyoming
Alternative A	352,780	294,680	58,100	0
Alternative B	1,991,222	359,798	630,971	1,000,453
Alternative C	830,296	40,325	490,460	299,511

- Alternative B includes 170,000 acres of land identified as having wilderness characteristics, which could be available for application for commercial development, while Alternative C includes 110,000 acres of these lands; Alternative A contains 6,972 acres.

- Alternative C removes from consideration lands with sensitive resources that have been identified in current BLM land use plans, including all existing ACECs, and thus removes known sensitive land uses from consideration for future leasing. Alternative A would remove some areas (including ACECs) from consideration for leasing, plus there are additional requirements for protection of both natural and community resources in the RMP that are not found in Alternative B.

- In the Piceance Basin, Alternative C would likely have less of an impact on oil and gas development than either Alternative A or B because considerably fewer acres of potentially valuable oil and gas deposits in a rapidly developing area are available for application for commercial oil shale development.

- Alternative B includes 185,000 acres of land that are identified as potential ACECs that could be available for application for commercial development, Alternative C includes 136,000 acres; Alternative A includes 26,731 acres.

- The potential development area within Colorado's Piceance Basin is much smaller under Alternative C than under either Alternative A or B. In the Piceance Basin, the potential development area under Alternative A is approximately 82% of the potential development area that would be available for application under Alternative B.

- There are no lands available for application for leasing in Wyoming under Alternative A. Because approximately 84% of the acreage available for application for leasing under Alternative A is in Colorado, potential impacts on existing land uses under Alternative A in Utah and Wyoming would be much less than under Alternatives B or C.

In comparing the overall potential for impact on land uses, Alternative A could result in fewer impacts than Alternatives B or C because fewer acres would be available for application for leasing. For potential impacts in Colorado, however, Alternative C would make substantially less land available for potential development than either Alternative A or B. Alternative A, in Colorado, although it is subject to resource and community protection constraints in the current RMP, makes available for leasing approximately 82% of the land area that would be available for application under Alternative B.

Overall, Alternative A would have much less potential impact on designated ACECs, potential ACECs, and areas with wilderness characteristics than Alternatives B and C. The difference between Alternatives A and C is that in Alternative A, while existing land use plans provide for protective prescriptions for various resources, it is still possible for the BLM to consider commercial development of oil shale resources. In Alternative C, these same areas are excluded from consideration for leasing. Whether there would be any difference in the actual impact on land uses between these two alternatives in the areas where they both identify land available for leasing cannot be determined at this time.

In Utah, Alternative A would have much less potential impact on land uses than either Alternative B or C. Between Alternatives B and C, there is somewhat less potential for impact on land uses from Alternative C since approximately 22% less land is available for application for leasing than under Alternative B. Alternative C could have less potential impact than Alternative B on areas with wilderness characteristics and potential ACECs, and Alternative C completely excludes designated ACECs from application for leasing.

In Wyoming, no lands are available for application for leasing under Alternative A and there is a large difference in acreage available for application for leasing between Alternatives B and C, which could lead to more potential impact on land uses from Alternative B.

6.1.4.2 Soil and Geologic Resources

The types of impacts on soil and geologic resources from the six RD&D projects would be the same under all three alternatives; these impacts would be associated with soil removal and compaction, subsurface disturbance of geologic resources during drilling and mining activities, and increased potential for erosion of exposed soils and geologic materials.

The identification of public lands under Alternatives A, B, and C as available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect soils or geologic resources in any of the lease areas. Soil and geologic resources could, however, be affected by future development of commercial oil shale projects in these areas under each alternative. Potential impacts, related primarily to construction and operation of project facilities and related infrastructure, could include soil disturbance, removal or compaction, and erosion.

Impacts on soil and geologic resources would be identical among Alternatives A, B, and C for similar projects located in areas common to the alternatives (i.e., in areas where the lands available for application are the same). However, the total amount of soil and geologic resources could be affected by the different commercial oil shale development alternatives (Table 2.3.2-1). In Colorado, soil and geologic resources could be affected by commercial development on only 40,325 acres under Alternative C, which is far less than in the area that could be affected by potential future development under Alternatives A or B (i.e., 294,680 acres under Alternative A and 359,798 acres under Alternative B). Alternative A includes 58,100 acres in Utah and no land in Wyoming. Areas in Utah and Wyoming where future development could affect soil and geologic resources would also be less under Alternative C than under Alternatives A and B (see Table 6.1.4-1). The approximately 1.2 million acres of land that would be excluded under Alternative C for lease availability represent environmentally sensitive areas as identified in BLM land use plans, that is, areas that could be developed in the future under Alternative B. The nature, location, and magnitude of project-related impacts on soil and geologic resources depend on the specific location of leases undergoing commercial development as well as the design of the projects.

6.1.4.3 Paleontological Resources

Table 6.1.4-2 identifies the amount of available acreage that has the potential to contain important paleontological resources under each of the alternatives. Under all alternatives, 800 acres in Colorado and 160 acres in Utah that would be impacted by the RD&D projects have the potential to contain paleontological resources; however, mitigation that is required to be applied in the development of these projects includes on-site monitoring by qualified paleontologists to determine whether important paleontological resources are present and to collect data from any such resources uncovered during the RD&D activities. Therefore, most of the possible adverse effects on paleontological resources from RD&D activities are expected to be mitigated. The impacts from the RD&D activities and expected mitigation would also occur under Alternatives B and C. In addition, under Alternative A, within the areas available for oil shale development under existing RMPs, approximately 345,000 acres have the potential to contain important paleontological resources (Table 6.1.4-2). Adverse effects, as described in Section 4.4, could occur in these areas.

Under Alternative B, about 1.8 million acres available for application for leasing have the potential to contain important paleontological resources (Table 6.1.4-2). This acreage includes existing ACECs not closed to mineral development that contain important paleontological resources. Adverse effects on paleontological resources, as described in Sections 4.4 and 6.1.2, could occur in these areas.

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important paleontological resources is reduced considerably from that of Alternative B, to approximately 0.75 million acres (see Table 6.1.4-1). Commercial development under Alternative C potentially would have an impact on approximately 42% of the acreage with important paleontological resources that could be impacted by Alternative B. In addition, under Alternative C, no direct impacts would occur on paleontological resources present within the designated ACECs, but adverse effects could occur within the lands made available for leasing and subsequent development (see Section 6.1.3).

TABLE 6.1.4-2 Amount of Available Acreage That Has the Potential to Contain Important Paleontological Resources

Parameter	Alternative A	Alternative B	Alternative C
Acres available for application for leasing and development	352,780	1,991,222	830,296
Acres with potential to contain important paleontological resources	345,000	1,793,480	749,920

6.1.4.4 Water Resources

Under Alternative A, surface disturbance could lead to increased erosion and possible contribution to sedimentation of local streams, runoff from saline soils, and soils contaminated by industrial processes and activities (see Section 6.1.1.2). By comparing the length of streams intercepted by the different alternatives (Table 6.1.4-3), Alternative A has the least mileage intercepted, while Alternative B has the most mileage intercepted. Therefore, depending on the location of specific projects, the impacts on water resources by soil erosion could be highest in Alternative B and lowest in Alternative A. For the six RD&D sites, water would not be withdrawn from surface streams near the projects but would be trucked to the site. Possible impacts on groundwater include dewatering and contamination of aquifers, as documented in the environmental analyses for the projects. Overall impacts on water resources are considered minimal for the RD&D sites, and all the EAs resulted in FONSIs. However, the impacts from development on nearly 295,000 additional acres in Colorado and more than 58,000 additional acres in Utah could be significant.

Alternative B would designate 1,991,222 acres of land as available for application to lease and includes sensitive lands identified in BLM land use plans excluded from leasing in Alternative C. Some of the lands excluded under Alternative C are designated for protection by the BLM because of steep slopes and/or fragile or highly erosive soils, which could contribute to adverse effects on water quality if disturbed. The exclusion of these soil areas from potential development may reduce impacts on water quality under Alternative C. Groundwater would be impacted under Alternatives B and C in terms of use, dewatering, and contamination. For all three alternatives, the impacts would depend on the degree of development, the technologies, and site-specific factors.

Table 6.1.4-3 includes a tabulation of perennial stream miles included within the four oil shale basins. Cumulatively, Alternative B contains almost 90% of the perennial stream miles in the four basins and, depending upon the location of any future developments, could expose more stream segments to both direct and indirect disturbance. In all basins, Alternative B contains more stream miles than Alternatives A and C. In the Piceance Basin, Alternative B contains substantially more stream miles that could be subject to adverse effects from commercial development within the area available for application for lease than Alternatives A and C. Even

TABLE 6.1.4-3 Perennial Stream Miles within the Four Oil Shale Basins

Basin	Total Perennial Stream Miles	Alternative A	Alternative B	Alternative C
Piceance	199	152 (76%)	189 (95%)	115 (58%)
Uinta	262	57 (22%)	262 (100%)	219 (84%)
Green	253		190 (75%)	67 (27%)
Washakie	39		39 (100%)	24 (61%)
Total	753	209 (28%)	680 (90%)	425 (57%)

under Alternative C, however, if development occurs on available lands in proximity to streams, there could be indirect effects on the streams as described previously. It is possible that Alternative B could result in more adverse impacts on water resources than Alternatives A and C. However, impacts on water resources would ultimately be determined by the site location and the technology employed. The gross number of acres available for application, and even the number of stream miles included within the area available for application for leasing, is less important from a water resource standpoint than the actual location of the developments and where water to support development is obtained.

Water requirements to support oil shale development are still unknown, but it is known that general water availability has become more constrained, and not merely from a legal appropriation standpoint. There is the likelihood that senior water rights could be purchased to either support future oil shale development and/or obtain water in a specific location. Access to water supplies, vis-a-vis locations near perennial streams where water rights could be acquired, could be greater in Alternative B because of the greater number of perennial stream miles present within the potential leasing area. This could be offset by an ability to transfer water in other ways.

6.1.4.5 Air Quality

Previous analyses (summarized in Appendix A, Section A.5.3 [BLM 2006a–h; 2007a,b]) indicated that no significant, adverse direct or cumulative air quality impacts are likely to occur from the six RD&D projects. Thus, the RD&D projects are expected to have no significant air quality impacts under any of the three alternatives.

Under Alternative A, 352,780 acres of land in Colorado and in Utah have already been allocated for commercial oil shale development. There are no air quality impacts associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Sections 4.6 and 5.6. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect air quality under Alternatives B or C. However, under both alternatives, local and regional air quality could be affected by the future construction and operation of commercial oil shale projects in the areas available for application for leasing and by construction and operation of off-lease infrastructures, such as electric power plants, if needed. Under Alternatives B and C, the potential future commercial development of a similar project in an area where the lease areas of the two alternatives overlap would be expected to affect local and regional impacts on air quality in the same manner.

Different areas are identified under Alternatives A, B, and C as available for application for leasing. Local air quality could be affected by commercial development in more locations under Alternative B than under Alternatives A or C. Many of the lands that would be open for application for leasing under Alternative B would be excluded from application for leasing for commercial oil shale development under Alternative C. However, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of regional air quality impacts of commercial oil shale development under Alternatives A, B, or C. Thus, it is not possible to differentiate among these alternatives regarding regional air quality impacts.

6.1.4.6 Noise

Under Alternative A, localized noise impacts (i.e., increased noise levels) would occur at each of the RD&D project locations as a result of construction activities; mining activities; use of a crusher and conveyor belt system; operation of a horizontal rotary kiln; use of pumps, generators, and transformers; and vehicular traffic. These same impacts would also occur under Alternatives B and C.

Under Alternative A, there are no noise impacts associated with the previous designation of lands as available for application for oil shale development. Impacts could result, however, from post-lease construction and operation as described in Section 4.7. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

The identification of areas available for application for leasing for commercial oil shale development and the associated amendment of appropriate land use plans would not affect noise levels in the available lease areas under either Alternatives B or C. However, under both alternatives, local noise levels could be affected if future leasing results in the construction and operation of commercial oil shale projects in the lease areas.

Impacts on noise levels would be identical under Alternatives A, B, and C for similar projects located in areas common to the alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, local noise levels could be affected by commercial development at more locations under Alternative B than under Alternative C. However, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of noise impacts of commercial oil shale development under Alternatives A, B, or C. Thus, it is not possible to differentiate among these alternatives regarding noise impacts.

6.1.4.7 Ecological Resources

6.1.4.7.1 Aquatic Resources. There are no impacts on aquatic resources associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The types of impacts on aquatic resources associated with construction and operations would be similar for all alternatives. Differences among alternatives exist in the amount of lands that would be made available for application for leasing and the location of potential lease areas. As a consequence, there are differences among alternatives relative to the amount of aquatic habitat that is immediately within or adjacent to the footprint of the allocation areas and in the amount of such habitat within a 2-mi zone surrounding the allocation areas. These differences are described in this section.

Of the three oil shale allocation alternatives, the least amount of land would be available for application for leasing under Alternative A (352,780 acres), an intermediate amount under Alternative C (830,296 acres), and the most under Alternative B (1,991,222 acres). However, Alternatives A and B would open some areas for consideration for leasing for which lease stipulations have been established in existing RMPs , while these areas would be excluded from consideration for oil shale development leasing under Alternative C. Because of these differences, aquatic habitat within prospective lease areas or within a 2-mi zone surrounding those areas differs among the alternatives and the relative impacts of the various alternatives are different for the various oil shale basins.

As shown in Table 6.1.4-3, the smallest amount of aquatic habitat would potentially be affected under Alternative C for the Piceance Basin (about 115 mi of perennial stream habitat within a 2-mi zone surrounding the allocation area) compared with Alternative A (about 152 mi of perennial stream habitat) or Alternative B (about 189 mi of perennial stream habitat). In the Uinta Basin, the smallest amount of aquatic habitat would potentially be affected by Alternative A (about 57 mi of perennial stream habitat within a 2-mi zone surrounding the allocation area), followed by Alternative B (about 262 mi of perennial stream habitat) and Alternative C (about 219 mi of perennial stream habitat). There would be no oil shale leasing on BLM-administered lands in Wyoming under Alternative A, resulting in no impacts on aquatic habitats within the Green River and Washakie Basins under this alternative. Of the alternatives that would allow such leasing to be considered in Wyoming, Alternative B would potentially affect more aquatic habitat than Alternative C (Table 6.1.4-3).

One further consideration, however, is that many of the aquatic habitats that would be excluded from application for leasing under Alternative C contain areas known or likely to contain sensitive aquatic species. On the basis of these considerations, it is anticipated that Alternative C would have the least impact on aquatic resources in the Piceance Basin, and potentially in the Uinta Basin, compared with Alternatives A and B, and that Alternative A would have a smaller potential for impacts compared with Alternative B. In the Green River and Washakie Basins, it is anticipated that this exclusion would also reduce the potential impacts of Alternative C compared with Alternative B. Under any of the alternatives, the specific nature and magnitude of impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

6.1.4.7.2 Plant Communities and Habitats. There would be no impacts on plant communities and habitats associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

The types of impacts associated with construction and operations would be similar for all alternatives. For similar projects located in areas common to the alternatives (i.e., in areas where land available for development overlaps), impacts on plant communities and habitats would be identical among Alternatives A, B, and C. Impacts on plant communities and habitats would occur at each of the RD&D project locations as a result of construction and operation activities under each of the alternatives. Differences among alternatives exist in the amount of lands that would be made available for application for leasing and the location of potential lease areas. These differences are described in this section.

Alternative A identifies 352,780 acres as available for application for commercial leasing, nearly 300,000 acres in the Piceance Basin and more than 50,000 in the Uinta Basin. Included in this acreage are 17 acres of land that have been identified in land use plans for the protection of wetlands and riparian habitats (Table 6.1.4-4). Alternative B identifies 1,991,222 acres as available for application for commercial leasing. Included in this acreage are more than 40,000 acres of land that have been identified in land use plans for the protection of

TABLE 6.1.4-4 Acreage of Lands in Which Plant Communities and Habitats Could Be Impacted by Future Commercial Oil Shale Development

	Total Land Area (acres) Available for Leasing Where Future Commercial Oil Shale Development Could Impact Plant Communities and Habitats		
Location	Alternative A	Alternative B	Alternative C
Colorado	294,680	359,798	40,325
Utah	58,100	630,471	490,460
Wyoming	0	1,000,453	299,511
Total	352,780	1,991,222	830,296
	Land Area (acres) Identified for Protection of Wetlands, Riparian Habitat, and Floodplains Included in Lands Available for Leasing and Potentially Impacted by Future Commercial Development		
	Alternative A	Alternative B	Alternative C
Colorado	17	7,919	0
Utah	0	1,983	0
Wyoming	0	31,068	0
Total	17	40,970	0

wetlands, riparian habitats, and floodplains. About 1.2 million acres of land identified under Alternative B (including all of the 40,000 acres identified for protection of wetlands, riparian habitats, and floodplains) would be excluded from availability for leasing under Alternative C. Commercial oil shale development would be restricted to only 40,325 acres in Colorado, 490,460 acres in Utah, and 299,511 acres in Wyoming (830,296 total acres) under Alternative C.

Because of the difference in the amount of area identified under Alternatives A, B, and C as available for application for leasing, plant communities and habitats could be affected by commercial development at more locations under Alternative B than under Alternatives A or C. Oil shale endemic plant species occur on oil shale outcrops within the available lease areas identified under each of the alternatives. Because Alternative B includes more land area in the vicinity of oil shale outcrops than the other alternatives, there is a greater potential for impacts on oil shale endemic species under Alternative B. Alternative A includes the least land area in the vicinity of oil shale outcrops in the Uinta Basin, while Alternative C includes the least land area in the vicinity of oil shale outcrops in the Piceance Basin. There is, therefore, less potential for impacts on oil shale endemic species under Alternative A in the Uinta Basin and under Alternative C in the Piceance Basin.

6.1.4.7.3 Wildlife. There would be no impacts on wildlife species associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The types of impacts on wildlife species associated with construction and operation would be similar for all alternatives. Differences among alternatives exist in the amount of land that would be made available for application for commercial leasing and the location of areas protected from leasing. These differences are described in this section.

Impacts on wildlife and their habitats (see Section 4.1.8.3) would be identical under all three alternatives for similar projects located in areas common to the alternatives (i.e., in areas where land available for development overlaps). Because of the difference in the areas identified under the alternatives as available for application for leasing, wildlife and their habitats could be affected by subsequent commercial development at more locations under Alternative B than under the other two alternatives, and at more locations under Alternative C than under Alternative A. Alternative A identifies 352,780 acres as available for application for leasing, and Alternative B identifies 1,991,222 acres as available for application for leasing. Wildlife and their habitats in these areas could be impacted by the construction and operation of commercial oil shale projects.

In contrast, about 1.2 million acres of land identified under Alternative B would be excluded from availability for leasing under Alternative C. As a result, thousands of acres of important wildlife habitat would be removed from the Alternative C lease areas, and these areas and their wildlife would not be directly affected by commercial oil shale development that could occur in these lease areas. Table 6.1.4-5 shows the comparison among the three alternatives in the amounts of wildlife habitat identified for protection in current land use plans. Table 6.1.4-6

TABLE 6.1.4-5 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative A, B, and C Oil Shale Lease Areas

Wildlife Habitat	Total Land Area (acres) Available for Leasing Where Future Commercial Oil Shale Development Could Impact Wildlife Habitat Identified in BLM Land Use Plans		
	Alternative A	Alternative B	Alternative C
Birds			
Sage grouse lek sites	2,644 (3,563)[a,b]	19,186 (30,892)	0 (30,892)
Sage grouse nesting habitat	33,960 (40,243)	304,390 (477,948)	0 (477,948)
Sage grouse nesting and lek habitat	0 (599)	598 (599)	0 (599)
Raptor nests	11,507 (19,976)	101,265 (163,218)	0 (163,218)
Raptor habitat/nesting area	0 (3,436)	3,435 (3,436)	0 (3,436)
Waterfowl (in Pariette Wetlands)	0 (79)	79 (79)	0 (79)
Goose nest sites (in Pariette Wetlands)	0 (80)	80 (80)	0 (80)
Big game			
Big game severe winter range	46,446 (90,088)	89,312 (90,088)	0 (90,088)
Deer and elk summer range	155,372 (169,172)	163,654 (169,172)	0 (169,172)
Pronghorn crucial kidding habitat	47 (25,815)	25,814 (25,815)	0 (25,815)
Pronghorn crucial winter habitat	–[c]	269,453 (566,031)	0 (566,031)[d]
Elk crucial winter habitat	47 (25,815)	79,579 (92,927)	0 (92,927)[d]
Mule deer crucial winter habitat	–	87,564 (113,194)	0 (113,194)
Other			
Wild horses	55,829 (66,091)	65,615 (66,091)	0 (66,091)

[a] Acreage may be overestimated because of unknown degree of habitat overlap among species or habitat types for a species. For these reasons, columns should not be totaled.

[b] Numbers in parentheses are the wildlife habitat acreage identified for protection within the most geologically prospective lands.

[c] A dash = not identified for protection, or identified otherwise for protection within the state.

[d] Crucial winter habitat may be overestimated because it includes areas labeled as simply winter habitat for one or more field offices.

shows similar information for important state-identified wildlife habitat. The number of acres of wild horse HMA that could be affected by commercial oil shale development under each alternative is as follows: 52,500 for Alternative A, 653,850 for Alternative B, and 247,550 for Alternative C.

6.1.4.7.4 Threatened and Endangered Species. There are no impacts on threatened and endangered species associated with amending land use plans to identify lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 4.8.1.4. These impacts would be considered in project-

TABLE 6.1.4-6 Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Oil Shale Development

	Total Land Area (acres) Available for Leasing Where Commercial Oil Shale Development Could Impact State-Identified Wildlife Habitat		
Location	Alternative A	Alternative B	Alternative C
Sage grouse habitat	33,255	501,503	355,792
Mule deer winter habitat	184,180	733,500	180,200
Mule deer summer habitat	158,496	181,476	12,339
Elk winter habitat	251,258	649,700	145,200
Elk summer habitat	158,510	181,216	12,335

specific NEPA analyses and ESA consultations that would be conducted at the lease and development phases of projects. The types of potential impacts on threatened and endangered species associated with construction and operations would be similar for all alternatives. Differences among alternatives exist in the amount of lands that would be made available for application and the location of potential lease areas. These differences are described in this section.

Of the three alternatives under consideration, the least amount of land would be available for application for commercial leasing under Alternative A (352,780 acres), an intermediate amount under Alternative C (830,296 acres), and the most under Alternative B (1,991,222 acres). The difference in acreage results in a potential difference in the number of threatened and endangered species that could occur in project areas (Table 6.1.4-7).

Of the 172 federal candidate, BLM-designated sensitive, and state-listed species listed in Table 4.8.1-4, there are 68, 170, and 170 species that potentially occur in areas that are available for application for leasing under Alternatives A, B, and C, respectively. Of the 16 federally listed threatened and endangered species listed in Table 4.8.1-5, there are 14 species that potentially occur in areas that are available for leasing under Alternatives A, B, and C.

Alternatives differ in the amount of critical habitat for Colorado River endangered fishes contained within areas available for application for commercial leasing; there are 1.5, 99, and 71 mi of critical habitat associated with Alternatives A, B, and C, respectively (Table 6.1.4-7). The areas that are available for application under Alternatives A and B also include about 61,000 and 382,000 acres, respectively, of land for which lease stipulations have been established in existing RMPs to protect federally listed and candidate species, BLM-designated sensitive species, and other special status species. These lands have been excluded from consideration for leasing under Alternative C.

TABLE 6.1.4-7 Threatened and Endangered Species and Selected Habitats Present in Potential Lease Sale Areas That Could Be Affected by Future Commercial Oil Shale Development

Resource That Could Be Affected by Development in Project Areas	Alternative A	Alternative B	Alternative C
Number of federal candidates, BLM-designated sensitive species, and other special status species	61	160	160
Number of federally listed species	14	14	14
Miles of critical habitat of federally endangered Colorado River fishes	1.5	99	71
Acres of land identified in land use plans as potential habitat for federally listed and candidate species, BLM-designated sensitive species, and other special status species	61,055	382,696	0

6.1.4.8 Visual Resources

Under Alternative A, visual resources could be affected by:

1. The construction, operation, and reclamation of the RD&D projects, and the construction, operation, and reclamation of oil shale facilities that might be developed on the PRLAs for the RD&D projects if RD&D operators are granted use of the PRLA for commercial development. These impacts would also occur under Alternatives B and C.

2. The construction, operation, and reclamation of oil shale facilities that might be developed in the oil shale priority management areas (Utah) and the lands available for oil shale leasing under the White River RMP in Colorado. Impacts for nearly all of the oil shale priority management areas in Utah would also occur under Alternatives B and C. Impacts for all of the lands available for oil shale leasing under the White River RMP in Colorado would also occur under Alternative B; however, more land is available for oil shale leasing under the White River RMP in Colorado under Alternative A than under Alternative C, and impacts under Alternative A could, therefore, be greater in Colorado then for Alternative C.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not affect visual resources within, or in the vicinity, of the lease areas identified under Alternatives A, B, or C. However, there are a number of sensitive visual resource areas within, and in the vicinity of, the areas available for application for leasing identified by all three alternatives. These sensitive visual resource areas could be affected if application for leasing leads to the future construction and operation of commercial oil shale projects in the lease areas.

The visual resources that could be affected by the construction, operation, and reclamation of commercial oil shale projects would be identical under Alternatives A, B, and C for similar projects located in areas available for application for leasing common to the alternatives (i.e., where the areas available for application for leasing overlap). Because of the difference in the areas identified under Alternatives A, B, and C as available for application for leasing, visual resources could be affected by commercial oil shale development at more locations under Alternative B than under Alternatives A and C. Alternative B identifies 1,991,222 acres as available for application for leasing, and visual resources in and in the vicinity of these lease areas could be impacted by the construction, presence, and operation of commercial oil shale projects.

About 1.2 million acres of land identified under Alternative B would be excluded from availability for leasing under Alternative C, and visual resources in these excluded areas would not be directly affected by commercial oil shale development in the Alternative C lease areas (Table 6.1.4-8). There is relatively little difference in potentially affected visual resources that are present beyond the lease area boundaries of Alternatives B and C at the foreground-middleground and background BLM VRM distance limits.

As noted above, more lands are available for application for leasing in Colorado under Alternative A than under Alternative C; however, in Utah, more lands are available for leasing under Alternative C than under Alternative A, and no lands are available for leasing under Alternative A in Wyoming. Thus, the total area available for leasing under Alternative C in Wyoming is much greater than the total area available for leasing under Alternative A.

More lands are available for leasing in Colorado under Alternative B than under Alternative A; however, under Alternative A, all mining methods could be used, while under Alternative B, only in situ methods and underground methods would be permitted, which could result in greater visual impacts in Alternative A depending on the number, size, and nature of the developments. In Utah, more lands are available for leasing under Alternative B than under Alternative A, and no lands are available for leasing under Alternative A in Wyoming; thus, the total area available for leasing under Alternative B is much greater than the total area available for leasing under Alternative A.

6.1.4.9 Cultural Resources

Table 6.1.4-9 identifies the amount of available acreage that has the potential to contain important cultural resources under each of the alternatives. Under Alternative A, 800 acres in Colorado and 160 acres in Utah that would be impacted by the RD&D projects have been surveyed for cultural resources, and two of the six 160-acre tracts contain archaeological sites (Section 6.1.1.9). Mitigation is required to be applied in the development of these projects. Therefore, most of the possible adverse effects on cultural resources are expected to be

TABLE 6.1.4-8 Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified in Alternatives A, B, and C[a]

State	Alternative A	Alternative B	Alternative C
		Visual Resource Areas within Proposed Lease Areas	
Colorado	2 ACECs	6 ACECs	
Utah	1 WSA 2 potential ACECs 2 River segments eligible for WSR designation	3 ACECs 10 Potential ACECs 2 River segments eligible for WSR designation	10 Potential ACECs
Wyoming		1 ACEC	
		Visual Resource Areas within 5 mi of the Lease Area Boundary (BLM VRM Foreground-Middleground Distance Limit)	
Colorado	6 ACECs 2 River segments eligible for WSR designation	1 WSA 3 ACECs 2 River segments eligible for WSR designation	1 WSA 5 ACECs 2 River segments eligible for WSR designation
Utah	1 WSA 4 potential ACECs 2 River segments eligible for WSR designation	3 WSAs 3 ACECs 13 Potential ACECs 6 River segments eligible for WSR designation 1 National scenic highway	3 WSAs 3 ACECs 13 Potential ACECs 6 River segments eligible for WSR designation 1 National scenic highway
Wyoming		4 WSAs 5 ACECs 9 National historic trails 1 River segment eligible for WSR designation	3 WSAs 4 ACECs 9 National historic trails 1 River segment eligible for WSR designation
		Visual Resource Areas within 15 mi of the Lease Area Boundary (BLM VRM Background Distance Limit)	
Colorado	2 WSAs 6 ACECs 1 National Scenic Highway 2 River segments eligible for WSR designation	2 WSAs 1 National scenic highway	2 WSAs 2 ACECs 1 National scenic highway 2 River segments eligible for WSR designation

TABLE 6.1.4-8 (Cont.)

State	Alternative A	Alternative B	Alternative C
		Visual Resource Areas within 15 mi of the Lease Area Boundary (BLM VRM Background Distance Limit)	
Utah	1 WSA 2 ACECs 9 potential ACECs 4 River segments eligible for WSR designation	7 WSAs 1 ACEC 8 Potential ACECs 5 River segments eligible for WSR designation 1 National monument 1 National scenic highway	8 WSAs 1 ACEC 8 Potential ACECs 4 River segments eligible for WSR designation 1 National monument 1 National scenic highway
Wyoming		4 WSAs 4 ACECs 9 National historic trails 2 River segments eligible for WSR designation 1 National scenic highway	3 WSAs 3 ACECs 9 National historic trails 1 River segment eligible for WSR designation 1 National scenic highway

[a] ACEC = area of critical environmental concern; potential ACECs = areas eligible for ACEC designation; WSR = Wild and Scenic River; WSA = wilderness study area.

TABLE 6.1.4-9 Available Acreage under Each Alternative with the Potential to Contain Cultural Resources

Parameter	Alternative A	Alternative B	Alternative C	% Difference in Alternatives B and C
Acres available for application for leasing and development	352,780	1,991,222	830,296	42
Acres surveyed	77,143	261,602	131,921	50
Percentages of area surveyed	22%	13%	16%	39
Number of sites recorded	1,067	2,991	1,157	39
Acres of high or medium sensitivity to contain cultural resources	298,000	1,665,109	719,060	43
Percentages of area with high or medium sensitivity	85%	84%	87%	NA[a]

[a] NA = not applicable.

mitigated. These impacts from the RD&D activities would also occur under Alternatives B and C, as well as the mitigation measures. In addition, under Alternative A, within the areas available for oil shale development under existing RMPs, approximately 298,000 acres have the potential to contain important cultural resources (Table 6.1.4-9). Adverse effects could occur in these areas.

Under Alternative B, 1,665,109 acres of the 1,991,222 acres available for application for commercial leasing have the potential to contain important cultural resources. This acreage includes existing ACECs not closed to mineral development that contain important cultural resources. Adverse effects on cultural resources, as described in Sections 4.10 and 6.1.2, could occur in these areas as a result of future commercial development.

Under Alternative C, the amount of acreage available for application for commercial leasing with the potential to contain important cultural resources is reduced considerably from that of Alternative B to 719,060 acres, out of 830,296 acres. Commercial development in Alternative C lease areas potentially could impact approximately 43% of the acreage with important cultural resources that could be impacted by Alternative B. In addition, under Alternative C, no direct impacts from commercial development on cultural resources present within the designated ACECs would occur, but adverse effects could occur within the lands made available for leasing and subsequent development (see Section 6.1.3).

6.1.4.10 Socioeconomics

Under Alternatives B and C, the proposed land use plan amendments could result in impacts on the socioeconomic environment, specifically in increases or decreases in property values (see Section 4.11.1.6).

The socioeconomic impacts of the RD&D projects and impacts on transportation systems and traffic levels at each of the RD&D locations are the same for each of the three alternatives as described in Section 6.1.1.10. Under Alternative A, 352,780 acres of land in Colorado and in Utah have been allocated for commercial oil shale development. With the possible exception of impacts on property values (see Section 4.11.1.6), there are no socioeconomic or transportation impacts associated with this land use designation. Socioeconomic and transportation impacts could result, however, from post-lease construction and operation as described in Sections 4.11 and 5.11. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

As shown in Table 6.1.4-10, more lands would be made available for application for commercial leasing under Alternative B than under Alternatives A and C; however, because of the need for project and site-specific information, it is not possible to identify the nature and

The types of impacts on transportation systems and traffic levels would be identical under Alternatives A, B, and C for similar projects located in areas common to the alternatives (i.e., in areas where land available for leasing is the same). Because of the difference in the areas identified as available for application for leasing under Alternatives B and C, transportation systems and traffic levels could be affected by commercial development at more locations under Alternative B than under Alternative C. However, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of the impacts of commercial oil shale development on transportation systems under Alternatives A, B, or C.

TABLE 6.1.4-10 Estimated Acres Potentially Available for Application for Leasing for Commercial Oil Shale Development by State under Each Alternative[a]

State	Alternative A	Alternative B	Alternative C
Colorado	294,680	359,798	40,325
Utah	58,100	630,971	490,460
Wyoming	0	1,000,453	299,511
Total	352,780	1,991,222	830,296

[a] Totals may not be exact because of rounding. These estimates were derived from GIS data compiled to support the PEIS analyses. The GIS data may contain errors; therefore, these estimates should be considered to be only representative of the proposed leasing area.

6.1.4.11 Environmental Justice

Under Alternative A, there are no environmental justice impacts associated with the previous designation of lands as available for application for oil shale development. Impacts could result, however, from post-lease construction and operation as described in Sections 4.12 and 5.12. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

More lands would be made available for application for leasing under Alternative B than under Alternatives A and C; however, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of the potential environmental justice impacts of commercial oil shale development under Alternatives A, B, or C. Thus, it is not possible to differentiate among these alternatives regarding environmental justice impacts.

6.1.4.12 Hazardous Materials and Waste Management

The construction and operation of the six RD&D projects under Alternative A will utilize and generate hazardous materials and wastes (see Section 6.1.1.12); however, if appropriately managed, the use of these materials will result in only minor impacts. These impacts would also occur under Alternatives B and C.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not result in hazardous material and waste issues within or in the vicinity of the lease areas identified under either Alternative B or Alternative C. However, the construction and operation of commercial oil shale projects in the lease areas would use and generate hazardous materials and wastes under both alternatives.

Because the use of hazardous materials and the generation of wastes are related to the specific design of a commercial oil shale project rather than project location, it is not possible to differentiate among the alternatives as to the hazardous materials and waste that could be used or generated during commercial oil shale construction and operation. For similar commercial oil shale projects (similar in design and operation), the hazardous materials and wastes associated with projects developed under Alternatives A, B, or C would be similar. Because of the larger amount of land that would be made available for application for leasing under Alternative B, the use and/or generation of hazardous materials and wastes could occur at more locations under Alternative B than under Alternatives A or C. In any case, the impacts of hazardous material and waste handling (storage, use, and disposal) would be expected to be similar under each alternative (Section 4.13.1) regardless of project location.

6.1.4.13 Health and Safety

Under Alternative A, the construction and operation of the six RD&D projects could result in health and safety impacts on facility workers. Impacts on health and safety from the six RD&D projects would be the same under all three alternatives; these impacts would be associated with the potential for accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or volatile compounds emitted from the facilities. As stated in Section 6.1.1.13, the statistically expected number of injuries from all the RD&D projects combined is about 75 per year during construction and 40 per year during operations. During both construction and operations, less than 1 fatality per year would be expected.

The amendment of land use plans to identify areas available for application for leasing for commercial oil shale development would not result in health and safety issues within or in the vicinity of the areas available for application for leasing identified under either Alternative B or Alternative C. The future construction and operation of commercial oil shale projects would have identical health and safety concerns among Alternatives A, B, and C for projects with identical plans of development located in areas available for application for leasing common to the alternatives (i.e., where the areas would overlap). Potential impacts could occur from accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or volatile compounds emitted from the facilities. Construction and operation of individual facilities under any of the alternatives statistically would be expected to result in less than 1 fatality per year and approximately 125 injuries per year. Health impacts on the general public could occur from exposure to emissions from oil shale facilities, but in the absence of site-specific and process-specific data, no differences in health and safety impacts among Alternatives A, B, or C can be identified.

Differences in health and safety concerns among the alternatives would be largely associated with differences in individual project designs and, to a lesser degree, differences in the locations of individual projects. For example, projects requiring longer transportation routes and longer utility and pipeline ROWs would have a greater potential for transportation accidents as well as ROW construction-related accidents. It is not possible to quantify differences in health and safety impacts from project construction and operation under Alternatives B and C in this

PEIS. Under either of the alternatives, health and safety issues would be evaluated at the project level (i.e., as part of project-specific NEPA analyses), and a comprehensive facility health and safety plan and worker safety training would be required as part of the plan of development for every proposed commercial oil shale project.

6.1.5 Cumulative Impacts

The CEQ (1997), in its regulations implementing the procedural provisions of NEPA (40 CFR Part 1508.7), defines cumulative effects as follows:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

In this PEIS, the proposed action is to amend land use plans to allow certain lands to be considered for commercial leasing. That is, the decision made at the plan level does nothing more than remove (or leave in place) the administrative barrier (plan conformance) to the BLM considering any applications for leasing. The plan amendments would open the areas in question for leasing. The phrase "available for application for leasing" is used above, and throughout the PEIS, rather than simply "available for leasing" to highlight that, unlike the BLM's practice with respect to oil and gas leasing, additional NEPA analysis would be required prior to the issuance of any lease of oil shale or tar sands resources. Amendment of the RMPs does not authorize any ground-disturbing activities and is not an irreversible or irretrievable commitment of resources under NEPA (see 40 CFR 1502.16). Moreover, amendment of RMPs does not constitute the granting of any property right. In this respect, the limited scope and scale of the proposed action of amending the land use plans—and any potential environmental impacts of these amendments—necessarily results in the need for only a limited cumulative effects analysis in this PEIS. Analysis of the cumulative effects in this PEIS will be qualitative to reflect the limited and highly speculative character of the information available, and the limited nature of the decision to be made on the basis of this PEIS.[1] At the leasing decision and at the decision to approve a plan of development, more specific cumulative effects analyses would be appropriate, and such analysis would be able to be completed, because specific technical and environmental information for those analyses should be available.

As stated above, and in Sections 6.1.2 and 6.1.3, with the possible exception of a change in local property values, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for application for commercial oil shale leasing. Therefore, there would be no cumulative impacts from these alternatives. However, direct, indirect, and cumulative impacts could occur as a result

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1 Oil shale and tar sands development could not occur until a leasing decision has been made and implemented (leases issued). After leases are issued, additional permits and environmental analysis would be required before operations could begin.

of future commercial oil shale development that could be facilitated by such land use plan amendments. The focus of this cumulative impacts assessment, then, is the impacts from this future development, rather than the impacts from the land use plan amendment decision. That is, the purpose of this cumulative impacts assessment is to discuss, in a qualitative way, how the environmental and socioeconomic conditions within the study area might be incrementally affected over the next 20 years (the study period) by oil shale development that could occur on lands made available for application for commercial development in the land use plan amendments under either Alternative B or Alternative C.

This section describes, in a preliminary way, the possible cumulative impacts of potential commercial oil shale development that could occur over the next 20 years. More specific information regarding impacts, including cumulative impacts, would be provided by the analysis conducted at any future leasing stage, and at the review of any project- specific plan of development. The impacts presented here are in the context of other major activities in the study areas on both BLM-administered and nonfederal lands that could also affect environmental resources and the socioeconomic setting. The study areas considered usually include the lands managed by a BLM field office that contain oil shale resources and the ROI counties associated with them, as defined in Table 3.10.2-1. Larger areas are considered for certain resources (e.g., land, air, and water). This section considers five major categories of activities that could have cumulative impacts: oil and gas development, coal mining and preparation, other minerals development, energy infrastructure development, and other activities (e.g., tar sands development, grazing, fire management, forestry, and recreation). Section 6.1.5.3 presents the possible cumulative impacts of potential commercial oil shale development that could occur under each of the alternatives, B and C, and addresses the same resources analyzed in Sections 4.2 through 4.14.

The current status of resources (including past and present actions) is described in Chapter 3. This section focuses on the cumulative impacts of the possible oil shale development that could occur under either Alternative B or C, when added to a set of reasonably foreseeable future actions that are projected to occur or that could occur over the next 20 years (as described in Section 6.1.5.2). These projections were drawn from a variety of sources, as indicated in the text, but include developments on both BLM-administered and nonfederal lands. The accuracy of such projections is greatest during the first few years of the 20-year period and decreases over the time frame assessed. In particular, future levels of commercial oil shale development are unknown. For the purposes of analysis, this cumulative impacts assessment looks at the incremental impacts of a single oil shale facility (as described in Section 4.1), recognizing that there may be more than one of these facilities brought into operation during the study period. While the cumulative impacts described in this section represent an initial estimate of impacts for activities projected to occur in the 20-year time frame, the assessment requires reevaluation if the planned level of development changes drastically in the future.

However, because under both alternatives, there is a lack of information on the magnitude of future actions on public land, how many projects might be undertaken, and the likely locations for future development, the magnitude of the differences between the cumulative effects of the alternatives cannot be identified (i.e., the same level of future development might occur under each alternative).

6.1.5.1 Overview of Assumptions and Impact-Producing Factors for Major Activities in the Study Area

6.1.5.1.1 Oil and Gas Development. Associated with oil and gas development both on federal and nonfederal lands are impact-producing factors such as water use, the production of wastes and water, contaminant emissions to air and water, the use and alteration of land, and potential oil spills. The environmental impacts of oil and gas drilling are highly variable, depending on the depth of drilling, drilling methods used, depressurization and dewatering of aquifers and alteration of flow patterns, and depending on factors such as construction techniques, degree of hydraulic fracturing, the hydrologic framework, and the depth of exploration. Table 6.1.5-1 summarizes the estimated impacts of oil and gas drilling on a per-well basis for select resource areas.

Rough estimates of overall resource requirements for oil and gas drilling are available from several sources. The BLM is continuing to improve the way it manages oil and gas operations, in particular, establishing BMPs to minimize environmental effect. Many of these specific mitigation measures reduce surface impacts and are applied as conditions of approval prior to operations on a lease. For wells on federal lands, the amount of surface disturbance for each well has been decreasing from about 3 acres to 1.5 acres per well or less. It is expected that standard industry practices in accordance with existing regulations are used for installation of oil and gas wells on private lands.

TABLE 6.1.5-1 Assumptions Associated with Oil and Gas Drilling

Impact-Producing Factor	Values Used in Impact Analysis (per well drilled)	Reference
Suface disturbance (acres)	2.5–15	McClure et al. 2005; Thompson 2006a; DOE 2006; BLM 1994b, 2002a, 2006i
Water use (ac-ft/yr)	0.55	BLM 2006i
Drilling waste (bbl)	4,100	DOE 2006
Regulated emissions (CO, SO_2, NO_x) (tons)	0.37	DOE 2006
CO_2 emissions (tons)	97	DOE 2006
Other nonregulated emissions (CH_4, non-CH_4 hydrocarbons) (tons)	0.17	DOE 2006
Amount of oil spilled (gal)	24	DOE 2006
Employment (direct FTEs)	3	BLM 2006i

For the purpose of analysis, it is assumed that the amount of land disturbed for oil and gas well installation on either federal or nonfederal lands varies from 2.5 to 15 acres per well. The higher end of the range is certainly an overestimate in locations where multiwell pads would be used (e.g., the Roan Plateau RMP amendments call for 17 wells per pad atop the plateau) (BLM 2006i). In addition, only about 60% of the initially disturbed area would have long-term surface disturbance, with the other 40% generally being revegetated within 2 years (BLM 2006i).

6.1.5.1.2 Coal Mining and Preparation. Impact-producing factors for coal mining and preparation (e.g., removal of sulfur) on either federal or nonfederal lands include water use, contaminant emissions to air and water, use and alteration of land, and occupational hazards. These factors are discussed in DOE (1988) and summarized for select resource areas in Table 6.1.5-2. As is the case with oil and gas operations, the BLM is improving its management of coal operations by establishing BMPs to minimize environmental effect. Many specific mitigation measures reduce surface impacts and are applied as conditions of approval prior to operations on a lease.

6.1.5.1.3 Other Minerals Development. Although several metals and minerals are mined in the three states (e.g., clay, copper, gilsonite, gold, iron, lead, lime, molybdenum, potash [potassium-based compounds], sand, gravel, silver, sodium minerals [e.g., nahcolite, trona], uranium, vanadium, and zinc), most are not mined in the counties that might experience oil shale development. The predominant materials currently mined in these areas are sand and gravel.

Sand and gravel deposits are found in river and stream terraces, floodplains, and channels, both current and ancient. These deposits are a type of salable minerals. Extraction of instream sand and gravel deposits could result in adverse environmental impacts, such as changes in streamflow and increased turbidity, that would affect fisheries and recreational use. Extraction of sand and gravel from floodplains or low terraces could create new channels and alter sediment deposition, again adversely affecting the ecology of the nearby river or stream. Other general impacts from sand and gravel mining on either federal or nonfederal lands could include land disturbance, changes in groundwater quality, noise, dust, and visual changes. The proper management of sand and gravel mining and the application of mitigation could decrease impacts such that there would be minimal adverse impacts. For example, siting mining locations high up in the landscape (on floodplains and terraces rather than in stream channels) would decrease adverse impacts on stream hydrologic processes (Langer 2002).

Other materials mined in the potential oil shale development area include clay, gilsonite, gold, lime, sandstone, sodium minerals, uranium, and vanadium. These metals and minerals may be obtained through underground mining, surface (open pit) mining, or solution mining. Gold is obtained through both surface and underground mining. Mining of these substances can cause a variety of adverse environmental impacts, including the production of high volumes of solid and potentially hazardous waste, the contamination of surface water and groundwater, uncontrolled releases of produced water, land subsidence, physical instability of mine units, and air quality

TABLE 6.1.5-2 Assumptions Associated with Coal Mining and Preparation[a]

Impact-Producing Factor	Impact (per million tons surface mined)	Impact (per million tons underground mined)
Surface disturbance (acres)		
Area for facilities	4.3	4
Strip mining	20	NA[b]
Waste storage	2.6	1
Water use (million gal)		
Coal preparation	20	20
Dust control	35	35
Air emissions (tons)[c]		
CO	15	6.3
SO_2	4.9	0.59
NO_x	76	[d]
Particulates	4	0.48
Fugitive dusts[e]	1,870	[d]
Hydrocarbons	4.8	0.48
Aldehyde	1.2	[d]
Diesel fuel use (10^3 gal)	3,021	38
Electricity use (10^6 MWh)	6	39
Employment (direct FTEs)	180	460
Occupational hazards (deaths per 100,000 workers, disabling injuries per 100 workers)	0.07, 8	0.37, 45

[a] Coal is prepared to increase its quality and heating value by removing sulfur and ash-forming constituents.

[b] NA = information not available.

[c] Surface mining values are for the western United States; underground values are for the eastern United States.

[d] Unquantified or negligible.

[e] Based on estimates for an Illinois surface mine with the following controls: paved access roads, watered and unpaved haul roads, and enclosed coal dumps with baghouse. Without these controls, estimated fugitive dust emissions would be 3,030 tons.

Source: DOE (1988).

degradation, especially from particulate emissions. Uranium has an added potential for radiologically contaminating environmental media, leading to the subsequent possibility of exposures of biota and humans.

Metal mining historically has also caused contamination of surface water. The sources of contamination have included waste rock disposal, tailings, leaching sites (locations where valuable metals are collected by running solutions through the ore), and mine water. Depending on the local geology, the waste rock may contain other naturally occurring minerals toxic to biota, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, and nickel. In addition, cyanide (a highly toxic substance composed of carbon and nitrogen) is used extensively in the mining industry to aid in metal extraction. Serious adverse impacts on surface water from metal mining have occurred when runoff from waste sources has entered nearby water bodies; these impacts have included degradation of aquatic habitat and contamination of drinking water supplies. Additional adverse impacts would occur as a result of erosion and increased sedimentation of surface water.

An environmental impact from metal mining is the large volume of waste that is generated. The product-to-waste ratio can be very high; for example, in gold mining, almost all of the material removed from the earth (99.99%) is waste rock and tailings. Another area of concern is air quality degradation. Many metal-mining operations generate large volumes of fugitive dust from ore crushing and loading, blasting, and, over time, from dried-up tailings ponds.

Many of the adverse impacts from mining discussed above occurred primarily in the past, and mitigation measures have been adopted to minimize their occurrence in present practice. Because of the wide variety of possible contaminants and impacts from mining of metals and other minerals, generic impacts (e.g., on a “per-ton-mined” basis) are not discussed in this section. Cumulative impacts are discussed in Section 6.1.5.3 on the basis of the specific types of minerals being developed in each region.

6.1.5.1.4 Energy Infrastructure Development

Energy Corridors. An extensive infrastructure of oil and gas pipelines and electricity transmission ROWs exists in the western states. Most of the existing ROWs cross public lands (National Energy Policy Development Group 2001). As of 2005, Colorado had 6,177, Utah had 5,120, and Wyoming had 15,775 ROWs crossing public lands (BLM 2001, BLM 2005k). These ROWS serve as either long-distance paths or subregional and local distribution lines. It is projected that the growing demand for additional energy and electricity will result in an increased number of ROWs across public lands in the future (National Energy Policy Development Group 2001). Other federal agencies authorized to grant ROWs for electric, oil, and gas transmission include the USFS, the NPS (electric only), the USFWS, the BOR, and the Bureau of Indian Affairs (BIA).

The BLM, along with DOE, is preparing a PEIS (DOE 2008) to designate public lands for potential use for long-distance energy transmission corridors in the West. This is an effort to expedite permitting of transmission systems, such as oil and gas pipelines and power lines (DOE 2008). The proposed action of that PEIS designates federal energy corridors on public lands in areas that would be beneficial for energy development, but excludes sensitive lands (such as National Parks and National Monuments, ACECs, and roadless areas) to the extent practicable. Consideration is given to the locations of oil shale deposits, and possible corridor locations have been designated relatively near to these areas for future use if the oil shale is developed. The designation of public lands for potential use in energy transmission ROWs as proposed under the Draft West-wide Energy Corridor PEIS would not have direct impacts, with the possible exception of affecting current land use within the corridors and property values on private lands adjacent to or between corridor segments.

The eventual construction and operation of energy transmission ROWs, whether within federally designated energy corridors, within energy corridors on federal lands that are currently identified in land use plans, or at locations on nonfederal lands identified by industry and evaluated and authorized by appropriate agencies (e.g. BLM, USFS, Tribes), could result in adverse environmental impacts on federal and nonfederal lands. The specific types, magnitudes, and extents of project-specific impacts would be determined by the project type (transmission line, pipeline) and its length and location on federal and nonfederal lands; thus, the impacts could be evaluated only at the project level. However, general potential impacts typical of project construction and operation include the use of geologic and water resources; soil disturbance and erosion; degradation of water resources; localized generation of fugitive dust and air emissions from construction and operational equipment; noise generation; disturbance or loss of paleontological and cultural resources and traditional cultural properties; degradation or loss of fish and wildlife habitat; disturbance of resident and migratory fish and wildlife species, including protected species; degradation or loss of plant communities; increased opportunity for invasive vegetation establishment; alteration of visual resources; land use changes; accidental release of hazardous substances; and increased human health and safety hazards. Construction and operation of energy transmission ROWs could also affect minority and low-income populations in the vicinity of the projects on both federal and nonfederal land as well as local and regional economies.

Electric Power Plants. Electric power plants are generally sited on private lands. Impacts from electric power generating plants include emissions of air pollutants, water use, production of large volumes of solid waste (e.g., coal combustion products [ash]) and flue-gas cleanup waste), use and alteration of land, emissions and accidents associated with the transportation of raw materials and wastes, and socioeconomic impacts. Air emissions differ depending on the quality of feed coal utilized. Table 6.1.5-3 summarizes the estimated impacts on various resource areas from the construction and operation of electric power plants. In the near term, it is most likely that low-sulfur Wyoming coal would be utilized for power plants in the study area. Additional electric power might be required over the study period to support new development.

TABLE 6.1.5-3 Assumptions Associated with Coal-Fired Power Plants[a]

Impact-Producing Factor	Assumed Values for a 1,500-MW Plant (BLM 2007d)	Assumed Values for a 360-MW Current Design Plant and a 425-MW NSPS Plant (Spath et al. 1999)[b]
Land use (acres)	3,000 total (includes construction acreage)	NA[c]
Water use (ac-ft/yr)	8,000 ac-ft/yr	NA
Fuel source and composition	Wyoming-grade low-sulfur coal (0.47% sulfur, 6.4% ash); heat of combustion = 8,220 Btu/lb (Representative data from Powder River Basin coal; Ellis et al. 1999)	Illinois No. 6 bituminous (4% sulfur, 0.1% chlorine, 1.1% nitrogen, 10% ash dry basis); heat of combustion = 10,800 Btu/lb
Fuel requirements	3.75 million tons/yr (2,330 tons/yr/MW)[d]	Current plant: 1.6 million tons/yr (4,320 tons/yr/MW); NSPS plant: 1.7 tons/yr (3,950 tons/yr/MW)
Coal combustion products (ash)[e]	NA	Current plant: ~36,000 kg/GWh; NSPS plant: ~33,000 kg/GWh
Solid waste (flue-gas cleanup)	NA	Current plant ~86,000 kg/GWh; NSPS plant: ~92,000 kg/GWh
Emissions		
SO_2	Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu)	Current plant: 6,400 kg/GWh; NSPS plant: 2,229 kg/GWh
NO_x	Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu)	Current plant: 3,039 kg/GWh; NSPS plant: 2,041 kg/GWh
CO	NA	Current plant: 134 kg/GWh; NSPS plant: 123 kg/GWh
CO_2	NA	Current plant: ~970,000 kg/GWh; NSPS plant: ~890,000 kg/GWh
Particulates	Meet NSPS standards: 13 g/GJ heat input (0.03 lb/MMBtu)	Current plant: 135 kg/GWh; NSPS plant: 123 kg/GWh
VOCs	NA	Current plant: 16 kg/GWh; NSPS plant: 14 kg/GWh
Employment (direct FTEs)[f]	Construction: 800 average over 4 yr (1,200 peak); operations: 135	NA
Transportation	12 trains/week; 100 cars/train; 10,000 tons/train[d]	13–14 trains/week; 17 cars/train; 1,445 tons/train

Footnotes on following page.

TABLE 6.1.5-3 (Cont.)

[a] Power plants are assumed to operate at 60% efficiency; thus, a 1,500-MW plant generates approximately 7,900 GWh/yr; a 325-MW plant generates 1,900 GWh/yr; and a 425-MW plant generates 2,200 GWh/yr.

[b] NSPS = new source performance standard.

[c] NA = information not available.

[d] Sources for fuel requirement and transportation assumptions are Thompson (2006b,c).

[e] Coal combustion products may not require disposal in landfills; the EPA sponsors a beneficial reuse program (EPA 2008).

[f] Source for FTE employment values is Thompson (2006b).

Sources: BLM (2007d); Ellis et al. (1999); Spath et al. (1999); Thompson (2006b,c).

6.1.5.1.5 Other Activities

Other Oil Shale Development. As described under Alternative A (the no action alternative), the leases associated with the RD&D projects grant the lessees the right to develop oil shale on the designated PRLAs if they are able to meet certain requirements (see Section 1.4.1). At this time, it is not known whether the lessees will be able to meet these requirements; if they are met, the lessees will be allowed to develop these lease areas (Figure 2.3.2), totaling 30,720 acres, with the same basic technologies demonstrated during the RD&D process. Therefore, the five Colorado PRLAs could be developed using in situ technologies, and the Utah PRLA could be developed using underground mining. It is assumed that the impacts from these projects would fall within the range of impacts for similar oil shale facilities as summarized in Chapter 4. Because of the incomplete stage of the RD&D projects, such commercial development is not expected in the near term (e.g., within the next 5 years).

As described in Chapters 1 and 2, the BLM may issue new RD&D leases where the land use plans allow for oil shale leasing. As with future commercial oil shale leasing, it is not known where the industry would seek to locate the most promising RD&D projects. It is also not known what new technologies would be demonstrated; however, it is most probable that the types of technologies, as well as their possible effects, would be qualitatively similar to the three kinds of processes analyzed in the PEIS, although smaller in scale prior to any conversion to commercial leases and expansion to preference right acreage. Furthermore, it is not known how many RD&D leases, if any, would be issued pursuant to a call for expressions of interest, or in what sequence. The environmental impacts of such RD&D leases will be analyzed in lease-specific NEPA documents. The BLM has not yet published in the *Federal Register* a new call for expressions of interest in RD&D leasing. Therefore, it is less likely that any new RD&D leases would be converted to commercial operations within the next 5 years than it is that existing RD&D leases would reach commercial development within that time.

Nonfederal lands (e.g., state lands, private lands) overlay about 40% of the most geologically prospective oil shale area (see Section 3.1). These lands could also support oil shale development in the future. Because extensive R&D and environmental studies are required to attain permits, it is not anticipated that such development would occur in the next 10 years; it may, however, occur within the next 20 years.

Tar Sands Development. This PEIS addresses the environmental and socioeconomic impacts of land use plan amendments and potential development for both oil shale and tar sands, and thus, potential tar sands development is considered in the cumulative impact assessment. Because the level of tar sands development over the next 20 years is unknown, this assessment has assumed that one tar sands facility would be constructed and operated in any one of the Utah STSAs during the study period. Impact-producing factors for such a tar sands facility include surface disturbance, water use, waste generation, and local changes in employment and population density. The assumptions used for these factors are given in Section 5.1.

Grazing. Public and private lands in the study area are used extensively for livestock grazing. Environmental impacts of note associated with livestock grazing include potential degradation of soil, vegetation, wildlife habitat, and surface water quality (Krueger et al. 2002; BLM 2006k). For example, overgrazing could result in increased rates of erosion and topsoil losses. Allowing grazing during the nesting seasons of some species could result in trampling of the eggs and decreased viability of those species in the study area. Livestock could also degrade surface water quality if their manure and urine were deposited directly into the water or on land nearby. Good management practices can eliminate or mitigate many of these impacts. On BLM lands, grazing permits are required that specify the species allowed to graze, amount of grazing permitted, and other requirements to minimize environmental impacts. Today, the BLM manages livestock grazing in a manner aimed at achieving and maintaining public land health. To achieve desired conditions, the agency uses rangeland health standards and guidelines that the BLM developed in the 1990s with input from citizen-based Resource Advisory Councils across the West. Standards describe specific *conditions* needed for public land health, such as the presence of stream bank vegetation and adequate canopy and ground cover. Guidelines are the management *techniques* designed to achieve or maintain healthy public lands, as defined by the standards. These techniques include such methods as seed dissemination and periodic rest or deferment from grazing in specific allotments during critical growth periods.

Fire Management. Fire management is used on public and private lands to aid in wildfire suppression. Underbrush is burned at regular intervals to avoid the buildup of large amounts of fuel on these lands. Fire is considered to have a natural role in the ecosystems and is used as a tool in managing those ecosystems. However, fires have potential environmental impacts that should be considered, particularly impacts on air quality and on threatened and endangered species (BLM 2002b). In general, impacts would be lower from more frequent, less intense, controlled fires than from infrequent wildfires.

Forestry. In Colorado, Utah, and Wyoming, the BLM administers approximately 14.2 million acres of forested lands of various types. Forested land is defined as being 10% stocked with live trees and at least 1 acre in size and 120 ft wide. A 2006 report on the status and condition of these forests states that the national priorities for them include “maintaining and restoring forest health, salvaging dead and dying timber, providing high-quality wildlife and fish habitat, and providing economic opportunities in rural communities by making timber and other forest products, including biomass, available from vegetation management treatments” (BLM 2006l). Management techniques for BLM-administered forest lands include grazing restrictions, selective thinning of undergrowth and dead wood, prescribed burns, and selective harvesting of trees. Adverse environmental impacts on air quality, water quality, habitat, and threatened and endangered species could occur as a result of these management practices. For example, increased erosion after land clearing could cause siltation in streams and decrease water quality.

Recreation. One mission of the BLM is to accommodate recreational use of public lands, such as fishing, hiking, horseback riding, mountain biking, camping, and OHV use. However, these uses can have adverse environmental impacts. For example, OHV use can result in soil compaction, increased erosion, and the proliferation of non-native plant species. Overuse of trails in primitive areas can also result in erosion and disturbance of threatened and endangered species habitat. Other ways by which recreational visitors can affect the environment include producing waste, emitting air pollutants from motorized vehicles, and using water. However, recreational use also has benefits, including allowing visitors to enjoy outdoor wilderness areas and reduce their stress, and stimulating economic growth in the area. The BLM works to minimize the adverse environmental impacts of recreational use by managing the activity. Examples of plan requirements include habitat improvement projects in recreational areas, construction of recreational use facilities that lead to decreased random use and degradation of wild areas, and waste management (BLM 2006m).

6.1.5.2 Projected Levels of Major Activities in the Study Area

Data on past, current, and planned future activities on BLM-administered lands and also on nonfederal lands were obtained mainly from various BLM RMPs and EISs available through the field offices. Also, because projected developments have been changing rapidly, particularly for oil and gas development, field office staff were contacted to obtain their best current estimates for projected activities in the areas of oil and gas development (both on public and private lands), coal development, other minerals development, energy development, and other activities (e.g., grazing, fire management, forestry, and recreation) over the 20-year time period between 2007 and 2027. The projected levels of major activities are summarized in Table 6.1.5-4 for Colorado, Table 6.1.5-5 for Utah, and Table 6.1.5-6 for Wyoming.

TABLE 6.1.5-4 Projected Levels of Major Activities on BLM-Administered and Nonfederal Lands Considered in Cumulative Impacts Assessment for Oil Shale Development in Colorado[a]

	Individual Colorado Field Offices					
Activity	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	Summary for Field Offices
Oil Shale						
Oil shale development on PRLAs (federal lands)	None	None	Up to 5 in situ projects on 5,120 acres of PRLAs (total of 25,600 acres).	None	None	See White River.
Oil shale development on nonfederal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown	Potential unknown	Potential unknown; development unlikely to occur within next 10 years due to R&D and permitting requirements.
Oil and Gas						
Recoverable oil and gas reserves	NA	15.4 TCF gas (9 TCF on federal lands); oil ~15 BB (BLM 2006i).	86.7 MMCF gas, 11.5 MB oil over 20 yr [1997–2016] (BLM 1996).	21 TCF federal lands gas; 175.6 MB federal oil (BLM 1986b).	NA	>36 TCF gas; >5 BB oil
Potential oil and gas wells drilled/yr over next 20 yr (2007–2027)[c]	60 wells/yr (BLM 1999a) (based on 1,200 total over 20 yr [2000–2019]; assume same annual rate.	185 wells/yr (based on 3,691 total over 20 yr [2005–2024]; 1,570 on federal lands, 2,121 private) (BLM 2006i).	1,060 wells/yr (Hollowed 2007) (based on 21,200 total over 20 yr).	152 wells/yr (Thompson 2006a) (based on 3,031 total over 20 yr).	50 wells/yr (based on 1,000 over 20 yr [1986–2005]; assume same annual rate).	~1,500 wells/yr
Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[d]	150–900	460–2,800	2,650–16,000	380–2,300	125–750	3,800–23,000 acre/yr

TABLE 6.1.5-4 (Cont.)

	Individual Field Offices					
Activity	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	Summary for Field Offices
Oil and Gas (Cont.)						
Wells to be abandoned annually over next 20 yr (2007–2027)[e]	15 wells/yr	46 wells/yr	265 wells/yr	38 wells/yr	13 wells/yr	~380 wells/yr
Geophysical (seismic) exploration projects[f]	NA	NA	NA	NA (Ernst 2006).	NA	NA (~3,200–6,400 acres/yr of temporary vegetation and habitat disturbance)
Coal						
Recoverable reserves (million tons)	1,600 (BLM 1983)—Grand Hogback field.	Not economically recoverable (BLM 2004a).	740 (BLM 1994b).	5,800 (BLM 1986b).	4,900	13,000 million tons
Predicted production over next 20 yr (2007–2027) (million tons/yr)	None (Thompson 2006a).	None	2–2.5 (Thompson 2006a).	29 (2005 statewide production was 39 million tons (EIA 2006a); Little Snake produces 75% of that (BLM 1986b).	0.3 initially, increasing to 4–6 (Thompson 2006a).	~38 million tons/yr
Surface area potentially leasable (acres)	29,000 (BLM 1983.)	None	118,000 (surface and subsurface) (BLM 1997a).	275,000 surface only; 457,000 (includes surface and subsurface acres); (BLM 1986c).	150,000 (Thompson 2006a).	At least 570,000 acres
Surface mining area potentially disturbed annually (acres/yr)	None (Thompson 2006a).	None	None (Thompson 2006a).	200 (based on current activity) (Thompson 2006a).	None (Thompson 2006a).	200 acre/yr

TABLE 6.1.5-4 (Cont.)

Activity	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	Summary for Field Offices
	Individual Field Offices					
Coal (Cont.)						
Surface area potentially disturbed for underground mine support facilities (total, 2007–2027) (acres)	None (Thompson 2006a).	None	500	500 (in addition to 1,000 currently disturbed) (Thompson 2006a).	500 (in addition to 100 currently disturbed) (Thompson 2006a).	1,500 acres
Other coal impacts	None known	None known	None known	None known	None known	None known
Other Minerals (Sodium, Locatable and Salable Minerals)						
Sodium reserves (billion tons)	Not known to occur	Not known to occur	32 (nahcolite); 19 (dawsonite) (BLM 1994b).	Not known to occur	Not known to occur	51 billion tons
Sodium production rate over next 20 yr (2007–2027) (tons/yr)	Not known to occur	Not known to occur	Unknown; current pilot scale at 6 tons/h nahcolite (BLM 1994b); leases have stipulation not to damage commingled/overlying oil shale.	Not known to occur	Not known to occur	Unknown
Surface disturbance from sodium production (acres/yr)	None	None	20 (Thompson 2006a).	None	None	20 acres/yr

TABLE 6.1.5-4 (Cont.)

	Individual Field Offices					
Activity	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	Summary for Field Offices
Other Minerals (Sodium, Locatable and Salable Minerals) (Cont.)						
Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, salt, limestone)	Numerous claims, no significant activity (BLM 1983); potential for limestone production for rock dust and power plant scrubbers (Thompson 2006a).	Not known to occur	Uranium/vanadium: post-WWII mining, none current (BLM 1994b).	Uranium—several areas favorable for deposits; increasing current activity; gold—significant placer gold potential; juniper limestone—disturb 3 acres/yr (Ernst 2006); others—relatively unexplored (BLM 1986b).	Uranium: high potential for renewal of mining in Uravan Mineral Belt; currently a surge of activity in staking and exploration (Thompson 2006a).	Expected increase in uranium/vanadium exploration and development; ongoing limestone production.
Salable minerals (gravel, sand, clay)	Limited, localized production expected.	Limited, localized production expected (BLM 2004a).	Demand is high in Rangely area (BLM 1994b).	Limited, localized production expected (BLM 1986b).	Limited, localized production expected.	Limited, localized production expected.
Energy Development						
Energy corridors (acres)	NA	NA	NA	NA	NA	Estimated 420 mi (262,000 acres) in Colorado; substantial portion in these field offices (DOE 2008).
Electric generating utilities	NA	NA	NA	NA	NA	~1,600 MW currently produced in region (80% from coal (EIA 2007); three new plants proposed for Colorado (~2,840-MW capacity [EPA 2002]).

TABLE 6.1.5-4 (Cont.)

Activity	Individual Field Offices					Summary for Field Offices
	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	
Energy Development (Cont.)						
Wind power	No planned projects	No planned projects; area not rated high in wind potential (BLM 2004a).	No planned projects	No planned projects; Little Snake Field Office wind rankings poor to fair (EIA 2006b).	No planned projects	Colorado currently produces 291 MW of wind power; no current plans for further development in this part of the state (AWEA 2006).
Other						
Forestry	NA	NA	Annual allowable harvest from 45 to 890 acres/yr (BLM 1994b).	Harvest levels 300,000 board ft in 1986, managed for sustained yield (BLM 1986b); assume same level through study period. 200 acres/yr Ponderosa pine, 50 acres/yr lodgepole pine, and 500 acres/yr pinyon/juniper woodland to be restored (BLM 2007e).	NA	Assume >300,000 board ft/yr production; total acres disturbed unknown.
Fire management	NA	NA	5,400 acres/yr prescribed burn (based on total for 1995–2009 [BLM 1994b]).	NA	1,800 acres/yr prescribed burn (based on total for 1985–1999).	NA (>7,200 acres/yr prescribed burn)
Geothermal (leasable)	NA (but 254 mi^2 with high potential) (BLM 1999a)	Area not rated high in geothermal potential (BLM 2004a).	NA	Low-temperature geothermal activity present; utilization local and limited (BLM 1986b).	NA	Geothermal development not expected.

TABLE 6.1.5-4 (Cont.)

	Individual Field Offices					
Activity	Glenwood Springs	Roan Plateau within Glenwood Springs but Assessed Separately	White River	Little Snake[b]	Grand Junction (BLM 1985b)[a]	Summary for Field Offices
Other (Cont.)						
Land and realty	NA	Lands on top of plateau would be retained (BLM 2006i).	NA	NA	NA	NA
Grazing and rangeland management	NA	Managed using combination of administrative, project, and best management practices (e.g., pasture and rest rotation, livestock exclusion, fences, and ponds) (BLM 2004a).	NA	NA	NA	NA
Special management areas, recreation	NA	Of 259 mi of routes, 163 mi to be designated for motorized use, 28 mi closed and reclaimed, 68 mi for administrative use. Hubbard Mesa open to OHV use (BLM 2006i).	NA	Developed recreation sites with established campgrounds, boat ramps, or other developed recreational facilities would be protected by a 40-acre NSO stipulation (BLM 2007e).	NA	NA
Vegetation	NA	NA	NA	NA	NA	NA
Noxious/invasive weeds	NA	NA	NA	NA	NA	NA

Footnotes on following page.

TABLE 6.1.5-4 (Cont.)

Abbreviations: BB = billion barrels; MB = million barrels; MMCF = million cubic feet; NA = information not available; NSO = No Surface Occupancy; OHV = off-highway vehicle; TCF = trillion cubic feet.

[a] Activities listed are those considered in addition to potential oil shale and tar sands development on federal lands. For the Grand Junction Field Office, the main reference citation is given in the title field. Other references are given with specific data. In general, values are rounded to two significant figures.

[b] The Little Snake Field Office does not contain potential oil shale development areas; however, it is included in this summary because of its proximity to the potential project area and extensive related potential future development.

[c] Includes projections for federal lands and, where available, nonfederal lands.

[d] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres/well from DOE (2006), 13 acres/well from White River RMP (BLM 1994b), net disturbance of 9.3 acres/well for Little Snake (Thompson 2006a), disturbance of 3.4 acres/well for Roan Plateau (BLM 2006i), 3 acres/well from Vernal Utah Planning Area (BLM 2002a), and 15 acres/yr from Moab Utah Planning Area (BLM 2005a).

[e] Assumes 25% of new wells would be abandoned annually (based on estimate for the Rawlins Wyoming Field Office) (Allison 2006). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[f] If information not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 1,600 wells drilled/yr, expect 32 to 64 projects/yr for Colorado overall.

TABLE 6.1.5-5 Projected Levels of Major Activities for Seven Planning Areas Considered in the Cumulative Impacts Assessment for Oil Shale Development in Utah[a]

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Oil Shale				
Oil shale development on PRLAs (federal lands)	Potential for one underground mining project on 5,120 acres of PRLA		None	None
Oil shale and tar sands development on nonfederal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown
Oil and Gas				
Recoverable oil and gas reserves	NA	NA	NA	NA
Potential oil wells drilled/yr over next 20 yr (2007–2027)[b]	76 wells (based on 2,055 total in VPA, 1,130 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]).	62 wells (based on 2,055 total in VPA, 925 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]).	30 wells total in RPA; 3 in HM only (includes oil, gas, and CBNG; based on 454 total over 15 yr [2005–2020]; 3/yr in HM only, as projected by BLM [2005c]).	Few (based on only 8 currently producing wells), discussion that no significant oil production expected in the future (BLM 2004b; Appendix 21).
Potential gas wells drilled/yr over next 20 yr (2007–2027)[b]	147 wells (based on 4,035 total in VPA, 2,195 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]).	143 wells (based on 4,035 total in VPA, 2,150 BC only over 15 yr [2003–2017] as projected by BLM [2005b]).	Included with potential oil wells drilled for HM PA.	55–95 wells (includes CBNG; based on 1,100–2,000 over 20 yr [2005–2024] as projected by BLM [2004b; Table 4-2;BLM 2008b]).

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Oil and Gas (Cont.)				
Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b]	4 wells (based on 130 total in VPA, 50 in DM over 15 yr [2003–2017] as projected by BLM [2005b]).	6 wells (based on 130 total in VPA, 80 in BC over 15 yr [2003–2017] as projected by BLM [2005b]).	Included with potential oil wells drilled for HM PA. HM coal field not likely to be developed for CBNG in the next 15 yr (2005–2020) (BLM 2005d).	Included with potential gas wells drilled for San Rafael PA; numbers above include Price Project: 545 wells/10 yr on 1,609 acres, 20–70 jobs; Ferron Project: 335 wells/5 yr, acres unknown. Impacts on mule deer populations and winter habitat (BLM 2004b).
Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c]	570–3,400 acres/yr total (190–1,100 oil; 370–2,200 gas; 10–60 CBNG).	540–3,200 acres/yr total (160–930 oil; 360–2,100 gas; 15–90 CBNG).	75–450 acres/yr RPA total; 9–45 HM (includes oil, gas, and CBNG).	140–1,400 acres/yr (includes gas and CBNG)
Wells to be abandoned annually over next 20 yr (2007–2027)[d]	57 wells total (19 oil; 37 gas; 1 CBNG).	54 wells total (16 oil; 36 gas; 2 CBNG).	8 wells in RPA total, 1 in HM (includes oil, gas, and CBNG).	14–24 wells (includes gas and CBNG)
Seismic exploration projects[e]	2–3 projects per yr (based on 45–75 total for Vernal, assume half in DM) over 15 yr (2003–2015) (BLM 2002a); 200–300 acres/yr disturbance.	2–3 projects per yr (based on 45–75 total for Vernal, assume half in BC) over 15 yr (2003–2015) (BLM 2002a); 200–300 acres/yr disturbance.	340 acres/yr disturbance (based on 5,100 total over 15 yr as projected by BLM [2005c]).	150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2004b]).
Coal				
Recoverable reserves (million tons)	Tabby Mountain Coal Field: ~320 million tons (BLM 2002a).	No known reserves (BLM 2002a).	Includes south part of Wasatch Plateau Coal Field: ~6,000 million tons; HM Coal Field: 20 million tons (Jackson 2006); Emery Coal Field: reserve information not available.	Includes northern part of Wasatch Plateau Coal Formation: ~690; Book Cliffs Coal Field: ~280; Emery Coal Field: ~240 (all 3 in million tons) (BLM 2004b; Section 3.3.5.2).

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Coal (Cont.)				
Predicted production over next 20 yr (2007–2027) (million tons/yr)	None (BLM 2002a).	None (BLM 2002a).	Wasatch Plateau Coal Field: 25; no production planned for HM (Jackson 2006). Emery Coal Field: no production information available.	Lila Canyon: 0.8–1; North Horn: 2–4; Willow Creek: 2–4 (BLM 2004b; Chapter 4).
Surface area potentially leasable (acres)	NA	None	NA	NA
Surface mining area potentially disturbed annually (acres/yr)	None	None	None	None
Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f]	None projected	None projected	500 acres	Most coal would be mined through underground mining methods (BLM 2004b; Section 3.3.5.2); 500 acres.
Other coal impacts	None known	None known	None known	Lila Canyon: 5-mi road, 550 round-trips/day on US 6, 150–200 jobs; North Horn: roads, power line, and infrastructure construction, EIS ongoing, start of operations unknown; Willow Creek: not currently leased, if operations begin, 250–300 jobs, surface disturbance, safety issues (BLM 2004b; Chapter 4).

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)				
Phosphate production over next 20 yr (2007–2027)	5,800 acres on BLM-administered land; 14,000 acres on private land (BLM 1993 and 2002a); assume 50% surface mining (i.e, 10,000 acres).	None (BLM 2002a).	None	None
Gilsonite production rate over next 20 yr (2007–2027) (tons/yr)	None (BLM 2002a).	60,000 (based on BLM projections for 2003–2017) (BLM 2002a).	None	None
Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt)	Minor to no activity (BLM 2002a).	Minor to no activity (BLM 2002a).	Uranium, vanadium, gold, copper: high potential for occurrence and development in HM area; exploration for economic quantities is continuing (BLM 2005d). One salt mine on west side of RPA to continue operations. Gypsum and salt production unlikely in next 15 yr, especially in HM area (BLM 2005d).	Gypsum: fairly large areas in southern and central parts of PA have high potential for development over the next 15 yr (2005–2020) (BLM 2004b; Section 3.3.5.1). Number of acres: NA.

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)				
Salable minerals (gravel, sand, clay)	Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a). Limestone: 30,000 tons/yr (based on USFS land production, most in DM) (BLM 2002a). Sand and gravel: some production, quantity unknown (BLM 2002a).	Stone: 30 tons/yr (based on 60 tons/yr total for VPA), 2003–2017 (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a).	For planning period of 2006–2020: 57 active sand and gravel disposal sites on BLM land; likely to continue producing ~20,000 yd^3/yr, additional sites on public land (BLM 2005d). Assume 2 permits at 6 acres/permit: 12 acres/yr. Clay: only small-scale development. Stone: continue at current rate of about 1–1,000 tons/yr (BLM 2005d). Humate production to continue on small scale at Factory Butte in HM (BLM 2005d).	Clay: current areas of active mining will continue over next 15 yr (2005–2020), unlikely that new deposits would be developed (BLM 2004b; Section 3.3.5.1). Sand and gravel, stone, humate: high potential areas near major paved roads would be developed 2005–2020 (BLM 2004b; Section 3.3.5.3).
Energy Development				
Energy corridors	NA	NA	NA	NA
Electric generating utilities	NA	NA	NA	NA

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Energy Development (Cont.)				
Existing power plants	NA	NA	NA	Hiawatha Cogeneration Plant, Questar Pipeline Dewpoint Plant, Sunnyside Cogeneration Facility, coal-fired PacifiCorp Hunter, Huntington and Carbon plants: all provide employment, emit NO_X, use water, decrease water quality. Planned PacifiCorp Hunter expansion: add 350 long-term jobs, increase NO_X and SO_X emissions, use and degrade water (BLM 2004b).
Other				
Forestry	NA	NA	NA	Logging on private lands (not quantified) (BLM 2004b; Section 4.2.2).
Fire management	5,500–7,800 acres/yr prescribed burns annually based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/ decade total in VPA (BLM 2005b; Table 2.3).	5,500–7,800 acres/yr prescribed burns annually based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/ decade total in VPA (BLM 2005b; Table 2.3).	NA	One prescribed burn of 5,000 acres every 2 yr (based on last 20 yr of data) (BLM 2004b; Section 3.2.10.4).

TABLE 6.1.5-5 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Other (Cont.)				
Land and realty	NA	NA	NA	Utah Department of Transportation—road improvements between 2006 and 2025 on US 6 between Green River and Spanish Fork (~3-mi widening, 12 mi of new asphalt). Also SR-10 corridor (5 mi) (BLM 2004b; Section 4.2.2)
Livestock	NA	NA	NA	NA
Special management areas, recreation	4–27 mi/yr nonmotorized recreational trails, and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in DM.	4–27 mi/yr nonmotorized recreational trails, and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in BC.	NA	NA
Vegetation	2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in DM.	2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in BC.	NA	NA
Soils/watersheds	NA	NA	NA	NA
Miscellaneous	NA	NA	NA	NA

TABLE 6.1.5-5 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Oil Shale				
Oil shale development on PRLAs (federal lands)	None	None	None	See Vernal
Oil shale and tar sands development on federal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown
Oil and Gas				
Recoverable oil and gas reserves	NA	>270 million bbl (Allison 1997)	NA	NA
Potential oil wells drilled/yr over next 20 yr (2007–2027)[b]	5–21 wells (includes gas, average of 13/yr, 195 total from 2005–2020 (BLM 2005e).	Few (only 47 exploratory wells currently in GSENM; ~200,000 acres of old leased land is under review) (BLM 1999b).	12–40 wells (includes gas, average of 26/yr, 390 total from 2005–2020 (BLM 2005a).	190–230 oil wells drilled/yr
Potential gas wells drilled/yr over next 20 yr (2007–2027)[b]	Included with potential oil wells drilled for San Juan PA.	None (BLM 1999b).	Included with potential oil wells drilled for MOAB PA.	350–390 gas wells drilled/yr
Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b]	None (BLM 2005f).	None (BLM 1999b).	1 well (based on three 5-spot well clusters between 2006 and 2020 [BLM 2005g]; assume same annual rate).	11 CBNG wells drilled/yr
Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c]	13–320 acres/yr (includes oil and gas).	NA	33–620 acres/yr total (30–600 [oil and gas]; 3–15 CBNG (similar to 225 total acres CBNG between 2006 and 2020) (BLM 2005g).	1,400–9,400 acres/yr
Wells to be abandoned annually over next 20 yr (2007–2027)[d]	2–8 wells (includes oil and gas) (BLM 2005e).	NA	6–20 wells (BLM 2005a).	140–170 wells abandoned/yr

TABLE 6.1.5-5 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Oil and Gas (Cont.)				
Seismic exploration projects[e]	150-acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2005e]).	NA	240-acres/yr disturbance (based on 3,600 total over 15 yr [2005–2020] as projected by BLM [2005a]).	NA (~1,300–1,500 acres/yr of temporary vegetation and habitat disturbance)
Coal				
Recoverable reserves (million tons)	San Juan Coal Field (530,000 acres; 60% privately owned) (BLM 1991a), 77 million tons available to surface mining; no current production because of poor quality/lack of rail transport (BLM 2005f).	NA	NA (Sego Formation produced ~3 million tons up through the 1950s) (BLM 2005g).	~7.6 billion tons
Predicted production over next 20 yr (2007–2027) (million tons/yr)	None (BLM 2005f).	None (BLM 1999b).	None (BLM 2005g).	30–34 million tons/yr (approximately 87% from underground mining; 17% from surface mining).
Surface area potentially leasable (acres)	NA	NA	NA (Sego Formation may be attractive for future production because of low sulfur content, close to railway).	NA
Surface mining area potentially disturbed annually (acres/yr)	NA	NA	NA	NA
Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f]	None projected	None projected	None projected	1,000 acres total 2007–2027

TABLE 6.1.5-5 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Coal (Cont.)				
Other coal impacts	None known	None known	None known	See San Rafael PA.
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)				
Phosphate production over next 20 yr (2007–2027)	None (BLM 2005f).	None (BLM 1999b).	None (BLM 2005g).	10,000 acres surface disturbance (see DM)
Gilsonite production rate over next 20 yr (2007–2027) (tons/yr)	None (BLM 2005f).	None (BLM 1999b).	None (BLM 2005g).	60,000 tons/yr gilsonite (see BC)
Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt)	Uranium/vanadium: 4.2 million-ton reserves in Four Corners area–estimated disturbance of 20 acres/yr for next 15 yr (2005–2020) (BLM 2005f). Gold: 5–20 acres total disturbed for next 15 yr in Recapture Creek and Johnson Creek (BLM 2005f). Limestone: 20–30 thousand tons/yr, 20–50 acres total disturbed for next 15 yr (BLM 2005f).	Uranium/vanadium: deposits present (Allison 1997), not to be developed (BLM 1999b). Alabaster: ongoing production of 300 tons/yr, from surface, not usually quarried.	Uranium/vanadium: >1-million ton ore reserves; estimated disturbance of 10 acres/yr for next 15 yr (2005–2020) (BLM 2005g). Copper: Lisbon Valley Project, produce for 10 yr (2006–2015); disturb 110 acres/yr (1,103 total, includes 266-acre pad for leaching, processing plant, ponds, 11-mi power line). Salt/potash: 3.3 acres/yr (50-acres disturbance total over next 15 yr [2005–2020] BLM 2005g).	Uranium/vanadium: high potential for development with at least 30 acres/yr surface disturbance. Gold: at least 5 acres/yr disturbed; Limestone: at least 20 acres/yr disturbed. Gypsum: high potential for development, acres NA. Alabaster: 300 tons/yr, acres NA. Salt: at least 3 acres/yr disturbed. Copper: at least 110 acres/yr disturbed. Total: at least 170 acres/yr disturbed.

TABLE 6.1.5-5 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)				
Salable minerals (gravel, sand, clay)	Sand and gravel: 4 permits/yr producing ~127,000 yd^3/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005f). Building stone: 5–10 acres/yr over next 15 yr (2005–2020) (BLM 2005f).	Sand and gravel: limited production for local use (Allison 1997).	Sand and gravel: 4 permits/yr producing ~60,000 yd^3/yr, 6 acres/permit; thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005g). Building stone: ~0.5 acres/yr over next 15 yr (1 new facility, producing 5,000–10,000 tons/yr for 5 yr between 2006 and 2020) (BLM 2005g).	Sand and gravel: at least 60 acres/yr disturbed. Stone: at least 6 acres/yr disturbed. Clay: no new deposits to be developed.
Energy Development				
Energy corridors	NA	NA	NA	Estimated 640 mi (356,000 acres) in Utah; a portion of the corridor is expected to be sited near the oil shale resource (DOE 2008).
Electric generating utilities	NA	NA	NA	3,200 MW currently produced in region (98% from coal) (EIA 2007). Three new plants proposed in Utah (~1,570-MW capacity [EPA 2002]).
Existing power plants	NA	None	NA	See San Rafael PA.
Other				
Forestry	NA	NA	NA	See San Rafael PA.

TABLE 6.1.5-5 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Other (Cont.)				
Fire management	NA	NA	NA	NA (at least 13,500 acres/yr prescribed burn)
Land and realty	NA	NA	NA	See San Rafael PA (roadwork planned).
Livestock	About 2.1 million acres used for grazing (BLM 1986d).	NA	NA	NA (About 2.1 million acres used for grazing in Monticello PA.)
Special management areas, recreation	About 1.3 million acres used for recreation (BLM 1986d)	~6 acres/yr disturbed (total of 85 acres over 15 yr [2000–2014] for recreation and campsites (BLM 1999b).	NA	NA (motorized and nonmotorized trails and campsites to be developed)
Vegetation	NA	1,000–3,000 acres/yr for vegetation restoration through burning (20,000 acres total for 2000–2014).	NA	At least 3,300 acres/yr vegetation treatment or burning for restoration.
Soils/watersheds	NA	<1 acre/yr (10 sites at 1 acre/site) (BLM 1999b).	NA	NA (at least 1 acre/yr disturbance)
Miscellaneous	NA	~17 acres/yr for utility and road ROWs and communications sites (260 acres total over 15 yr [2000–2014] [BLM 1999b]).	NA	NA (at least 17 acres/yr disturbance)

Footnotes on following page.

TABLE 6.1.5-5 (Cont.)

Abbreviations: BC = Book Cliffs; BCF = billion cubic feet; CBNG = coal bed natural gas; DM = Diamond Mountain; GSENM = Grand Staircase–Escalante National Monument; HM = Henry Mountain; NA = information not available; PA = planning area; RPA = Richfield Planning Area; STSA = Special Tar Sand Area; USFS = Forest Service; VPA = Vernal Planning Area.

[a] Activities are those considered in addition to potential oil shale and tar sands development on federal lands. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres from DOE (2006), 3 acres from Vernal Mineral Potential Report (BLM 2002a), and 15 acres from Moab PA (BLM 2005a). The 2.5 to 15-acre range encompasses estimates for San Rafael of 7.9 acres/well + 20-acres/ancillary facility (BLM 2004b; Appendix 21); Henry Mountain (4 acres/well + 8 acres/well for roads) (BLM 2005c); and Monticello (9.6 acres/well) (BLM 2005e).

[d] Generally assumes that 25% of new wells would be abandoned (based on estimate for the Rawlins Wyoming Field Office [Allison 2006]). Assumes 50% for Moab (BLM 2005a) and 40% for Monticello (BLM 2005e). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[e] If information not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 550 to 630 wells drilled/yr, expect 11 to 26 projects/yr for Utah overall.

[f] For areas where coal mining is ongoing and subsurface, a limited amount of surface disturbance over the 20-year study period was assumed (i.e., 500 acres).

TABLE 6.1.5-6 Projected Levels of Major Activities Considered in Cumulative Impacts Assessment for Oil Shale Development in Wyoming[a]

	Individual Wyoming Field Offices			
Activity	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Oil Shale				
Oil shale development on nonfederal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown
Oil and Gas				
Recoverable oil and gas reserves	20–60 BCF gas; 63–260 MB oil (Easley 2006).	NA	31–47 TCF gas; 55 MB oil; 748 MB natural gas liquids (Allison 2006).	>31–47 TCF gas; ~120–320 MB oil; ~750 MB natural gas liquids
Potential oil and gas wells drilled/yr over next 20 yr (2007–2027)[b]	100 wells/yr (Easley 2006) (includes oil and gas; based on 2,040 total over 20 yr; includes Moxa Arch, Bear River Divide and Darby Thrust).	140 wells/yr (based on 4,207 wells over 20 yr for Hiawatha project, 66% in Wyoming [BLM 2006n]; also 61 wells total for Bitter Creek [BLM 2005h]).	482 wells/yr (Continental Divide/Creston, 8,850 wells; Desolation Flats, 592 wells; Atlantic Rim, 200 wells; over 20 yr) (Allison 2006).	~720 wells/yr
New CBNG wells drilled/yr over next 20 yr (2007–2027)[b]	30 wells/yr (based on 640 total over 20 yr [2004–2023] projected by BLM [2004d]).	Included with oil and gas above.	157 wells/yr (Continental Divide/Creston, 100 wells; Atlantic Rim, 1,800 wells; Seminoe Rd, 1,240 wells; over 20 yr) (Allison 2006).	~190 wells/yr
Annual surface disturbance over next 20 yr (2007–2027) acres/yr[c]	330–2,000 (based on 130 wells/yr).	350–2,100 (based on 140 wells/yr).	1,600–9,600 (based on 640 wells/yr).	2,300–14,000 acres/yr
Wells to be abandoned annually over next 20 yr (2007–2026)[d]	20–33 wells/yr (15% [Easley 2006] to 25%).	35 wells/yr	160 wells/yr	220–230 wells/yr

TABLE 6.1.5-6 (Cont.)

Activity	Individual Wyoming Field Offices: Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Oil and Gas (Cont.)				
Geophysical (seismic) exploration projects[e]	2–4 projects/yr within the Kemmerer Field Office area (Easley 2006).	3 projects/yr: Hay River, South Jonah (subsurface data on 400 mi^2), LaBarge 3D (BLM 2004c).	4–5 projects/yr within the Rawlins Field Office area (Allison 2006).	9–12 projects/yr; ~900–1,200 acres/yr of temporary vegetation and habitat disturbance.[d]
Monell enhanced oil recovery project	NA	A total of 126 wells drilled between 2006 and 2012 (80 on non-BLM-administered lands); total initial disturbance 1,100 acres; net disturbance after 20–25 yr 260 acres (BLM 2006o).	NA	Land disturbance: 1,100 acres gross; 260 acres net.
Coal				
Recoverable reserves (million tons)	66 (BLM 1986a).	NA (35 for Black Butte Coal Co. Pit 14, surface mining site only (BLM 2006c); 122 for Ten Mile Rim subsurface, includes private (BLM 2004g).	2,489 (surface mineable) (BLM 2004e).	>2,700 million tons
Predicted production over next 20 yr (2007–2027) (million tons/yr)	4–5 current; annual 0.8% increase (based on predictions for 2005–2015 [BLM 2004d]).	6–9 (based on projection for Sweetwater County through 2010 [Lyman and Jones 2005]). Individual projects: 1.5–3 tons/yr (permitted for 7) for 20 yr from Black Butte (BLM 2006p); 4.5–5.5 tons/yr for 15–20 yr from Ten Mile Rim (BLM 2004g).	None (Allison 2006).	10–14 million tons/yr

TABLE 6.1.5-6 (Cont.)

Activity	Individual Wyoming Field Offices: Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Coal (Cont.)				
Surface area potentially leasable (acres)	NA	453,000 (30,000 of this already leased) (BLM 1997b).	56,000 (5,000 Carbon Basin only) (BLM 2004e).	NA (at least 510,000 acres)
Project area (acres)	8,600 (Easley 2006).	4,500 (2,200 at Black Butte [BLM 2006p], 2,242 total at Ten Mile Rim but only 124 disturbed [BLM 2004g]).	None (Allison 2006).	~13,000 acres
Subsurface area potentially disturbed (acres)	6,900 (BLM 1986a).	2,200 (BLM 2004g).	None (Allison 2006).	~9,100 acres
Surface mining area potentially disturbed annually (acres/yr)	430 (project area/20-yr project duration).	120 (project area/20-yr project duration).	0 (Allison 2006).	550 acres/yr
Sodium/CO_2				
Known sodium reserves (billion tons)	114	NA	NA	NA (at least 114 billion tons)
Sodium production rate over next 20 yr (2007–2026) (million tons/yr)	12 (underground mines—rate in 2002, BLM projects no new leasing, permits, or off-lease drilling over life of plan [BLM 2004d]).	6 (underground mines) (Nara-Kloepper 2006)	None	18 million tons/yr (all from existing underground mines)
New sodium facilities	2006—subsurface solution mine and processing plant (BLM 2004d).	NA	None	One subsurface solution mine and processing plant.

TABLE 6.1.5-6 (Cont.)

Activity	Individual Wyoming Field Offices: Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Sodium/CO_2 (Cont.)				
Sodium production surface disturbance (acres/yr)	Minimal surface disturbance over next 20 years (Easley 2006).	Minimal surface disturbance over next 20 years (Nara-Kloepper 2006).	None	Minimal surface disturbance over next 20 years.
CO_2 production	Shute Creek Gas Plant, 435 M ft^3/day in 2001 (BLM 2004d).	None known	None known	~160 BCF CO_2 production/yr
Locatable Minerals (e.g., precious metals/gems, uranium, bentonite)				
Uranium	None projected	Uranium production potential low (BLM 2004c).	Little, if any, production expected (Allison 2006); reserves: >58 million lb (BLM 2004e).	Limited, if any, uranium exploration and development expected.
Magnetite	None projected	None projected	Little, if any, production expected (Allison 2006); reserves: ~30 million tons massive ore, 148 million tons disseminated ore (BLM 2004e).	Limited, if any, magnetite production expected.
Gold	Limited deposits have been identified; very limited if any activity expected (BLM 2004d).	Potentially present; current activities disturb less than 5 acres/yr (BLM 2004c).	Little, if any, production expected (Allison 2006); reserves: >100 million tons of Fe-gold ore at 28–68% Fe (BLM 2004e).	Limited gold production expected, although reserves are present.
Diamonds	No current production, although diamond potential is rated as high (BLM 2004d).	Potentially present, but not recovered to date (BLM 2004c).	None projected	Limited, if any, diamond production expected.

TABLE 6.1.5-6 (Cont.)

	Individual Wyoming Field Offices			
Activity	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Locatable Minerals (e.g., precious metals/gems, uranium, bentonite) (Cont.)				
Bentonite	Known to occur, not produced because of co-placement with coal (BLM 2004d).	None projected	None projected	Limited, if any, bentonite production expected.
Salable Minerals (gravel, sand, clay)	Assume 475,000 tons/yr mined (based on 475,283 tons sold in 2002; demand expected to continue [BLM 2004d]). Two clay-producing companies, one on private land.	One 4-acre borrow area for sand and gravel in use. Clay uneconomical for production (BLM 2004c).	Assume 2.5 million tons/yr mined (based on current contracts that allow 21 million tons over 10 yr (2005–2014) [BLM 2004e] and anticipated increase [Allison 2006]).	NA (>3 million tons/yr mined)
Energy Development				
Energy corridors	NA	NA	NA	Estimated 440 mi (186,000 acres) in Wyoming; substantial portion in these field offices.
Electric generating utilities	NA	NA	NA	~3,600 MW currently produced in the region (85% from coal) (EIA 2007); 9 new plants proposed for Wyoming (5,930 MW [EPA 2002]).
Wind power	One 80-turbine facility operating in Uinta County; other proposals exist (BLM 2004f).	One 1–6 turbine facility proposed (BLM 2004c).	One 1,000-turbine facility, to disturb 6,020 acres, 45% to be revegetated, 100 additional acres/yr for miscellaneous (BLM 2004e).	Wyoming currently produces 290 MW of wind power (AWEA 2006); additional development expected.

TABLE 6.1.5-6 (Cont.)

Activity	Individual Wyoming Field Offices: Kemmerer	Individual Wyoming Field Offices: Green River/Rock Springs	Individual Wyoming Field Offices: Great Divide/Rawlins	Summary for Field Offices
Energy Development (Cont.)				
Pipelines	300 acres/yr short-term disturbance (over <5 yr) from pipelines, all to be reclaimed (Easley 2006).	NA	Overland Pass Pipeline: 780 mi from Opal Wyoming to Kansas; through all three field offices; would disturb total of 4,619 acres, 2,903 acres farmland; 10 acres surface facilities; employ 325–650 workers, 80% nonlocal (BLM 2007f).	NA (at least 300 acres/yr disturbed for pipeline construction)
Other				
Forestry	125 acres/yr (100% reclaimed)	NA	300 tons biomass removal/10 yr; 6,000 trees/yr thinned (BLM 2004e).	NA (>125 acres/yr)
Fire management	2,000 acres/yr prescribed burn (99% reclaimed) (Easley 2006).	NA	1,500–10,000 acres/yr prescribed burn (BLM 2004e).	NA (>3,500–12,000 acres/yr prescribed burn)
Land and realty	NA	Proposed Haul Road (includes 6 pipelines and 1 fiber optic cable; ROW = 400 ft construction; 200 ft operations) (BLM 2004c).	78 acres/yr disturbed—ditch and communications construction (BLM 2004e).	NA (at least 78 acres/yr disturbed)
Livestock	Approximately 6,160 acres to be maintained as public stock trails; reserve forage AUMs—no physical disturbance (BLM 1986a).	2 projects to increase game fish populations (BLM 2004c).	46 acres/yr (BLM 2004e)	NA (Land disturbance: at least 50 acres/yr)

TABLE 6.1.5-6 (Cont.)

Activity	Individual Wyoming Field Offices: Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	Summary for Field Offices
Other (Cont.)				
Special management areas, recreation	NA	Recreation activities assumed to require 290 wells over 20 years (BLM 2004c).	480-acre OHV area with 5 mo/yr use (BLM 2004e).	NA (disturb at least 500 acres total)
Vegetation	Vegetation manipulation proposed for 82,610 acres (~4,100 acres/yr) to improve wildlife habitat (BLM 1986a).	New riparian enclosures to mitigate sheep to cattle conversion impacts (BLM 2004c).	16,400 acres/yr treated (BLM 2004e).	~21,000 acres/yr vegetation treated
Noxious/invasive weeds	NA	NA	800–8,000 acres/yr treated.	NA (at least 800–8,000 acres/yr treated)
Soils/watersheds	NA	Eden/Farson Irrigation Project (supply for 17,000 acres) (BLM 2004c).	25 stream mi restored, 50 groundwater and precipitation monitoring sites.	NA (various projects)

Abbreviations: AUM = animal unit month; BCF = billion cubic feet; Fe = iron; MB = million barrels; MW = megawatts; NA = information not available; OHV = off-highway vehicle; ROW = right-of-way; TCF = trillion cubic feet.

[a] Activities listed are those considered in addition to potential oil shale and tar sands development on federal lands. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on Rawlins 7 acres/well (BLM 2004e), Rawlins Mineral Occurrence and Development Report (5 to 22 acres/well [BLM 2003]), Kemmerer, 3.5 to 6.5 acres/well (Easley 2006), Moab Utah Planning Area, 15 acres/well (BLM 2005a), and 2.5 acres/well (DOE 2006). The 22 acres/well estimate is not included in the range because it is for deep wells; very few deep wells are planned.

[d] Assumes that 25% of new wells would be abandoned annually (based on estimate provided for the Rawlins Field Office [Allison 2006]). All surface disturbance is assumed to be reclaimed within 10 yr of abandonment.

[e] Assumes 100 acres disturbed/project. This is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr.

6.1.5.2.1 Colorado

Oil Shale Development. As stated in Section 6.1.5.1.5, five PRLAs with a total area of 25,600 acres may be eligible for in situ oil shale developments in the future, assuming the RD&D leaseholders can meet BLM requirements. In addition, an unknown level of oil shale development could occur on nonfederal lands in the future.

Oil and Gas Development. In the Colorado study area, it is projected that a large amount of new oil and gas drilling and production would occur over the 20-year planning horizon. The largest amount is projected for the White River Field Office, for which a maximum of 1,060 wells drilled per year is predicted; the total projected new oil and gas wells for applicable field offices in the state is 1,500 per year (see Table 6.1.5-4), which includes wells both on federal and nonfederal lands (projections for nonfederal lands not available for all field offices).

Coal Mining. The largest coal reserves are in the Little Snake and Grand Junction Field Offices, with smaller amounts in the Glenwood Springs and White River Field Offices (see Table 6.1.5-4). Predicted production for all field offices combined is about 40 million tons/yr. About half of this production would be from surface mines, and half would be from underground mines.

Other Minerals Development. Metals produced in Colorado include copper (two mines), gold (seven mines, 1.2% of U.S. production), lead (two mines), molybdenum (two mines), silver (four mines), and zinc (one mine) (EPA 1997). In the ROI counties (i.e., Moffat, Rio Blanco, and Garfield), only sand and gravel and sodium bicarbonate are produced. Sand and gravel are produced in the Colorado River valley in Garfield County (Widmann 2002), just south of the oil shale area, and sodium bicarbonate is produced by Natural Soda, Inc., in Rio Blanco County (USGS 2004a). The sodium bicarbonate is solution-mined in the Piceance Basin; the plant produced 72,000 tons of sodium bicarbonate in 2004. Currently, uranium and vanadium are mined in Montrose County, to the south of the oil shale area. Although there are currently no operating mines, it is projected that uranium and vanadium mining would increase in the Grand Junction and Little Snake Field Offices over the study period, because there has been a recent increase in exploration.

Energy Development. Table 6.1.5-7 gives the projected miles and total acres of energy corridors on federal lands in Colorado under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2008). This development would be in addition to the existing 6,177 ROWs crossing public lands in Colorado as of 2005.

Table 6.1.5-8 summarizes the electric generating units operating in oil shale ROI counties in Colorado in 2005, including the primary fuel source for each plant and its electric power generating capacity. Of the 1,571 MW of nameplate power available from 25 generating units,

TABLE 6.1.5-7 Energy Corridors on Public Lands in the Three-State Area[a]

	Proposed Action	
State	mi	acres
Colorado	420	262,000
Utah	640	356,000
Wyoming	440	186,000

[a] Sources: DOE (2008).

89% was from five coal-fired generators. As of 2000, there were also three new plants proposed for Colorado with a total generating capacity of 2,840 MW (EPA 2002).

Other (Grazing, Forestry, Fire Management, and Recreation). Prescribed burns are used for fire management in the study area; a total of 7,200 acres per year are burned under current management practices. The BLM manages more than 5 million acres of forest lands in Colorado; the majority are in the western half of the state. Most (80%) of the forests are woodlands (forests dominated by low-stature trees such as pinyon and juniper). The net annual growth in forest lands has been estimated as 29 million ft^3 (BLM 2006l); the major causes of tree mortality have been insect damage and fires. Timber is harvested on BLM lands in the White River and Little Snake Field Offices.

6.1.5.2.2 Utah

Oil Shale and Tar Sands Development. As stated in Section 6.1.5.1.5, in the future, one PRLA with an area of 4,960 acres may be eligible for oil shale development using underground mining techniques, assuming the RD&D leaseholder can meet BLM requirements. In addition, an unknown level of oil shale and tar sands development could occur on nonfederal lands in the future. Potential tar sands development would predominantly affect resources in Utah in the Monticello, Price, Richfield, and Vernal Field Offices where the STSAs are located. The assumptions used for impact-producing factors for a single tar sands facility are given in Section 5.1.

Oil and Gas Development. In the Utah study area, far less oil and gas production are expected over the next 20 years than in Colorado. The largest amount is projected for the Vernal Planning Area, for which about 440 wells per year are predicted; the total projected maximum number of new oil and gas wells for applicable field offices in the state is 620/yr

TABLE 6.1.5-8 Electric Power Generating Units in ROI Counties in the Three-State Area in 2005[a]

State	Primary Fuel	No. of Generating Units	Combined Power (MW-nameplate)
Colorado	Coal	5	1,405
	Gas	9	131
	Oil	2	0.3
	Water	8	35
	Total	25	1,571
Utah	Coal	8	3,157
	Waste coal	1	58
	Water	5	5.4
	Total	14	3,220
Wyoming	Coal	9	3,055
	Gas	7	171
	Wind	16	287
	Water	10	99
	Oil	2	1.5
	Total	44	3,614

[a] ROI counties include Delta, Garfield, Mesa, Moffat, and Rio Blanco Counties in Colorado; Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne Counties in Utah; and Carbon, Lincoln, Sweetwater, and Uinta Counties in Wyoming.

Source: EIA (2007).

(see Table 6.1.5-5), which includes wells both on federal and nonfederal lands (projections for nonfederal lands are not available for all field offices).

Coal Mining. The largest coal reserves are in the Henry Mountain Planning Area, with smaller amounts in the San Rafael Planning Area (see Table 6.1.5-5). Predicted production for all field offices combined is about 30 to 34 million tons/yr. About half of this production would be from surface mines, and half would be from underground mines.

Other Minerals Development. Metals produced in Utah include copper (one mine), iron (two mines), phosphate (one mine), molybdenum (one mines), potash (three mines), silver (four mines), and uranium (one mine) (EPA 1997). In the ROI counties (Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne), only sand and gravel, gilsonite, clay, gypsum, dimension sandstone, lime, helium, and gold are produced (USGS 2004b). Phosphate production occurs in the Diamond Mountain area, and gilsonite production in the Book Cliffs area. Uranium/vanadium has a high potential for development in the Henry Mountain and San Juan Planning Areas; it would result in at least 30 acres/yr of surface disturbance. A limited amount of other minerals development is expected (see Table 6.1.5-5).

Energy Development. Table 6.1.5-7 gives the projected miles and total acres of energy corridors in Utah under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2008). This development would be in addition to the existing 5,120 ROWs crossing public lands in Utah as of 2005.

Table 6.1.5-8 summarizes the electric power generating units operating in oil shale ROI counties in Utah in 2005, including the primary fuel source for each plant and its electric generating capacity. Of the 3,220 MW of nameplate power available from 14 generating units, 98% was from eight coal-fired generators. As of 2000, there were also three new generating plants proposed for Utah, with a total capacity of 1,570 MW (EPA 2002).

Other (Grazing, Forestry, Fire Management, and Recreation). Although information is not available for every planning area, at least 13,500 acres/yr are planned to be used for prescribed burns under current management practices. Large tracts of land are used for grazing in the Monticello Planning Area.

The BLM manages more than 8 million acres of forest lands in Utah; the majority are in the southern half of the state, including the planning areas addressed in this PEIS. Most (more than 90%) of the forests are woodlands. The net annual growth in forest lands has been estimated as 9.2 million ft^3 (BLM 2006l). The major cause of tree mortality has been fires, followed by insect damage.

6.1.5.2.3 Wyoming

Oil Shale Development. There are no RD&D projects in Wyoming; thus, there are no PRLA lands that could be developed. As in Colorado and Wyoming, an unknown level of oil shale and tar sands development could occur on nonfederal lands in the future.

Oil and Gas Development. In the Wyoming study area, it is projected that a large amount of new oil and gas drilling and production would occur over the 20-year planning horizon. The total number of new oil and gas wells for applicable field offices in the state is projected to be 910 wells per year, with the largest amount, 635 wells/yr, projected for the Great Divide/Rawlins Field Office (see Table 6.1.5-6), which includes wells on both federal and nonfederal lands (projections for nonfederal lands not available for all field offices).

Coal Mining. Most of the coal reserves are in the Great Divide/Rawlins Field Office (i.e., about 2,500 million tons); however, no coal mining is currently planned in that field office over the study period (see Table 6.1.5-6). Predicted production for the Kemmerer and Green River/Rock Springs Field Offices is about 10 to 14 million tons/yr. Production from the Black Butte Coal Pit would be from surface mines, and production from the Ten Mile Rim area would be from underground mines.

Other Minerals Development. Wyoming is a large producer of uranium (two mines; >12% of U.S. production) (EPA 1997). In the ROI counties (Carbon, Lincoln, Sweetwater, and Uinta), only sulfur, helium, clay, sand and gravel, crushed stone, and sodium carbonate are produced (USGS 2004c). The largest projected development is for salable minerals (sand and gravel and clay) in Kemmerer County, which has ongoing production of about 480,000 tons/yr of these minerals. A very limited amount of other minerals development is expected (see Table 6.1.5-6).

Energy Development. Table 6.1.5-7 gives the projected miles and total acres of energy corridors in Wyoming under the proposed action of the Draft West-wide Energy Corridor PEIS (DOE 2008). This development would be in addition to the existing 15,775 ROWs crossing public lands in Wyoming as of 2005.

Table 6.1.5-8 summarizes the electric generating units operating in oil shale ROI counties in Wyoming in 2005, including the primary fuel source for each plant and its electric generating capacity. Of the 3,614 MW of nameplate power available from 44 generating units, 85% was from nine coal-fired generators. As of 2000, there were also nine new generating plants proposed for Wyoming, with a total generating capacity of 5,930 MW (EPA 2002). Wyoming also currently has a capacity of 290 MW of wind power, and more development is expected. Extensive short-term disturbance from pipeline construction could occur in association with planned projects (see Table 6.1.5-6).

Other (Grazing, Forestry, Fire Management, and Recreation). The BLM manages only about 1.7 million acres of forest lands in Wyoming. Almost half (47%) of the forests are juniper pine woodlands. Of Wyoming's forest lands, a large amount is classified as forest area (forests with primarily tall-stature trees such as limber and ponderosa pine) in contrast to woodland area (low-stature trees); forest areas make up about 50% of the total forest lands. The net annual growth in all forest lands has been estimated as 11 million ft^3 (BLM 2006p). The major cause of mortality for all tree types has been fires, followed by insect damage; however, insect damage caused a higher percentage of mortality in the tall-stature trees.

There is a small amount of BLM forest land in the three field offices addressed in this PEIS. Approximately 125 acres/yr of forest land is planned to be used for reclamation in the Kemmerer Field Office area during the study period.

Up to 12,000 acres/yr of planned burning is projected for all the field offices combined. Varying amounts of land disturbance are also projected for activities such as the management of livestock, recreation, vegetation, and weeds (Table 6.1.5-6).

6.1.5.3 Cumulative Impacts Assessment for the Possible Oil Shale Development That Could Occur under Each of the Alternatives, B and C

As stated above, and in Sections 6.1.2 and 6.1.3, with the possible exception of a change in local property values, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for application for commercial oil shale leasing. Therefore, there would be no cumulative impacts from these alternatives. However, direct, indirect, and cumulative impacts could occur as a result of future commercial oil shale development that could be facilitated by such land use plan amendments. The focus of this cumulative impacts assessment, then, is the impacts from this future development, rather than the impacts from the land use plan amendment decision. That is, the purpose of this cumulative impacts assessment is to discuss, in a qualitative way, how the environmental and socioeconomic conditions within the study area might be incrementally affected over the next 20 years (the study period) by oil shale development that could occur on lands made available for application for commercial leasing by the land use plan amendments under either Alternative B or Alternative C.

Potential impacts on resources associated with a single future commercial oil shale facility (whether the facility is on a PRLA associated with an RD&D project, on federal land within the footprint of any of the Alternatives, or on nonfederal lands), in conjunction with past, present, and reasonably foreseeable future other actions in the study area, are preliminarily assessed in this section. If and when applications to lease oil shale resources for commercial development are received and accepted by the BLM, where information is less speculative, a reasonably foreseeable development scenario (RFDS) will provide a broad and generalized effects analysis for the type and extent of effects from more than one facility. When individual project-level plans of development are received, these will provide specific technical information for analysis of the cumulative impacts of specific proposed oil shale facilities.

6.1.5.3.1 Land Use. Potential land use impacts associated with a single future commercial oil shale facility include the exclusion of grazing, recreation, and other mineral development land uses from lands used for oil shale development facilities and associated off-lease facilities (e.g., employer-provided housing, ROWs, and power plants if needed). Oil shale development could also alter the quality of lands with wilderness characteristics. Oil shale development facilities would disturb from 1,650 to 5,760 acres of public lands for the facilities themselves, and up to an additional 8,200 acres of lands for ROWs, employer-provided housing, and power plants (locations where these ancillary facilities will be sited are unknown, but are not expected to be on public lands). While the total amount of ground disturbance for an oil shale facility using in situ technology could equal that of facilities using mining technologies, the surface acreage disturbed at any one time might be considerably less depending on the cycle of preparation, production, and reclamation.

Table 6.1.5-9 presents estimates of the amount of land needed for other major industrial activities in the study area over the 20-year study period. These lands may be federal or nonfederal lands. As this table shows, land use in the three-state study area is characterized by an extensive amount of industrial activity that is expected to continue into the future. Depending on the number and types of oil shale facilities constructed and operating, future commercial oil shale development could contribute a substantial increment to the cumulative land use and disturbance impacts. Over a 20-year time horizon, a single oil shale facility could contribute 3 to 33% of total surface disturbance for the activities considered in each state (i.e., up to about 14,000 acres for a single oil shale project compared with the range of other disturbances of 69,000 to 470,000 acres, depending upon the state). If several oil shale leases are eventually granted relatively close to one another, this amount of leasing within a small area would result in substantial changes in land use in that area. Tar sands development, if it occurs, would also contribute to cumulative land disturbance impacts. Note that the projections given in Table 6.1.5-9 are very sensitive to the assumptions on amount of disturbance due to oil and gas development that will occur in the three states, with a particularly large range of possible disturbance in Colorado making the oil and gas land use estimates quite uncertain for Colorado.

As discussed in Section 6.1.5.2, many public lands are currently used as ROWs for short- and long-distance energy transmission. The Draft West-wide Energy Corridor PEIS (DOE 2008) could designate additional regional corridors on public lands for long-distance energy transmission ROWs. Under the proposed action of that PEIS, the proposed corridors include about 260,000 acres in Colorado, about 360,000 acres in Utah, and about 190,000 acres in Wyoming. Not all lands designated as energy corridors would be developed and/or disturbed; however, the percentage of potential disturbance is currently unknown. In each of the three states, a portion of these proposed corridors would fall within the potential oil shale development area. Should these proposed corridors be fully developed for energy-related ROWs, additional land use impacts in the region could be substantial.

6.1.5.3.2 Soil and Geologic Resources. Oil shale development could result in impacts on soil and geologic resources by increasing soil removal, soil compaction, and erosion. Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas would remain susceptible to these impacts until completion of construction, mining, oil shale processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs, surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-site infrastructure (such as access roads, utility ROWs, and power plants) would be located.

Oil and gas development, other minerals development, tar sands development, and construction of additional power plants would cause similar impacts on soil and geologic resources in the three-state study area. Table 6.1.5-9 gives estimates of the amount of land that could be disturbed for these activities over the 20-year study period. In each state, additional types of land use could also disturb soil. These would include, but not be limited to, agricultural development, grazing, recreation, forestry, and residential development. The potential impacts from these have not been quantified. Also as discussed in Section 6.1.5.3.1, large areas might be

TABLE 6.1.5-9 Summary of Cumulative Long-Term Land Use for Oil Shale Development and Other Major Industrial Activities

	Estimated Acres Disturbed[a]		
Activity	Colorado	Utah	Wyoming
Existing RD&D leases	800	160	0
Commercial oil shale development on federal lands or nonfederal lands[b]	Up to 14,000 per project	Up to 14,000 per project	Up to 14,000 per project
Commercial tar sands development on federal or nonfederal lands[c]	0	Up to 9,500 per project	0
Oil and gas development (acres/yr)	3,800–23,000	1,400–9,400	2,300–14,000
Coal development (acres/yr)	280	50	550
Sodium minerals (nahcolite and dawsonite) development (acres/yr)	20	0	0
Phosphate development (acres)	0	10,000	0
Proposed power plants[d]	5,700	3,100	12,000
Annual total by state, excluding oil shale and tar sands development	10,600–29,000	15,000–23,000	15,000–27,000
20-year totals, excluding oil shale and tar sands development	89,000–470,000	42,000–200,000	69,000–300,000
Three-state total acres disturbed		200,000–970,000	
Single oil shale facility (percent of 20-year total by state)	3–16	7–33	5–20

[a] Except where otherwise indicated, acreage estimates are the maximum projected totals from Tables 6.1.5-1, 6.1.5-2, and 6.1.5-3.

[b] Acreage estimates represent the maximum possible disturbance for commercial or RD&D projects, which includes 4,800 acres for a new electric power generating plant, if needed by a commercial operation.

[c] Acreage estimates represent the maximum possible disturbance for tar sands facilities (see Section 5.1).

[d] The acreages represent the estimated footprint of projected new power plant development in each state as discussed in Section 6.1.5.2, assuming that all would be coal-fired plants requiring 3,000 acres per 1,500 MW of capacity.

designated as energy corridors in each state, and their development would also contribute to total soil disturbance. All these activities could result in soil being displaced, stockpiled, eroded, or compacted. The disturbance could yield more sediment to surface waters; also, in areas with high salinity in the soils, the salt content in surface water could increase.

As shown in Section 6.1.5.3.1, impacts on soil and geologic resources from oil shale development could add a substantial increment to cumulative impacts on this resource. Impacts would increase with increasing numbers of oil shale facilities. A single facility could be associated with soil disturbance of up to about 14,000 acres.

6.1.5.3.3 Paleontological Resources. Disturbances from oil shale development, combined with other surface-disturbing development activities, could uncover and/or destroy fossils on BLM-administered land and on other lands. Given the surface disturbance projected from oil shale facilities and from other activities (Table 6.1.5-9) in the study area during the 20-year period, it is likely that many sites would require paleontological evaluations and subsequent mitigative actions. On the basis of the assumption that these evaluations and mitigative actions are conducted in accordance with existing regulations, there would be increased knowledge about paleontological resources in the region and increased protection of resources based on this knowledge. However, there would inevitably be some loss of information about individual sites and some adverse impacts. Resources lost from oil shale leasing and development would be in addition to those losses from other activities discussed in this section. Unless a concentration of unique resources was found to exist within a small area and that area was the location of oil shale development, the individual site losses from construction and operation of an oil shale facility would be unlikely to have a major incremental adverse impact on paleontological resources in the study area.

6.1.5.3.4 Water Resources. Ground disturbance along ROWs and near construction sites, mining sites, access roads, and river crossings could increase sediment and dissolved solid loads of streams downstream from disturbed sites. After the protective layers of soils are disturbed, the soils become vulnerable to soil erosion by surface runoff. Leaching of mine tailings and waste, overburden piles, and source rock piles would potentially bring organic and metal contaminants to nearby streams. Potential leaks (or spills) of oil or other petroleum products from pipelines are additional risks for contamination of surface water resources. Modification of surface drainage and water extraction could cause flow regime and morphological changes of stream channels. Most of the impacts would occur in the vicinity of the water bodies close to project sites and would be incremental. Other potential impacts on water resources are described in Section 6.1.5.1.

If oil and gas development, mining activities, and power plant construction continue to grow as projected from 2007 to 2027, the disturbed areas are estimated to increase by a total of 200,000 to 970,000 acres in Colorado, Utah, and Wyoming (Table 6.1.5-9). If a single oil shale facility is developed, it is projected to contribute about 3% to 16%, 7% to 33%, or 5% to 20% additional ground disturbance in Colorado, Utah, or Wyoming, respectively (Table 6.1.5-9). The incremental impacts on water resources caused by oil shale development in each state could be significant relative to these other activities. While the total amount of ground disturbance from oil shale development using in situ technologies could equal that of facilities using mining technologies, the surface acreage disturbed at any one time might be considerably less depending on the cycle of preparation, production, and reclamation.

The water uses and losses in the Upper Colorado Basin are shown in Figures 6.1.5-1 to 6.1.5-4. From the 1970s to the 1990s, the water uses increased, reflecting growth in agricultural and in municipal and industrial water uses (Figures 6.1.5-1 and 6.1.5-2). The export of Colorado River water to outside the Upper Colorado River Basin also increased gradually with time (Figure 6.1.5-3). From 1990 to 2000, the combined water use and losses in Colorado, Utah, and Wyoming within the Upper Colorado Basin fluctuated between 3,580 and 4,400 thousand ac-ft (Figure 6.1.5-4). This includes water losses from major and minor reservoirs, agricultural, and municipal and industrial water uses, and water transfers out of the basin. From 2001 to 2004, the combined water uses and losses dropped from 4,280 to 3,400 thousand ac-ft (primarily through declining agricultural water uses) because of drought conditions (BOR 2004, 2005, 2006).

To preliminarily assess cumulative water use in the study area over the next 20 years and the potential impacts of oil shale development, water use projections for oil and gas development, coal mining, and power generation are compared with water use for individual oil shale facilities and with available water in the Upper Colorado River Basin (see Table 6.1.5-10). The sustainable, annually available water in the Upper Colorado River Basin was assumed to be 6,000 thousand ac-ft per year (SWCA 1997) (a prolonged drought condition may decrease this water availability.) The total amount of legally apportioned water available to Colorado, Utah, and Wyoming is 5,280 thousand ac-ft per year. The water transfer out of the Upper Colorado River Basin fluctuates, but was assumed to remain in the same range (540 to 800 thousand ac-ft/yr) as for 1970 to 2004 (Figure 6.1.5-3). Also, the currently combined water uses for agricultural, municipal, and industrial activities were assumed to remain at the same level as those found in 1990 to 2000 (i.e., 3,600 to 4,400 thousand ac-ft/yr; Figure 6.1.5-4).

Therefore, currently available water would be between 80 and 1,140 thousand ac-ft/yr in the three states. The water requirement for individual commercial oil shale facilities is estimated to be from about 5 to 35 thousand ac-ft/yr of water, depending on the technology being used, while the combined water needed for oil and gas, coal mining, and new power plants would be about 68 thousand ac-ft/yr (Table 6.1.5-10). There will be additional water needed to support regional population growth, potential water exports to areas outside the Upper Colorado River Basin, new instream flow water rights for protecting endangered species, and possibly for tar sands development. The level of oil shale development that could be supported by available water over the next 20 years depends on the type of technology used, the scale of the development, and the other competing uses of water at the time of development. Another alternative to make more water available is to transfer water from current agricultural use to industrial use. Any water transfer and new water development must meet different state and federal regulations. Eventually, whether enough water is available for oil shale development depends on the results of negotiations among various parties, including water right owners, state and federal agencies, and municipal water providers as well as the developers.

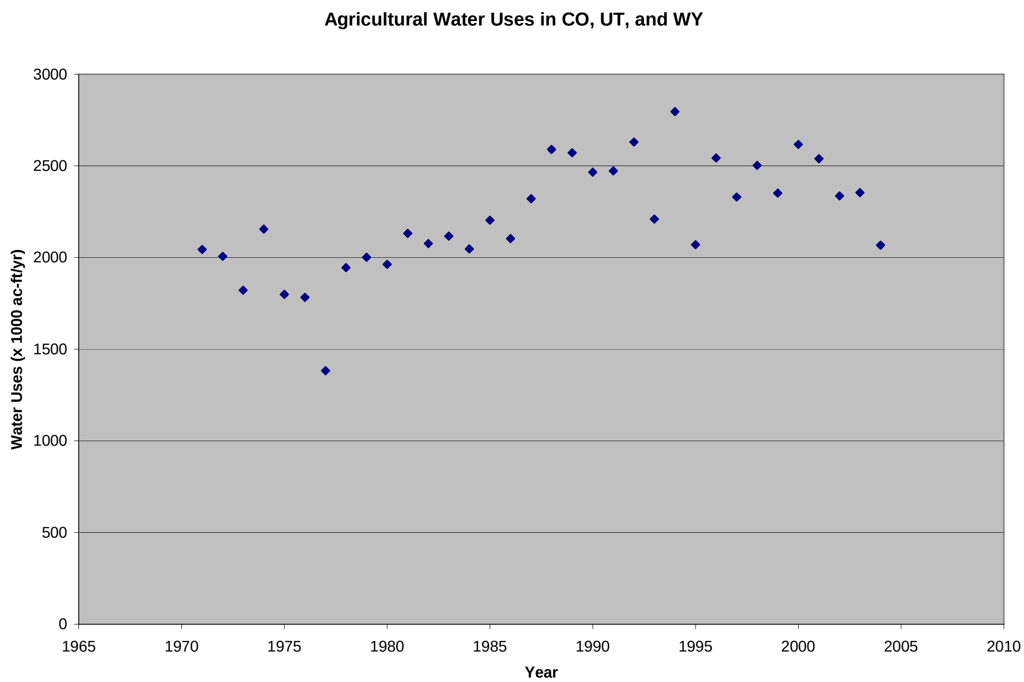

FIGURE 6.1.5-1 Agricultural Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

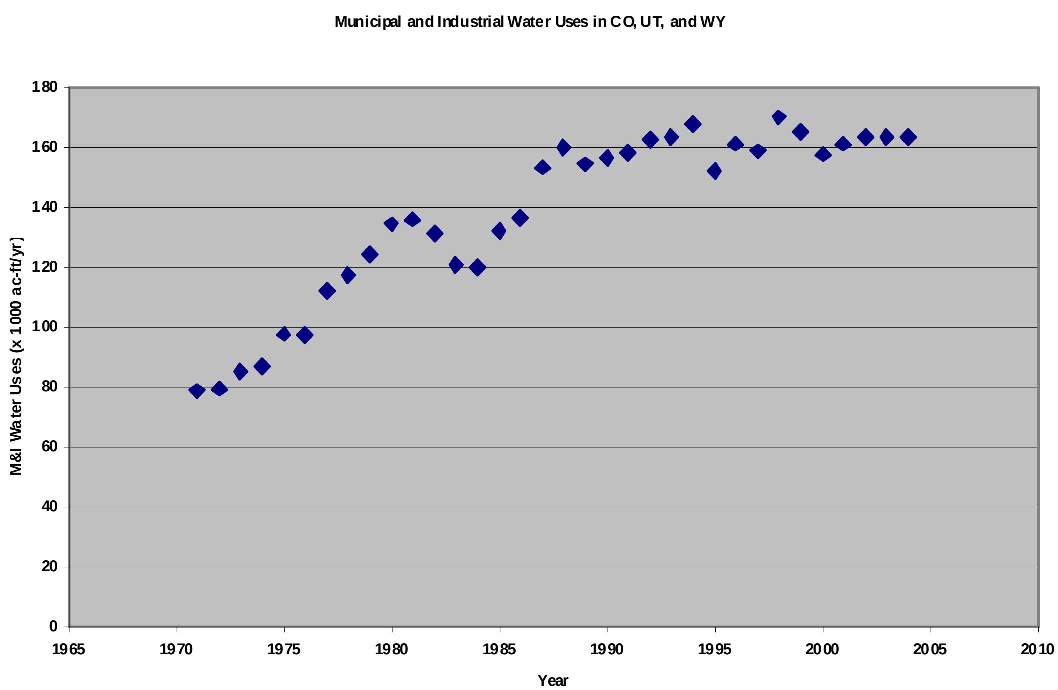

FIGURE 6.1.5-2 Municipal and Industrial Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

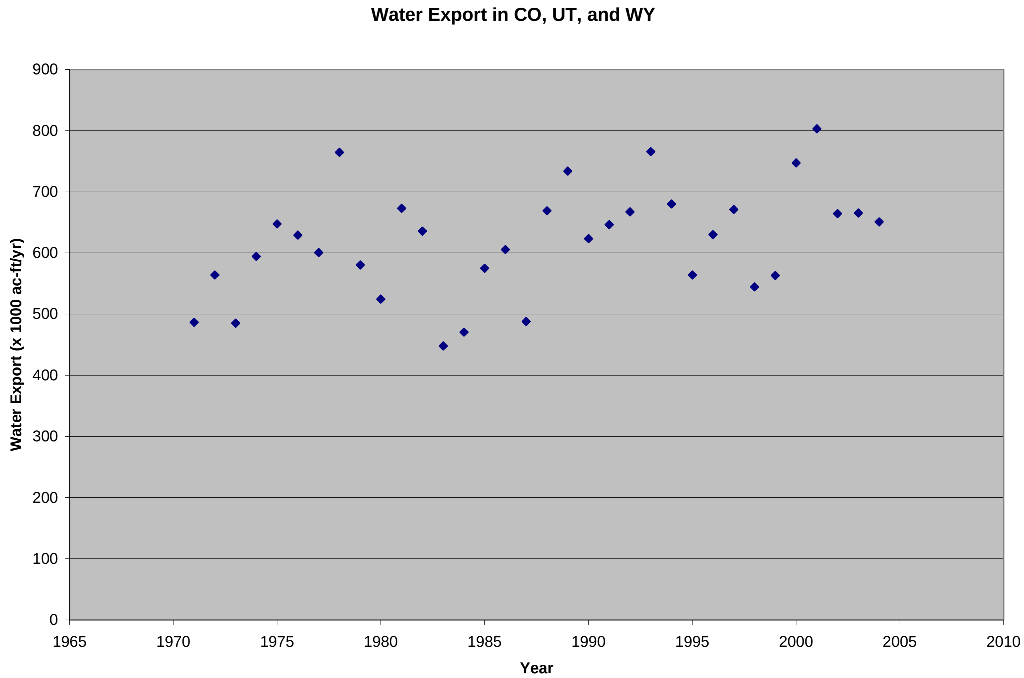

FIGURE 6.1.5-3 Water Exports from the Upper Colorado River Basin in Colorado, Utah, and Wyoming from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

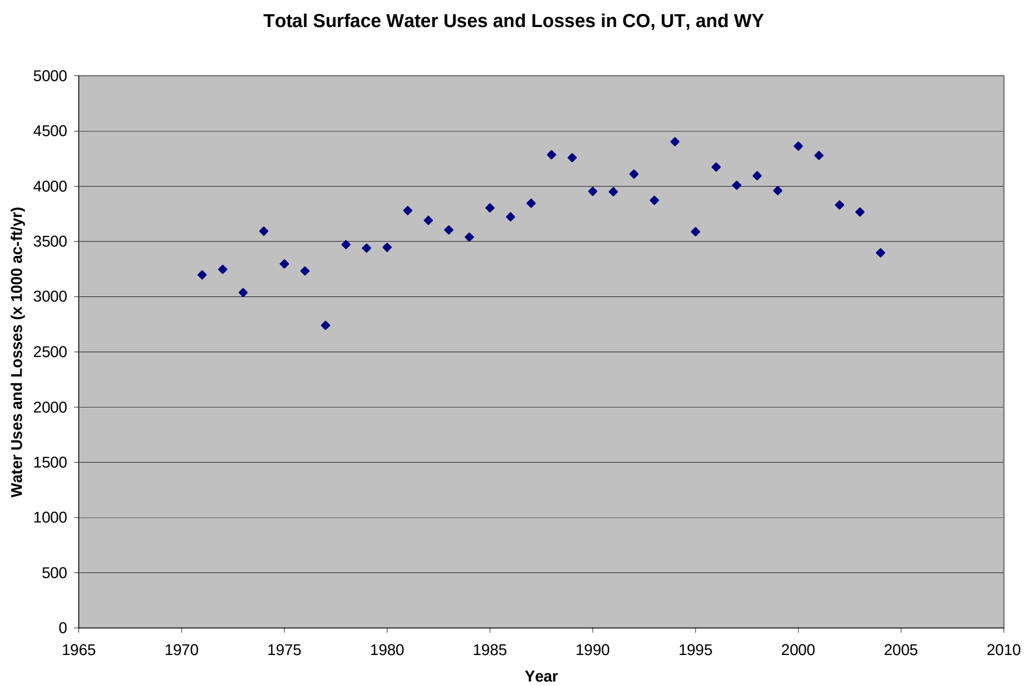

FIGURE 6.1.5-4 Combined Water Uses and Losses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

TABLE 6.1.5-10 Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Oil Shale Development (× 1,000 ac-ft/yr)

Available Water and Water Use	Annual Volume
Amount of legally available water from the Colorado River	5,280
Consumptive uses, including export, agricultural, M&I, and evaporation	4,140–5,200
Range of net amount available	80–1,140
Water use estimates for oil shale and tar sands	
Commercial oil shale development on federal or nonfederal lands (individual 200,000 bbl/day in situ facility and ancillary facilities, including power plant)[a]	19–35
Commercial oil shale development on federal or nonfederal lands (individual 50,000 bbl/day surface mine/surface retort or underground mine/surface retort facility and ancillary facilities)[a]	4.9–7.4
Commercial tar sands development on federal or nonfederal lands (individual 20,000 bbl/day tar sands facility)[a,b]	<1–5.4
Water use for other development	
Oil and gas[c]	1.6
Coal mining[d]	13.4
Power plants[e]	53
Total other development	68

[a] Includes processing and human consumption (see Table 4.5.2-1).

[b] See Table 5.5.2-1.

[c] Assumes that 3,000 wells are drilled per year and that each uses 0.55 ac-ft of water.

[d] Assumes 82 million tons of production per year; 20 million gal of water per million tons of coal mined is assumed for coal preparation and 35 million gal of water per million tons of coal mined is assumed for dust control.

[e] Assumes a total of 9,940 MW new production from coal-fired power plants; water consumption of 8,000 ac-ft/yr per 1,500 MW (see Section 6.1.5.1.4).

Sources for water availability: SWCA (1997); BOR (2004, 2005, 2006).

Meeting the water requirements also depends on how many facilities would be constructed, the technologies used, and the location of the sites. For example, the water demand in northwestern Colorado is more than twice its water consumption. Though the consumption is below the state's legally allocated water amount as specified by the Upper Colorado River Basin Compact, the current water demand already well exceeds the state's allocation. Alternatively, using water conservation practices and transferring agricultural water rights to industrial rights (including oil shale development) could make more water available if extensive oil shale development is desired. Currently, most of the water use in the Upper Colorado Basin is for agricultural purposes. The agricultural component ranges from 55% in the Upper Main Stem

(Colorado River and its tributaries above the mouth of the Green River) to 87% in the San Juan–Colorado area (Colorado River and its tributaries below the mouth of the Green River and above Lee Ferry, Arizona) (BOR 2004, 2005, and 2006).

6.1.5.3.5 Air Quality. Air resources in and around the study area would be affected by commercial development of oil shale. Local, short-term air quality impacts could be incurred as a result of PM and exhaust emission releases during construction activities. Similar short-term impacts could also occur in other areas where electric transmission or oil pipeline ROWs and other infrastructure would be developed. Longer term impacts on local and regional air quality could occur during normal project operations, such as mining, and processing of the oil shale, and construction and operation of off-lease infrastructure, including electric power plants, resulting in emissions of criteria pollutants and HAPs.

Oil and gas development, other minerals development, and other activities (e.g., agricultural development and residential development) would all involve impacts on local air quality during land clearing and construction because of increased PM emissions and exhaust emission from construction equipment. There could also be regional air quality impacts if these activities involve long-term emissions of criteria pollutants or HAPs at substantial levels. The incremental impact of oil shale development activities on total cumulative impacts would be assessed during future site-specific NEPA analyses.

6.1.5.3.6 Noise. Noise is a transient problem; its impacts do not accumulate in the environment as do air and water pollutants. Dissipation mechanisms, such as geometric spreading, ground effects, and air absorption, dissipate noise energy within short distances from noise sources. However, cumulative noise impacts could occur with oil shale development on both federal and nonfederal lands, oil and gas development, surface and underground mining of coal, production of other minerals, and energy development (see Tables 6.1.5-4 through 6.1.5-6); such impacts would depend critically on site-specific considerations and the proximity of the operations being considered to each other. The cumulative impacts of sufficiently separated noise sources are essentially the same as the noise impacts of each source considered separately. For example, the cumulative impacts of an oil shale or tar sands production facility and a gas or oil wellfield could be considerably different if the wells and pumps associated with the two facilities were only a mile apart than if they were separated by even a few miles.

Cumulative impacts also depend upon which phases in the lifetime of the sources being considered are occurring simultaneously. For example, construction associated with an oil shale facility would cause only a slight cumulative increase in the preexisting noise levels associated with a pumping station on an oil pipeline, while operation of the oil shale facility could cause a large increase over the preexisting levels around the facility and along nearby roads.

The construction noise impacts discussed in Section 4.7.1 are based on general considerations and are applicable to a wide range of construction projects. For many oil shale development projects, the leased area is large enough that noise levels would be below EPA guideline levels at the site boundaries. Because of the probable large distance between projects, it is unlikely that construction of oil shale facilities will cause a substantial incremental increase in noise impacts over those associated with existing and reasonably foreseeable future projects. However, the construction of large-scale commercial oil shale projects involving drilling of many wells could produce higher noise levels with larger cumulative impacts. Also, if oil shale development is close to other projects and construction and worker vehicles from both projects use the same roads, there could be cumulative noise increases due to increased traffic on local roads. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

As noted in Section 4.7, adverse noise impacts could be associated with the operation of commercial oil shale facilities. Drilling and pumping in oil and gas recovery fields could also contribute to high cumulative noise levels, and mining operations could cause high noise levels in the vicinity of the mine. If these other activities occur close to oil shale development operations, the possibility of substantial cumulative impacts exists; however, these impacts cannot be estimated at this time given the lack of quantitative estimates for oil shale facilities and the lack of data on specific locations of other development activities. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

6.1.5.3.7 Ecological Resources. Cumulative impacts of commercial oil shale development on ecological resources in the three-state study area would result from the past, present, and future impacts of a wide variety of human activities, including agricultural development and production, grazing activities, range management, timber harvest and management, residential and commercial development, recreational activities, water resource development projects, mineral resource development, and energy development. The current status of ecological resources as described in Section 3.7, reflects the cumulative impacts of past and present activities. This section focuses on the potential incremental impacts of the oil shale development alternatives and a set of reasonably foreseeable future actions that are expected to occur or that could occur over the next 20 years if commercial oil shale projects are developed. Reasonably foreseeable future projects include oil and gas development, coal mining, mining of metals and minerals, energy transmission, electrical generation, and other activities, including grazing, fire management, forestry, and recreation as described in Section 6.1.5.2.

The cumulative impacts of greatest concern to ecological resources in the study area include loss or degradation of habitat and habitat fragmentation related to land disturbance; loss of individuals in populations (especially those of rare species); and changes in the amount, availability, and quality of surface water resources. All other factors described in Section 4.8.1 have the potential to contribute to cumulative impacts, but their contributions would be relatively minor and more localized.

Section 6.1.5.2 presents available information on the projected levels of development for major activities in the study area. Major increases in land disturbance from reasonably foreseeable future projects total approximately 1 million acres for the projected 20-year study period in the three-state area of interest (see Table 6.1.5-9). Land disturbance associated with individual commercial oil shale facilities could be up to about 14,000 acres.

Water depletions associated with reasonably foreseeable future actions over the next 20 years represent significant increases in cumulative water use in the three-state study area (more than 68,000 ac-ft/yr of the 80,000 to 1.1 million ac-ft/yr potentially available). Existing water use in the three-state area totals 4.1 to 5.2 million ac-ft/yr. Water consumption associated with individual commercial oil shale development facilities would range from 5,000 to 35,000 ac-ft/yr; water consumption associated with individual commercial tar sands development facilities would range from less than 1,000 to 5,400 ac-ft/yr (see Table 6.1.5-10).

Cumulative impacts on aquatic resources; plant communities and habitats; wildlife; and threatened, endangered, and sensitive species are discussed below.

Aquatic Resources. The analysis of cumulative impacts on aquatic habitats and the organisms that inhabit those habitats considered the potential impacts of oil shale development in Colorado, Utah, and Wyoming, together with impacts from other anticipated development activities as described in Section 6.1.5.2. The types of factors associated with these activities would be similar to those described in Section 4.8.1 for the direct and indirect effects of oil shale development, including (1) direct disturbance of aquatic habitats; (2) sedimentation of aquatic habitats as a consequence of soil erosion from nearby areas; (3) changes in water quantity or water quality as a result of changes in surface runoff patterns, depletions or discharges of water into nearby aquatic habitats, or releases of contaminants into nearby aquatic systems; or (4) changes in human access to aquatic habitats.

Direct disturbance of aquatic habitats could result from activities that occur within water bodies or within the active channel of streams and rivers. Such disturbance could occur as a result of mineral (e.g., gravel) extraction from streambeds; construction of stream crossings for pipelines, transmission lines, and roads; driving vehicles through or using heavy machinery within active channels; and from livestock that walk through waterways. There is a potential for all of these activities to occur within oil shale areas, although it is generally anticipated that the related impacts would be relatively small and localized. Activities such as oil and gas development, mining, energy development, grazing, fires and fire management, and logging would affect erosion potential by disturbing soils and removing or altering vegetated cover. Such activities associated with other future projects are expected to result in a considerable increase in land disturbance over the 20-year project time frame in the three-state area and could result in a considerable increase in sediments entering aquatic habitats.

As described in Section 4.8.1.1, construction activities for oil shale development could also directly disturb aquatic habitats and alter the potential for erosion and sedimentation within affected areas, depending upon the specific locations of leased parcels, the routes selected for transmission lines, roads, and pipelines, and the configuration of structures used for crossing those habitats. Although the direct disturbance and sedimentation of aquatic habitats resulting from oil shale development would likely be somewhat localized, such development could contribute substantially to the cumulative level of such impacts within affected watersheds.

In the absence of project-specific information, it was assumed that the potential for direct habitat disturbance and soil erosion and the resulting sediment loading of nearby aquatic habitats is proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, the proximity to aquatic habitats, and measures that are implemented to control erosion and sedimentation. Individual oil shale projects would contribute substantially to additional surface disturbance over the 20-year development period as compared with other activities planned within the evaluated oil shale regions, depending on location and size.

Activities within stream channels and the construction or placement of roads, culverts, and water diversion devices across or in waterways have a potential to fragment aquatic habitats by blocking upstream or downstream movements of aquatic organisms as identified in Section 4.8.1.1. From a cumulative standpoint, some roadways, dams, water diversion devices, pipeline crossings, and other structures associated with existing development activities in the drainages associated with the oil shale basins may already contribute to such habitat fragmentation, and a large increase in such infrastructure would likely increase aquatic habitat fragmentation in the future. Areas surrounding and within the oil shale areas for which future allocation alternatives are being considered in this PEIS currently contain a large proportion of oil and gas wells, and the associated structures (such as roads and pipelines) that occur within the overall Colorado and Green River Basins and the addition of oil shale development would be expected to further increase such fragmentation. The application of appropriate mitigation measures, such as controls on the designs of stream crossings, would reduce the potential for significant cumulative impacts to occur.

From a cumulative perspective, water quality within the oil shale regions would also be affected by many human activities that introduce excess nutrients or contaminants into water bodies, including oil and gas development, coal mining, construction of additional power plants, and grazing of livestock. Oil shale development has the potential to contribute to degradation of water quality through the introduction of contaminants, either as leachate from spent oil shale or from spills or releases of oil, lubricants, and herbicides.

Within the arid regions of Colorado, Utah, and Wyoming where oil shale development would occur, water availability is of great concern and results in conflicts over balancing water needs for current and future development with water needed to maintain ecological conditions in aquatic habitats. The anticipated water needs for individual oil shale production facilities would range from 5,000 to 35,000 ac-ft/yr. One or more oil shale facilities utilizing amounts of water at the higher end of the range could certainly contribute substantially to adverse cumulative impacts on water availability.

Cumulative impacts on fisheries could result from increased public access to remote areas via newly constructed access roads and utility corridors and from the increased population levels that are likely to occur over the 20-year project period as a combined result of reasonably foreseeable actions. As discussed in Section 6.1.5.3.10, it is projected that there would be substantial population increases within the oil shale regions over the next 20 years. Each of the states in the ROI (Colorado, Utah, and Wyoming) has designated management authority for fishery resources to the state's fish and wildlife agency. As part of their management activities, these agencies routinely monitor the condition of specific fisheries within the state and establish and enforce regulations to maintain or improve the condition of those fisheries. Examples of regulations include limits on open fishing seasons and on the numbers, sizes, and species of fish that can be harvested from specific bodies of water. On the basis of the assumption that the effects of such regulations are monitored and adjusted effectively, the overall incremental and cumulative impacts on fishery resources with increased access due to potential oil shale and other development would be expected to be minor.

Plant Communities and Habitats. Wetland habitats have been severely impacted throughout the lower 48 states, including Colorado, Utah, and Wyoming, since the 1700s as a result of drainage and fill activities associated with agriculture, resource extraction, urban development, and other human activities. Wetland losses in Colorado from the 1780s to 1980s have been estimated to be approximately 50%, with 30% losses in Utah and 38% losses in Wyoming; however, the rate of loss is currently much lower than historic levels (Dahl 1990). Over the past several decades, federal agencies, such as the BLM, and state and private organizations have made considerable efforts to protect and restore wetlands and riparian habitats, and ongoing and planned wetland and riparian management programs are expected to continue to contribute to the improvement in wetland and riparian habitat function (BLM 2005i).

Human activities have also had an impact on terrestrial habitats in Colorado, Utah, and Wyoming for many years. Species composition and diversity have been affected by fire suppression, heavy grazing, introduction of invasive species, and other factors (BLM 2005i). Habitat losses, fragmentation, and degradation have historically resulted from oil and gas development, mining, and other resource extraction activities that disturb surface soils. Although the BLM and other land management agencies have made considerable advances in habitat protection and restoration, ongoing resource extraction and other land uses are expected to continue to result in losses or changes to plant communities and habitats.

The factors that would affect plant communities and habitats as a result of oil shale development activities are also associated with a number of other activities that occur both within and outside of the oil shale basins. The ecoregions and associated plant communities that include the oil shale basins extend well beyond the basin boundaries, and activities that occur outside the basins can also affect these habitats. Direct losses of habitat could occur as a result of oil and gas development, coal mining, mining of metals and minerals, energy development, and other activities. Approximately 1 million acres could be directly impacted by these future development activities. Native plant communities could also be indirectly impacted or degraded by these activities. Changes in water quality, surface water or groundwater flows, or air quality, could adversely affect terrestrial or wetland plant communities, and changes in community characteristics, such as species composition or distribution, could result from vegetation disturbances related to some activities, such as grazing. Commercial oil shale development would constitute a substantial incremental increase to the impacts associated with other foreseeable activities.

Wildlife. This section evaluates the potential cumulative impacts of oil shale development on wildlife, including wild horses and burros. The current status of wildlife and their habitats, as described in Section 3.8, reflects the cumulative impacts of past and present activities. This section focuses on the incremental impacts of oil shale development alternatives and a set of reasonably foreseeable federal and nonfederal activities, as described in Section 6.1.5.2, which could occur over the 20-year study period. In addition to these activities, natural events (e.g., floods, drought, and fires), disease, predation, and fluctuations in prey are among the natural phenomena that contribute to cumulative impacts on wildlife.

In general, the types of cumulative impacts on wildlife would be similar to the direct and indirect impacts associated with oil shale development (Section 4.8.1.3). Thus, cumulative impacts on wildlife resources would include (1) habitat loss, alteration, or fragmentation; (2) disturbance or displacement; (3) mortality; (4) obstruction to movement; and (5) exposure to contaminants. The effects of these actions could include (1) immediate physical injury or death; (2) increased energy expenditures or changes in physiological condition that could reduce survival or reproduction rates; or (3) long-term changes in behavior, including the traditional use of ranges. Potential differences between cumulative impacts on wildlife and the impacts arising from the oil shale development activities alone would depend on the intensity (magnitude), scale (geographic area), duration, timing, and frequency of development activities. Although habitat protection and restoration activities are incorporated into most projects, some losses or modifications to habitats are expected from most activities. Even without the potential impacts of commercial oil shale development, the projected major increases in land disturbance and water depletions resulting from other reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on wildlife.

Cumulative impacts of greatest concern to wildlife and their habitats include loss or degradation of habitat and habitat fragmentation related to land disturbance and changes in the availability and quality of surface water resources. The cumulative effects of numerous land use activities (e.g., livestock grazing, crop production, and energy development and associated infrastructure) have caused widespread habitat loss and fragmentation of sagebrush ecosystems (Knick et al. 2003). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (i.e., functional habitat loss) also contributes to the cumulative loss of habitat associated with facility development. Also, developments could further obstruct wildlife movements. Habitat loss and fragmentation can be particularly devastating to sagebrush-dependent species such as sage grouse and to big game species or other wildlife that have large home ranges or that make annual migrations among various habitats. Factors can act synergistically, compounding the importance of cumulative impacts. For instance, developments could result in extensive fragmentation that leaves only small, isolated areas of native vegetation. These areas are often more prone to invasive plant species and to grazing by livestock, wild horses, or feral animals (BLM 2005i; Hobbs 2001).

Wildlife disturbance and mortality associated with activities such as recreation also could have significant and widespread impacts because of the high number of recreation use days. For example, more than 1.3 million visitor days were spent hunting, and nearly 1.6 million visitor days were spent snowmobiling or other winter motorized traveling on BLM-administered lands within Colorado, Utah, and Wyoming during FY 2004 (BLM 2005j). The other factors discussed above have the potential to contribute to cumulative impacts; their contribution, however, would be relatively minor and more localized.

Other industrial developments could result in more workers within remote areas and increased public access due to new roads and ROWs. Increased access could result in increased hunting pressure and illegal poaching depending on location and extent of the developments. Repeated intrusions (e.g., from recreationists) within a specific area have been shown to cause progressive declines in avian richness and abundance (Riffell et al. 1996). Traffic associated with industrial activities and recreation could result in additional roadkills. Also, structures associated with other industrial activities could increase the number of bird collisions. Increased densities of predators and scavengers attracted to areas of human activity could result in increased predation pressure on prey populations. Increased predation would be in addition to impacts associated with habitat loss, displacement, roadkills, collisions with structures and transmission lines, and other factors.

Site-specific mitigation, standard operating procedures, wildlife-related stipulations, reclamation and rehabilitation, and monitoring would minimize cumulative impacts and/or benefit wildlife and their habitats (BLM 2005i, 2006q; DOI and USDA 2006; WGFD 2004). These would reduce the contribution of oil shale impacts to cumulative impacts throughout the project area. Also, implementation of state comprehensive wildlife conservation strategies and regional conservation plans would provide means of proactively minimizing cumulative impacts on wildlife and their habitats. For example, some of these plans identify areas where habitat is critical for the continued viability of key species and communities and areas where development can occur with lower risk to the welfare of ecosystems (Jones et al. 2004). The plans also present means of restoring and maintaining the health and function of lands within the study region. Management of game populations and enforcement of hunting laws has reduced the risk of declines in the number of game species compared with historic levels (BLM 2005i).

Threatened, Endangered, and Sensitive Species. In general, the cumulative impacts on threatened, endangered, and sensitive species would be similar to those described for other ecological resources. However, for many of the species, there would be a difference in the potential consequence of the impacts. Because of their small populations, threatened, endangered, and sensitive species would be far more vulnerable to impacts than more common and widespread species.

The current status and distribution of ESA-listed species, BLM-designated sensitive species, and state-listed species are presented in Section 3.7. Current status and distribution reflect the cumulative effects of past and present human activities and natural limiting factors. Some species are considered threatened, endangered, or sensitive in the area because cumulative impacts have resulted in a reduction in numbers that has increased the chances the species would become extinct in the near future (e.g., black-footed ferret, Canada lynx, and whooping crane). Other species (e.g., Graham's beardtongue and Dudley Bluffs bladderpod) are considered vulnerable because their specific ecological requirements result in limited distributions and smaller population sizes that are less resilient. For either group of species, any incremental addition to cumulative impacts could be considered significant.

The potential direct and indirect impacts of commercial oil shale development on threatened, endangered, and sensitive species are listed in Table 4.8.1-4 and discussed in

Section 4.8.1.4. The evaluation indicates the potential for adverse impacts for most of the species in the study area. Potential contributions to cumulative impact are associated with direct effects (e.g., vegetation clearing, habitat fragmentation, and water depletion) and indirect effects (e.g., sedimentation from runoff, fugitive dust, and disruption of groundwater flow patterns). Even without the potential impacts of commercial oil shale development, the projected major increases in land disturbance and water depletions resulting from other reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on these species.

Each alternative would require adherence to BLM policy on the protection of sensitive species and project-specific ESA Section 7 consultation with the USFWS. These latter consultations must include a consideration of cumulative effects on listed species under the ESA. Adherence to BLM policy and consultation with the USFWS are expected to reduce, but not eliminate, the contribution of commercial oil shale development to cumulative impacts under both NEPA and the ESA.

6.1.5.3.8 Visual Resources. The construction and operation of commercial oil shale projects that may occur on federal and nonfederal lands in Utah, Colorado, and Wyoming would likely have cumulative visual impacts in the context of other development activities under way in the three-state study area, as described in Section 6.1.5.2. These development activities could have large visual impacts on locations where concentrated development activity occurred. Where construction and operation of a commercial oil shale project occurred in the same areas as these other development activities, the visual absorption capability of some landscapes might be exceeded. Incremental visual impacts could be of particular concern where oil shale facilities, related infrastructure, and other development activities would be located near sensitive visual resources in landscapes with low visual absorption capability, and/or where the oil shale and other development would be located in the viewsheds of visually sensitive linear features, such as scenic/historic trails, highways, or scenic rivers. Careful facility siting and application of mitigation measures along with conformance with BLM VRM classes would protect visual values in more sensitive areas from large impacts associated directly with the oil shale development projects. However, the accumulation of small impacts from the oil shale projects, together with impacts from other development activities, could potentially degrade visual qualities. For VRM Classes I through III, the classifications would likely change; Class IV areas would likely degrade further. Also, the VRM classes of surrounding areas within view of the facilities may change.

Further cumulative visual impacts could occur because the presence of the oil shale projects would likely bring workers and their families to live in local communities and recreate in the surrounding areas, and because the roads and other infrastructure associated with the oil shale development projects could cause increased visitation and usage of remote areas (e.g., OHV use). The increases in population and access could result in urbanized development that would contrast sharply with more natural-appearing existing landscapes, add to visual clutter around existing urbanized areas, increase visible human and vehicular activity in remote areas, degrade air quality (thereby negatively affecting long-distance views), and result in litter, erosion, and other visual changes that would not harmonize with the naturally occurring forms, lines, colors, and textures of existing landscapes.

6.1.5.3.9 Cultural Resources. Disturbances from oil shale development, combined with other surface-disturbing development activities, could uncover and/or destroy cultural resource sites on BLM-administered land and on other lands. Given the surface disturbance projected from oil shale development and from other activities (Table 6.1.5-9) in the study area during the 20-year study period, it is likely that many sites would require cultural resource evaluations and mitigations. Assuming that these evaluations and mitigations are conducted in accordance with existing regulations, there would be an increased knowledge about cultural resources in the region. However, there would inevitably be some loss of information about individual sites. Unless a concentration of unique resources was found to exist within a small area and that area was the location of oil shale development, these individual site losses from construction and operation of an oil shale facility would be unlikely to have a major incremental adverse impact on cultural resources in the area.

6.1.5.3.10 Socioeconomics. Economic impacts can be measured in terms of changes in employment in the three-state study area in which oil shale resources are located. Because of the relative economic importance of oil shale development in small rural economies, and the consequent lack of available local labor and economic infrastructure, oil shale development could mean a large influx of population. As population increases are likely to be rapid, with local communities unable to quickly absorb new residents, there would also be impacts on housing in the three-state study area.

The impacts of oil shale developments would include (1) wage and salary expenditures associated with the construction and operation of oil shale facilities and power plants, (2) material procurement and wage and salary expenditures associated with the construction of temporary housing in the ROI for oil shale facility and power plant workers and family members, and (3) wage and salary spending associated with indirect workers required to provide goods and services resulting from increases in economic activity in each ROI with oil shale developments. Overall, oil shale development could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 600 jobs during the construction of temporary housing, and a range of 2,200 to 2,900 jobs during construction. Operations would create between 780 and 3,300 jobs, depending on the technology used, see Table 4.11.1-1.)

Population in-migration would also occur with oil shale resource development, with workers required to move into the three-state region during construction and operation of oil shale and power plant facilities. Workers would also be required to move into the region to facilitate the demand for goods and services resulting from the spending of oil shale, power plant, and housing construction worker wages and salaries.

A substantial number of oil and gas wells are projected for the area beginning in 2008, producing about 8,900 direct jobs and an estimated 23,000 total (direct and indirect) jobs in each year through 2027 (Minnesota IMPLAN Group, Inc. 2007). Development of coal resources in the three-state study area is also expected and would produce 15,000 direct jobs and 32,500 total jobs each year between 2008 and 2027. In the three-state region, oil and gas and coal development alone could result in an increase of about 10% to 20% in total employment in the region over 20 years, and in a population increase of about 2% to 4%, if these activities would require population in-migration. It is not known whether development of oil and gas and coal resources in the three-state region would require the in-migration of construction and operations workers or the construction of additional temporary housing.

If tar sands development occurs, it could also add a substantial number of jobs in the ROIs, depending on the scale of development (e.g., for an individual facility, 550 jobs during the construction of temporary housing, and 1,800 jobs during construction of tar sands facilities; operations would create 750 jobs.)

Rapid population growth in small rural communities hosting large resource development projects could also produce social and psychological disruption, together with the undermining of established community social structures (see Section 4.11.1.2). Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5% and 15% (see Section 4.11.1.3).

On the basis of employment estimates given above, reasonably foreseeable oil and gas and coal production in the study area are estimated to have a larger socioeconomic impact than a single oil shale facility. However, depending on the future level of oil shale development and given the estimated population increases due to construction and operation of a single oil shale facility, there may be substantial incremental socioeconomic impacts (e.g., interruption of community services, availability of housing, social disruption, decreases in property value, loss of employment and income in the recreation sector) from oil shale development when considered in conjunction with the other ongoing and reasonably foreseeable activities in the study area.

Cumulative impacts on transportation systems and traffic levels would be related to both employment and freight requirements to service projects. Overall, oil shale development could produce a substantial number of jobs, depending on the scale of development. Transportation impacts would be additive to other activities taking place on private and public lands. Substantial increases in traffic flow and in transportation infrastructure maintenance requirements would be expected to support oil shale operations.

6.1.5.3.11 Environmental Justice. Construction and operation of oil shale facilities, employer-provided housing, and power plants (if required) could affect environmental justice if any adverse health and environmental impacts resulting from either phase of development were large and if these impacts disproportionately affected minority and low-income populations. Disproportionality is determined by comparing the proximity of high and adverse impacts on the locations of low-income and minority populations. As described in Sections 6.1.5.3.1 through 6.1.5.3.10, oil shale development in conjunction with other ongoing and reasonably foreseeable activities could potentially have high and adverse effects on several resources, including local demographics, social structures, property values, noise, landscape views, land use, water quality, and air quality.

In each of the three states potentially hosting oil shale development, there are a number of census block groups with low-income and minority populations, where the minority population exceeds 50% of the total population in each block group and where the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.11). Given the potential for high and adverse incremental impacts on a number of resource areas from oil shale development in conjunction with oil, gas, coal, and potential tar sands development, and given the existence of environmental justice populations in each state, impacts on these resources could disproportionately affect minority and low-income populations. Of particular importance would be the impact of large increases in population in small rural communities on social disruption, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on water quality and on the demand for water in the region could also be important. Impacts on low-income and minority populations could also occur with the development of transmission lines associated with oil shale and power plant facilities in each state, depending on the locations of these infrastructures. Land use and visual environmental justice impacts might be significant, depending on the locations of land parcels affected by all these activities. Cumulative impacts on environmental justice would be evaluated in future NEPA analyses when the locations and sizes of the projects in relation to low-income and minority populations are known.

6.1.5.3.12 Hazardous Materials and Waste Management

Wastes Associated with Oil and Gas Development. Oil and gas development can involve three basic stages: exploration, well development, and production. Exploring, locating, and characterizing the petroleum resource can involve the installation of a relatively small number of small-bore wells to collect geologic cores for inspection and analysis. Increasingly, exploration is conducted with nonintrusive technologies, and wastes associated with exploration are limited and inconsequential.

Well development produces the greatest volume and array of wastes. Wells drilled on BLM-administered lands would be subject to the requirements and BMPs contained in the BLM's Gold Book (DOI and USDA 2006) and to any additional requirements established as lease stipulations by the BLM field office. It is expected that waste management for wells installed on private property would be in accordance with accepted industry practice. Each well installed would generate well development fluid wastes and waste cuttings, some of which could be contaminated with oil from the formation being exploited. However, unless the well progressed through previously contaminated subsurface zones or encountered contaminated groundwater, the waste typically associated with well installation would not exhibit hazardous characteristics and would most likely be managed according to standard practices. Well development fluids[2] would be collected on-site for reuse and/or disposal; free water would be separated from development fluids; drilling muds would be verified as being free of unexpected contamination and released to the ground surface; drilling muds such as bentonite clays would be accumulated on-site for recovery and reuse; and drill cuttings would be verified as being free of contamination and disposed of at the land surface, usually in the vicinity of the well.[3] Special management would be required for development fluids, drilling muds, and produced water that exhibited contamination from NORM or brackish characteristics. All NORM-contaminated wastes would be collected and delivered to properly permitted treatment and disposal facilities. Brackish water would be either reinjected down the well (or an injection well) or collected for delivery to treatment facilities. Likewise, downhole equipment removed from the well and found to have NORM contamination would be managed in the same manner. It is assumed that all of the drill rigs used for well development would be portable and would not undergo routine servicing (except for maintenance of fluid levels) at the well site. No wastes associated with drill rig operation and maintenance (e.g., maintenance of the rig's diesel engine) would be expected to be generated at wellheads, but they might be generated elsewhere in the study area where the rigs are serviced.

Products recovered from oil and gas wells are typically complex mixtures of oil, hydrocarbon gases, other gases such as H_2S, water, suspended solids such as sand and silt, chemicals injected to enhance recovery, and water/oil emulsions. Actions to separate these phases are performed at the wellhead or at a central processing facility.

Produced water (water recovered from the oil- or gas-bearing formations or other subsurface formations) is by far the largest volume of waste produced during well production. Produced water is typically discharged back down the well or through a second injection well completed in the same formation. Produced water can also be used for nonpotable purposes such as fugitive dust control, provided it is free of contamination from polar organics (e.g., benzene, naphthalene, toluene, phenanthrene), inorganics (e.g., lead, arsenic, sulfide), or NORM, and provided it exhibits no brackish characteristics. Produced water can also need special management because of high concentrations of sodium, chloride, calcium, or magnesium. Discharge of high-salinity waters to the ground surface or surface waters would be prohibited, and capture and treatment or reinjection would be required.

The exact natures and volumes of well development-related wastes would depend on numerous site-specific factors; however, reliable approximations are possible. It is estimated that

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2 Well development fluids are water-based (most frequently used), petroleum-based (used primarily in very deep wells where high temperatures may be encountered [usually >10,000 ft], or in directional drilling where greater lubricity is required for the drill bit), or they are composed entirely of synthetic chemicals (e.g., linear alkyl olefins, synthetic paraffins, and alkybenzenes). These fluids perform a number of functions, including cooling and lubricating the drill bit, carrying cuttings up the borehole to the surface, and temporarily filling the well bore with material that is sufficiently dense to prevent the premature inflow of groundwater, other fluids (e.g., oil), or subsurface materials that would collapse the borehole before casings are installed. Development fluids also typically contain various other chemicals, such as naturally occurring clays (referred to as drilling muds), dispersants, corrosion inhibitors, flocculants, surfactants, and biocides, to enhance their overall performance.

3 Although drill cuttings are, in most cases, nonhazardous, care must nevertheless be exercised in their disposal so as not to significantly alter surface drainage patterns or release sediments to area surface waters.

each well installed would result in the generation of an average of 4,100 bbl (172,200 gal) of well development fluids (DOE 2006). Over the study period, it is projected that many oil and gas wells would be installed in the study area, resulting in the generation of large volumes of development fluids and produced water. Some oil shale facilities might also generate large volumes of well-development wastes. If all the wastes are managed appropriately, incremental cumulative impacts from disposal of these wastes should be minimal.

Wastes Associated with Mining of Coal and Other Minerals. Wastes associated with coal mining include landscape wastes from clearing active mine areas, solid industrial wastes resulting from the maintenance and repair of mining equipment, overburden soils (topsoils and subsoils) removed to gain access to the coal resource,[4] and domestic solid wastes resulting from support of the workforce,[5] produced water, and wastes from coal preparation (e.g., shale, coal fines, and other impurities). Produced water would likely require treatment as a result of the leaching of metals from the coal resource or to adjust its pH. Treatment might result in the generation of metal-bearing sludge that would require off-site disposal in most instances. Coal preparation wastes are typically disposed of on-site or stockpiled for later use in mine reclamation.

Coal production in the study area over the period 2007 to 2027 is projected to be about 78 to 86 million tons/yr (see Tables 6.1.5-4 through 6.1.5-6). The amounts of solid wastes generated would be proportional to total coal mined, but would vary significantly with the particular mining techniques employed and the extent of coal preparation occurring at the mine site. Oil shale development using surface or underground mining would generate waste streams similar to those produced during coal mining. At the PEIS level, it is not possible to equate the nature or volumes of solid wastes with the amount (tons) of coal or oil shale mined. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Sodium minerals (e.g., nahcolite) are produced in Wyoming at a rate of 18 million tons/yr, and this production is expected to continue through the study period. Gilsonite, uranium, and vanadium would be mined within the study area over the period 2007 to 2027; estimated total production rates for these minerals are not available. Gold, lead, molybdenum, silver, and zinc have all been previously mined in Colorado, but no information on any projects or future activities involving these metals is available. Saleable minerals, such as sand and gravel, continue to be mined in small quantities, and that level of activity is expected to continue at the local level throughout the study period. In Utah, materials mined in the ROI include sand and gravel, gilsonite, clay, gypsum, dimensionless sandstone, lime, gold, uranium,

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4 Although overburden must be managed carefully to avoid adverse impacts (primarily increased sediment loading to area surface water bodies as a result of erosion), it is not considered a waste; it is typically stockpiled over the active life of the coal mining operation and replaced (in the order of the original soil horizon) as part of mine reclamation.

5 It is assumed that the workforce would not reside at or near the coal mine, but instead would live in nearby communities. Consequently, wastes related to workforce support would be minimal, consisting primarily of kitchen/food preparation solid wastes, small amounts of administrative (office) solid wastes, and small amounts of sanitary wastes.

vanadium, and phosphate. Materials mined in the Wyoming ROI include sand and gravel, crushed stone, and sodium carbonate.

Mineral (e.g., copper, gold, silver) mining and processing can generate wastes during recovery (i.e., mining), beneficiation (separation of mined material), and processing. Recovery can result in large volumes of overburden materials needing management, as discussed above for coal mining. Although those materials are generally not considered waste, they must be managed properly to avoid adverse impacts. Beneficiation can result in the generation of relatively large volumes of potentially hazardous material. This material, referred to as tailings, is processed through dump leaching, in which solutions containing strong acids or cyanides are sprayed onto the tailings to "leach" the metal of interest for capture. The tailings can be voluminous (EPA 1994) and hazardous. Processing of the mineral ore involves a variety of chemical and physical manipulations that produce a wide variety of wastes, many of them capable of producing significant adverse environmental impacts if not managed properly. In 1985, the EPA published Reports to Congress on the environmental aspects of non-coal-mining activities; the reports provide relatively comprehensive discussions of possible environmental impacts, including the types of wastes resulting from typical recovery, beneficiation, and processing schemes for selected metals (EPA 1985).

As in the development of metallic ores, oil shale development could generate produced water and large volumes of overburden; however, tailings would not be generated. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Wastes Associated with Designation and Development of Energy Corridors. The designation of energy corridors within the study area would not, in and of itself, have any waste consequences. Waste would, however, be generated during actual corridor development for gas and liquid pipelines and for electric power transmission systems on public and private lands. Construction-related wastes would be similar in character to wastes generated during construction of gas and liquid pipelines.

Solid wastes associated with gas and liquid pipelines and with power transmission systems would be generated during construction, operation, and decommissioning. The majority of wastes would be generated during the construction phases. Construction wastes would include wastes generated during preparation of the ROW (these wastes would primarily consist of removed vegetation) and during installation of the pipeline or cables (primarily maintenance-related wastes for vehicles and equipment, dunnage, packaging, and some chemical cleaner wastes). Support of the workforce would result in the production of domestic solid wastes and sanitary wastewaters. It is expected that the majority of construction-related wastes would be nonhazardous and would be managed in existing local landfills or existing municipal or specially built sewage treatment facilities.

Operational wastes would result from the maintenance of equipment (e.g., change-outs of lubricating oils, coolants, and hydraulic fluids from equipment that uses such materials, and sludge from the periodic cleaning of the insides of the pipelines through the use of pigs). The frequency of cleaning and the amount of waste generated would be a function of the commodity being transported, with the greatest amounts of pipeline cleaning–related wastes generated by pipelines that convey crude oil.

Solid wastes associated with the decommissioning of pipelines or power transmission systems would include wastes from cleaning equipment and some pipeline components. For pipelines it is expected that much of the underground pipeline might be abandoned in place, and for those pipeline components that were removed, the majority would be put into service in other pipeline systems or sold for scrap. As would occur during the construction phase, solid domestic and sanitary wastes would be generated in support of the workforce (albeit in lesser amounts, since it is expected that decommissioning would take substantially less time than initial construction); all such wastes would likely be managed or disposed of in existing facilities. Finally, a certain volume of remedial wastes would be expected to result from the cleanup of spills or leaks that were not removed during operation or occurred during decommissioning.

The construction of gas and liquid pipeline ROWs and transmission ROWs to support oil shale development would generate waste types similar to those discussed above. Large numbers of gas and liquid ROWs are already present on public lands in the study area, and many more areas may be designated as corridors for ROWs during the study period (see Section 6.1.5.2). Incremental impacts from waste generation and disposal would depend on the level of oil shale development and would be analyzed in future site-specific environmental evaluations.

Wastes Associated with Construction and Operation of New Electric Power Generation Plants. Some new power plants are projected to be needed in the study area during the next 20 years. Wastes associated with power plant construction would primarily consist of wastes from maintenance of construction equipment and vehicles powered by internal combustion engines (e.g., used crankcase oil, hydraulic fluids, and coolants). Other major solid waste streams would result from the support of the workforce (e.g., domestic solid wastes and sanitary wastewaters). All such wastes are expected to be easily managed in local or regional landfills or existing or specially built sewage treatment facilities. Minor amounts of industrial solid wastes would also result from the use of various chemicals (paints, coatings, adhesives, and cleaning solvents) during facility construction.

Solid wastes generated during operations by coal-fired power plants would consist of fly ash and bottom ash. It is assumed that newly constructed units would be required to conform to new source production standards. Typical coal-fired power plants generate on the order of 500,000 tons/yr of fly and bottom ash and an additional 150,000 tons/yr of sodium sulfate solid waste (generated as a part of sulfur-capture).

If new power plants are required for oil shale development (e.g., to support in situ facilities), then they would generate waste types similar to those discussed above. Incremental impacts from power plant waste generation and disposal associated with oil shale development would depend on the level of that development and would be analyzed in future site-specific environmental evaluations.

Wastes Associated with Tar Sands Development. Wastes that would be generated from tar sands development would be of the same nature as those described in Section 5.13. Incremental impacts from waste generation and disposal due to oil shale development would depend on the level of oil shale development and would be analyzed in future site-specific environmental evaluations.

6.1.5.3.13 Health and Safety. Given the large amount of development for oil and gas, coal mining, and other mineral production projected in the study area over 20 years, many workers will be needed. The types of industries being developed, especially mining, have been associated with relatively high numbers of worker injuries and fatalities in the past (see Section 4.14). Oil shale production activities would add to worker injuries and fatalities in proportion to the level of development. Without more detailed information on future production levels for oil shale as well as the other industries, quantitative estimates of incremental health and safety impacts due to oil shale development are not possible. However, all these industries are required by law to protect worker health and safety by using adequate engineering controls and personal protective devices.

6.1.6 Other NEPA Considerations

6.1.6.1 Unavoidable Adverse Impacts

The amendment of land use plans to identify public lands as available for application for leasing for commercial oil shale development would not result in unavoidable adverse environmental impacts under either Alternative B or C, but there may be impacts on land values. Unavoidable adverse impacts on resources could occur under Alternative A as a result of the RD&D projects. However, the mitigated environmental impacts (including unavoidable adverse impacts) of the RD&D activities are considered minimal, and all the EAs resulted in FONSIs.

Under Alternatives A, B, and C, the future development of commercial oil shale projects could result in unavoidable adverse impacts on resources. The magnitude of these unavoidable adverse impacts, as well as the degree to which they could be mitigated, would vary by project type and location. Many of the project-specific impacts could be reduced through implementation of the mitigation practices identified in this PEIS (see Chapter 4).

6.1.6.1.1 Land Use. No adverse impacts on land use would occur from the identification of lands available for application for leasing and the associated land use plan amendments under Alternatives A, B, or C. However, the development of commercial oil shale projects within the areas identified as applicable for leasing would result in unavoidable changes in land use in the areas undergoing project development. Land uses that could be affected by the construction and operation of commercial oil shale projects include livestock grazing, agriculture, oil and gas leasing, minerals extraction, and recreation.

6.1.6.1.2 Soil, Geologic, and Paleontological Resources. No adverse impacts on geologic and paleontological resources would occur under either Alternative B or C from the identification of lands available for application for leasing and the associated land use plan amendments. Unavoidable adverse impacts could be incurred under Alternatives A, B, and C as a result of future commercial project construction in the lease areas. Project construction could result in unavoidable impacts on natural topography, soil erosion, drainage patterns, and slopes, as well as damage or destroy paleontological resources within project footprints. Project construction could also result in the compaction, excavation, and removal of soil from the project area. The likelihood, magnitude, and extent of unavoidable impacts could be reduced under all three alternatives through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.3 Water Resources. The identification under Alternatives B and C of lands available for application for leasing and the associated land use plan amendments would not adversely impact water resources (either surface water or groundwater). Unavoidable adverse impacts could be incurred under Alternatives A, B, and C as a result of future commercial oil shale development in the lease areas. Impacts on water quality could occur as a result of soil erosion from construction sites; runoff from oil shale mine, processing, and waste storage locations; and accidental spills of hazardous liquids (such as fuels, lubricating oils, solvents, and other industrial liquids), and accidental oil spills from project-related pipelines. Although there is a potential for unavoidable adverse impacts on water resources from construction under all three alternatives, the likelihood, magnitude, and extent of these impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.4 Air Quality and Ambient Noise Levels. No adverse impacts on air quality or ambient noise would occur from the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives A, B, and C. Construction, clearing and grading, trenching, excavation and blasting, and construction vehicle traffic would result in fugitive dust and vehicle emissions, as well as increased ambient noise levels in construction locations. During project operations, unavoidable air impacts would occur primarily during operation of mining and oil shale–processing facilities and equipment and associated vehicular traffic. Noise impacts could also be incurred by these activities, as well as by the operation of pipeline compressor stations. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.5 Ecological Resources. No adverse ecological impacts would occur as a result of the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under Alternatives A, B, or C as a result of potential future commercial development of oil shale projects. The construction and operation of project facilities, as well as maintenance of project-related utility, pipeline, and transportation ROWs, under each alternative could result in unavoidable temporary and permanent changes in aquatic resources, plant communities and habitats, wildlife, and threatened and endangered species.

Ecological resources immediately within a project footprint would be destroyed during clearing, grading, and construction activities. Unavoidable impacts on wildlife could include habitat loss, disturbance and/or displacement, mortality, and obstruction to movement. Increased noise during project construction and operation could disrupt local wildlife foraging and breeding of some wildlife. Aquatic biota and habitats could be affected by siltation resulting from runoff from areas of disturbed soils and from accidental releases of hazardous materials from construction and operations equipment (such as fuels) and from an accidental oil pipeline releases. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.6 Visual Resources. No adverse impacts on visual resources would occur from the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts on visual resources could occur as a result of the future development of commercial oil shale projects in areas identified as available for application for leasing under Alternatives A, B, and C. Short-term impacts would occur during construction. Fugitive dust and the presence of construction equipment and crews would be visible in the vicinity of the construction site, potentially affecting local viewsheds and recreational experiences. Because project-specific ROWs and infrastructure (e.g., electricity transmission towers, pipelines and compressor stations, surface mines, and oil shale–processing facilities) would be visible throughout the life span of any project, there could be long-term unavoidable impacts on some viewsheds and the recreational experiences of visitors in those viewsheds. Major landforming activities such as recontouring and on-site disposal of spent oil shale could result in impacts lasting well beyond the life span of the project, and in some cases might result in permanent visual impacts. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.7 Cultural Resources. No adverse impacts on cultural resources would occur from identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. However, leasing itself has the potential to impact cultural resources to the extent that the terms of the lease could limit an agency’s ability to avoid, minimize, or mitigate adverse effects of proposed commercial oil shale development on cultural properties. Cultural resources could also incur unavoidable adverse impacts as a result of the future development of commercial oil shale projects in areas identified as available for application for leasing under Alternatives A, B, and C. Cultural resources could be destroyed by construction activities, such as clearing and grading, mining, facility construction, and pipeline trenching. Development of new ROWs could also increase access to previously inaccessible areas, which could lead to vandalism of both known and undiscovered cultural sites. The likelihood, magnitude, and extent of unavoidable adverse impacts on cultural resources could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.8 Socioeconomics and Environmental Justice. With the exception noted regarding potential impacts on land values, the identification of lands as available for application for commercial leasing under Alternative A, B, or C would not result in any socioeconomic, transportation, or environmental justice impacts. Unavoidable adverse social and environmental justice impacts could occur under Alternatives A, B, or C as a result of the future construction and operation of commercial oil shale projects and associated power plants, coal mines, transportation infrastructure, and employer-provided housing. Rapid population growth could occur following the in-migration of construction and operations workers into communities; this could lead to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants and, consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts could also occur in association with the degradation of air quality, water quality, increases in traffic and congestion, and visual resources, and the removal of land from traditional uses during commercial project development. Many of these impacts would affect quality of life for the general population in many communities, in addition to that of low-income and minority populations residing in the vicinity of oil shale developments. Many locations of cultural significance to Tribal groups may have been protected or identified. Nevertheless, with the alteration of, or restricted access to, water and visual resources and the degradation or migration of particular animal species, oil shale developments would have impacts on subsistence and traditional landscape-based activities important to tribal groups.

6.1.6.1.9 Hazardous Materials and Waste Management. No adverse impacts from hazardous materials and waste management would occur from the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives A, B, and C. Construction and operations of oil shale projects would result in the use of hazardous materials and the generation of hazardous and nonhazardous wastes, including materials typically utilized during construction and operations (e.g., fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, corrosion control coatings, and herbicides for vegetation clearing). During construction, nonhazardous landscape wastes would be generated. In general, the appropriate management of these materials would result in only minor impacts. Disposal of spent shale within the leased area could result in unavoidable adverse impacts. The likelihood, magnitude, and extent of unavoidable adverse impacts from hazardous materials and waste management could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.1.10 Health and Safety. No adverse impacts on health and safety would occur from the identification of lands available for application for leasing and the associated land use plan amendment under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial oil shale projects in the areas identified under Alternatives A, B, and C. Hazards for workers at oil shale development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. A comprehensive facility health and safety plan and worker safety training would be required as part of the plan of development for every proposed commercial oil shale project. The likelihood, magnitude, and extent of unavoidable adverse impacts on health and safety could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.1.6.2 Short-Term Use of the Environment and Long-Term Productivity

The amendment of land use plans to identify lands available for application for leasing for commercial oil shale development would not affect the short-term uses or long-term productivity of the environment. The impacts (short and long term) from utilization of resources associated with project development under Alternatives B and C are presented in Chapter 4, while such impacts under Alternative A are presented in Section 6.1.1. For this PEIS, *short-term* refers primarily to the period of construction of a commercial oil shale project; generally, it is during this time that the most extensive environmental impacts would occur. *Long-term* refers primarily to the 20-year time frame considered within this PEIS.

Within the 20-year time frame considered in the PEIS, the development of oil shale projects would not require the short-term disturbance or long-term alteration of a major amount of federal and nonfederal land under any of the three alternatives. Future development of commercial oil shale projects under Alternatives A, B, and C would result in the local, short- and long-term disturbance of most resources. There would be little difference in the types of impacts that could result from project development under either of these alternatives. Under each of these alternatives, land clearing and grading and construction activities would disturb surface soils, wildlife and their habitats, and affect local air and water quality, visual resources, noise levels, and recreational activities within individual project footprints. Similar effects could be expected on other federal and nonfederal lands where project-related infrastructure (e.g., power plants, utility and pipeline ROWs, and worker residences) would be located. Short-term construction-related disturbance of biota (and their habitats) could result in long-term reductions in biological productivity within the project areas.

The long-term presence of commercial oil shale projects and associated ROWs could affect long-term land use within and in the vicinity of the lease areas, as well as on both federal and nonfederal lands where support infrastructure (power plants, ROWs, and employee housing) would be located, especially if previous land use activities in those areas are determined to be incompatible with commercial oil shale projects. The lands and surrounding areas associated with Alternatives A, B, and C currently support a variety of land uses (depending on their specific locations), including livestock grazing, agriculture, recreation, oil and gas leasing, and minerals extraction. Under Alternatives A, B, and C, commercial oil shale projects could also affect long-term quality and use of visual resources and recreational use on federal and nonfederal lands. While some recreational activities (such as OHV use) could experience long-term increases in activity as a result of new ROWs into previously inaccessible areas, changes in the types and patterns of recreational usage can be positive or negative, depending on the subjective values of the interested and affected public.

6.1.6.3 Irreversible and Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitments of resources associated with the implementation of the three alternatives evaluated in this PEIS. A resource commitment is considered *irreversible* when direct and indirect impacts from its use limit future use options. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and to those resources that are renewable only over long periods of time, such as soil productivity or forest health. A resource commitment is considered *irretrievable* when the use or consumption of the resource renders it neither renewable nor recoverable for future use. Irretrievable commitments apply to loss of production, harvest, or use of natural resources.

The amendment of land use plans to identify lands available for application for leasing for commercial oil shale development would not result in the irreversible or irretrievable commitment of resources. However, irreversible and irretrievable commitments of resources could occur as a result of future commercial oil shale projects that are authorized, constructed, and operated. The nature and magnitude of these commitments would depend on the specific location of the project development as well as its specific design and operational requirements. The commitment of resources would be identical for any specific project located in the same lease area under Alternative A, B, or C.

The construction of future commercial oil shale projects under Alternative A, B, or C could result in the consumption of sands, gravels, oil shale, and other geologic resources, as well as fuel, structural steel, and other materials. Water resources could also be consumed during construction, although water use would be temporary and largely limited to on-site concrete-mixing and dust-abatement activities.

In general, the impact on biological resources from future project construction and operation would not constitute an irreversible and irretrievable commitment of resources. During project construction and operation, individual animals would be impacted. Site- and species-specific analyses and mitigation conducted at the project level during authorization would make adverse impacts on entire populations unlikely. However, if adverse impacts occurred to threatened or endangered species, those impacts would likely contribute an irreversible commitment of resources.

The clearing of project areas (including off-lease locations where utility and pipeline ROWs, power plants, and employee housing) would result in the direct loss of vegetation and habitats within the construction footprints, which would be irretrievable in areas where project infrastructure would be constructed and operated. While habitat would be impacted during project construction, implementation of project-specific mitigation measures (such as habitat restoration) would reduce these impacts over time. However, habitats within project infrastructure footprints (such as buildings and surface mines) would be irretrievably committed to the development and operation of commercial oil shale projects.

Cultural and paleontological resources are nonrenewable, and any disturbance of these resources would constitute an irreversible and irretrievable commitment of resources. However, consideration and implementation of mitigation could minimize the potential for impacts on these resources. Access to previously inaccessible areas could lead to vandalism of both known and unknown cultural and paleontological resources, thereby rendering them irretrievable. Impacts on visual resources could constitute an irreversible and irretrievable commitment of resources, but these impacts could also be lowered somewhat through the consideration and implementation of the mitigation measures.

6.1.6.4 Mitigation of Adverse Effects

Following the amendment of land use plans to identify areas available for application for commercial leasing, any future development of commercial oil shale projects within the lease areas could result in adverse impacts on many resources (see Chapter 4 and Sections 6.1.2 and 6.1.3). The nature, extent, magnitude, and duration of any project-related impacts would be directly determined by (1) the project location, (2) the nature and quality of resources at and in the vicinity of the project site (and its associated infrastructure), (3) the technology used and the plan of development for the project. Many of the impacts could be reduced or avoided through the implementation of appropriate site- and project-specific mitigation measures. Development of individual commercial oil shale projects would require additional project-specific NEPA analyses and the identification of location-, project- and resource-specific mitigation measures. Mitigation measures would be identified as lease stipulations by the BLM for any authorized commercial development. Chapter 4 of this PEIS identifies many types of resource-specific mitigation measures that could be implemented during project construction and operation.

6.2 TAR SANDS ALTERNATIVES

This section presents the impacts associated with the three tar sands alternatives. Alternative A, the no action alternative, is discussed in Section 6.2.1. The impacts of Alternatives B and C are discussed in Sections 6.2.2 and 6.2.3, respectively. Section 6.2.4 presents a comparison of the tar sands alternatives. Discussions of the cumulative impacts and other NEPA considerations associated with Alternatives B and C are presented in Sections 6.2.5 and 6.2.6, respectively.

Information contained in Sections 6.2.2 and 6.2.3 describes (1) the impact of the land allocation decisions proposed in Alternatives B and C, which is the focus of the PEIS, and (2) the potential impact of future commercial tar sands development on the public lands that would be made available for application for future leasing and development in each alternative. The bulk of the information provided in Sections 6.2.2 and 6.2.3 addresses the effects of potential future commercial development. However, as has been explained previously in the PEIS, commercial leasing and development are not being approved at this time. The information on potential impacts is being presented to help agency decision makers and the public form an impression of the effects of potential future development. Together with the information contained in Chapter 5, this analysis and comparison of potential impacts of future development associated with each of the alternatives aids agency decision makers in making an informed decision regarding the relative merits of the alternatives. It is also intended that these analyses will help identify information that will be needed to process future applications for commercial development.

On the basis of the analyses contained in the PEIS, the BLM has determined that with the exception noted in the socioeconomic analysis regarding potential impacts on land values, the land use plan amendments contained in Alternatives B and C would not result in any impacts on the environment or socioeconomic setting. However, the future development of commercial tar sands projects that could be approved after subsequent NEPA analysis on lands identified in these alternatives as available for application for leasing would have impacts on the environment and the socioeconomic setting. The bulk of the information presented in Sections 6.2.2 and 6.2.3 identifies in a non-site-specific manner the potential impacts associated with future commercial tar sands development under each alternative. The magnitude of the impacts cannot be quantified at this time because key information about the location of commercial projects, the technologies that may be employed, the project size or production level, development time lines, and potential mitigation that might be employed are unknown.

6.2.1 Impacts of Alternative A, No Action Alternative, Continuation of Current Management

In this alternative, any leasing or development of tar sands resources would be managed under the requirements of the six existing land use plans in Utah that address tar sands resources. Prior to approval of any commercial leasing or development of tar sands resources, additional NEPA analysis would be required. As discussed in Section 2.3.2, under Alternative A, the BLM has assumed that there would be no commercial leasing or development of tar sands on public lands in the next 20 years. Although a number of CHLs were issued in the mid-1980s and there are additional pending applications to convert oil and gas leases or tar sands claims to CHLs, there has been no tar sands development on public lands in the last 20 years or more. Furthermore, at the time this PEIS was drafted, no commercial tar sands project proposals had been submitted to the BLM. On this basis, the BLM has determined that it is unlikely that commercial tar sands development would occur under the existing CHL Program. Under Alternative A, land use plans would not be amended to allow for leasing for commercial tar sands development under any program other than the CHL Program. Commercial tar sands leasing would occur in the future only under the auspices of the CHL Program. Such leasing would be subject to additional NEPA analyses and the existing CHL regulations in 43 CFR Part 3140.

Under Alternative A, because no commercial tar sands development is projected, there would be no environmental or socioeconomic impacts. If commercial tar sands development in the past has been impeded by constraints imposed by existing CHL regulations, under Alternative A, no action would be taken to alleviate those constraints and, therefore, there could be adverse impacts on the level and pace of future commercial tar sands development.

6.2.2 Impacts of Alternative B, the Proposed Plan Amendment

Under Alternative B, the BLM would amend six BLM land use plans to make 431,224 acres of public land in Utah available for application for leasing for commercial development of tar sands within 10 designated STSAs: Argyle Canyon, Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon (see Figure 2.4.3-1 and Table 2.4.3-1). The eleventh existing designated STSA, Circle Cliffs, would not be available for leasing under any alternative because the portion administered by the BLM is located entirely within the GSENM. The public lands that would be available under Alternative B consist of 360,115 acres of BLM-administered lands and 71,110 acres of split estate lands. (See Sections 2.4.3 and 2.4.3.1 for a complete description of Alternative B.) The six land use plans that would be amended include:

- Book Cliffs RMP (BLM 1985a);
- Diamond Mountain RMP (BLM 1994a);
- Henry Mountain MFP (BLM 1982);
- Price River Resource Area MFP, as amended (BLM 1989);
- San Rafael Resource Area RMP (BLM 1991b); and
- San Juan Resource Area RMP (BLM 1991a).

On the basis of the analysis in this PEIS, the BLM has determined that there is no environmental impact associated with amending land use plans to make lands available for application for commercial leasing in the three-state study area, but there may be impacts on land values. However, the development of commercial tar sands projects on lands identified as available for application for leasing would impact resources on these lands.

In general, potential impacts of future commercial development on specific resources located within the 431,224 acres cannot be quantified at this time because key information about the location of projects, the technologies that will be employed, the project size or production level, and development time lines are unknown. While it is not possible to quantify the impacts of project development, it is possible to make observations and draw conclusions on the basis of certain lands being made available for application for leasing and their overlap with specific resources. The following sections describe the potential impacts on the environment and socioeconomic setting of subsequent commercial development that might occur on the lands identified as available for leasing in Alternative B. Many of these potential impacts might be successfully avoided or mitigated, depending upon site- and project-specific factors and future regulations that will guide leasing actions.

The total amount of public land within the 10 designated STSAs is 598,572 acres (Table 2.3-1). Alternative B would make about 72% (431,224 acres) of these lands available for application for commercial leasing. Table 6.2.2-1 lists the acreages and percentages per STSA. The public lands that would not be available for application for leasing include all those areas

TABLE 6.2.2-1 Amount of Land Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Corresponding Percentage of Total Public Lands by STSA[a]

	Alternative B		Alternative C	
STSA	Acres Available	Percentage	Acres Available	Percentage
Argyle Canyon	11,226	86	0	0
Asphalt Ridge	5,435	100	1,464	27
Hill Creek	56,506	100	19,934	35
Pariette	10,161	82	830	7
P.R. Spring	153,003	79	56,728	29
Raven Ridge	14,364	100	9,950	69
San Rafael Swell	70,475	61	54,492	47
Sunnyside	78,116	80	62,741	64
Tar Sand Triangle	24,938	30	22,511	27
White Canyon	7,001	87	386	5
Total	431,224	72	229,038	38

[a] Acreage estimates and percentages were derived from GIS data compiled to support the PEIS analyses.

that are excluded from leasing and development by virtue of existing laws and regulations, E.O.s, land use plan designations, and other administrative designations or withdrawals. These excluded lands (e.g., Wilderness Areas, WSAs, National Monuments, WSRs, and ACECs) encompass many of the areas where special resources are known to exist. In addition, the BLM has excluded all lands within the Circle Cliffs STSA (which is located inside the GSENM) and corridors along potentially eligible WSR segments, in order to protect certain resources.

6.2.2.1 Land Use

The identification of 431,224 acres of public land in Utah as available for application for leasing for commercial development of tar sands (approximately 72% of the study area) is expected to have no impacts on other land uses, although there may be some effect on land values. The identification of these lands does not authorize or approve any ground-disturbing activities that could affect land uses; however, existing land uses could be adversely affected by future commercial tar sands development on these lands.

As described in Section 3.1, lands where commercial tar sands development might occur are currently used for a wide variety of activities, including recreation, mining, hunting, oil and gas production, livestock grazing, wild horse and burro management, communication sites, and ROW corridors (e.g., roads, pipelines, and transmission lines). Commercial tar sands development would have a direct effect on these uses, displacing them from areas that are being developed for tar sands production. Tar sands development will require off-lease construction of certain infrastructure, such as transmission and pipeline ROWs and possibly employer-provided housing.

Future indirect impacts of tar sands development could be associated with changing existing land uses, including conversion of land in and around local communities from existing agricultural, open space, or other uses to provide services and housing for employees and families that move to the region in support of commercial tar sands development. Increases in traffic, increased access to previously remote areas, and development of tar sands facilities in currently undeveloped areas would continue to change the overall character of the landscape. The value of private ranches and residences in the area affected by tar sands developments or associated ROWs either may be reduced because of perceived noise, traffic, or human health or aesthetic concerns or may be increased by additional demand.

Transmission and pipeline ROWs associated with commercial tar sands development would not preclude other land uses but would result in both direct and indirect impacts. Direct impacts, such as the loss of available lands to physical structures, maintenance of ROWs free of major vegetation, maintenance of service roads, and noise and visual impacts on recreational users along the ROW, would last as long as the transmission lines and pipelines were in place. Indirect impacts of ROW development could include the introduction of new or increased recreational use to an area due to improved access, avoidance of the area for residential or recreational use for aesthetic reasons, and increased traffic.

The specific impacts on land use and the magnitude of those impacts would depend on project location; project size, technology employed and scale of operations; and proximity to roads, transmission lines, and pipelines. Impacts on various land uses that could be caused by commercial development of tar sands are discussed in Section 5.2 and are summarized below:

- Commercial tar sands development, using any technology under consideration in this PEIS, is largely incompatible with other mineral development activities because each of the technologies would dominate the land area on which it is located. Oil and gas development is ongoing in many parts of the study area, and conflict between tar sands projects and oil and gas projects may occur. While it is possible that undeveloped portions of a tar sands lease area could be available for other mineral development, such development would be unlikely to occur on a widespread basis, except possibly in areas where a single company is developing multiple resources.

- Where existing agricultural water rights are acquired to support tar sands development, existing irrigation-based agricultural uses of the land from which the water is acquired would be modified to support lower-value dry land use of the lands and/or may result in a complete loss of agricultural uses in some areas. Some areas could be converted to nonfarm uses depending upon local zoning decisions.

- Grazing activities would be precluded by commercial tar sands development in those portions of the lease area that were (1) undergoing active development; (2) in preparation for a future development phase; (3) undergoing restoration after development; or (4) occupied by long-term surface facilities, such as surface mine excavations, production facilities, office buildings, retorts, and parking lots. Depending on conditions unique to the individual grazing allotment, temporary reductions in authorized grazing use may be necessary because of loss of a portion of the forage base. It is possible, depending upon how commercial leases would be developed, that some grazing uses might be accommodated on parts of the leases at various times during the lease period.

The impact of the removal of acreage from individual grazing leases would depend on site-specific factors regarding the grazing allotment(s) affected. There is a large variation in size and productivity of BLM grazing allotments across the PEIS study area, and the loss of up to 5,760 acres for individual tar sands facilities from larger allotments would not be as significant as from smaller allotments. Some allotments could become completely unavailable for grazing use. Others would lose varying percentages of grazing area that may affect their overall economic viability.

- Commercial tar sands development activities are largely incompatible with recreational land use (e.g., hiking, biking, fishing, hunting, bird-watching, OHV use, and camping). Recreational uses, including OHV use, would be precluded from those portions of commercial lease areas involved in ongoing development and restoration activities. Impacts on vegetation, development of roads, and displacement of big game could degrade the recreational experiences and hunting opportunities near commercial tar sands projects. The impact of displacement of recreation uses from tar sands development lease areas would be highly dependent upon site-specific factors, especially the nature of existing uses on the site.

- Specially designated areas, including all designated Wilderness Areas, WSAs, other areas that are part of the NLCS (e.g., National Monuments, NCAs, WSRs, and National Historic and Scenic Trails) and existing ACECs would not be available for application for tar sands leasing and commercial development and would not be directly affected. They might, however, incur indirect impacts (e.g., dust and degraded viewshed) resulting from commercial tar sands development on adjacent lands or on areas within the general vicinity.

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah as having one or more characteristics of wilderness. Table 6.2.2-2 lists these areas. Should commercial development of tar sands occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative B includes

TABLE 6.2.2-2 Areas with Wilderness Characteristics That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap[a.b]

Name of Area with Wilderness Characteristics	Amount of Overlap (acres) Alternative B	Alternative C
Hill Creek STSA		
Wolf Point	937	0
P.R. Spring STSA		
Bitter Creek	12,252	4,854
Hideout Canyon	993	0
Lower Bitter Creek	514	509
Mexico Point	739	0
Wolf Point	5,147	790
San Rafael STSA		
Devils Canyon	968	254
Hondu Country	4,207	4,203
Mexican Mountain	13,430	10,665
Muddy Creek–Crack Canyon	10,826	8,750
San Rafael Knob	5,412	3,871
San Rafael Reef	3,991	3,991
Sids Mountain	4,244	772
Sunnyside STSA		
Desolation Canyon	6,832	6,739
Tar Sand Triangle STSA		
Dirty Devil–French South	24,255	22,210
White Canyon STSA		
Dark Canyon	218	91
Fort Knocker Canyon	71	0
Gravel and Long Canyon	1,727	0
Red Rocks Plateau A	69	0
White Canyon	2,751	251
Total	99,583	67,951

[a] The key characteristics of wilderness that may be considered in land use planning include an area's appearance of naturalness and the existence of outstanding opportunities for solitude or primitive and unconfined types of recreation.

[b] Totals may be off due to rounding. Acreage estimates were derived from GIS data compiled to support the PEIS analyses.

approximately 100,000 acres of these lands that could be subject to potential development.

- In Utah, there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this PEIS is published. Table 6.2.2-3 lists the areas and the number of acres of overlap by field office that would be available for application for commercial tar sands leasing. If tar sands development occurs on these lands, depending on the nature of resources present on the lands, these resources could be lost. The decisions regarding designation of these lands would be made at the field office level and not in this PEIS. Should designation as ACECs be completed before the PEIS is issued, these lands would not be available for lease. If this PEIS is issued before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for tar sands development. Alternative B includes approximately 180,000 acres of these lands that could be subject to potential development.

6.2.2.2 Soil and Geologic Resources

The amendment of land use plans to make 431,224 acres of public land available for application for leasing for commercial tar sands development under Alternative B would not have any direct impacts on soil or geologic resources. Soil and geologic resources within the area could, however, be affected by future commercial tar sands development on these lands.

Soil and geologic resources could be affected during project construction as a result of removal or compaction (e.g., during site clearing and grading, foundation excavation and preparation, and pipeline trenching), and by erosion during project construction and operation (e.g., erosion of exposed soils in construction areas or of topsoil stockpiles (see Section 5.3.1). Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust, which could affect local air quality. Project areas would remain susceptible to erosion until completion of construction, mining, tar sands processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (e.g., access roads, utility ROWs, and power plants) would be located.

Under Alternative B, impacts on soil and geologic resources could occur wherever individual projects are located within the 431,224 acres made available for application for commercial leasing. For any project, the erosion potential of the soils would be a direct function of the lease and project location, and also the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

TABLE 6.2.2-3 Potential ACECs That Overlap with Lands Made Available for Application for Commercial Tar Sands Leasing under Alternatives B and C and the Amount of Overlap[a]

Potential ACEC	Amount of Overlap (acres)	
	Alternative B	Alternative C
Argyle Canyon STSA		
Nine Mile Canyon	325	40
Hill Creek STSA		
Main Canyon	5,592	4,637
Pariette STSA		
Coyote Basin–Myton Beach	2,621	631
P.R. Spring STSA		
Bitter Creek	20,715	8,782
Bitter Creek/P.R. Spring	47,951	7,942
Main Canyon	40,665	17,831
Raven Ridge STSA		
Coyote Basin–Snake John	6,774	5,855
San Rafael STSA		
Lucky Strike	575	2
Wild Horse	610	566
Sunnyside STSA		
Desolation Canyon	3,355	3,177
Nine Mile Canyon	27,182	13,663
Range Creek	936	933
Tar Sand Triangle STSA		
Dirty Devil–North Wash	22,684	21,021
Total	179,985	85,801

[a] Totals may be off due to rounding. Acreage estimates were derived from GIS data compiled to support the PEIS analyses.

6.2.2.3 Paleontological Resources

The identification of 431,224 acres of public land as available for application for leasing for commercial development of tar sands and the amendment of land use plans to identify these areas would not have direct impacts on paleontological resources. Of the 431,224 acres identified under Alternative B as being available for application within the STSAs, a total of 335,395 acres (approximately 78%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Paleontological resources within these areas could be adversely impacted if leasing and future commercial development occurs. Impacts could include the destruction of individual resources present within development footprints, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 5.4).

6.2.2.4 Water Resources

The amendment of land use plans to make 431,224 acres of public land in Utah available for application for leasing for commercial development of tar sands (approximately 66% of the federal lands in the STSAs) would not have direct impacts on water resources. Surface water and groundwater resources could, however, be adversely affected by subsequent commercial tar sands development on these lands. The amount of water that may be required for future commercial development and the potential mix among surface water, groundwater, and treated process water is unknown.

The inability to predict specific locations for potential future commercial development and the lack of information regarding the type of technology that might be employed make it impossible to predict the specific impacts on water resources that could occur with commercial development. The magnitude of such impacts would depend on the specific location of the area being developed, as well as the design of the project and associated infrastructure.

Section 5.5 of this PEIS provides a generic description of the potential impacts on water resources. These impacts could occur anywhere within the 431,224 acres available for application for leasing under this alternative. The following is a summary of these generic impacts:

- Degradation of surface water quality caused by increased sediment load or contaminated runoff from project sites;

- Surface disturbance that may alter natural drainages by both diverting and concentrating natural runoff;

- Surface disturbance that becomes a non-point source of sediment and dissolved salt to surface water bodies;

- Withdrawal of water from a surface water body that reduces its flow and degrades the water quality of the stream downgradient from the point of the withdrawal;

- Withdrawals of groundwater from a shallow aquifer that produce a cone of depression and reduce groundwater discharge to surface water bodies or to the springs or seeps that are hydrologically connected to the groundwater;

- Construction of reservoirs that might alter natural streamflow patterns, alter local fisheries, temporarily increase salt loading, cause changes in stream profiles downstream, reduce natural sediment transport mechanisms, and increase evapotranspiration losses;

- Discharged water from a project site that could have a lower water quality than the intake water that is brought to a site;

- Mine tailings that might be sources of salt, metal, and hydrocarbon contamination for both surface and groundwater;

- Dewatering operations of a mine, or dewatering through wells that penetrate multiple aquifers, that could reduce groundwater discharge to seeps, springs, or surface water bodies if the surface water and the groundwater are connected;

- Degradation of groundwater quality resulting from the injection of lower quality water, from contributions of residual hydrocarbons or chemicals from retorted zones after recovery operations have ceased, and from spent shales replaced in either surface or underground mines; and

- Reduction or loss of flow in domestic water wells from dewatering operations or from production of water for industrial uses.

As noted above in Section 6.2.2.2, lands made available for application for leasing under Alternative B include lands that have been identified in BLM land use plans as having high potential for erosion due to steep slopes and/or highly erosive soils. Surface water quality could be adversely impacted by erosion from these lands and similar lands throughout the STSAs that would contribute to increases in sediment and salinity loads.

In addition, lands made available for application for leasing under Alternative B contain sensitive hydrologic areas identified by the BLM, including about 6,100 acres of watershed, floodplains, and other sensitive water resources in Utah. Impairment of the function of these areas by increased sedimentation from disturbance of sensitive soil areas or from runoff of contaminated water from project sites would also contribute to overall adverse effects on water quality.

There are approximately 107 mi of perennial stream miles in the STSAs. Alternative B contains approximately 28 mi (26%) of these perennial streams that could be adversely impacted, either directly or indirectly, by future commercial tar sands development.

6.2.2.5 Air Quality

Air resources would not be affected by the amendment of land use plans to identify public lands as available for application for potential leasing for commercial tar sands development. However, air resources in and around these areas could be affected by future commercial development of tar sands. Under Alternative B, local, short-term air quality impacts could be incurred as a result of (1) PM releases (fugitive dust and diesel exhaust) during construction activities such as site clearing and grading in preparation for facility construction, and (2) exhaust emissions (SO_2, CO, and NO_x) from construction equipment (see Section 5.6). These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations such as mining and processing of the tar sands. Processing activities may also result in regional impacts on air quality that could extend beyond the boundaries of the potential lease areas. These regional impacts would be associated with operational releases of CO, NO_x, and other pollutants (VOCs and SO_2) during tar sands excavation and processing (see Section 5.6). Operational releases of HAPs (such as benzene, toluene, and formaldehyde) as well as diesel PM could also affect workers and nearby residences (if any are present); these impacts, however, would be localized to the immediate project location and subject to further analyses prior to implementation.

6.2.2.6 Noise

Under Alternative B, 431,224 acres of public land in Utah would be made available for application for leasing for commercial development of tar sands. Ambient noise levels in these areas would not be affected by the amendment of land use plans to identify these areas. However, ambient noise levels could be affected by future commercial development of tar sands. Under Alternative B, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of tar sands projects (see Section 5.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in Sections 5.8.1.3 and 5.2.1.3, respectively. Noise levels could be affected as a result of the operation of construction equipment (graders, excavators, and haul trucks) and as a result of any blasting activities. Increases in ambient noise levels during operations would be associated with mining and tar sands processing activities and would be more long-term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump stations, and could also be affected by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA guidelines. Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed EPA guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the 431,224 acres identified for application for leasing under Alternative B.

6.2.2.7 Ecological Resources

Under Alternative B, land use plans would be amended to identify 431,224 acres of land in Utah as available for application for commercial tar sands development. These lands support a wide variety of biota and their habitats (Section 3.7). Ecological resources in these areas would not be affected by the amendment of six land use plans to identify these areas (Section 6.2.2); however, ecological resources could be affected by future commercial development of tar sands in and around the 431,224 acres of available lands. The following sections describe the potential impacts on ecological resources that may result with commercial tar sands development within the areas identified as available for application for commercial leasing under Alternative B.

The magnitude of potential impacts on specific ecological resources that could occur from commercial tar sands development of areas identified as available for application for leasing in Alternative B would depend on the specific location of the future commercial projects as well as on the specific project design.

6.2.2.7.1 Aquatic Resources. Under Alternative B, land use plans would be amended to identify 431,224 acres of land in Utah as available for application for commercial tar sands development. There are no impacts on aquatic habitats associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Potential impacts on aquatic resources from tar sands development could result primarily from increased turbidity and sedimentation, changes to water table levels, degradation of surface water quality (e.g., alteration of water temperature, salinity, and nutrient levels), release of toxic substances to surface water, and increased public access to aquatic habitats as described in Section 5.8.1.1. As described in Section 5.8.1.1, there is a potential for development and production activities in upland areas to affect surface water and groundwater beyond the area where surface disturbance or water withdrawals are occurring. Consequently, this analysis considers the potential for impacts on waterways up to 2 mi beyond the boundary of the lands that would be allocated for potential leasing under this alternative. However, as project development activities are located more distant from waterways, the potential for negative effects on aquatic resources is reduced. For the analysis of potential impacts under each of the alternatives considered in the PEIS, it was assumed that the potential for negative impacts on aquatic resources increases as the area potentially affected (i.e., the area that would be considered for leasing) increases and as the number and extent of waterways within a 2-mi zone surrounding those areas increases.

Under Alternative B, there are 9 perennial streams and about 28 mi of perennial stream habitat within the STSAs of Utah that are directly overlain by areas that would be potentially available for tar sands development (Table 6.2.2-4). When an additional 2-mi zone surrounding these areas is considered, there are 20 perennial streams and about 185 mi of perennial stream habitat that could be affected by future development activities (Table 6.2.2-5). The development of commercial tar sands projects in the areas identified under Alternative B could affect aquatic biota and their habitats during project construction and operations, thereby resulting in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. As described in Section 5.1.1.1, impacts from water quality degradation and water depletions could affect not only resources in areas within or immediately adjacent to leased areas, but also in areas farther downstream in affected watersheds. The nature and magnitude of impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

TABLE 6.2.2-4 Perennial Streams Occurring in Utah within the Lease Areas Identified under Alternative B

Stream	Length of Stream (mi)
Tabyago Canyon	2.0
Bitter Creek	0.7
Center Fork	1.9
Sand Wash	0.5
Sweetwater Canyon	6.0
Wells Draw	1.1
Cottonwood Canyon	5.1
Dry Creek	5.9
Nine-Mile Creek	5.2
Total	28.4

The types of aquatic habitats and organisms that could be impacted by future development in the vicinity of the STSAs are described in Section 3.7.1.2, and some of these aquatic habitats are known to, or are likely to, contain federally listed endangered fish, state-listed or BLM-designated sensitive species (Section 3.7.4), and other native fish and invertebrate species that could be negatively affected by development. Specific impacts would depend greatly upon the locations and methods of extraction used by future projects. Project-specific NEPA analyses would be conducted prior to any future leasing to evaluate potential impacts in greater detail.

6.2.2.7.2 Plant Communities and Habitats. Under Alternative B, land use plans would be amended to identify 431,224 acres of land in Utah as available for application for commercial tar sands leasing. There would be no impacts on plant communities and habitats associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Areas identified as available for application for commercial leasing under Alternative B support a wide variety of plant communities and habitats (see Section 3.7.2). These areas include approximately 1,599 acres that are currently identified in BLM land use plans for the protection

TABLE 6.2.2-5 Streams and Approximate Miles of Each Stream in STSAs and in the Vicinity[a] of Areas To Be Considered for Leasing under Alternatives B and C

Stream	Stream Miles within STSAs	Alternative B	Alternative C
Big Water Canyon	9.4	–[b]	–
Bitter Creek	18.1	17.6	17.6
Center Fork	5.5	5.5	5.5
Cliff Creek	13.5	13.5	13.1
Colorado River	10.5	–	–
Cottonwood Canyon	15.1	15.1	15.1
Deep Creek	4.0	2.3	–
Dirty Devil River	22.0	13.9	12.3
Dry Creek	14.9	14.9	14.9
Eagle Canyon	3.2	0.4	0.4
Green River	9.7	4.8	4.8
Halls Creek	3.3	–	–
Horse Canyon	7.8	–	–
Joe Hole Wash	1.0	–	–
Mosby Creek	5.1	2.2	–
Nine Mile Creek	22.5	22.2	22.2
No Name Available[c]	1.4	–	–
Pariette Draw	7.0	4.4	–
Pleasant Valley Wash	5.7	4.8	–
San Rafael River	37.2	26.6	16.3
Sand Wash	4.0	3.9	3.3
South Fork Avintaquin Creek	4.0	1.1	–
Sowers Canyon	2.9	2.8	–
Sweetwater Canyon	14.5	14.5	13.8
Tabyago Canyon	14.3	7.4	–
Wells Draw	7.3	6.8	6.5
Whiterocks River	6.9	–	–
Total miles	272.2	184.9	145.9

[a] Stream lengths for alternatives include portions of streams within each potential allocation area and a 2-mi zone surrounding the potential allocation area.

[b] A dash = stream does not fall within potential allocation area or within a 2-mi buffer surrounding the potential allocation area under this alternative.

[c] No name was given for this stream in the GIS database used for analysis in the PEIS.

of floodplains. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 5.8.1.2). Some impacts (e.g., habitat loss) could continue beyond the termination of tar sands production.

Direct impacts from future construction and operation activities would include the destruction of vegetation and habitat during land clearing on the lease site and where ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing would be developed. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature (occurring within construction and operation footprints and in the immediate surrounding area), the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the location of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

The area available for application for commercial leasing under Alternative B includes locations that support oil shale endemic plant species. Local populations of oil shale endemics, which typically occur as small scattered populations on a limited number of sites, could be reduced or lost as a result of tar sands development activities. Establishment and long-term survival of these species on reclaimed land may be difficult.

6.2.2.7.3 Wildlife. Under Alternative B, land use plans would be amended to identify 431,224 acres of lands in Utah as available for application for commercial tar sands leasing. There would be no impacts on wildlife species associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operations as described in Section 5.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. These areas and surrounding locations support a diverse array of wildlife and habitats (see Section 3.7.3). Important areas identified for protection in BLM land use plans within areas that would be available for application for commercial leasing in Alternative B include greater sage-grouse habitat; raptor nests; big game winter and summer ranges; and calving, fawning, and lambing areas. Table 6.2.2-6 identifies the amount of each of these habitats that would be included in the Alternative B areas available for application for leasing and that could be impacted by future commercial tar sands development in these areas.

Areas that would be available for application for leasing in Alternative B also contain areas identified by state natural resource agencies as important for greater sage-grouse and big game species. These areas include greater sage-grouse habitat and lek sites (Figure 6.2.2-1), and mule deer and elk winter and summer ranges (Figures 6.2.2-2 and 6.2.2-3). Table 6.2.2-7

TABLE 6.2.2-6 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in Tar Sands Areas in Alternative B Available for Application for Commercial Leasing

Wildlife Resource	Acres
Birds	
Sage grouse lek nesting areas	1,003 (1,011)[a,b]
Sage grouse lek sites	2,549 (3,194)
Raptor nests	7 (18)
Waterfowl (in Pariette Wetlands)	42 (536)
Goose nest sites (in Pariette Wetlands)	9 (131)
Mammals	
Deer and elk crucial winter range	80 (1,118)
Deer fawning and elk calving crucial habitat	18,044 (19,520)
Desert bighorn sheep crucial habitat	3,845 (4,865)
Elk crucial winter habitat	12,086 (13,177)
Pronghorn crucial kidding habitat	5,892 (5,893)

[a] Acreages may be overestimated because of unknown degree of habitat overlap among species or habitat types for a species. For these reasons, columns should not be totaled.

[b] Numbers in parentheses are the wildlife habitat acreage identified for protection within the most geologically prospective lands.

presents the amounts of these habitats identified by the State of Utah that are included in the Alternative B areas available for application for commercial leasing and that could be impacted by potential future commercial tar sands development.

Several wild horse HMAs overlap with the lands that would be available for application for leasing, including the Hill Creek HMA (about 18,725 acres), which overlaps the Hill Creek STSA; the Muddy Creek and Sinbad HMAs (about 3,500 and 39,675 acres, respectively), which overlap with the San Rafael STSA; the Range Creek HMA (about 13,875 acres), which overlaps the Sunnyside STSA; and the Canyon Lands HMA (about 265 acres), which overlaps with the Tar Sand Triangle STSA (Figure 6.2.2-4).

Impacts on wildlife (including wild horses and burros) from the construction and operation of future commercial tar sands projects could occur in a number of ways and could be related to (1) habitat loss, alteration, or fragmentation (as a result of construction); (2) disturbance and displacement of biota (by construction and operation activities and the presence of project infrastructure); (3) mortality (from construction activities and collisions with project infrastructure and vehicles); (4) exposure to hazardous materials; and (5) increase in human access. These impacts can result in changes in habitat use; changes in behavior; collisions with structures or vehicles; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

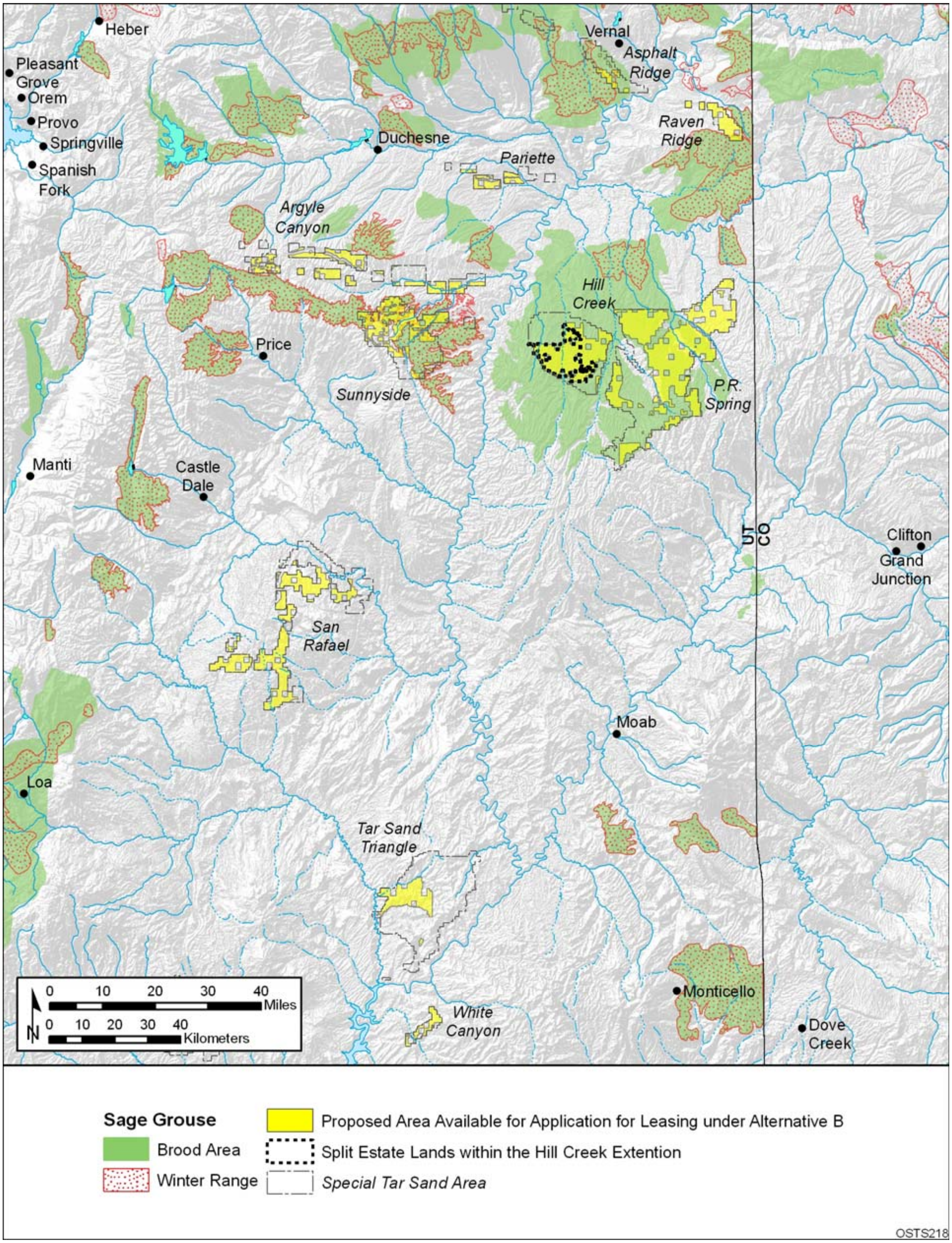

FIGURE 6.2.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse

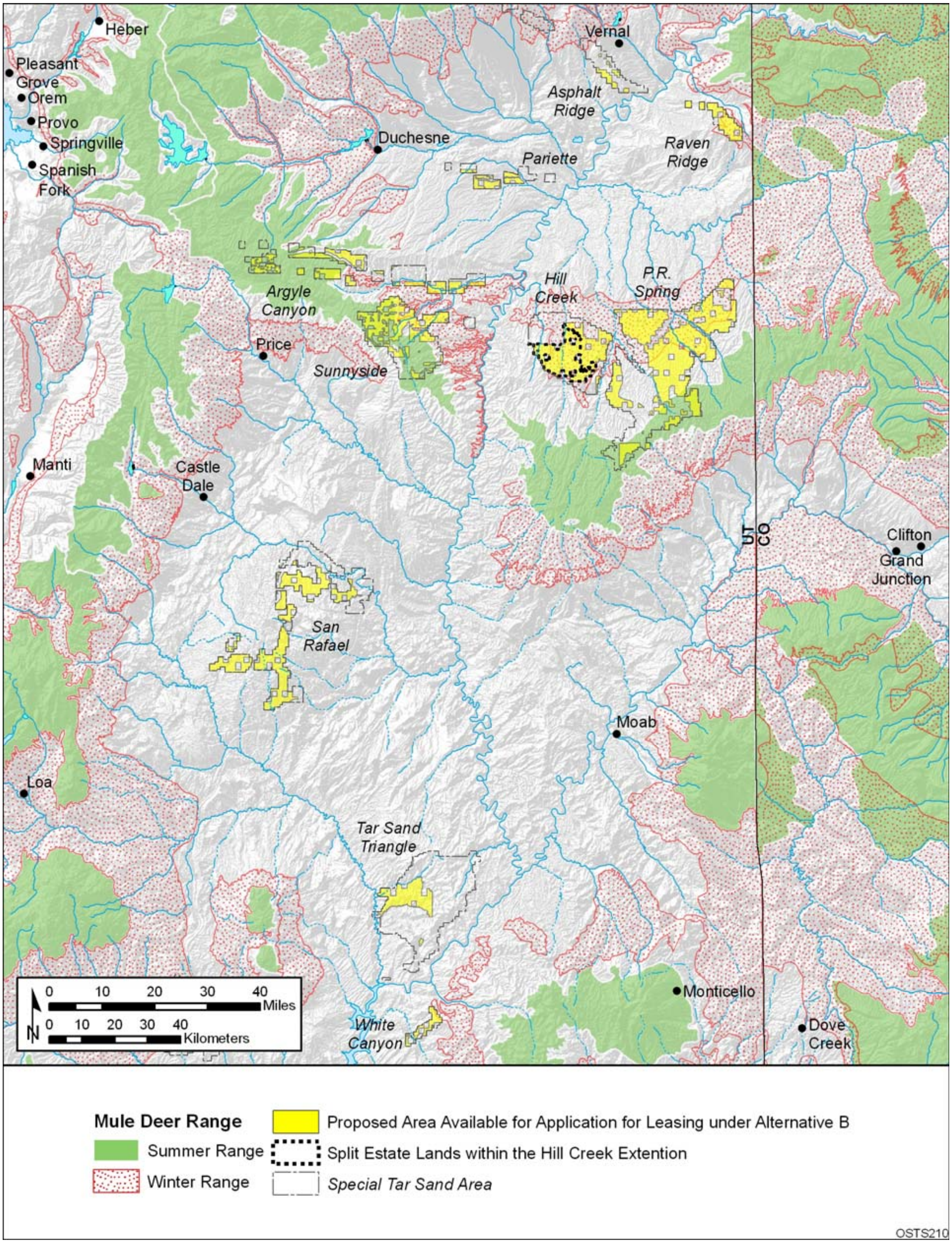

FIGURE 6.2.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer

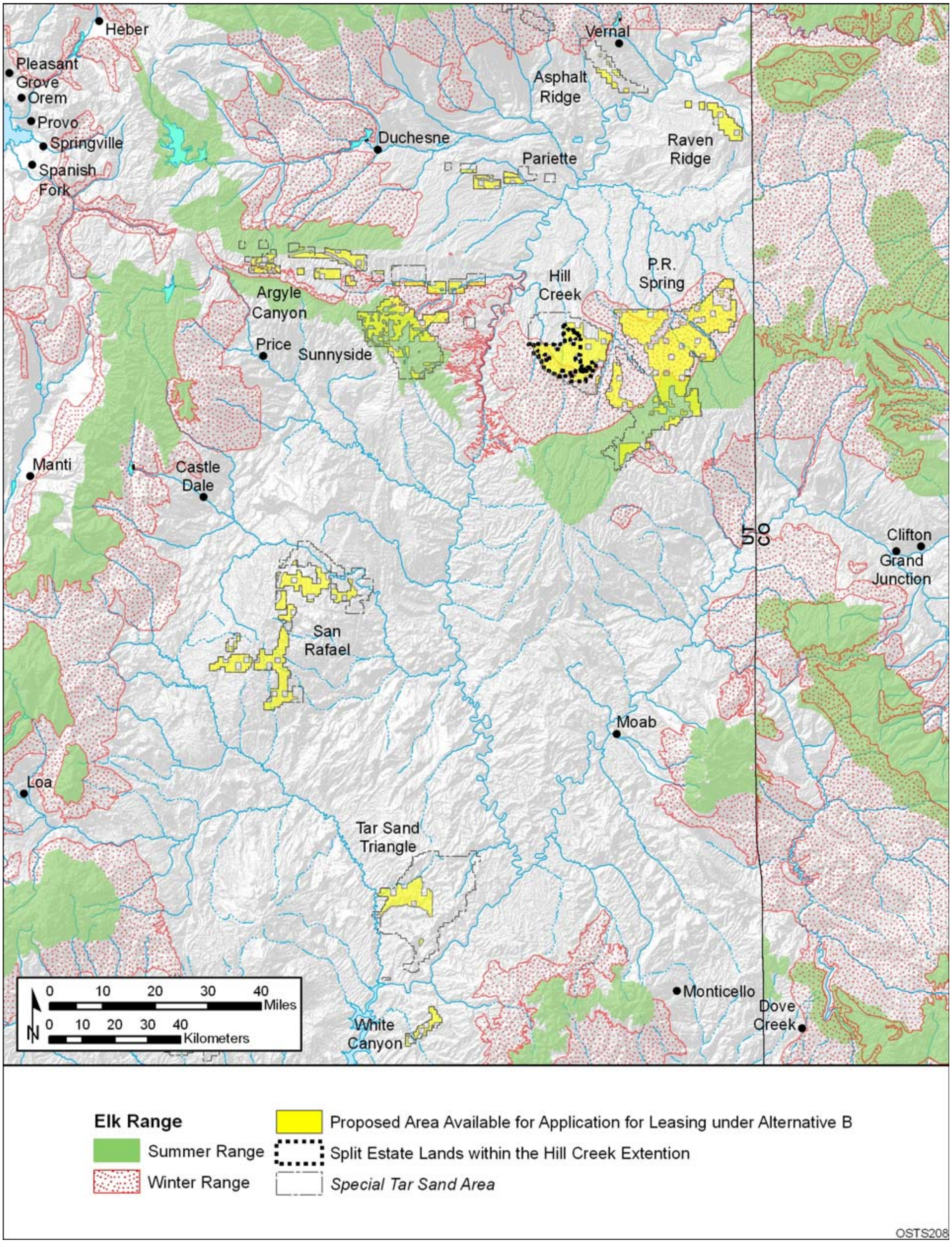

FIGURE 6.2.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk

TABLE 6.2.2-7 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative B Lease Areas

Wildlife Resource	Utah
Sage grouse habitat	227,700
Mule deer winter habitat	147,200
Mule deer summer habitat	67,100
Elk winter habitat	161,300
Elk summer habitat	65,400
Big game calving, fawning, or lambing habitat[a]	18,000
Crucial pronghorn kidding habitat	5,900

[a] Applies to elk and mule deer.

Wildlife could also be affected by human activities not directly associated with commercial tar sands projects or workforces, but instead associated with the potentially increased human access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads may lead to increased human access into the area. Potential impacts associated with increased access include the disturbance of wildlife from human activities, including an increase in legal and illegal harvest; an increase of invasive vegetation; and an increase in the incidence of fires.

The potential for impacts on wildlife and their habitats by commercial tar sands development is directly related to the amount of land disturbance that would occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitat affected by development (i.e., the location of the project). Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, water depletions, contamination, and disturbance and harassment are also considered. The magnitude of these impacts is also considered to be proportional to the amount of land disturbance.

6.2.2.7.4 Threatened and Endangered Species. Under Alternative B, land use plans would be amended to identify 431,224 acres of land in Utah as available for application for commercial tar sands development. There would be no impacts on threatened and endangered species associated with identifying lands as available for application for commercial leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.4. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Under Alternative B, 95 of the 110 federal candidate, BLM-designated sensitive, and state-listed species listed in Table 5.8.1-5, and 20 of the 24 federally listed threatened or endangered species listed in Table 5.8.1-6 could occur in areas that are available for application for leasing (based on records of occurrence in STSA counties). Potential lease areas do not include any of the critical habitat for Colorado River endangered fishes in Utah (Figure 6.2.2-5). The areas that are available for application for commercial leasing under Alternative B also include about 15,450 acres for which lease stipulations have been established in existing RMPs to protect federally listed and candidate species, BLM-designated sensitive species, and other special status species.

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by future commercial tar sands development would be directly related to the amount of land disturbance that would occur with a project (including its ancillary facilities such as utility

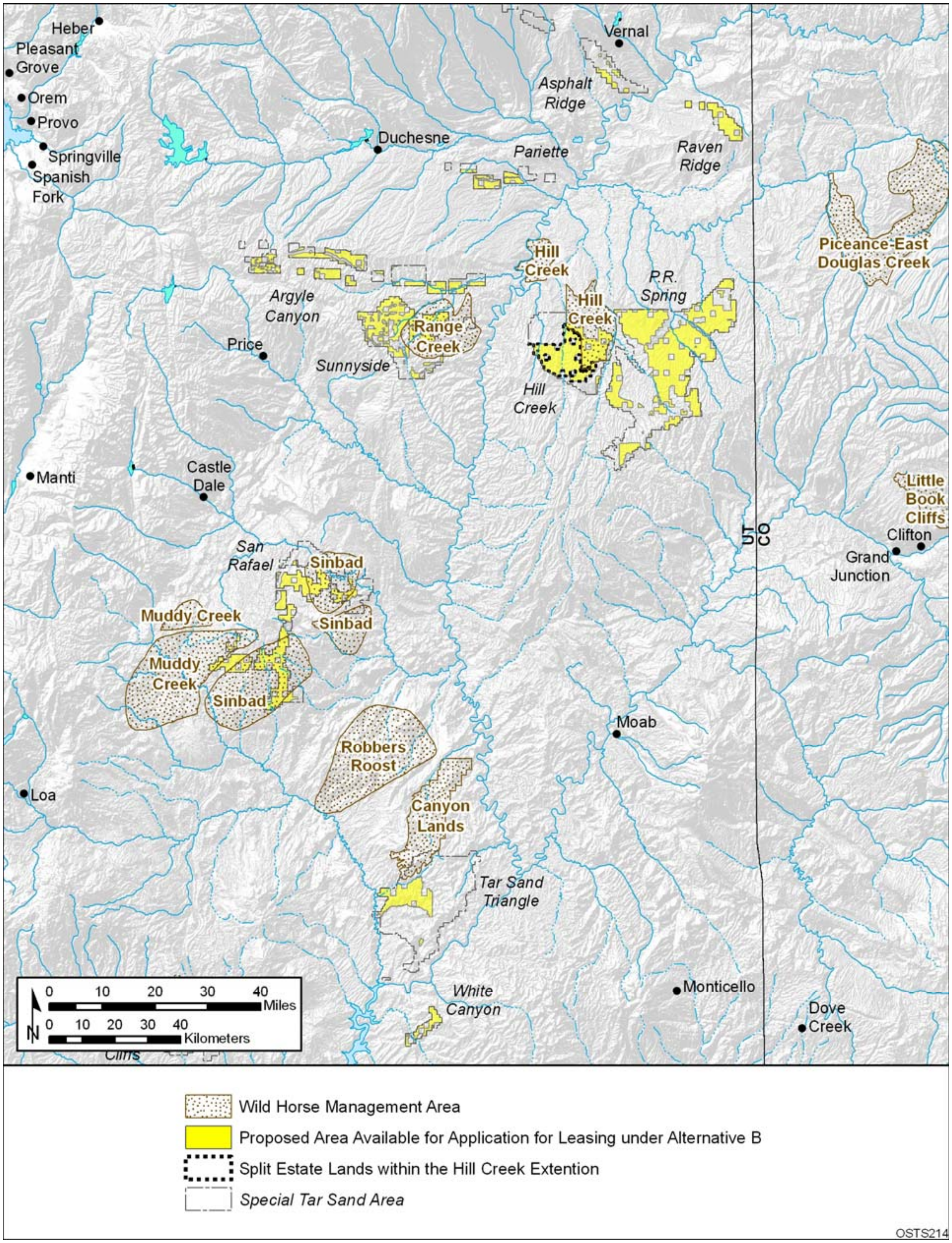

FIGURE 6.2.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas

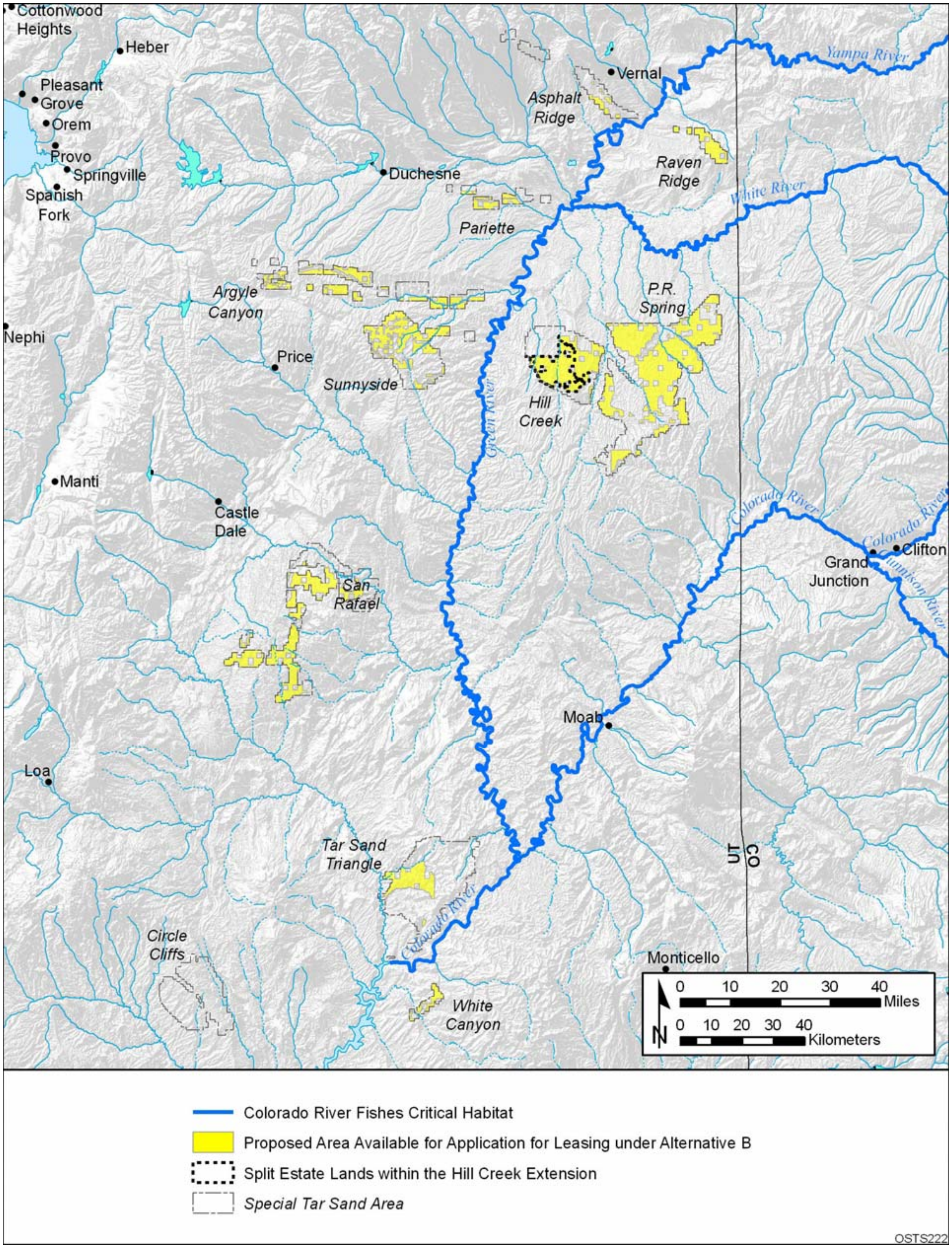

FIGURE 6.2.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B

and pipeline ROWs), the duration and timing of construction and operation periods, and the specific habitats affected by development. Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, surface or groundwater depletions, accidental release of contaminants, and disturbance and harassment of animal species, are also considered, but their relative magnitude also is considered proportional to the amount of land disturbance.

Potential impacts on threatened and endangered species (see Section 5.8.1.4) under Alternative B would be similar to or the same as those described for impacts on aquatic resources; plant communities and habitats; and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. The most important difference is the potential consequence of the impacts. Because of low population sizes, threatened and endangered species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific assessments and consultations conducted prior to leasing and development.

6.2.2.8 Visual Resources

Under Alternative B, land use plans would be amended to identify 431,224 acres of public land in Utah as available for application for commercial tar sands development. While these lands support a wide variety of visual resources (Section 3.8), these resources would not be affected by the amendment of land use plans to identify these potential lease areas. However, visual resources in and around areas available for application for leasing could be affected by future commercial development of tar sands.

Several scenic resource areas are located within areas identified as available for application for leasing under Alternative B (Figures 6.2.2-6 through 6.2.2-9). These scenic resource areas include:

- The Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Lucky Strike, Main Canyon, Nine Mile Canyon, Range Creek, and Wild Horse Potential ACECs;

- Segments of the Nine Mile Creek determined to be eligible for WSR designation; and

- A portion of the Dinosaur Diamond Prehistoric National Scenic Highway.

Additional scenic resource areas are located within 5 or 15 mi of the Alternative B proposed lease areas (Figures 6.2.2-6 through 6.2.2-9). The 5-mi zone corresponds to the BLM’s VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM’s background distance limit. Assuming an unobstructed view of a commercial tar sands project,

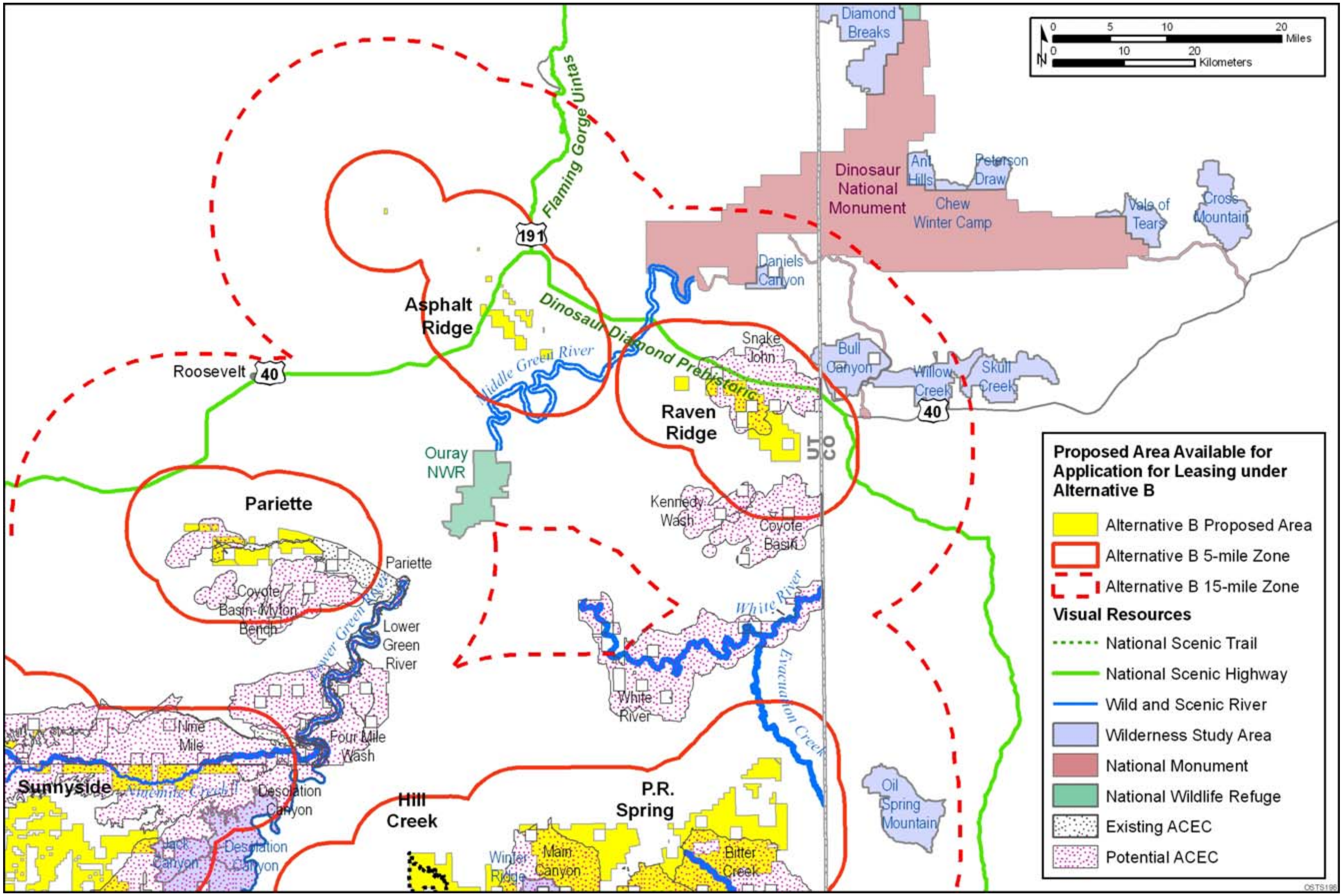

FIGURE 6.2.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Asphalt Ridge, Pariette, and Raven Ridge STSAs

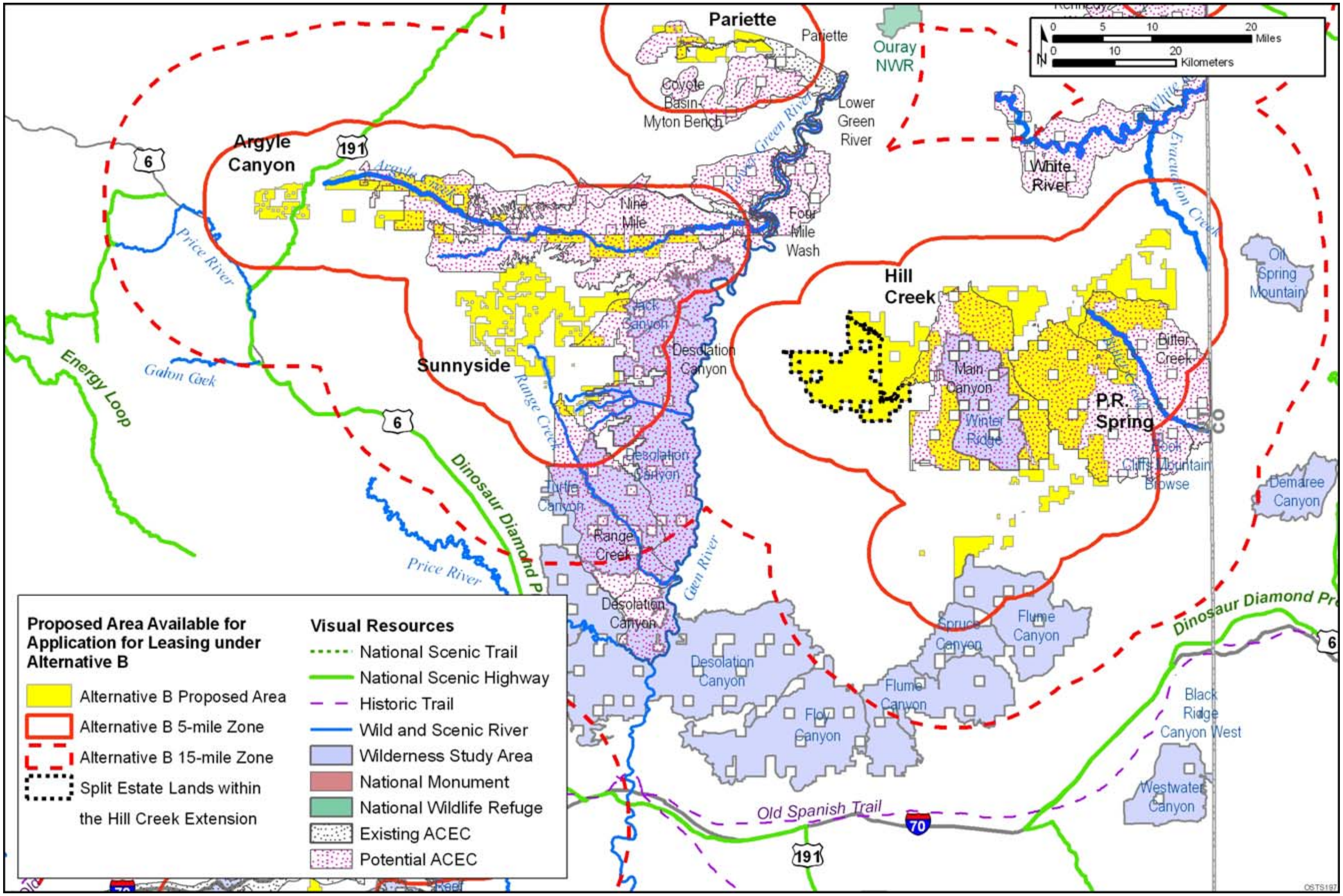

FIGURE 6.2.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Argyle Canyon, Hill Creek, P.R. Spring, and Sunnyside STSAs

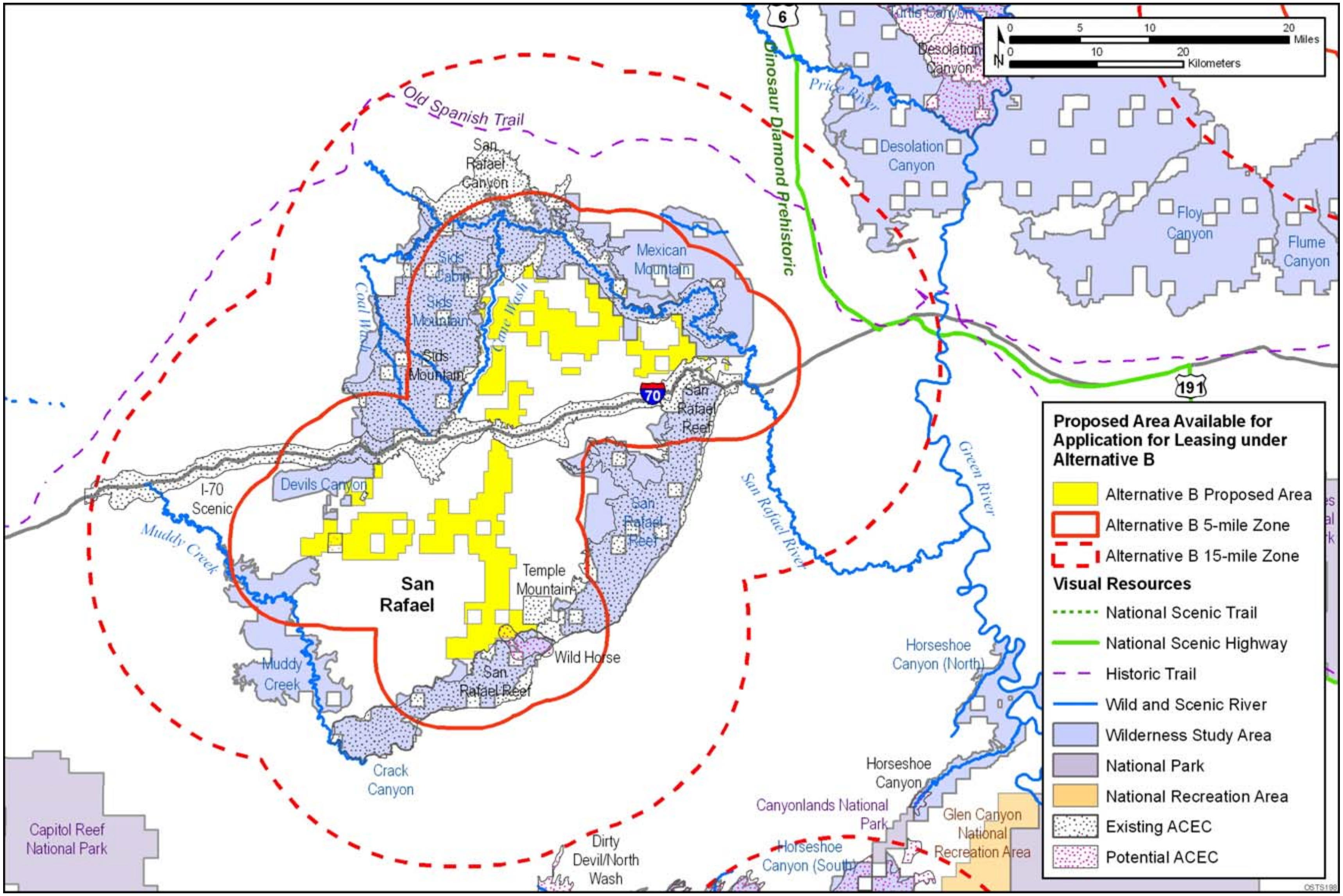

FIGURE 6.2.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the San Rafael STSA

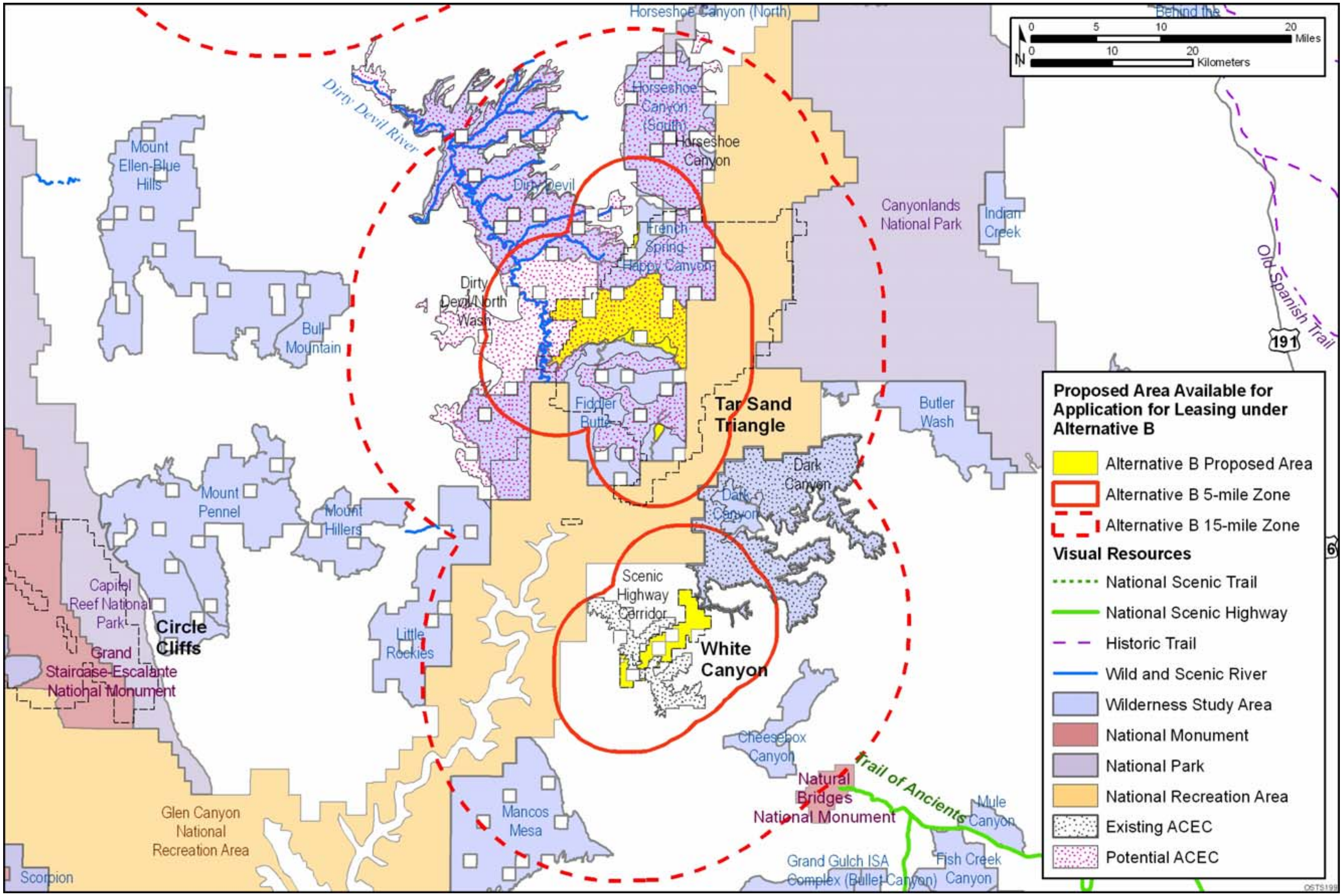

FIGURE 6.2.2-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Tar Sand Triangle and White Canyon STSAs

viewers in these areas would be likely to perceive some level of visual impact from the project, with impacts expected to be greater for resources within the foreground-middleground distance, and lesser for resources within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.2.2-8 presents the scenic resource areas that fall within these zones.

Visual resources could be affected at and near the lease areas where commercial tar sands projects would be developed and operated, and at areas where supporting infrastructure (such as utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 5.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as tar sands processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

6.2.2.9 Cultural Resources

Under Alternative B, the amendment of land use plans to identify 431,224 acres of public land as available for commercial tar sands leasing would not result in impacts on cultural resources. The lands made available overlap with lands specifically identified as having cultural resources (O'Rourke et al. 2007). More than 10%[6] of public lands that would be made available for application for leasing in the STSAs under Alternative B have been surveyed for cultural resources (more than 42,620 acres in addition to 460 linear mi). In those areas that have been surveyed, 183 sites have been identified. Additional cultural resources are likely in unsurveyed portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), nearly 220,650 acres within areas available for application for leasing in Alternative B have been identified as having a medium or high sensitivity for containing cultural resources.[7]

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts from future development could include the destruction of individual resources present within development areas, degradation and/or destruction of near-surface resources in or near the development area,

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6 This percentage was calculated using block acre surveys only and does not include approximately 460 linear mi of survey.

7 Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 431,224 acres available under Alternative B, sensitivity information is available for 341,536 acres; therefore, 220,650 acres represent 65% of the STSAs for which sensitivity information is available.

TABLE 6.2.2-8 Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative B

Scenic Resources within 5 mi of Alternative B Lease Areas	Scenic Resources between 5 and 15 mi of Alternative B Lease Areas
Bull Canyon, Crack Canyon, Dark Canyon, Desolation Canyon, Devils Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon (South), Jack Canyon, Link Flats, Mexican Mountain, Muddy Creek, San Rafael Reef, Sid's Cabin, Sid's Mountain, Spruce Canyon, and Winter Ridge WSAs.	Book Cliffs Mountain Browse, Bull Canyon, Butler Wash, Cheesebox Canyon, Crack Canyon, Dark Canyon, Daniels Canyon, Demaree Canyon, Desolation Canyon, Dirty Devil, Fiddler Butte, Floyd Canyon, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon, Jack Canyon, Little Rockies, Mancos Mesa, Mexican Mountain, Mount Hillers, Muddy Creek, Oil Spring Mountain, San Rafael Reef, Sid's Mountain, Skull Creek, Spruce Canyon, Turtle Canyon, and Willow Creek WSAs.
Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Sid's Mountain, and Temple Mountain ACECs.	Dark Canyon, I-70 Scenic Highway, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Seger's Hole, and Sid's Mountain ACECs.
Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Lucky Strike, Main Canyon, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, Shepards End, and Wild Horse potential ACECs.	Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, and White River potential ACECs.
Segments of Argyle Creek, Bear Canyon, Bitter Creek, Buckskin Canyon, Cane Wash, Dirty Devil River, Evacuation Creek, Middle Green River, Muddy Creek, Ninemile Creek, North Fork Coal Wash, Price River, Range Creek, Rock Creek, Sams Mesa Box Canyon, San Rafael River, South Fork Coal Wash, and Twin Corral Box Canyon determined to be eligible for WSR designation.	Segments of Argyle Creek, Beaver Wash, Bitter Creek, Coal Wash, Cottonwood Wash, Dirty Devil River, Evacuation Creek, Fish Creek, Gordon Creek, Green River, Larry Canyon, Lower Green River, Maidenwater Creek, Middle Green River, Muddy Creek, Nine Mile Creek, No Mans Canyon, North Fork Coal Wash, North Salt Wash, Price River, Range Creek, Robbers Roost Canyon, Robbers Roost Canyon White Roost, Robbers Roost Middle Fork, Robbers Roost North Fork, Robbers Roost South Fork, Rock Creek, San Rafael River, South Fork Coal Wash, Twin Corral Box Canyon, and White River determined to be eligible for WSR designation.
Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways.	Dinosaur Diamond Prehistoric, Energy Loop, and Flaming Gorge Uintas National Scenic Highways.
Canyonlands National Park and Glen Canyon National Recreation Area.	Canyonlands National Park, Glen Canyon National Recreation Area, Dinosaur National Monument, and Natural Bridges National Monument.
	Old Spanish Trail National Historic Trail.

increased potential of loss of resources from looting or vandalism of resources as a result of increased human presence/activity in the sensitive areas, and visual degradation of the cultural setting (see Section 5.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested Tribes. The cultural resources in the Circle Cliffs STSA would not be impacted by tar sands leasing and development as no leasing and development would occur in this STSA. The cultural resources in Argyle Canyon, Hill Creek, Pariette, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs are less likely to be impacted by tar sands leasing and development than those resources present in the Asphalt Ridge, P.R. Spring, and Sunnyside STSAs.

6.2.2.10 Socioeconomics

Under Alternative B, land use plans would be amended to identify 431,224 acres of land in Utah as available for application for commercial tar sands development. With the possible exception of an impact on property values, there is no socioeconomic impact from this action. The socioeconomic impacts described in Section 5.11 and summarized in this section are for hypothetical individual commercial tar sands projects. These represent the types of impacts that could occur as a result of development on lands identified as available for commercial leasing under Alternative B. The specific socioeconomic impacts would depend on the technologies employed, the project size or production level, and development time lines and mitigation measures.

- Tar sands developments and their associated ancillary facilities could affect property values in ROI communities located nearby. Furthermore, it is possible that there will be property value impacts simply from designating land as available for application for leasing; these impacts could result in either decreased or increased property values (see Section 4.11.1.6). Property values could decline in some locations as a result of the deterioration in aesthetic quality, increases in noise, real or perceived health effects, congestion, or social disruption. In other locations, property values could increase as a result of access to employment opportunities associated with tar sands development.

- Under Alternative B, a single tar sands facility would produce 1,831 jobs in the ROI (1,187 direct jobs at tar sands facilities and 644 indirect jobs in the remainder of the local economy) during the peak construction year. During commercial production, 747 employees (482 direct and 265 indirect) would be required in the ROI.

- Construction of housing for tar sands workers and families would create 552 jobs (432 direct and 119 indirect in the remainder of the local economy) in the ROI.

- Population in-migration associated with tar sands construction would represent an increase of 1.0% over the projected ROI population baseline.

- In-migrating population associated with tar sands facilities would absorb 3.2% of the projected vacant housing stock in the ROI.

- Provision of additional local public services for in-migrant workers would require an increase in 1.0% in local expenditures during the peak construction year and 0.7% during operations.

- The number of new residents from outside the producing regions and the pace of population growth associated with the commercial development of tar sands resources, including large-scale production facilities and housing developments, could lead to substantial demographic and social change in small rural communities. These communities could be required to adapt to a different quality of life, with a transition away from a more traditional lifestyle in small, isolated, close-knit, homogenous communities with a strong orientation toward personal and family relationships, toward a more urban lifestyle, with increasing cultural and ethnic diversity, and increasing dependence on formal social relationships within the community.

- Substantial changes in access to water by agriculture could have large impacts on the economy of each ROI, which would depend on the amount of agricultural production lost, the extent of local employment in agriculture, the reliance of other industries in each ROI on agricultural production, the extent of local procurement of equipment and supplies by agriculture, and the local spending of wage and salaries by farmers, ranchers, and farmworkers. Loss of property tax revenues on agricultural land could also impact local government expenditures and consequently impact the provision of public services in local communities in each ROI. Changes in agricultural activity would likely change the character of community life in each ROI, with a movement away from activities that historically represent small rural communities.

- The impact of tar sands development on recreational visitation, assuming a 10% reduction in recreation employment in the ROI, would be the loss of 388 jobs in the ROI, and 776 jobs lost assuming a 20% reduction.

Under Alternative B, the amendment of land use plans to identify 431,224 acres of public land as being available for commercial tar sands leasing would not result in impacts on transportation systems and infrastructure. The types of impacts on transportation that may occur on lands identified as available for commercial leasing are described in Section 5.11.3. Because there are many variables regarding project location, location of employee housing, and the variability of the level of employment depending upon the phase of individual projects, this general assessment of potential transportation impacts utilizes the maximum number of direct employees employed in support of only tar sands projects as the basis for this discussion. Direct and indirect jobs associated with construction of housing, pipelines, and power lines serving the tar sands facilities are not included in this number because of additional uncertainties over location and timing. The maximum number of direct employees would occur during the construction period for projects and, therefore, overstates potential traffic volume effects during the operations phase for the projects. In addition, because the potential locations of projects are unknown, identifying specific impacts is not possible at this time. Specific transportation impacts would be assessed once site-specific proposals are evaluated.

The maximum number of direct employees for a commercial tar sands facility is estimated to be 1,187 during the construction phase and 482 employees during the operations phase. Assuming a range of 2 to10 average passengers per vehicle, the estimated number of employees could add from 119 to 593 daily vehicle trips during construction to 48 to 241 additional daily vehicle trips during operations. Depending on the distribution of this traffic volume, impacts on traffic flow may occur. Structural changes to road systems may be required to provide traffic additional capacity and to deal with heavier loads of associated construction equipment.

The above maximum vehicle numbers do not include traffic generated by indirect jobs associated with tar sands development. Uncertainties about where indirect jobs may be located further complicate making assumptions about their specific impact; however; these employees will also have an impact on traffic loads throughout the immediate region.

6.2.2.11 Environmental Justice

The environmental justice impacts described in Chapter 5 and summarized in this section for individual commercial tar sands projects represent the types of impacts that could occur as a result of development on lands identified as available for commercial leasing under Alternative B. As with the environmental impacts discussed elsewhere in Section 6.2.2, the specific environmental justice impacts of future commercial tar sands projects would be dependant upon specific project locations, the technologies employed, the project size or production level, and development time lines and mitigation measures.

Since tar sands development projects and associated facilities would lead to rapid population growth in many of the communities in each ROI, it is possible that social disruption would occur, leading to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants, and consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts on property values of property owned by minority and low-income individuals would depend on the range of alternate uses of specific land parcels, current property values, and the perceived value of costs (traffic congestion, noise and dust pollution, and visual, air quality, and EMF effects) and benefits (infrastructure upgrades, employment opportunities, and local tax revenues) associated with proximity to oil shale-related facilities.

Tar sands development would produce surface disturbance, fugitive dust, vehicle emissions, and activity that could generate visual impacts. Emissions associated with construction activities would consist primarily of particulate matter ($PM_{2.5}$ and PM_{10}), criteria pollutants, VOCs, CO_2, and certain HAPs released from heavy construction equipment and vehicle exhaust. Because of the limited surface water and groundwater, the amount of water needed in Utah for commercial tar sands projects and associated population growth would mean that additional water resources would be needed. Tar sands facilities might impact certain animals or vegetation types that may be of cultural or religious significance to certain population groups, or that form the basis for subsistence agriculture. Similarly, land used for these facilities that has additional economic uses might affect access to resources by low-income and minority population groups.

Given the location of environmental justice populations in Utah, construction and operation of tar sands facilities and employer-provided housing required for the operation of tar sands development projects could produce impacts that would be experienced disproportionately by minority and low-income populations. Of particular importance would be social disruption impacts of large increases in population in small rural communities, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Land use and visual impacts could be significant depending on the locations of land parcels for tar sands projects and the associated housing facilities, their importance for subsistence, their cultural and religious significance, and alternate economic uses. Depending on the locations of low-income and minority populations, impacts could also occur with the development of transmission lines associated with power development and the supply of power to tar sands facilities in each state.

6.2.2.12 Hazardous Materials and Waste Management

The amendment of land use plans to identify 431,224 acres of land as available for application for leasing for commercial tar sands development would not result in any hazardous material or waste management concerns. Impacts related to hazardous materials and wastes could occur during the construction and operation of commercial tar sands projects within areas identified in Alternative B as available for application for commercial leasing. Such impacts would generally be independent of location and would be unique to the technology combinations used for tar sands development. Hazardous materials and wastes would also be associated with ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development of energy transmission or pipeline ROWs and employer-provided housing.

Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, glycol-based coolants, and solvents, adhesives, and corrosion-control coatings. Construction-related wastes could include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 5.13.1).

During project operations, hazardous materials could be utilized and a variety of wastes (some hazardous) would be generated. Hazardous materials used include fuels, solvents, corrosion-control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations would depend on the specific design of the commercial tar sands project (surface mining, various surface retorting technologies, and in situ processes). Waste materials produced during operations could include waste engine fuels and lubricants, flammable gases, volatile and flammable organic liquids, and heavier molecular weight organic compounds (Section 5.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial tar sands project, it is not possible to quantify project-related impacts of these materials. Under Alternative B, individual facilities could be located anywhere within the areas identified as available for leasing, pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Sections 5.14 and 6.2.2.13) at locations wherever the individual projects are sited within the Alternative B lease areas.

6.2.2.13 Health and Safety

The amendment of land use plans to identify 431,224 acres of land as available for application for leasing for commercial tar sands development would not result in any direct health and safety concerns. However, a number of health and safety concerns would be associated with the commercial development of tar sands projects within the areas made available for application for commercial leasing in Alternative B . The level of health and safety impacts would be mainly dependent on the extent of tar sands development, the extent of health and safety precautions imposed by the operators, and the design of each project (as related to the level of air and water emissions associated with a facility).

Potential health and safety impacts from the construction and operation of commercial tar sands projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure; (2) surface mining (if processing is not in situ) the tar sands; (3) obtaining and upgrading the syncrude, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposure of the general public to water and air contamination associated with tar sands development. Hazards from tar sands development (summarized in Table 5.14-1) could include physical injury from construction, tar sands processing, and vehicle transportation accidents, and exposure to fugitive dust and hazardous materials such as retort emissions and industrial chemicals (Section 5.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents may also affect members of the general public that could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road or recreational users in areas adjacent to the project lease area).

Workers would be exposed to different hazards depending on the type of jobs they do. Workers at all types of tar sands development facilities could be exposed to high noise levels, resulting in hearing loss. The health and safety of miners could be impacted by injuries or deaths due to accidents (e.g., highwall bank failures or cave-ins, uncontrolled explosions, and accidents involving heavy machinery), or heat exposures. Workers operating surface retorts also could be injured or die due to accidental explosions, heat stress, or accidents involving heavy machinery. Physical hazards from well drilling, use of explosives, and operation of heavy equipment would be present for in situ workers.

Serious and often fatal lung disease in miners has been associated with inhalation of particulates and volatile compounds containing carcinogenic PAHs; such exposures could be limited by adherence to applicable occupational health and safety standards. Lung disease caused by inhalation of emissions from the retorting process is also of concern for retort operators, although these exposures are generally lower than those associated with mining. For workers at facilities using in situ recovery techniques, hazards associated with inhalation of emissions would also be expected to be lower than those associated with mining.

Estimates of expected injuries and fatalities can be made on the basis of the number of employees and the type of work. On the basis of the numbers of employees projected to be needed for construction and operation of tar sands facilities, there statistically would be less than 1 death and about 100 injuries per year expected per facility during construction activities, and less than 1 death and about 30 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training could be required as part of the plan of development for every proposed commercial tar sands project.

Health and safety concerns are largely independent of the locations of tar sands development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions and on the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

6.2.3 Impacts of Alternative C

Under Alternative C, the BLM would amend the same six BLM land use plans that would be amended under Alternative B (Section 6.2.2), and would make 229,038 acres (approximately 35% of the federal lands in the STSAs) available for application for leasing for commercial development of tar sands within nine designated STSAs: Asphalt Ridge, Hill Creek, Pariette, P.R. Spring, Raven Ridge, San Rafael, Sunnyside, Tar Sand Triangle, and White Canyon STSAs (see Figure 2.4.3-2 and Table 2.4.3-2). As with Alternative B, leasing would not be allowed in the Circle Cliffs STSA, but in addition, Argyle Canyon STSA would be totally unavailable under Alternative C, and the acreage available in both Pariette and White Canyon STSAs could be so small as to make them practically unavailable for development. The public lands that would be available under Alternative C comprise approximately 209,000 acres of BLM-administered lands and 21,000 acres of split estate lands. (See Sections 2.4.3 and 2.4.3.2 for a complete description of Alternative C.)

In addition to those public lands that are excluded under Alternative B, under Alternative C, the BLM also would exclude lands that are identified as requiring special management or resource protection in existing land use plans. By making these additional exclusions, the BLM is placing a priority on protecting known sensitive resources within each field office. By excluding these lands from future commercial leasing and development, direct impacts on resources on these lands would be avoided. The resources present in these excluded areas could incur indirect impacts as a result of commercial tar sands development on adjacent lands or within the region.

On the basis of the analysis in this PEIS, the BLM has determined that there is no environmental impact associated with amending land use plans to make lands available for application for commercial leasing in the three-state study area, but there may be impacts on land values. However, the development of commercial tar sands projects that could occur on lands made available for application for commercial leasing by these land use plan amendments would have impacts on these resources. The following sections describe the impacts of Alternative C on the environment and the socioeconomic setting. The sections also describe the potential impact of subsequent commercial development that might occur on the lands identified as available for leasing.

6.2.3.1 Land Use

Alternative C would amend the same land use plans as Alternative B but would identify 229,038 acres of public land in Utah as available for application for leasing for commercial development of tar sands (approximately 38% of the study area). The public lands that would be available under Alternative C are composed of approximately 208,000 acres of BLM-administered lands and 22,000 acres of split estate lands. Table 6.2.2-1 lists the acreages and percentages per STSA.

Although Alternative C makes approximately 200,000 fewer acres available for application for commercial leasing, it does not provide for less potential development of commercial tar sands than does Alternative B. Some of the potential impacts on land use could be the same as those under Alternative B, although Alternative C does not make available for commercial leasing areas currently identified by the BLM in current land use plans for protection of sensitive resources.

The nature of the impacts of Alternative C on land uses would be essentially the same as those listed for Alternative B in Section 6.2.2.1, with the following exceptions:

- Lands available for application for lease contain all or portions of areas that have been recognized by the BLM in Utah as having one or more characteristics of wilderness. Table 6.2.2-2 (in Section 6.2.2.1) lists these areas. Should commercial development occur on these lands, the identified wilderness characteristics in both the areas that are developed and those that border the developed areas would be lost. Alternative C includes approximately 68,000 acres of these lands that would be subject to potential development.

- In Utah, there are areas that have been identified as being eligible for designation as ACECs. These areas are being reviewed as part of ongoing land use planning activities that may or may not be complete before this PEIS is published. Table 6.2.2-3 (in Section 6.2.2.1) lists the areas and the number of acres of overlap that would be available for application for commercial tar sands leasing. If tar sands development occurs on these lands, depending on the nature of resources present on the lands, it is likely these resources would be lost. The decisions regarding designation of these lands will be made at the field office level and not in this PEIS. Should designation as an ACEC be completed before the PEIS is issued, these lands would not be available for lease. If this PEIS is issued before the land use planning process is completed, the field offices still would make the decisions regarding the future management of these lands and would determine whether they would be available for application for leasing for commercial tar sands development. Alternative C includes approximately 86,000 acres of these lands that would be subject to potential development.

6.2.3.2 Soil and Geologic Resources

Under Alternative C, 229,038 acres of public land in Utah would be identified as available for application for leasing for commercial tar sands development. The amendment of land use plans to identify these areas would not have any direct impacts on soil and geologic resources in these lands. Development of commercial tar sands projects could, however, affect soils and geologic resources in these lands. Construction-related activities could directly disturb surface and subsurface soils during clearing and grading activities and construction of project facilities and infrastructure. This disturbance could include soil disturbance, removal, and compaction, and disturbed areas would be more susceptible to the effects of precipitation and wind-driven erosion (see Section 5.3.1). Surface and subsurface mining activities during project operations would directly disturb geologic resources. Erosion of exposed soils could lead to increased sedimentation of nearby water bodies and to the generation of fugitive dust. Soils in project areas would remain susceptible to erosion until completion of construction, mining, and tar sands processing activities, and site stabilization and reclamation (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as to areas where associated off-lease infrastructure (e.g., access roads and utility ROWs) would be located.

Under Alternative C, project-related impacts could occur wherever individual projects are located within the 229,038 acres identified for application for leasing under this alternative. For any project, the erosion potential of the soils would be a direct function of the lease and project location, and the soil characteristics, vegetative cover, and topography (i.e., slope) at that location. Development in areas that have erosive soils and steep slopes (e.g., in excess of 25%) could lead to serious erosion problems at those locations.

6.2.3.3 Paleontological Resources

Under Alternative C, 229,038 acres in the STSAs would be identified as being available for application for leasing and potential future commercial development. The identification of these lands as available for application for leasing, as well as the amendment of land use plans to identify these areas, would not affect paleontological resources because it does not authorize or approve any ground-breaking actions. However, the lands that are made available for application for leasing overlap with some lands known to be potentially rich in paleontological resources. Of the acreage identified as available for application for leasing under Alternative C, a total of 147,937 acres (approximately 65%) have been identified as having the potential to contain important paleontological resources (Murphey and Daitch 2007). Resources within these areas could potentially be adversely impacted if future commercial development occurs. Impacts could include the destruction of individual resources present within development areas, degradation and/or destruction of near-surface resources in or near the development area, and increased potential for loss of resources from looting or vandalism as a result of increased human presence/activity in the sensitive areas (see Section 5.4).

6.2.3.4 Water Resources

The acreage available for application for leasing under Alternative C specifically excludes lands identified in BLM land use plans as sensitive for numerous resources (see Table 2.2.3-3). Excluding these lands from application for leasing would provide complete protection from direct impacts on water resources found on these lands. To the extent that development could occur adjacent to these excluded lands, there is the potential for indirect adverse impacts on water resources on the excluded lands, as described in Section 5.5. In those areas that are available for application for leasing under Alternative C, the potential impacts would be the same as those described for Alternative B in Section 6.2.2.4, with the exception that under Alternative C, approximately 19 mi (19%) of perennial streams in the STSAs could be impacted by future commercial development (in comparison with 28 mi under Alternative B).

The assessment of impacts on water resources under Alternative C has the same limitations identified under Alternative B. Without site-specific information regarding the location and type of technology to be employed, it is not possible to assess the overall impacts of this alternative.

6.2.3.5 Air Quality

Air resources would not be affected by the amendment of land use plans to identify 229,038 acres of public lands as being available for application for leasing for commercial tar sands development. Air resources in and around these areas could, however, be affected by future commercial tar sands development. Under Alternative C, local, short-term, air quality impacts may be incurred as a result of (1) PM releases (fugitive dust and diesel exhaust) during construction activities such as site clearing and grading in preparation of facility construction and (2) exhaust emissions (SO_2, CO, and NO_x) from construction equipment (see Section 5.6). These types of impacts would be largely limited to specific project locations and immediately adjacent areas, as well as to other areas where project-related electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located and developed.

Similar but longer-term impacts on local air quality could occur during normal project operations such as mining and processing of the tar sands. Processing activities could also result in regional impacts on air quality that could extend beyond the lease areas identified under Alternative C. These regional impacts would be associated with operational releases of CO, NO_x, and other pollutants (VOCs and SO_2) during tar sands processing (Section 5.6). Operational releases of HAPs (such as benzene, toluene, and formaldehyde) as well as diesel PM could also affect workers and nearby residences; these impacts, however, would be localized to the immediate project location.

6.2.3.6 Noise

Ambient noise levels in the Alternative C potential lease areas would not be affected by the amendment of land use plans to identify areas available for leasing for tar sands development. However, ambient noise levels could be affected by subsequent commercial development of tar sands. Under Alternative C, local, short-term changes in ambient noise levels could occur during the construction, operation, and reclamation of tar sands projects (see Section 5.7.1). Project-related increases in noise levels could disturb or displace wildlife and recreational users in nearby areas. Impacts on wildlife and recreational users are discussed in Sections 5.8.1 and 5.2.1.3, respectively.

Increased noise levels could result from the operation of construction equipment (graders, excavators, and haul trucks) and from blasting activities. Increases in noise levels during operations would be associated with mining and tar sands processing activities and would be more long-term than construction-related noise. These types of impacts would be largely limited to specific project locations and the immediate surrounding area. Similar short-term and long-term impacts could also occur in other areas where electric transmission lines, oil pipelines, transportation ROWs, and other infrastructure would be located, developed, and operated. For example, ambient noise levels could also be increased in the immediate vicinity of any pipeline pump station and could also be affected by project-related vehicular traffic at the project site and related locations such as access roads to the site.

Construction-related noise levels could exceed EPA guidelines. Similarly, operational noise associated with mining and retort activities could, in the absence of mitigation, exceed EPA guidelines at some project locations. Noise generated as a result of project-related (but nonconstruction) vehicular traffic is not expected to exceed EPA guideline levels except for short durations and very close to road or high traffic areas.

In the absence of lease- and project-specific information, it is not possible at the level of this PEIS to identify the duration and magnitude of any project-related changes in noise levels. Changes to ambient noise levels from project development could occur wherever a project is located within the acres identified for application for leasing under Alternative C.

6.2.3.7 Ecological Resources

Under Alternative C, 229,038 acres of public land would be made available within Utah for application for commercial tar sands leasing. The ecological resources in these areas (Section 3.7) would not be affected by the amendment of land use plans to identify these areas. However, ecological resources in and around these areas could be affected by future commercial development of tar sands in these areas. The following sections describe the potential impacts on ecological resources that may result from commercial tar sands development within the Alternative C lease areas.

6.2.3.7.1 Aquatic Resources. Under Alternative C, 229,038 acres of land in Utah would be made available for application for leasing for commercial tar sands development. There are no impacts on aquatic habitats associated with this land use designation. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Potential impacts on aquatic resources from tar sands development could result primarily from increased turbidity and sedimentation, changes to water table levels, degradation of surface water quality (e.g., alteration of water temperature, salinity, and nutrient levels), release of toxic substances to surface water, and increased public access to aquatic habitats as described in Section 5.8.1.1. As described in Section 5.8.1.1, there is a potential for development and production activities in upland areas to affect surface water and groundwater beyond the area where surface disturbance or water withdrawals are occurring. Consequently the analysis here considers the potential for impacts in waterways up to 2 mi beyond the boundary of the lands that would be allocated for potential leasing under this alternative. However, as project development activities occur farther from waterways, the potential for negative effects on aquatic resources is reduced. For the analysis of potential impacts under each of the alternatives considered in the PEIS, it was assumed that the potential for negative impacts to aquatic resources increases as the area potentially affected (i.e., the area that would be considered for leasing) increases and as the number and extent of waterways within a 2-mi zone surrounding those areas increases.

Under Alternative C, there are 8 perennial streams, and about 20 mi of perennial stream habitat within the STSAs of Utah that are directly overlain by areas that would be potentially available for tar sands development (Table 6.2.3-1). When an additional 2-mi zone surrounding these areas is considered, there are 13 perennial streams and about 146 mi of perennial stream habitat that could be affected by future development activities (Table 6.2.2-5). The development of commercial tar sands projects in the areas identified under Alternative C could impact aquatic biota and their habitats during project construction and operations, thereby resulting in short- and/or long-term changes (disturbance or loss) in the abundance and distribution of affected biota and their habitats. As described in Section 5.1.1.1, impacts from water quality degradation and water depletions could affect not only resources in areas within or immediately adjacent to leased areas, but also in areas farther downstream in affected watersheds. The nature and magnitude of impacts, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

The types of aquatic habitats and organisms that could be impacted by future development in the vicinity of the STSAs are described in Section 3.7.1.2, and some of these aquatic habitats are known to, or are likely to, contain federally listed endangered fish, state-listed or BLM-designated sensitive species (Section 3.7.4), and other native fish and invertebrate species that could be negatively affected by development. Specific impacts would depend greatly upon the locations and methods of extraction used by future projects. Project-specific NEPA analyses would be conducted prior to any future leasing decisions to evaluate potential impacts in greater detail.

TABLE 6.2.3-1 Perennial Streams in Utah within the Lease Areas Identified under Alternative C

Stream	Length of Stream (mi)
Bitter Creek	0.6
Center Fork	1.4
Sand Wash	0.2
Sweetwater Canyon	0.7
Wells Draw	0.4
Cottonwood Canyon	5.1
Dry Creek	5.9
Nine-Mile Creek	5.2
Total	19.4

6.2.3.7.2 Plant Communities and Habitats. Under Alternative C, 229,038 acres of land in Utah would be made available for application for commercial leasing of tar sands resources. There would be no impacts on plant communities and habitats associated with identifying lands as available for application for leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

Areas available for application for commercial leasing under Alternative C support a wide variety of plant communities and habitats (see Section 3.7.2). None of these potential lease areas contain land designated in BLM land use plans for the protection of floodplains. Direct and indirect impacts could be incurred during project construction and operation, extending over a period of several decades (especially within facility and infrastructure footprints) (see Section 5.8.1.2). Some impacts (e.g., habitat loss) could continue beyond the termination of tar sands production.

Direct impacts on plant communities and habitat from future construction and operation activities would include the destruction of vegetation and habitat during land clearing on the lease site and also where ancillary facilities such as access roads, pipelines, transmission lines, and employer-provided housing would be located. Soils disturbed during construction would be susceptible to the introduction and establishment of non-native invasive species, which in turn could greatly reduce the success of establishment of native plant communities during reclamation of project areas and create a source of future colonization and subsequent degradation of adjacent undisturbed areas. Plant communities and habitats could also be adversely affected by changes in water quality or availability, resulting in plant mortality or reduced growth, with subsequent changes in community composition and structure, and declines in habitat quality. Indirect impacts on terrestrial and wetland habitats on or off the project site could result from land clearing and exposed soil; soil compaction; and changes in topography, surface drainage, and infiltration characteristics. These impacts could lead to changes in the abundance and distribution of plant species and changes in community structure, as well the introduction or spread of invasive species.

Affected plant communities and habitats could incur short- and/or long-term changes in species composition, abundance, and distribution. While many impacts would be local in nature, occurring within construction and operation footprints and in the immediate surrounding area, the introduction of invasive species could affect much larger areas. The nature and magnitude of these impacts, as well as the communities or habitats affected, would depend on the locations of the areas where project construction and facilities would occur, the plant communities and habitats present in those areas, and the mitigation measures implemented to address impacts.

The area available for application for leasing under Alternative C includes locations that support oil shale endemic plant species. Local populations of oil shale endemics, which typically occur as small scattered populations on a limited number of sites, could be reduced or lost as a result of tar sands development activities. Establishment and long-term survival of these species on reclaimed land may be difficult.

6.2.3.7.3 Wildlife. Under Alternative C, 229,038 acres of land in Utah would be made available for application for commercial leasing for tar sands development. There would be no impacts on wildlife species associated with identifying lands as available for application for leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. These areas available for application for leasing support a diverse array of wildlife and habitats (see Section 3.7.3). While important areas (such as big game wintering areas, greater sage-grouse habitat, and raptor nests) are identified for protection in current BLM land use plans, none of these identified areas occur on areas identified in Alternative C as available for application for leasing.

Areas in Alternative C available for application for leasing overlap areas identified by state natural resource agencies as important for sage grouse and big game species. These areas include greater sage-grouse habitat and lek sites (Figure 6.2.3-1), and mule deer and elk winter and summer ranges (Figures 6.2.3-2 and 6.2.3-3). Table 6.2.3-2 presents the amounts of these habitats (as identified by state resource agencies) that would occur in the areas available for application and that could be affected by future commercial tar sands development in these areas.

Several wild horse HMAs overlap with lands that would be available for application for leasing, including the Hill Creek HMA, which overlaps with the Hill Creek STSA (about 9,980 acres); the Muddy Creek and Sinbad HMAs, which overlap with the San Rafael STSA (about 845 and 37,260 acres, respectively); the Range Creek HMA, which overlaps with the Sunnyside STSA (about 13,645 acres); and the Canyon Lands HMA, which overlaps with the Tar Sand Triangle STSA (about 100 acres) (Figure 6.2.3-4).

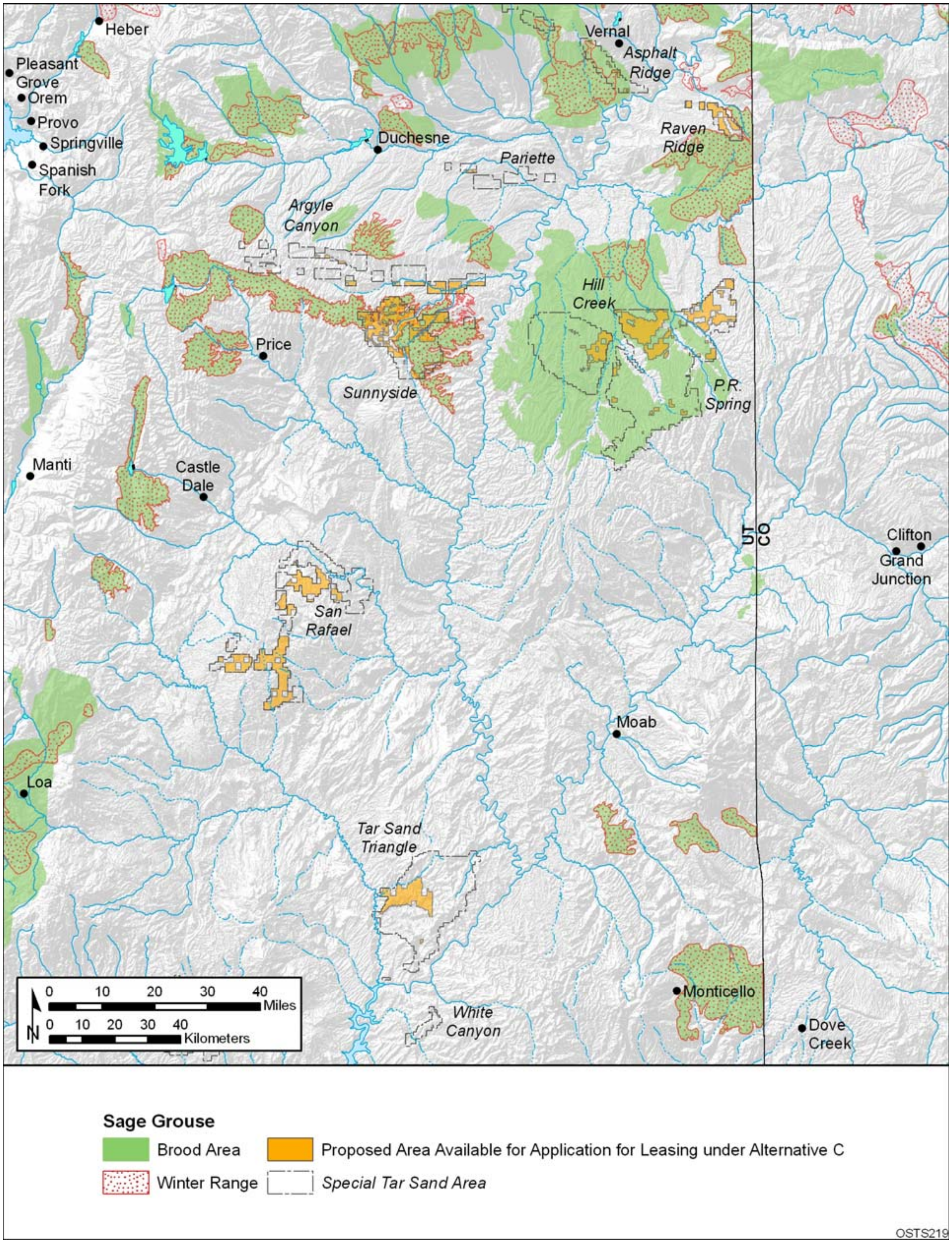

FIGURE 6.2.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse

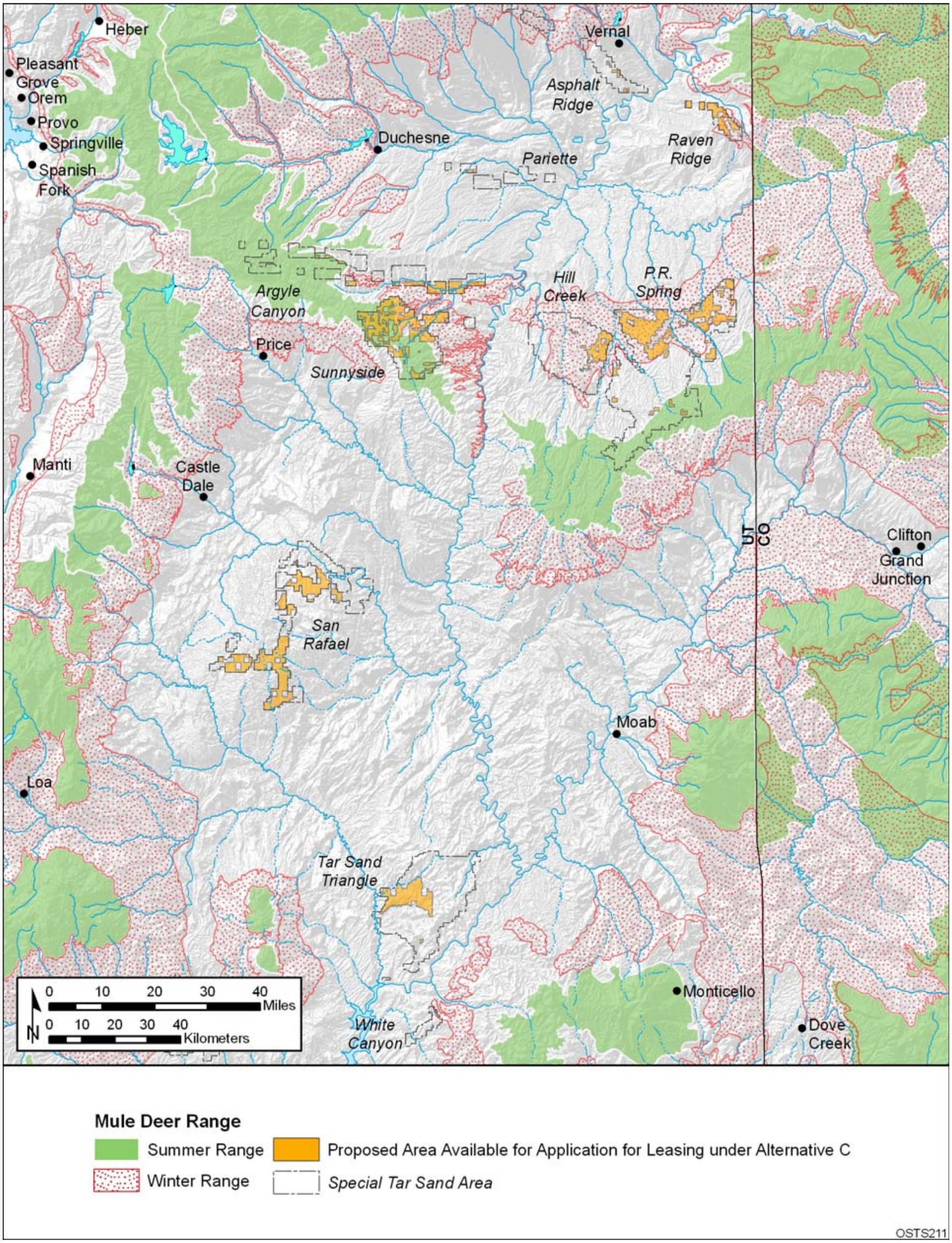

FIGURE 6.2.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer

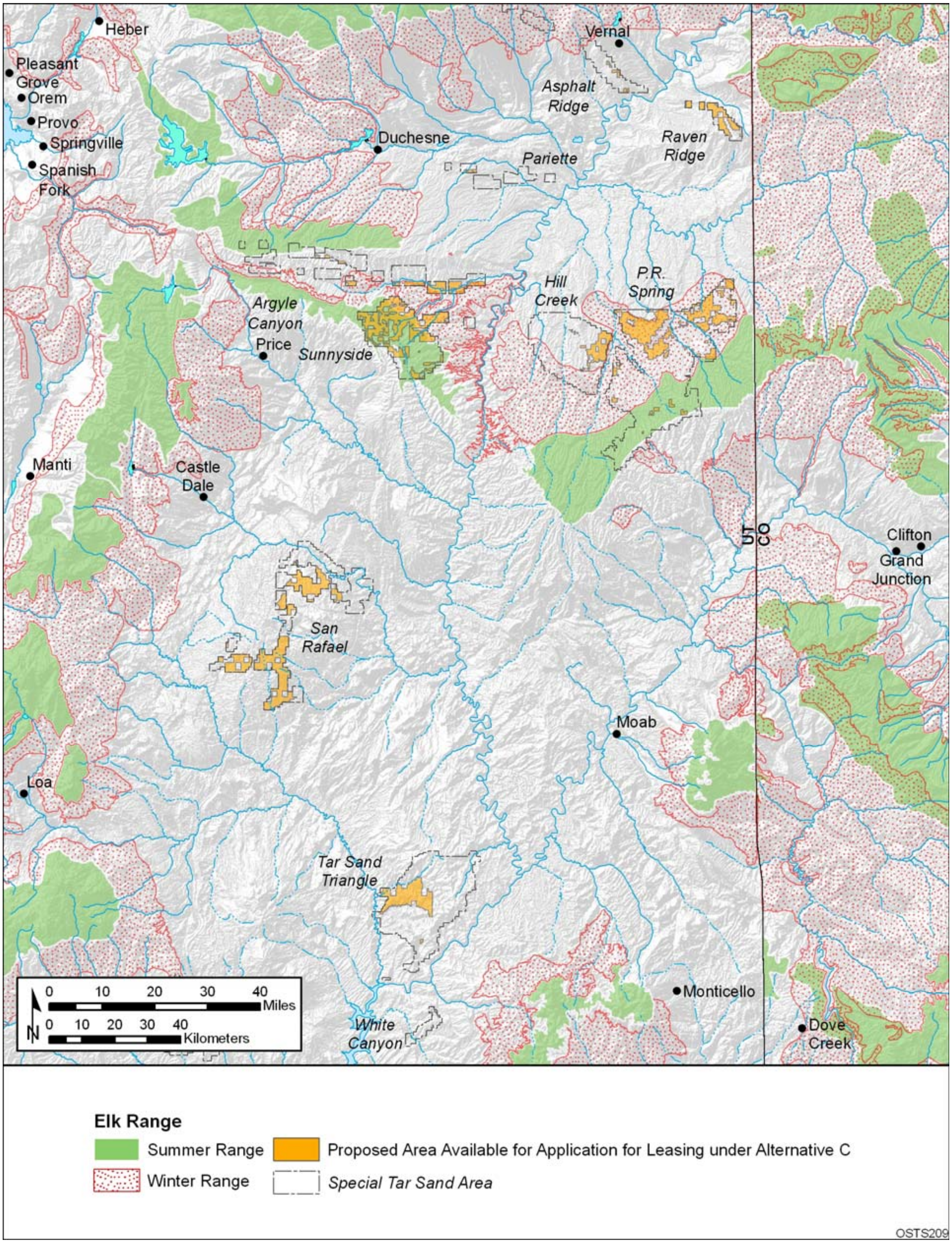

FIGURE 6.2.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk

Potential impacts on wildlife (including wild horses and burros) from the construction and operation of future commercial tar sands projects could occur in a number of ways and could be related to (1) habitat loss, alteration, or fragmentation (as a result of construction); (2) disturbance and displacement of biota (by construction and operation activities and the presence of project infrastructure); (3) mortality (from construction activities and collisions with project infrastructure and vehicles); (4) exposure to hazardous materials; and (5) increase in human access. These can result in changes in habitat use; changes in behavior; changes in predator populations; and chronic or acute toxicity from hydrocarbons, herbicides, or other contaminant exposures.

TABLE 6.2.3-2 Acres of State-Identified Sage Grouse, Elk, and Mule Deer Habitat Present in the Alternative C Lease Areas

Wildlife Resource	Acres within the Alternative C Lease Areas
Sage grouse habitat	101,300
Mule deer winter habitat	77,000
Mule deer summer habitat	30,900
Elk winter habitat	79,900
Elk summer habitat	37,600
Big game calving or fawning habitat[a]	18,000
Crucial pronghorn habitat	5,900

[a] Applies to elk and mule deer.

Wildlife could also be affected by human activities that would not be directly associated with commercial tar sands projects or workforces but that instead would be associated with the potentially increased access to BLM-administered lands that had previously received little use. The construction of new access roads or improvements to old access roads could lead to increased human access into the area. Potential impacts associated with increased access include the disturbance of wildlife from human activities, including an increase in legal and illegal harvest and an increase of invasive vegetation, and an increase in the incidence of fires.

The potential for impacts on wildlife and their habitats by commercial tar sands development is directly related to the amount of land disturbance that would occur with a commercial project (including its ancillary facilities, such as power plants and utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitat affected by development (i.e., the location of the project). Indirect effects, such as impacts resulting from the erosion of disturbed land surfaces, water depletions, contamination, and disturbance and harassment, are also considered. Their magnitude is also considered to be proportional to the amount of land disturbance.

6.2.3.7.4 Threatened and Endangered Species. Under Alternative C, 229,038 acres of land in Utah would be made available for application for commercial tar sands leasing. There would be no impacts on threatened and endangered species associated with identifying these lands as available for future leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.4. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects.

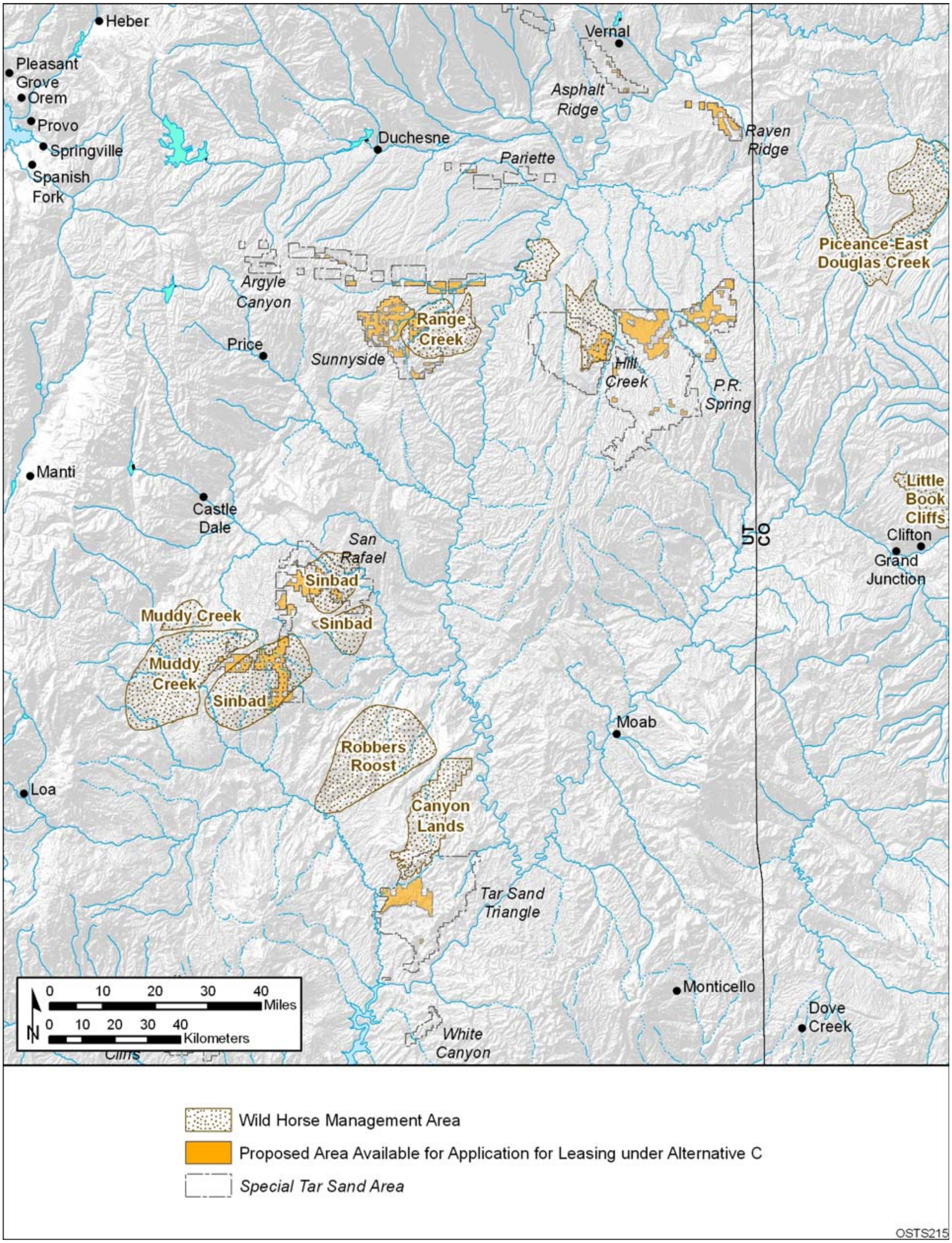

FIGURE 6.2.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas

Under Alternative C, 95 of the 110 federal candidate, 24 BLM-designated sensitive, and state-listed species listed in Table 5.8.1-5, and 20 of the federally listed threatened or endangered species listed in Table 5.8.1-6 could occur in areas that are available for application for leasing (based on records of occurrence in STSA counties). Potential lease areas do not include any critical habitat for Colorado River endangered fishes in Utah (Figure 6.2.3-5).

The potential for impacts on threatened, endangered, and sensitive species (and their habitats) by future commercial tar sands development would be directly related to the amount of land disturbance that would occur with a project (including its ancillary facilities such as utility and pipeline ROWs), the duration and timing of construction and operation periods, and the habitats affected by development. Indirect impacts such as those resulting from the erosion of disturbed land surfaces, surface and groundwater depletion, accidental release of contaminants, and disturbance and harassment of animal species would be proportional to the amount of land disturbance.

Potential impacts on threatened and endangered species (see Section 5.8.1.4) under Alternative C are similar to or the same as those described for aquatic resources; plant communities and habitats; and wildlife in Sections 5.8.1.1, 5.8.1.2, and 5.8.1.3, respectively. The most important difference is the potential consequences of the impacts. Because of low population sizes, threatened and endangered species are far more vulnerable to impacts than more common and widespread species. Low population size makes them more vulnerable to the effects of habitat fragmentation, habitat alteration, habitat degradation, human disturbance and harassment, mortality of individuals, and the loss of genetic diversity. Specific impacts associated with development would depend on the locations of projects relative to species populations and the details of project development. These impacts would be evaluated in detail in project-specific assessments and consultations conducted prior to leasing and development.

6.2.3.8 Visual Resources

The lands made available for application for leasing for commercial development of tar sands under Alternative C support a wide variety of visual resources (Section 3.9). These resources would not be affected by the amendment of land use plans to identify these lease areas. However, visual resources in and around the identified areas could be affected by subsequent commercial development of tar sands.

Several scenic resource areas are located within the areas identified as available for application for leasing under Alternative C (Figures 6.2.3-6 through 6.2.3-9). These scenic resource areas include:

- The Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Lucky Strike, Main Canyon, Nine Mile Canyon, Range Creek, and Wild Horse Potential ACECs; and

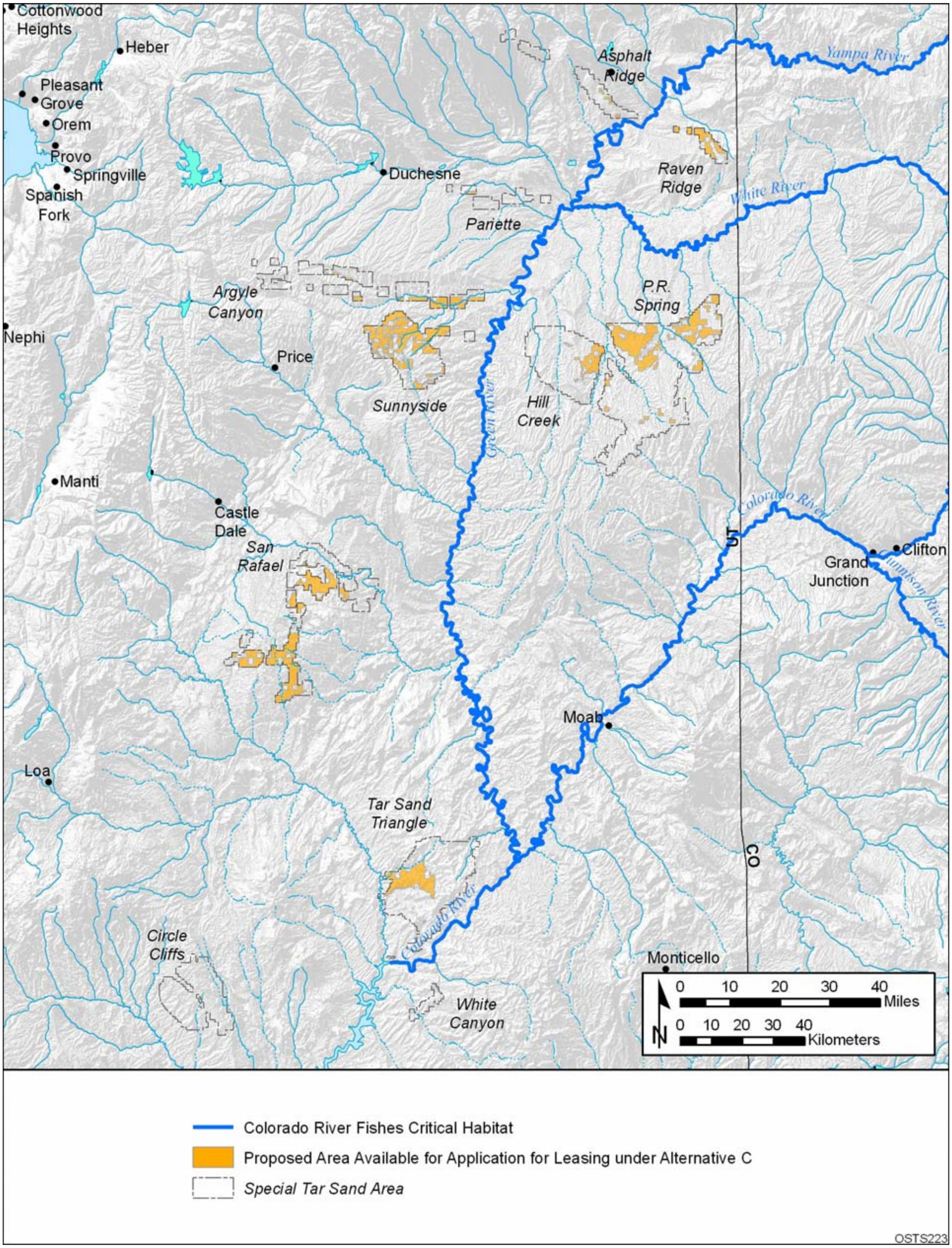

FIGURE 6.2.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C

- A segment of the Ninemile Creek determined to be eligible for WSR designation.

Additional scenic resource areas are located within 5 or 15 mi of the areas in Alternative C identified as available for commercial leasing (Figures 6.2.3-6 through 6.2.3-9). The 5-mi zone corresponds to the BLM's VRM foreground-middleground distance limit, and the 15-mi zone corresponds to the BLM's background distance limit. Assuming an unobstructed view of a commercial tar sands project, viewers in these areas would be likely to perceive some level of visual impact from the project, with more impacts expected for resources within the foreground-middleground distance, and fewer expected for resources within the background distance. Beyond the background distance, the project might be visible but would likely occupy a very small visual angle and create low levels of visual contrast such that impacts would be minor to negligible. Table 6.2.3-3 presents the scenic resource areas that fall within these zones.

Visual resources at these areas, as well as elsewhere within the areas available for application for leasing could be affected at and near where commercial tar sands projects are developed and operated, and at areas where supporting infrastructure (such as and utility and pipeline ROWs) would be located. Visual resources could be affected by ROW clearing, project construction, and operation (see Section 5.9.1). Potential impacts would be associated with construction equipment and activity, cleared project areas, and the type and visibility of individual project components such as tar sands processing facilities, utility ROWs, and surface mines. The nature, magnitude, and extent of project-related impacts would depend on the type, location, and design of the individual project components.

6.2.3.9 Cultural Resources

The amendment of land use plans to identify 229,038 acres of public land as available for application for commercial tar sands leasing would not result in impacts on cultural resources. The lands available for application for leasing overlap with some lands identified as having cultural resources present (O'Rourke et al. 2007). Approximately 5%[8] of public lands that would be made available for application for leasing in the STSAs under Alternative C have been surveyed for cultural resources (more than 12,537 acres in addition to 175 linear mi). In these areas that have been surveyed, 71 sites have been identified. Additional resources are likely to be found in unsurveyed portions of the study area. On the basis of a sensitivity analysis conducted for the Class I Cultural Resources Overview (O'Rourke et al. 2007), nearly 97,500 acres of the STSA Alternative C area have been identified as having a medium or high sensitivity for containing cultural resources.[9]

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8 This percentage was calculated using block acre surveys only and does not include approximately 175 linear miles of survey.

9 Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 229,038 acres available under Alternative C, sensitivity information is available for 167,132 acres; therefore, 97,500 acres represents 58% of the STSAs for which sensitivity information is available.

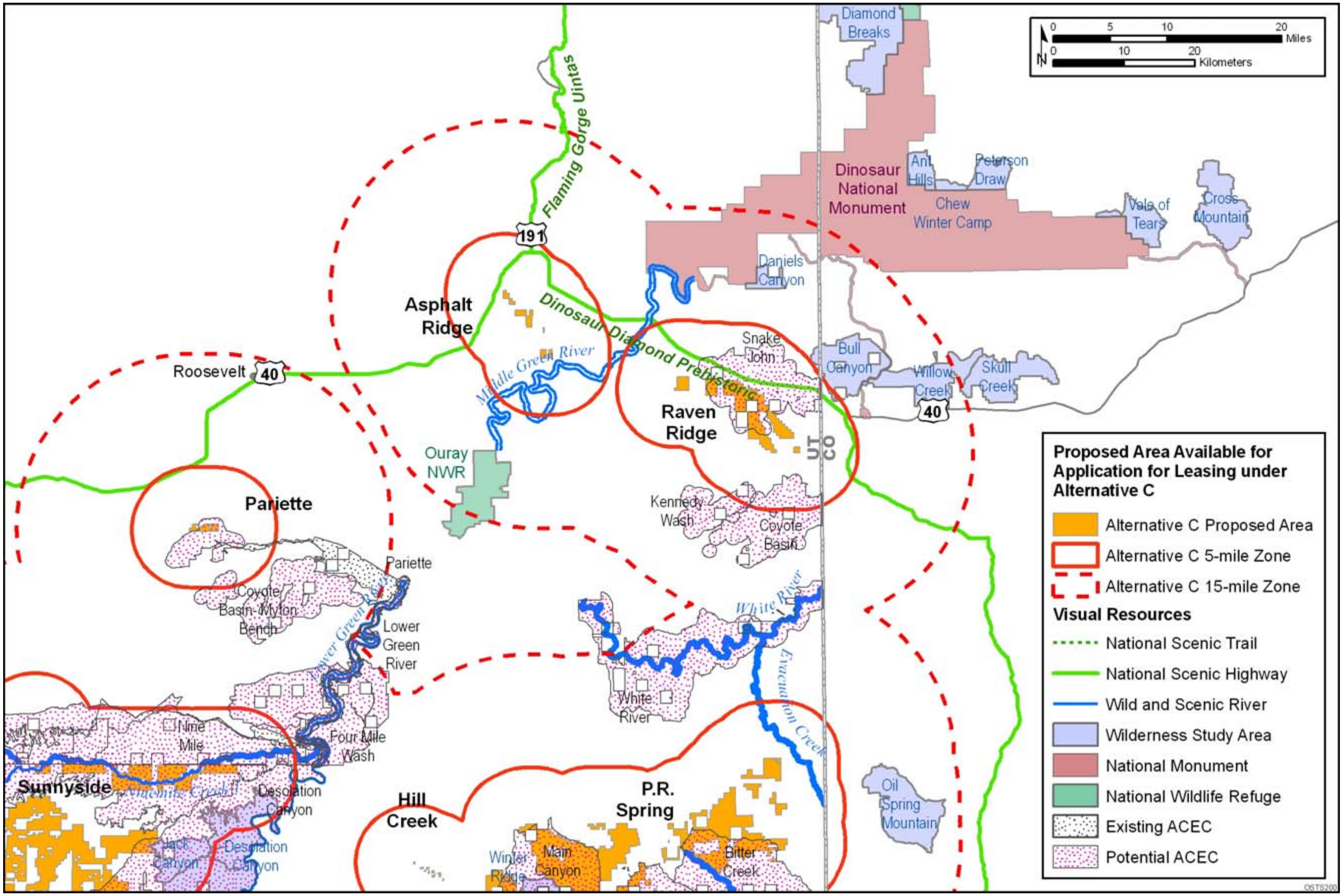

FIGURE 6.2.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Asphalt Ridge, Pariette, and Raven Ridge STSAs

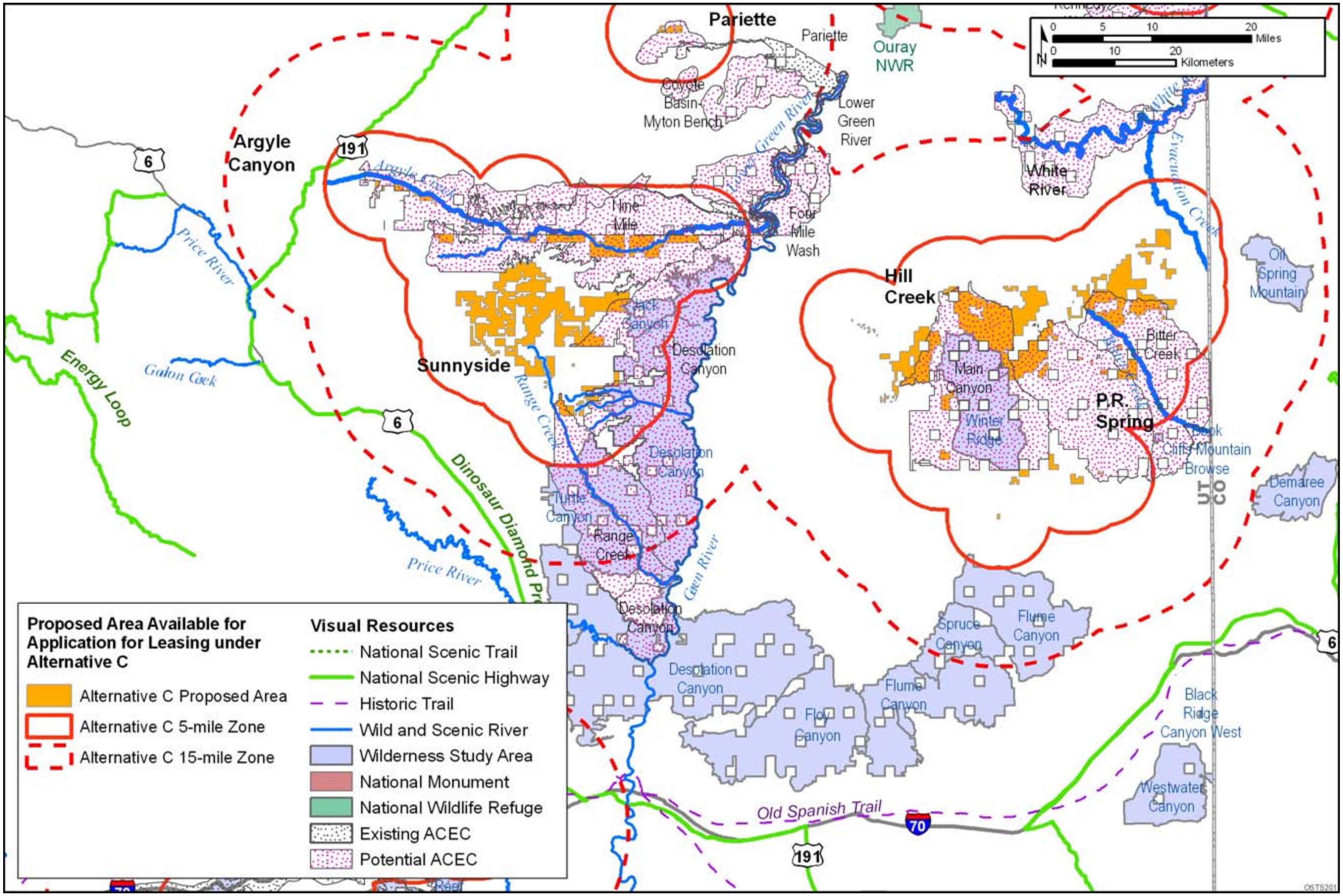

FIGURE 6.2.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Hill Creek, P.R. Spring, and Sunnyside STSAs

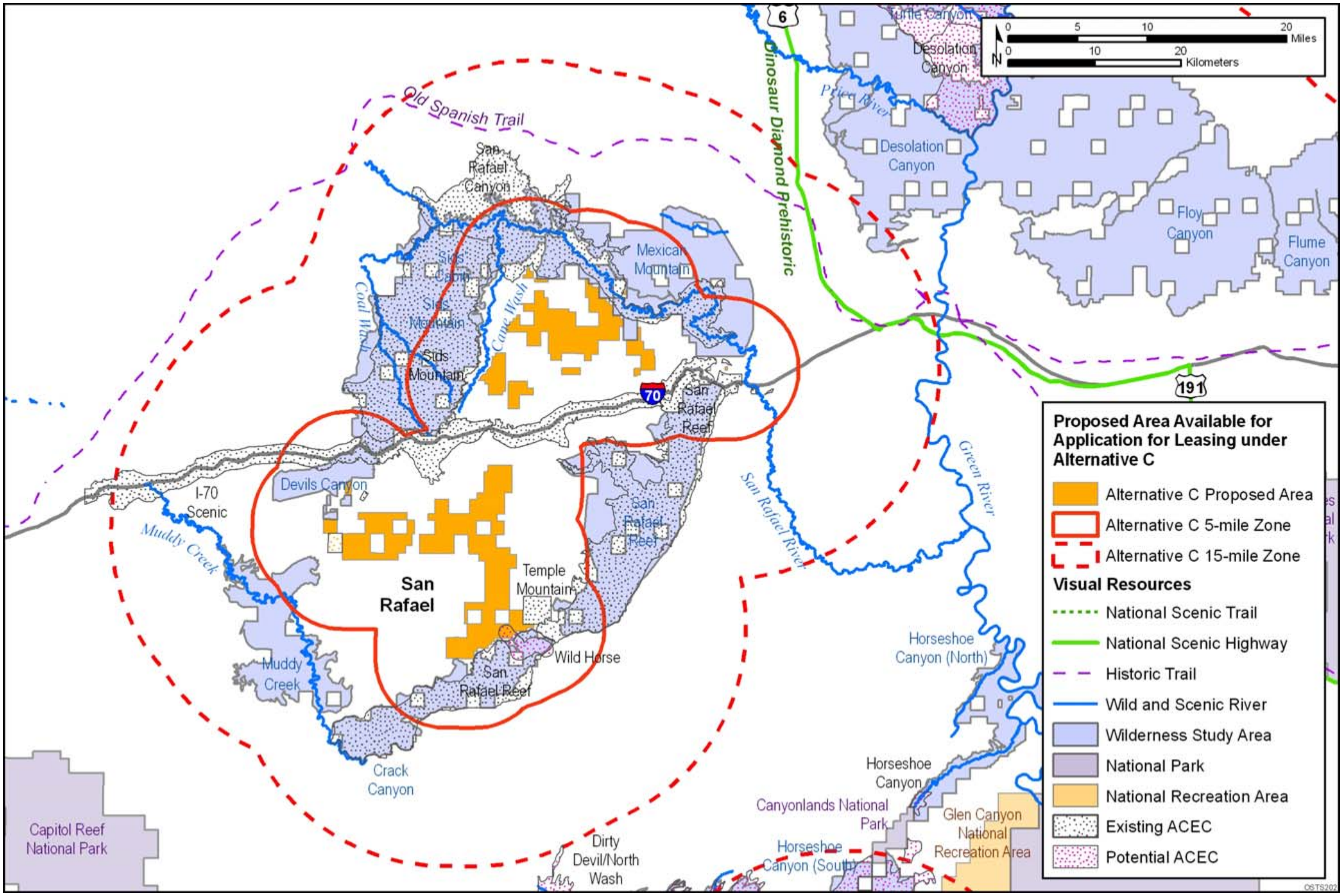

FIGURE 6.2.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the San Rafael STSA

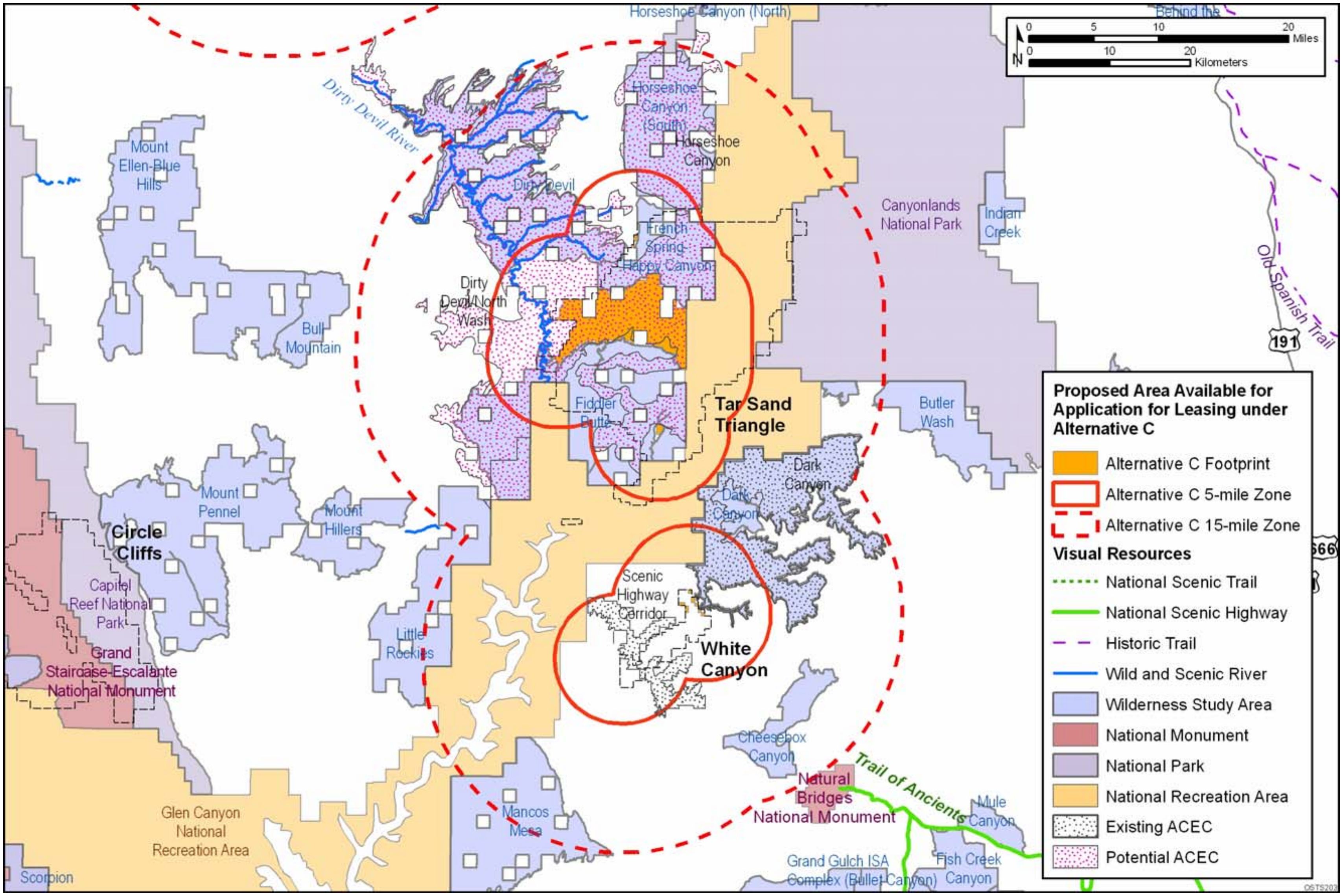

FIGURE 6.2.3-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Tar Sand Triangle and White Canyon STSAs

TABLE 6.2.3-3 Visually Sensitive Areas That Could Be Affected by Commercial Tar Sands Projects Developed in Lease Areas under Alternative C

Scenic Resources within 5 mi of Alternative C Lease Areas	Scenic Resources between 5 and 15 mi of Alternative C Lease Areas
Bull Canyon, Crack Canyon, Dark Canyon, Desolation Canyon, Devils Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon (South), Jack Canyon, Link Flats, Mexican Mountain, Muddy Creek, San Rafael Reef, Sid's Cabin, Sid's Mountain, and Winter Ridge WSAs.	Book Cliffs Mountain Browse, Bull Canyon, Butler Wash, Cheesebox Canyon, Crack Canyon, Dark Canyon, Daniels Canyon, Desolation Canyon, Dirty Devil, Fiddler Butte, Flume Canyon, French Spring–Happy Canyon, Horseshoe Canyon, Jack Canyon, Little Rockies, Mancos Mesa, Mexican Mountain, Creek, Oil Spring Mountain, San Rafael Reef, Sid's Cabin, Sid's Mountain, Skull Creek, Spruce Canyon, and Willow Creek WSAs.
Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Seger's Hole, Sid's Mountain, and Temple Mountain ACECs.	Copper Globe, Dark Canyon, I-70 Scenic Highway, Lears Canyon, Lower Green River, Nine Mile Canyon, Pariette, San Rafael Canyon, San Rafael Reef, Scenic Highway Corridor, Seger's Hole, Sid's Mountain, and Temple Mountain ACECs.
Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Coyote Basin–Snake John, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Lucky Strike, Main Canyon, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, Shepards End, and Wild Horse potential ACECs.	Bitter Creek, Bitter Creek–P.R. Spring, Coyote Basin–Coyote Basin, Coyote Basin–Kennedy Wash, Coyote Basin–Myton Bench, Desolation Canyon, Dirty Devil–North Wash, Four Mile Wash, Horseshoe Canyon, Lower Green River, Nine Mile Canyon, Nine Mile Canyon Expansion, Range Creek, and White River potential ACECs.
Segments of Argyle Creek, Bear Canyon, Bitter Creek, Buckskin Canyon, Cane Wash, Dirty Devil River, Evacuation Creek, Green River, Middle Green River, Muddy Creek, Ninemile Creek, North Fork Coal Wash, Range Creek, Rock Creek, Sams Mesa Box Canyon, San Rafael River, South Fork Coal Wash, and Twin Corral Box Canyon determined to be eligible for WSR designation.	Segments of Argyle Creek, Beaver Wash, Bitter Creek, Coal Wash, Cottonwood Wash, Dirty Devil River, Evacuation Creek, Green River, Larry Canyon, Lower Green River, Middle Green River, Muddy Creek, Ninemile Creek, No Mans Canyon, North Fork Coal Wash, North Salt Wash, Range Creek, Robbers Roost Canyon, Robbers Roost Canyon White Roost, Robbers Roost Middle Fork, Robbers Roost North Fork, Robbers Roost South Fork, Rock Creek, San Rafael River, South Fork Coal Wash, Twin Corral Box Canyon, and White River determined to be eligible for WSR designation.
Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways.	Dinosaur Diamond Prehistoric and Flaming Gorge Uintas National Scenic Highways.
Canyonlands National Park and Glen Canyon National Recreation Area.	Canyonlands National Park, Glen Canyon National Recreation Area, Dinosaur National Monument, and Natural Bridges National Monument.
	Old Spanish Trail National Historic Trail.

Cultural resources within these areas could be adversely impacted if leasing and future commercial development occur. Leasing itself has the potential to impact cultural resources to the extent that the terms of the lease limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed development on cultural properties. Impacts from future development could include the destruction of individual resources present within development areas, degradation and/or destruction of near-surface resources in or near the development area, increased potential of loss of resource from looting or vandalism as a result of increased human presence/activity in the sensitive areas, and visual degradation of the cultural setting (see Section 5.10). Special lease stipulations may be developed for specific lease parcels based on this information and consultation with interested Tribes. The cultural resources in the Circle Cliffs STSA would not be impacted by tar sands leasing and development because no leasing and development would occur in this STSA. The cultural resources in Argyle Canyon, Hill Creek, Pariette, Raven Ridge, San Rafael, Tar Sand Triangle, and White Canyon STSAs are less likely to be impacted by tar sands leasing and development than those resources present in the Asphalt Ridge, P.R. Spring, and Sunnyside STSAs.

6.2.3.10 Socioeconomics

Under Alternative C, land use plans would be amended to identify 229,038 acres of land in Utah as available for application for commercial tar sands development. With the possible exception of an impact on property values, there is no socioeconomic impact of this action. Although the socioeconomic and transportation impacts of Alternative C would be dependent on the exact locations of future development, the types of impacts that could occur would be the same as those described in Section 5.11 and summarized in Section 6.2.2.10 for Alternative B. The specific impacts would be dependent upon the technologies employed, the project size or production level, development time lines, mitigation measures, and the location of employee housing.

Under Alternative C, it is possible that there would be property value impacts simply from designating land as available for application for leasing; these impacts could result in either decreased or increased property values (see Section 4.11.1.6).

6.2.3.11 Environmental Justice

Although the environmental justice impacts of Alternative C would be dependent on the exact locations of specific developments, the types of impacts that would occur on lands made available for application for commercial leasing by the proposed land use plan amendments under Alternative C would be the same as those described in Chapter 5 and summarized in Section 6.1.2.11. As with the environmental impacts discussed elsewhere in Section 6.2.3, the specific environmental justice impacts would depend on the technologies employed, the project size or production level, and development time lines and mitigation measures.

6.2.3.12 Hazardous Materials and Waste Management

The amendment of land use plans under Alternative C to identify about 230,000 acres of land as available for application for leasing for commercial tar sands development would not result in any hazardous material or waste management effects. Impacts related to hazardous materials and wastes could occur during the future development of commercial tar sands projects within the areas identified in Alternative C as available for commercial leasing. Such impacts are generally independent of location and would be unique to the technology combinations used for tar sands development. Hazardous materials and wastes would also be associated with ancillary support activities that would be required for development of any tar sands facility regardless of the technology used. These include the impacts from development of energy transmission or pipeline ROWs and employer-provided housing.

Hazardous materials impacts associated with project construction would be minimal and limited to the hazardous materials typically utilized in construction, such as fuels, lubricating oils, hydraulic fluids, and glycol-based coolants, solvents, adhesives, and corrosion control coatings. Construction-related wastes could include landscape wastes from clearing and grading of the construction sites, and other wastes typically associated with construction, none of which are expected to be hazardous (Section 5.13.1).

During project operations, hazardous materials would be utilized and a variety of wastes (some hazardous) would be generated. Hazardous materials used include fuels, solvents, corrosion control coatings, flammable fuel gases, and herbicides (for vegetation clearing and management at facilities or along ROWs). The types and amounts of hazardous waste generated during operations would depend on the specific design of the commercial tar sands project (surface or subsurface mining, surface retorting, or in situ processes). Waste materials produced during operations could include waste engine fuels and lubricants, flammable gases, volatile and flammable organic liquids, and heavier molecular weight organic compounds (Section 5.13.1).

Because the use of hazardous materials and the generation of wastes are directly related to the specific design of a commercial tar sands project, it is not possible to quantify project-related impacts of these materials. Under Alternative C, individual facilities could be located anywhere within the area identified as being available for leasing pending project review and authorization. Accidental releases of the hazardous materials or wastes could affect natural resources (such as water quality or wildlife) and human health and safety (see Sections 5.14 and 6.2.3.13) at locations wherever the individual projects are sited within the Alternative C lease areas.

6.2.3.13 Health and Safety

The amendment of land use plans to identify 229,038 acres of land as available for application for leasing for commercial tar sands development would not result in any direct health and safety effects. However, a number of health and safety concerns would be associated with the commercial development of tar sands projects within the areas identified in Alternative C as available for application for commercial leasing. For commercial tar sands development in

Alternative C proposed lease areas, potential health and safety impacts from the construction and operation of commercial tar sands projects would be associated with the following activities: (1) constructing project facilities and associated infrastructure; (2) mining (if processing is not in situ) of the tar sands; (3) obtaining and upgrading the crude oil, either through surface retorting or in situ processing; (4) transporting construction and raw materials to the upgrading facility and transporting product from the facility; and (5) exposure to water and air contamination associated with tar sands development. Hazards from tar sands development (summarized in Table 5.14-1) could include physical injury from construction, tar sands processing, and vehicle transportation accidents, and exposure to fugitive dust and hazardous materials such as retort emissions and industrial chemicals (Section 5.14). Health and safety impacts would be largely restricted to the immediate workforce of each facility. Accidents could also affect members of the general public that could be present in the immediate vicinity of an accident (e.g., project-related truck accident on a public road, recreational users in areas adjacent to the project lease area).

Hazards for workers at tar sands development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. Estimates of expected injuries and fatalities can be made on the basis of numbers of employees and the type of work. On the basis of the number of employees projected to be needed for construction and operation of tar sands facilities, there statistically would be less than 1 death and about 100 injuries per year expected per facility during construction activities, and less than 1 death and about 30 injuries per year expected per facility during operations (NSC 2006). A comprehensive facility health and safety plan and worker safety training would be required as part of the plan of development for every proposed commercial tar sands project.

Health and safety concerns are largely independent of the location of tar sands development facilities. However, the health and safety impacts on the general public from emissions from these facilities would depend both on the specific characteristics and level of emissions, and the distance of the emissions source from population centers. The level of air and water emissions would be regulated under required permits. Potential impacts on the general public from emissions would be assessed in future site-specific NEPA and permitting documentation.

6.2.4 Comparison of Tar Sands Alternatives

The three alternatives assessed in this PEIS are a no action alternative (Alternative A) and two programmatic alternatives (Alternatives B and C) for amending BLM land use plans to (1) designate lands within STSAs available for application for commercial leasing; (2) specify requirements for future NEPA analyses and consultation activities; and (3) specify that the BLM would consider and give priority to land use exchanges, where appropriate and feasible, to facilitate commercial tar sands development pursuant to Section 369(n) of the Energy Policy Act of 2005. These alternatives are described in Sections 2.4.2 and 2.4.3; specific land use plan amendments are provided in Appendix C. The analyses of potential impacts associated with each alternative are presented in Sections 6.2.1, 6.2.2, and 6.2.3 of this chapter.

Under Alternative A, no new leasing and development of tar sand resources are projected to occur over the 20-year study period; thus, there would be no effect on any of the resources or resource uses under this alternative.

As noted in the preceding impact analysis sections for Alternatives B and C, with the exception noted in the socioeconomic analysis regarding potential impacts on land values, these land use plan amendments also would not result in any impacts on the environment or socioeconomic setting. However, the future development of commercial tar sands projects that could be approved after subsequent NEPA analysis identified in both of these alternatives would have impacts on these resources. The types of impacts associated with future commercial tar sands development are described in Chapter 5. The magnitude of the impacts cannot be quantified at this time because key information about the location of commercial projects, the technologies employed, the project size or production level, development time lines, and mitigation measures that would be applied is unknown.

6.2.4.1 Land Use

Under Alternative A, no new leasing of tar sand resources is projected to occur; thus, there would be no effect on land uses in the study area under this alternative. The amendment of the land use plans in both programmatic alternatives also would not cause direct impacts on land uses. The identification of lands does not authorize or approve any ground-disturbing activities that could affect these resources. However, under Alternatives B and C, existing land uses would be adversely affected by future commercial tar sand development.

The nature of the impacts of Alternatives B and C on land uses would be the same with the exceptions that are discussed below. It is only at the site-specific level that the impacts of either of the alternatives can be determined. In areas where the potentially leasable area of these two alternatives overlaps, the potential impacts would be the same.

The level of potential commercial development could be the same under both Alternatives B and C, although Alternative C would result in opening many smaller, discontinuous tracts that might not be as attractive for leasing as the larger tracts in Alternative B.

Although Alternative C does remove from consideration 200,000 acres of land with sensitive resources that have been identified in current BLM land use plans, those exclusions are generally not related to many of the land uses evaluated in this section, and, therefore, there is a small difference among the alternatives in protection of many of the existing land uses. Remaining acreage in Alternative C would be more than adequate to accommodate likely tar sands development over the next 20 years. The following is a summary of the principal differences in impacts on land uses between Alternatives B and C:

- Alternative B includes 100,000 acres of land identified as having wilderness characteristics, while Alternative C includes approximately 68,000 acres of these lands.

- Alternative B includes 180,000 acres that are identified as potential ACECs. Alternative C includes 86,000 acres that are identified as potential ACECs.

In comparing the overall potential for impact on land uses, Alternative C could result in less impact on land uses for potential ACECs and lands with wilderness characteristics than Alternative B. If a major portion of the development under Alternative B were assumed to occur within the 200,000 acres excluded by Alternative C, the difference between the alternatives would be larger.

6.2.4.2 Soil and Geologic Resources

The identification of public lands under Alternatives B and C as being available for application for leasing for commercial tar sands development, and the associated amendment of appropriate land use plans, would not affect soils or geologic resources in any of the potentially leasable areas. Soils and geologic resources could, however, be affected by subsequent development of commercial tar sands projects in these areas under either alternative. Potential impacts, related primarily to construction and operation of project facilities and related infrastructure, could include soil disturbance, removal or compaction, and erosion.

Impacts on soil and geologic resources would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). However, soil and geologic resources could be affected by commercial tar sands development in more locations under Alternative B than under Alternative C, with Alternative B having almost twice the number of acres of land available for leasing and subsequent development (about 200,000 additional acres). The lands excluded from application for leasing under Alternative C represent environmentally sensitive areas as identified in BLM land use plans that could be developed in the future under Alternative B. The nature, location, and magnitude of project-related impacts on soil and geologic resources would depend on the specific locations of leases undergoing commercial development as well as on the design of the projects.

6.2.4.3 Paleontological Resources

Table 6.2.4-1 identifies the amount of available acreage that has the potential to contain important paleontological resources under each of the alternatives. Under Alternative B, 335,395 acres available for application for leasing have the potential to contain important paleontological resources. Adverse effects on paleontological resources, as described in Sections 5.4 and 6.2.2.3, could occur in these areas.

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important paleontological resources is reduced considerably from that of Alternative B to 147,937 acres. Commercial development that could occur on lands made available for application for commercial leasing by Alternative C potentially could impact

TABLE 6.2.4-1 Available Acreage under Each Alternative with the Potential to Contain Important Paleontological Resources

	Alternative A	Alternative B	Alternative C	% Difference in Alternatives B and C
Acres available for application for leasing and development	0	431,224	229,038	53
Acres with the potential to contain important paleontological resources	0	335,395	147,937	44

approximately only 44% of the acreage with important paleontological resources that potentially would be impacted by Alternative B (see Section 6.2.3.3).

6.2.4.4 Water Resources

The amendment of the land use plans under both Alternatives B and C would not cause environmental impacts on water resources. However, water resources could be adversely affected by future commercial tar sands development on these lands.

While Alternative C makes considerably fewer acres available for application for commercial leasing, it does not provide for less potential development of commercial tar sands over the 20-year study period for the PEIS than does Alternative B. For that reason, many of the potential impacts on land use under Alternative C could be the same as those under Alternative B. The land available for application for leasing under both alternatives would be more than adequate to accommodate potential tar sands development over the next 20 years. The following is a summary of the principal differences in potential impacts on water resources between Alternatives B and C:

- Alternative C removes from consideration 200,000 acres of lands identified for resource protection in existing BLM land use plans, including lands having high potential for erosion due to the steep slopes and/or highly erosive soils that if disturbed could adversely affect water resources.

- Under Alternative C, the Argyle Canyon STSA would be totally unavailable for consideration for future development, and the acreage available in both the Pariette and White Canyon STSAs would be so small as to make them practically unavailable for development.

- Alternative B contains approximately 28 mi of perennial streams that could be affected by commercial development, while Alternative C contains 19 mi.

In comparing the overall potential for impact of commercial tar sands development on water resources, Alternative C would have less potential impact than Alternative B. If development under Alternative B was assumed to occur within the 200,000 acres excluded by Alternative C, the difference between the alternatives would be much larger.

6.2.4.5 Air Quality

The identification of areas available for application for leasing for commercial tar sands development and the associated amendment of appropriate land use plans is not expected to affect air quality under Alternative B or C. However, under both alternatives, local and regional air quality could be affected by the construction and operation of commercial tar sands projects in the areas available for application for leasing. Under Alternatives B and C, the commercial development of a similar project in an area where the areas of the two alternatives overlap would be expected to affect local and regional impacts on air quality in the same manner.

Impacts on air resources of future commercial development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified as available for application for leasing under Alternatives B and C, local air quality could be affected by commercial development in more locations under Alternative B than under Alternative C. Many of the lands identified under Alternative B as being available for application for leasing are excluded from application under Alternative C. However, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of regional air quality impacts for future commercial development under either Alternative B or C. Thus, it is not possible to differentiate between these two alternatives regarding regional air quality impacts.

6.2.4.6 Noise

The identification of areas available for application for leasing for commercial tar sands development and the associated amendment of appropriate land use plans would not affect noise levels under either Alternative B or C. However, under both alternatives, local noise levels could be affected by the future construction and operation of commercial tar sands projects in the potentially leasable areas.

Impacts on noise levels from future commercial development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, local noise levels could be affected by commercial development at more locations under Alternative B than under Alternative C. However, because of the need for project- and site-specific information, it is not possible to identify the nature and magnitude of noise impacts under these alternatives or to differentiate between them.

6.2.4.7 Ecological Resources

6.2.4.7.1 Aquatic Resources. The identification of areas available for application for leasing for commercial tar sands development and the associated amendment of appropriate land use plans would not affect aquatic resources in the areas available for application for leasing under either Alternative B or C. Although there are no impacts on aquatic resources associated with identifying lands available for application for leasing, impacts could result from post-lease construction and operation as described in Section 5.8.1.1. These impacts would be considered in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The types of impacts on aquatic resources associated with construction and operations would be similar for Alternatives B and C. However, differences exist between these alternatives in the amount of lands that would be made available for application for leasing and the location of potential lease areas. As a consequence, there are differences among Alternatives B and C relative to the amount of aquatic habitat that is immediately within or adjacent to the footprint of the allocation areas and in the amount of such habitat within a 2-mi zone surrounding the allocation areas. These differences are described in this section.

Impacts on aquatic resources from future commercial tar sands development would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Immediately within areas that would be made available for application for leasing under Alternative B, there are 9 perennial streams and about 29 total mi of perennial stream habitat that could be affected by future development. There are 8 perennial streams and about 20 total mi of perennial stream habitat immediately within the areas that would be considered for leasing under Alternative C. When a 2-mi buffer around the areas that would become available for application for leasing is considered, there are 20 perennial streams and about 185 mi of perennial stream habitat under Alternative B and 13 streams and 146 total mi of stream habitat under Alternative C (Table 6.2.2-5). Thus, Alternative B would potentially affect a greater amount of aquatic habitat than Alternative C. The specific nature and magnitude of impacts under Alternatives B and C, as well as the specific resources affected, would depend on the location of the areas where project construction and facilities occur, the aquatic resources present in those areas, and the mitigation measures implemented.

6.2.4.7.2 Plant Communities and Habitats. The identification of areas available for application for leasing for commercial tar sands development and the associated amendment of appropriate land use plans would not affect plant communities and habitats in the areas available for application for leasing under either Alternative B or C. However, under both alternatives, plant communities and habitats could be affected by future construction and operation of commercial tar sands projects in the areas available for application for leasing as described in Section 5.8.1.2. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The types of impacts associated with construction and operations would be similar for all alternatives. Potential impacts on plant communities and habitats from future project construction and operation would be identical between Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap).

Because of the difference in the areas identified under Alternatives B and C as available for application for leasing (about a 202,000-acre difference), plant communities and habitats could be affected by future commercial development at more locations under Alternative B than under Alternative C. Plant communities and habitats in Alternative B potential lease areas could be impacted by the construction and operation of commercial tar sands projects. Included in this acreage are about 1,599 acres of land identified in land use plans for the protection of floodplains. In contrast, about 202,000 acres of land identified under Alternative B (including all of the 1,599 acres identified for protection of floodplains) would be excluded from availability for leasing under Alternative C.

Oil shale endemic plant species occur on oil shale outcrops within the available lease areas identified under both Alternative B and Alternative C. Because Alternative B includes more land area in the vicinity of oil shale outcrops than Alternative C, there is a greater potential for impacts on oil shale endemic species under Alternative B.

6.2.4.7.3 Wildlife. Under Alternatives B and C, there would be no impacts on wildlife species associated with identifying lands available for application for leasing. Impacts could result, however, from post-lease construction and operation as described in Section 5.8.1.3. These impacts would be considered in greater detail in project-specific NEPA analyses that would be conducted at the lease and development phases of projects. The types of impacts on wildlife species associated with construction and operation would be similar for both alternatives. Differences among alternatives exist in the amount of lands that would be made available for application for leasing and the location of areas protected from lease development. These differences are described in this section.

Impacts on wildlife and their habitats from future commercial development (see Section 5.8.1.3) would be identical under Alternatives B and C for similar projects located in areas common to the two alternatives (i.e., in areas where these alternatives overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, wildlife and their habitats could be affected by subsequent commercial development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 200,000 acres more land as being available for application for leasing, and wildlife and their habitats in these areas could be impacted by the construction and operation of commercial tar sands projects (see Tables 6.2.2-6 and 6.2.2-7 in Section 6.2.2.7.3).

Because of the smaller area of lands potentially available for leasing under Alternative C, thousands of acres of important wildlife habitat would be removed from the areas available for application for leasing, and thus would not be directly affected by future commercial tar sands development. Table 6.2.4-2 shows the difference between Alternatives B and C in the amounts of wildlife habitat identified for protection in current land use plans. Table 6.2.4-3 shows similar information for important state-identified wildlife habitat. Under Alternative C, there also would

TABLE 6.2.4-2 Acres of Important Wildlife Habitat Identified for Protection in BLM Land Use Plans Present in the Alternative B and C Tar Sands Lease Areas

	Total Land Area (acres) Available for Leasing Where Future Commercial Tar Sands Development Could Impact Wildlife Habitat Identified for Protection in BLM Land Use Plans[a]	
Wildlife Habitat	Alternative B	Alternative C
Birds		
Sage grouse lek nesting areas	1,003 (1,011)[b,c]	0 (1,011)
Sage grouse lek sites	2,549 (3,194)	0 (3,194)
Raptor nests	7 (18)	0 (18)
Waterfowl (in Pariette Wetlands)	42 (536)	0 (536)
Goose nest sites (in Pariette Wetlands)	9 (131)	0 (131)
Mammals		
Deer and elk crucial winter range	80 (1,118)	0 (1,118)
Deer fawning and elk calving crucial habitat	18,044 (19,520)	0 (19,520)
Desert bighorn sheep crucial habitat	3,845 (4,865)	0 (4,865)
Elk crucial winter habitat	12,086 (13,177)	0 (13,177)
Pronghorn crucial kidding habitat	5,892 (5,893)	0 (5,893)

[a] No commercial tar sands development is projected to occur under Alternative A.

[b] Acreages may be overestimated because of unknown degree of habitat overlap among species or habitat types for a species. For these reasons, columns should not be totaled.

[c] Numbers in parentheses are the wildlife habitat acreage identified for protection within the most geologically prospective lands.

TABLE 6.2.4-3 Acreage of State-Identified Wildlife Habitat That Could Be Impacted by Commercial Tar Sands Development

	Total Land Area (acres) Available for Leasing Where Commercial Tar Sands Development Could Impact State-Identified Wildlife Habitat[a]	
Habitat	Alternative B	Alternative C
Sage grouse habitat	227,700	101,300
Big game winter habitat	308,500	156,900
Big game summer habitat	132,500	68,500
Big game calving, fawning, or lambing habitat	18,000	18,000
Crucial pronghorn habitat	5,900	5,900

[a] No commercial tar sands development would occur under Alternative A.

be about 14,210 fewer acres of wild horse HMA that could be affected by future commercial tar sands development than under Alternative B.

6.2.4.7.4 Threatened and Endangered Species. The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not affect threatened and endangered species in the areas available for application for leasing identified under either Alternative B or C. However, under both alternatives, threatened and endangered species and their habitats could be affected if the construction and operation of commercial tar sands projects occurs in the lease areas in the future.

The same 20 threatened and endangered species could be affected by future commercial tar sands development in either of the Alternative B or C lease application areas (see Table 5.8.1-6). Impacts on these species and their habitats (see Section 5.8.1.4) from future commercial development would be identical between Alternatives B and C for similar projects located in lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, threatened and endangered species and their habitats could be affected by commercial tar sands development at more locations under Alternative B than under Alternative C. Alternative B identifies approximately 202,000 more acres as available for application for leasing than does Alternative C, and threatened and endangered species and their habitats in these areas could be impacted in the future by construction and operation of commercial tar sands projects.

6.2.4.8 Visual Resources

Under either Alternative B or C, the amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not affect visual resources within or in the vicinity of the lease areas identified. However, there are a number of potential sensitive visual resources within, and in the vicinity of, the potential lease areas identified by both alternatives. These sensitive visual resource areas could be affected if construction and operation of commercial tar sands projects occur in the future in the areas identified as available for commercial leasing.

The visual resources that could be affected by the future construction and operation of commercial tar sands projects would be identical under Alternatives B and C for similar projects located in potential lease areas common to the two alternatives (i.e., where the lease areas would overlap). Because of the difference in the areas identified under Alternatives B and C as available for application for leasing, visual resources could be affected by commercial tar sands development at more locations under Alternative B than under Alternative C. Alternative B includes approximately 200,000 more acres where visual resources in, and in the vicinity of, these potential lease areas could be impacted by the construction, presence, and operation of commercial tar sands projects.

While Alternative C has about 200,000 fewer acres of land than Alternative B, there is relatively little difference between the alternatives in the numbers and types of sensitive visual resource areas that could be affected by future commercial development (Table 6.2.4-4).

6.2.4.9 Cultural Resources

Table 6.2.4-5 identifies the amount of available acreage that has the potential to contain important cultural resources under each of the alternatives.

Under Alternative B, 220,648 acres of the 431,224 acres available for application for leasing have the potential to contain important cultural resources. Adverse effects on cultural resources from future commercial development, as described in Sections 5.10 and 6.2.2.9, could occur in these areas.

TABLE 6.2.4-4 Potentially Affected Sensitive Visual Resource Areas Associated with Lease Areas Identified under Alternatives B and C

Alternative B	Alternative C
Visual Resource Areas within Proposed Lease Areas	
11 Potential ACECs	11 Potential ACECs
1 River segment eligible for WSR designation	1 River segment eligible for WSR designation
1 National scenic highway	
Visual Resource Areas within 5 mi of the Lease Area Boundary (BLM VRM Foreground-Middleground Distance Limit)	
19 WSA	18 WSAs
11 ACECs	13 ACECs
18 Potential ACECs	18 Potential ACECs
18 River segments eligible for WSR designation	18 River segments eligible for WSR designation
1 National park	1 National park
1 National recreation area	1 National recreation area
2 National scenic highways	2 National scenic highways
Visual Resource Areas within 15 mi of the Lease Area Boundary (BLM VRM Background Distance Limit)	
28 WSAs	25 WSAs
9 ACECs	13 ACECs
14 Potential ACECs	14 Potential ACECs
31 River segments eligible for WSR designation	28 River segments eligible for WSR designation
1 National park	1 National park
2 National monuments	2 National monuments
1 National recreation area	1 National recreation area
3 National scenic highways	2 National scenic highways
1 National historic trail	1 National historic trail

TABLE 6.2.4-5 Available Acreage under Each Alternative with the Potential to Contain Cultural Resources

Parameter	Alternative A	Alternative B	Alternative C	% Difference in Alternatives B and C
Acres available for application for leasing and development	0	431,224	229,038	53
Acres surveyed[a]	0	42,620	12,537	29
Percentage of area surveyed	100%	10%	5%	
Number of sites recorded	0	183	71	39
Acres of high or medium sensitivity to contain cultural resources	NA	220,648	97,492	44
Percentage of area with high or medium sensitivity[b]	NA	65%	58%	

[a] This acreage is from block acre surveys only and does not include linear miles of survey.

[b] Argyle Canyon, Circle Cliffs, and San Rafael STSAs and portions of Pariette and Tar Sand Triangle STSAs had not been surveyed sufficiently to derive sensitivity information; therefore, these acreages have not been included in this percentage calculation. Out of 431,224 acres available under Alternative B, sensitivity information is available for 341,536 acres; therefore, 220,650 acres represent 65% of the STSAs for which sensitivity information is available (rather than 51%). Out of 229,038 acres available under Alternative C, sensitivity information is available for 167,132 acres; therefore, 97,500 acres represents 58% of the STSAs for which sensitivity information is available (rather than 43%).

Under Alternative C, the amount of acreage available for application for leasing with the potential to contain important cultural resources is reduced considerably from that of Alternative B to 97,492 acres out of 229,038 acres. Future commercial development under Alternative C potentially would impact approximately 29% of the acreage with important cultural resources that could be impacted by Alternative B.

6.2.4.10 Socioeconomics

As shown in Table 6.2.4-6, Alternative B would make the greatest amount of land available for application for leasing; however, because of the need for project and site-specific information, it is not possible to identify the nature and magnitude of socioeconomic or transportation impacts of commercial oil shale development under Alternatives A, B, or C. Thus, it is not possible to differentiate among these alternatives regarding either socioeconomic or transportation impacts.

Also, since none of the alternatives impose a cap on the level of development that may occur, the level of future development could be the same under each alternative.

TABLE 6.2.4-6 Estimated Acres Potentially Available for Application for Leasing for Commercial Tar Sands Development by STSA under Each Alternative[a]

STSA	Alternative A[b]	Alternative B	Alternative C
Argyle Canyon	0	11,226	0
Asphalt Ridge	0	5,435	1,464
Circle Cliffs[c]	0	0	0
Pariette	1,066	10,161	830
P.R. Spring	6,080	153,003	56,728
Hill Creek	0	56,506	19,934
Raven Ridge	0	14,364	9,950
San Rafael	0	70,475	54,492
Sunnyside	0	78,116	62,741
Tar Sand Triangle	0	24,938	22,511
White Canyon	0	7,001	386
Total	7,146	431,224	229,038

[a] Totals may not be exact because of rounding. These estimates were derived from GIS data compiled for the PEIS analyses. The GIS data may contain errors; therefore, these estimates should be considered to be only representative of the proposed leasing area.

[b] Additional lands are involved in a number of pending conversion leases: 8,921.36 in the Circle Cliffs STSA, 27,668.04 in the P.R. Spring STSA, and 41,254.16 in the Tar Sand Triangle STSA. The adjudication process to determine the valid existing rights for pending conversion leases in these STSAs is currently underway.

[c] While the Circle Cliffs STSA is a designated STSA, the BLM-administered portion of it falls entirely within the GSENM and has been excluded from consideration for being designated as open to application for leasing in this PEIS.

6.2.4.11 Environmental Justice

Because it is not possible to quantify the environmental justice impacts of the commercial development that would be made possible under either Alternative B or C at this time, it is not possible to definitively conclude which of these two alternatives would result in the greatest impacts.

6.2.4.12 Hazardous Materials and Waste Management

The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development would not result in hazardous material and waste being generated within or in the vicinity of the areas available for application for leasing under either

Alternative B or C. However, the construction and operation of commercial tar sands projects in the areas available for application for leasing would use hazardous materials and generate wastes under both alternatives.

Because the use of hazardous materials and the generation of wastes are related to the specific design of a commercial tar sands project rather than project location, it is not possible to differentiate between Alternative B and C as to the hazardous materials and waste that could be used or generated during commercial tar sands construction and operation. For similar commercial tar sands projects (similar in design and operation), the hazard materials and wastes associated with projects developed under Alternatives B or C would be similar. Because of the larger amount of land that would be made available for leasing under Alternative B, the use and/or generation of hazardous materials and wastes could occur at more locations under Alternative B than under Alternative C. In both cases, the impacts of hazardous material and waste handling (storage, use, and disposal) would be expected to be similar under the two alternatives regardless of project location (Section 5.13.1).

6.2.4.13 Health and Safety

The amendment of land use plans to identify areas available for application for leasing for commercial tar sands development also would not result in health and safety issues within or in the vicinity of the areas identified as available for application for leasing under either Alternative B or C. The future construction and operation of commercial tar sands projects would have identical health and safety concerns between Alternatives B and C for projects with identical plans of development located in potential lease areas common to the two alternatives (i.e., where the areas would overlap). Potential impacts could occur from accidents causing injuries and fatalities, possible hearing loss from high noise levels, and inhalation of particulates and/or VOCs emitted from the facilities. Construction and operation of individual facilities under either alternative statistically would be expected to result in less than 1 fatality per year, and approximately 100 injuries per year during construction and 30 injuries per year during operations. The general public could have health impacts associated with exposure to emissions from tar sands facilities, but in the absence of site-specific and process-specific data, no differences between the health and safety impacts of Alternatives B and C can be identified.

Differences in health and safety concerns between the two alternatives would be largely associated with differences in individual project designs and, to a lesser degree, differences in the locations of individual projects. For example, projects requiring longer transportation routes and longer utility and pipeline ROWs would have a greater potential for transportation accidents as well as ROW construction-related accidents. It is not possible to quantify differences in health and safety impacts under Alternatives B and C in this PEIS. Under either of the alternatives, health and safety issues would be evaluated at the project level (i.e., as part of project-specific NEPA analyses), and a comprehensive facility health and safety plan and worker safety training would be required as part of the plan of development for every proposed commercial tar sands project.

6.2.5 Cumulative Impacts

The CEQ (1997), in its regulations implementing the procedural provisions of NEPA (40 CFR Part 1508.7), defines cumulative effects as follows:

> "the impact on the environment which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

In this PEIS, the proposed action is to amend land use plans to allow certain lands to be considered for commercial leasing for tar sands development. That is, the decision made at the plan level does nothing more than remove (or leave in place) the administrative barrier (plan conformance) to the BLM considering any applications for leasing. The plan amendments would open the areas in question for leasing. The phrase "available for application for leasing" is used above, and throughout the PEIS, rather than simply "available for leasing" to highlight that, unlike the BLM's practice with respect to oil and gas leasing, additional NEPA analysis would be required prior to the issuance of any lease of oil shale or tar sands resources. Amendment of the RMPs does not authorize any ground-disturbing activities and is not an irreversible or irretrievable commitment of resources under NEPA (see 40 CFR 1502.16). Moreover, amendment of RMPs does not constitute the granting of any property right. In this respect, the limited scope and scale of the proposed action of amending the land use plans—and any potential environmental impacts of these amendments—necessarily results in the need for only a limited cumulative effects analysis in this PEIS. Analysis of the cumulative effects in this PEIS will be qualitative to reflect the limited and highly speculative character of the information available, and the limited nature of the decision to be made on the basis of this PEIS.[10] At the leasing decision and at the decision to approve a plan of development, more specific cumulative effects analyses would be appropriate, and such analysis would be able to be completed because specific technical and environmental information for those analyses should be available.

As stated above and in Sections 6.2.2 and 6.2.3, with the possible exception of a change in local property values, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for application for commercial tar sands leasing. Therefore, there would be no cumulative impacts from these alternatives. However, direct, indirect, and cumulative impacts could occur as a result of future commercial tar sands development that could be facilitated by such land use plan amendments. The focus of this cumulative impacts assessment, then, is the impacts from this future development, rather than the impacts from the land use plan amendment decision. That is, the purpose of this cumulative impacts assessment is to discuss, in a qualitative way, how the environmental and socioeconomic conditions within the study area might be incrementally affected over the next 20 years (the study period) by tar sands development that could occur on

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10 Oil shale and tar sands development could not occur until a leasing decision has been made and implemented (leases issued). After leases are issued, additional permits and environmental analysis would be required before operations could begin.

lands made available for application for commercial leasing by the land use plan amendments under either Alternative B or Alternative C.

This section describes, in a preliminary way, the possible cumulative impacts of potential commercial tar sands development that could occur over the next 20 years. More specific information regarding impacts, including cumulative impacts, would be provided by the analysis conducted at any future leasing stage, and at the review of any project-specific plan of development. The impacts presented here are in the context of other major activities in the study areas on both BLM-administered and nonfederal lands that could also affect environmental resources and the socioeconomic setting. The cumulative impacts assessment also would be applicable for tar sands development that could occur on CHL leases, although this is considered unlikely (see Section 2.4). The study areas considered usually include the lands managed by a BLM field office that contain tar sands resources and the ROI counties associated with them as defined in Table 3.10.2-1. Larger areas are considered for certain resources (e.g., land, air, and water). This section considers five major categories of activities that could have cumulative impacts: oil and gas development, coal mining and preparation, other minerals development, energy infrastructure development, and other activities (e.g., tar sands development, grazing, fire management, forestry, and recreation). Section 6.2.5.3 presents the possible cumulative impacts of potential commercial tar sands development that could occur under each of the Alternatives, B and C, and addresses the same resources analyzed in Sections 5.2 through 5.14.

The current status of resources (including past and present actions) is described in Chapter 3. This section focuses on the cumulative impacts of the possible tar sands development that could occur under either Alternative B or C, when added to a set of reasonably foreseeable future actions that are projected to occur or that could occur over the next 20 years (as described in Section 6.2.5.2). These projections were drawn from a variety of sources, as indicated in the text, but include developments on both BLM-administered and nonfederal lands. The accuracy of such projections is greatest during the first few years of the 20-year period and decreases over the time frame assessed. In particular, future levels of tar sands development are unknown. For the purposes of analysis, this cumulative impacts assessment looks at the incremental impacts of a single tar sands facility (as described in Section 5.1), recognizing that there may be more than one of these facilities brought into operation during the study period. While the cumulative impacts described in this section represent an initial estimate of impacts for activities projected to occur in the 20-year time frame, the assessment would require reevaluation if the planned level of development changes drastically in the future.

However, because under all alternatives, there is a lack of information on the magnitude of future actions on public land, how many projects might be undertaken, and the likely locations for future development, the magnitude of the differences between the cumulative effects of the alternatives cannot be identified (i.e., the same level of future development might occur under each alternative).

6.2.5.1 Overview of Assumptions and Impact-Producing Factors of Major Activities in the Study Area

6.2.5.1.1 Oil and Gas Development. For both federal and nonfederal lands oil and gas development are associated with impact-producing factors in resource areas such as water use, the production of wastes and water, contaminant emissions to air and water, the use and alteration of land, and potential oil spills. The environmental impacts of oil and gas drilling are highly variable, depending on the depth of drilling, drilling methods used, and whether multiple wells per drill pad are constructed. Table 6.2.5-1 summarizes the estimated impacts of oil and gas drilling on a per-well basis for select resource areas.

Rough estimates of overall resource requirements for oil and gas drilling are available from several sources. The BLM is continuing to improve the way it manages oil and gas operations, in particular, establishing BMPs to minimize environmental effects. Many of these specific mitigation measures reduce surface impacts and are applied as conditions of approval prior to operations on a lease. For wells on federal lands, the amount of surface disturbance for each well has been decreasing from about 3 to 1.5 acres per well or less. It is expected that standard industry practices in accordance with existing regulations are used for installation of oil and gas wells on private lands. For the purpose of analysis, it is assumed that the amount of land disturbed for oil and gas well installation on either federal or nonfederal lands varies from 2.5 to 15 acres per well. The higher end of the range is certainly an overestimate in locations where multiwell pads would be used (e.g., the Roan Plateau amendments call for 17 wells per pad atop the plateau) (BLM 2006i). In addition, only about 60% of the initially disturbed area would have long-term surface disturbance; the other 40% generally would be revegetated within 2 years (BLM 2006i).

TABLE 6.2.5-1 Assumptions Associated with Oil and Gas Drilling

Impact-Producing Factor	Values Used in Impact Analysis (per well drilled)	Reference
Surface disturbance (acres)	2.5–15	McClure et al. 2005; Thompson 2006a; DOE 2006; BLM 1994b, 2002a, 2006i
Water use (ac-ft/yr)	0.55	BLM 2006i
Drilling waste (bbl)	4,100	DOE 2006
Regulated emissions (CO, SO_2, NO_x) (tons)	0.37	DOE 2006
CO_2 emissions (tons)	97	DOE 2006
Other nonregulated emissions (CH_4, non-CH_4 hydrocarbons) (tons)	0.17	DOE 2006
Amount of oil spilled (gal)	24	DOE 2006
Employment (direct FTEs)	3	BLM 2006i

6.2.5.1.2 Coal Mining and Preparation. Impact-producing factors for coal mining and preparation (e.g., removal of sulfur) on either federal or nonfederal lands include water use, contaminant emissions to air and water, use and alteration of land, and occupational hazards. These factors are discussed in DOE (1988) and summarized for select resource areas in Table 6.2.5-2. As is the case with oil and gas operations, the BLM is improving its management of coal operations by establishing BMPs to minimize environmental effects. Many specific mitigation measures reduce surface impacts and are applied as conditions of approval prior to operations on a lease.

6.2.5.1.3 Other Minerals Development. Although several metals and minerals are mined in Utah, most are not mined in the counties that might experience tar sands development. The predominant materials currently mined in these areas are sand and gravel.

Sand and gravel deposits are found in river and stream terraces, floodplains, and channels, both current and ancient. These deposits are a type of salable mineral. Extraction of in-stream sand and gravel deposits could result in adverse environmental impacts, such as changes in streamflow and increased turbidity, that would affect fisheries and recreational use. Extraction of sand and gravel from floodplains or low terraces could create new channels and alter sediment deposition, again adversely affecting the ecology of the nearby river or stream. Other general impacts from sand and gravel mining could include land disturbance, changes in groundwater quality, noise, dust, and visual changes. The proper management of sand and gravel mining and the application of mitigation could decrease impacts such that there would be minimal adverse impacts. For example, siting mining locations high up in the landscape (on floodplains and terraces rather than in stream channels) would decrease adverse impacts on stream hydrologic processes (Langer 2002).

Other materials mined in on near the potential tar sands development area include clay, gilsonite, gold, sandstone, sodium minerals, and uranium. These metals and minerals may be obtained through underground mining, surface (open pit) mining, or solution mining. Gold is mined using both surface and underground methods. Mining of these substances can cause a variety of adverse environmental impacts, including the production of high volumes of solid and potentially hazardous waste; the contamination of surface water and groundwater; uncontrolled releases of produced water; land subsidence; physical instability of mine units; and air quality degradation, especially from particulate emissions. Uranium has an added potential for radiologically contaminating environmental media, leading to the subsequent possibility of exposures of biota and humans.

Metal mining historically has also caused contamination of surface water. The sources of contamination have included waste rock disposal, tailings, leaching sites (locations where valuable metals are collected by running solutions through the ore), and mine water. Depending on the local geology, the waste rock may contain other naturally occurring minerals that could be toxic to biota, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, and nickel. In addition, cyanide (a highly toxic substance composed of carbon and nitrogen) is used extensively in the mining industry to aid in metal extraction. Serious adverse impacts on surface water from metal mining have occurred when runoff from waste sources has entered

TABLE 6.2.5-2 Assumptions Associated with Coal Mining and Preparation[a]

Impact-Producing Factor	Values Used in Impact Analysis (per million tons surface mined)	Values Used in Impact Analysis (per million tons underground mined)
Surface disturbance (acres)		
Areas for facilities	4.3	4
Strip mining	20	NA[b]
Waste storage	2.6	1
Water use (million gal)		
Coal preparation	20	20
Dust control	35	35
Air emissions (tons)[c]		
CO	15	6.3
SO_2	4.9	0.59
NO_x	76	[d]
Particulates	4	0.48
Fugitive dusts[e]	1,870	[d]
Hydrocarbons	4.8	0.48
Aldehyde	1.2	[d]
Diesel fuel use (10^3 gal)	3,021	38
Electricity use (10^6 MWh)	6	39
Employment (direct FTEs)	180	460
Occupational hazards (deaths per 100,000 workers, disabling injuries per 100 workers)	0.07, 8	0.37, 45

[a] Coal is prepared to increase its quality and heating value by removing sulfur and ash-forming constituents.

[b] NA = information not available.

[c] Surface mining values are for the western United States; underground values are for the eastern United States.

[d] Unquantified or negligible.

[e] Based on estimates for an Illinois surface mine with the following controls: paved access roads, watered and unpaved haul roads, and enclosed coal dumps with baghouse. Without these controls, estimated fugitive dust emissions would be 3,030 tons.

Source: DOE (1988).

nearby water bodies; these impacts have included degradation of aquatic habitat and contamination of drinking water supplies. Additional adverse impacts can occur as a result of erosion and increased sedimentation of surface water.

An environmental impact from metal mining is the large volume of waste that is generated. The product-to-waste ratio can be very high; for example, in gold mining, almost all of the material removed from the earth (99.99%) is waste rock and tailings. Another area of concern is air quality degradation. Many metal mining operations generate large volumes of fugitive dust from ore crushing and loading, blasting, and, over time, from dried-up tailings ponds.

Many of the adverse impacts from mining discussed above occurred primarily in the past, and mitigation measures have been adopted to minimize their occurrence in present practice. Because of the wide variety of possible contaminants and impacts from mining of metals and other minerals, generic impacts (e.g., on a “per-ton-mined” basis) are not discussed in this section. Cumulative impacts are discussed in Section 6.2.4.3 on the basis of the specific types of minerals being developed in each region.

6.2.5.1.4 Energy Infrastructure Development

Energy Corridors. The western states have an extensive infrastructure of oil and gas pipelines and electricity transmission ROWs. Most of the existing ROWs cross public lands (National Energy Policy Development Group 2001). As of 2005, Colorado had 6,177, Utah had 5,120, and Wyoming had 15,775 ROWs crossing public lands (BLM 2001, 2005k). These ROWS serve as either long-distance paths or subregional and local distribution lines. It is projected that the growing demand for additional energy and electricity will result in an increased number of ROWs across public lands in the future (National Energy Policy Development Group 2001). Other federal agencies authorized to grant ROWs for electric, oil, and gas transmission include the USFS, the NPS (electric only), the USFWS, the BOR, and the Bureau of Indian Affairs.

The BLM, along with DOE, is preparing a PEIS (DOE 2008) to designate public lands for potential use for long-distance energy transmission corridors in the West. This is an effort to expedite permitting of transmission systems, such as oil and gas pipelines and power lines (DOE 2008). The proposed action of that PEIS designates federal energy corridors on public lands in areas that would be beneficial for energy development, but excludes sensitive lands (such as National Parks and National Monuments, ACECs, and roadless areas) to the extent practicable. Consideration is given to the locations of tar sands deposits, and possible corridor locations have been designated relatively near to these areas for future use if the tar sands resource is developed. The designation of public lands for potential use in energy transmission ROWs as proposed under the Draft West-wide Energy Corridor PEIS (DOE 2008) would not have direct impacts, with the possible exception of affecting current land use within the corridors and property values on private lands adjacent to or between corridor segments.

The eventual construction and operation of energy transmission ROWs, whether within federally designated energy corridors, within energy corridors on federal lands that are currently identified in land use plans, or at locations on nonfederal lands identified by industry and evaluated and authorized by appropriate federal agencies (e.g., BLM, USFS, and Tribal lands), could result in adverse environmental impacts on federal and nonfederal lands. The specific types, magnitudes, and extent of project-specific impacts would be determined by the project type, that is, transmission line or pipeline, and its length and location on federal and nonfederal lands; thus, the impacts could be evaluated only at the project level. However, general potential impacts typical of project construction and operation include the use of geologic and water resources; soil disturbance and erosion; degradation of water resources; localized generation of fugitive dust and air emissions from construction and operational equipment; noise generation; disturbance or loss of paleontological and cultural resources and traditional cultural properties; degradation or loss of fish and wildlife habitat; disturbance of resident and migratory fish and wildlife species, including protected species; degradation or loss of plant communities; increased opportunity for invasive vegetation establishment; alteration of visual resources; land use changes; accidental release of hazardous substances; and increased human health and safety hazards. Construction and operation of energy-transmission ROWs could also affect minority and low-income populations in the vicinity of the projects on both federal and nonfederal land as well as local and regional economies.

Electric Power Plants. Impacts from electric power generating plants include emissions of air pollutants, water use, production of large volumes of solid waste (e.g., coal combustion products [ash] and flue-gas cleanup waste), use and alteration of land, emissions and accidents associated with the transportation of raw materials and wastes, and socioeconomic impacts. Air emissions differ depending on the quality of feed coal utilized. Electric power plants are generally sited on private lands. Table 6.2.5-3 summarizes the estimated impacts on various resource areas from the construction and operation of electric power plants. In the near term, it is most likely that low-sulfur Wyoming coal would be utilized for power plants in the study area. In this PEIS, it is assumed that the tar sands projects considered under Alternatives B and C would be powered from existing power plants. However, additional electric power might be required over the study period to support new development.

6.2.5.1.5 Other Activities

Oil Shale Development. This PEIS addresses the environmental and socioeconomic impacts of land use plan amendments and potential development for both oil shale and tar sands, and thus potential oil shale development must be considered in the cumulative impact assessment for tar sands development. Because the level of oil shale development over the next 20 years is unknown, this assessment has assumed that one oil shale facility could be constructed and operated in or near any one of the Utah STSAs during the study period. This oil shale facility could be on the PRLA associated with the Utah RD&D facility, on federal land within the footprint of oil shale Alternatives B or C, or on nonfederal land. Impact-producing factors for such an oil shale facility include surface disturbance, water use, waste generation, and local

TABLE 6.2.5-3 Assumptions Associated with Coal-Fired Power Plants[a]

Impact-Producing Factor	Assumed Values for a 1,500-MW Plant (BLM 2007d)	Assumed Values for a 360-MW Current Design Plant and a 425-MW NSPS Plant (Spath et al. 1999)[b]
Land use (acres)	3,000 total (includes construction acreage)	NA[c]
Water use (ac-ft/yr)	8,000 ac-ft/yr	NA
Fuel source and composition	Wyoming-grade low-sulfur coal (0.47% sulfur, 6.4% ash); heat of combustion = 8,220 Btu/lb (Representative data from Powder River Basin coal; Ellis et al. 1999)	Illinois No. 6 bituminous (4% sulfur, 0.1% chlorine, 1.1% nitrogen, 10% ash dry basis); heat of combustion = 10,800 Btu/lb
Fuel requirements	3.75 million tons/yr (2,330 tons/yr/MW)[d]	Current plant: 1.6 million tons/yr (4,320 tons/yr/MW); NSPS plant: 1.7 tons/yr (3,950 tons/yr/MW)
Coal combustion products (ash)[e]	NA	Current plant: ~36,000 kg/GWh; NSPS plant: ~33,000 kg/GWh
Solid waste (flue-gas cleanup)	NA	Current plant ~86,000 kg/GWh; NSPS plant: ~92,000 kg/GWh
Emissions		
SO_2	Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu)	Current plant: 6,400 kg/GWh; NSPS plant: 2,229 kg/GWh
NO_x	Meet NSPS standards: 258 g/GJ heat input (0.6 lb/million Btu)	Current plant: 3,039 kg/GWh; NSPS plant: 2,041 kg/GWh
CO	NA	Current plant: 134 kg/GWh; NSPS plant: 123 kg/GWh
CO_2	NA	Current plant: ~970,000 kg/GWh; NSPS plant: ~890,000 kg/GWh
Particulates	Meet NSPS standards: 13 g/GJ heat input (0.03 lb/MMBtu)	Current plant: 135 kg/GWh; NSPS plant: 123 kg/GWh
VOCs	NA	Current plant: 16 kg/GWh; NSPS plant: 14 kg/GWh
Employment (direct FTEs)[f]	Construction: 800 average over 4 yr (1,200 peak); Operations: 135	NA
Transportation	12 trains/week; 100 cars/train; 10,000 tons/train	13–14 trains/week; 17 cars/train; 1,445 tons/train

Footnotes on following page.

TABLE 6.2.5-3 (Cont.)

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[a] Power plants are assumed to operate at 60% efficiency; thus, a 1,500-MW plant generates approximately 7,900 GWh/yr; a 325-MW plant generates 1,900 GWh/yr; and a 425-MW plant generates 2,200 GWh/yr.

[b] NSPS = new source performance standard.

[c] NA = information not available.

[d] Sources for fuel requirement and transportation assumptions are Thompson (2006b,c).

[e] Coal combustion products may not require disposal in landfills. The EPA sponsors a beneficial reuse program (EPA 2008).

[f] Source for FTE employment values is Thompson (2006b).

Sources: BLM (2007d); Ellis et al. (1999); Spath et al. (1999); Thompson (2006b,c).

changes in employment and population density. The assumptions used for these factors are given in Section 4.1.

Grazing. Public and private lands in the study area are used extensively for livestock grazing. Environmental impacts of note associated with livestock grazing include potential degradation of soil, vegetation, wildlife habitat, and surface water quality (Krueger et al. 2002; BLM 2006k). For example, overgrazing could result in increased rates of erosion and topsoil losses. Allowing grazing during the nesting seasons of some species could result in trampling of the eggs and decreased viability of those species in the study area. Livestock could also degrade surface water quality if their manure and urine were deposited directly into the water or on land nearby. Good management practices can eliminate or mitigate many of these impacts. On BLM lands, grazing permits are required that specify the species allowed to graze, amount of grazing permitted, and other requirements to minimize environmental impacts. Today, the BLM manages livestock grazing in a manner aimed at achieving and maintaining public land health. To achieve desired conditions, the agency uses rangeland health standards and guidelines that the BLM developed in the 1990s with input from citizen-based Resource Advisory Councils across the West. Standards describe specific *conditions* needed for public land health, such as the presence of stream bank vegetation and adequate canopy and ground cover. Guidelines are the management *techniques* designed to achieve or maintain healthy public lands, as defined by the standards. These techniques include such methods as seed dissemination and periodic rest or deferment from grazing in specific allotments during critical growth periods.

Fire Management. Fire management is used on public and private lands to aid in wildfire suppression. Underbrush is burned at regular intervals to avoid the buildup of large amounts of fuel on these lands. Fire is considered to have a natural role in the ecosystems and is used as a tool in managing those ecosystems. However, fires have potential environmental impacts that should be considered, particularly air quality impacts and impacts on threatened and endangered species (BLM 2005l). In general, impacts would be lower from more frequent, less intense, controlled fires than from infrequent wildfires.

Forestry. In Colorado, Utah, and Wyoming, the BLM administers approximately 14.2 million acres of forested lands of various types. Forested land is defined as being 10% stocked with live trees and at least 1 acre in size and 120 ft wide. A 2006 report on the status and condition of these forests states that the national priorities for them include "maintaining and restoring forest health, salvaging dead and dying timber, providing high-quality wildlife and fish habitat, and providing economic opportunities in rural communities by making timber and other forest products, including biomass, available from vegetation management treatments" (BLM 2006l). Management techniques for BLM-administered forest lands include grazing restrictions, selective thinning of undergrowth and dead wood, prescribed burns, and selective harvesting of trees. Adverse environmental impacts on air quality, water quality, habitat, and threatened and endangered species could occur as a result of these management practices. For example, increased erosion after land clearing could cause siltation in streams and decrease water quality.

Recreation. One mission of the BLM is to accommodate recreational use of public lands, such as fishing, hiking, horseback riding, mountain biking, camping, and OHV use. However, these uses can have adverse environmental impacts. For example, OHV use can result in soil compaction, increased erosion, and the proliferation of non-native plant species. Overuse of trails in primitive areas can also result in erosion and disturbance of threatened and endangered species habitat. Other ways by which recreational visitors could affect the environment include producing waste, emitting air pollutants from motorized vehicles, and using water. However, recreational use also has benefits, including allowing visitors to enjoy outdoor wilderness areas and to reduce their stress, and stimulating economic growth in the area. The BLM works to minimize the adverse environmental impacts of recreational use by managing the activity. Examples of plan requirements include habitat improvement projects in recreational areas, construction of recreational use facilities that lead to decreased random use and degradation of wild areas, and waste management (BLM 2006m).

6.2.5.2 Projected Levels of Major Activities in the Study Area

Data on past, current, and planned future activities on BLM-administered lands and also nonfederal lands were obtained from various BLM RMPs and EISs available through the field offices. Also, because projected developments have been changing rapidly, particularly for oil and gas development, field office staff were contacted to obtain their best current estimates for projected activities in the areas of oil and gas development (both on public and private lands), coal development, other minerals development, energy development, and other activities (e.g., grazing, fire management, forestry, and recreation) over the 20-year time period between 2007 and 2027. The projected levels of major activities in Utah are summarized in Table 6.2.5-4.

6.2.5.2.1 Oil Shale and Tar Sands Development. As stated in Section 6.1.5.1.5, in the future, one PRLA with an area of 4,960 acres may be eligible for oil shale development using underground mining techniques, assuming the RD&D leaseholder can meet requirements of their existing lease. In addition, an unknown level of oil shale and tar sands development could occur on nonfederal lands in the future.

TABLE 6.2.5-4 Projected Levels of Major Activities for Seven Planning Areas Considered on BLM-Administered and Nonfederal Lands in the Cumulative Impacts Assessment for Tar Sands Development in Utah[a]

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Oil Shale and Tar Sands				
Oil shale development on PRLA(federal lands)	Potential for one underground mining project on 5,120 acres of PRLA		None	None
Oil shale and tar sands development on nonfederal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown
Oil and Gas				
Recoverable oil and gas reserves	NA	NA	NA	NA
Potential oil wells drilled/yr over next 20 yr (2007–2027)[b]	76 wells (based on 2,055 total in VPA, 1,130 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]).	62 wells (based on 2,055 total in VPA, 925 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]).	30 wells total in RPA; 3 in HM only (includes oil, gas, and CBNG; based on 454 total over 15 yr [2005–2020]; 3/yr in HM only, as projected by BLM [2005c]).	Few oil wells drilled (based on only 8 currently producing wells); discussion that no significant oil production is expected in the future (BLM 2004b; Appendix 21).
Potential gas wells drilled/yr over next 20 yr (2007–2027)[b]	147 wells (based on 4,035 total in VPA, 2,195 in DM only over 15 yr [2003–2017] as projected by BLM [2005b]).	143 wells (based on 4,035 total in VPA, 2,150 in BC only over 15 yr [2003–2017] as projected by BLM [2005b]).	Included with potential oil wells drilled for HM PA.	55–95 wells (includes CBNG; based on 1,100–2,000 over 20 yr [2005–2024] as projected by BLM (2004b; Table 4-2; BLM 2008b).

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Oil and Gas (Cont.)				
Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b]	4 wells (based on 130 total in VPA, 50 in DM over 15 yr [2003–2017] as projected by BLM [2005b]).	6 wells (based on 130 total in VPA, 80 in BC over 15 yr [2003–2017] as projected by BLM [2005b]).	Included with potential oil wells drilled for HM PA. HM coal field not likely to be developed for CBNG in the next 15 yr (2005–2020) (BLM 2005d).	Included with potential gas wells drilled for San Rafael PA. Numbers above include Price Project: 545 wells/10 yr on 1,609 acres, 20–70 jobs; Ferron Project: 335 wells/ 5 yr, acres unknown. Impacts on mule deer populations and winter habitat (BLM 2004b).
Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c]	570–3,400 acres/yr total (190–1,100 oil; 370–2,200 gas; 10–60 CBNG).	540–3,200 acres/yr total (160–930 oil; 360–2,100 gas; 15–90 CBNG).	75–450 acres/yr RPA total; 9–45 HM (includes oil, gas, and CBNG).	140–1,400 acres/yr (includes gas and CBNG).
Wells to be abandoned annually over next 20 yr (2007–2027)[d]	57 wells total (19 oil; 37 gas; 1 CBNG).	54 wells total (16 oil; 36 gas; 2 CBNG).	8 wells in RPA total, 1 in HM (includes oil, gas, and CBNG).	14–24 wells (includes gas and CBNG).
Seismic exploration projects[e]	2–3 projects/yr (based on 45–75 total for Vernal, assume half in DM) over 15 yr [2003–2015] [BLM 2002a]); 200–300 acres/yr disturbance.	2–3 projects/yr (based on 45–75 total for Vernal, assume half in BC) over 15 yr [2003–2015] [BLM 2002a]); 200–300 acres/yr disturbance.	340 acres/yr disturbance (based on 5,100 total over 15 yr as projected by BLM [2005c]).	150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2004b]).

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Coal				
Recoverable reserves (million tons)	Tabby Mountain coal field: ~320 million tons (BLM 2002a).	No known reserves (BLM 2002a).	Includes south part of Wasatch Plateau Coal Field: ~6,000 million tons; HM Coal Field: 20 million tons (Jackson 2006). Emery Coal Field: reserve information not available.	Includes northern part of Wasatch Plateau Coal Formation: ~690; BC Coal Field: ~280; Emery Coal Field: ~240 (all 3 in million tons) (BLM 2004b; Section 3.3.5.2).
Predicted production over next 20 yr (2007–2027) (million tons/yr)	None (BLM 2002a).	None (BLM 2002a).	Wasatch Plateau Coal Field: 25; no production planned for HM (Jackson 2006). Emery Coal Field: no production information available.	Lila Canyon: 0.8–1; North Horn: 2–4; Willow Creek: 2–4 (BLM 2004b; Chapter 4).
Surface area potentially leasable (acres)	NA	None	NA	NA
Surface mining area potentially disturbed annually (acres/yr)	None	None	None	None
Surface area potentially disturbed for underground mining support facilities (total acres, 2007–2027)[f]	None projected	None projected	500 acres	Most coal would be mined through underground mining methods (BLM 2004b; Section 3.3.5.2); 500 acres.

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Coal (Cont.)				
Other coal impacts	None known	None known	None known	Lila Canyon: 5-mi road, 550 round-trips/day on US 6, 150–200 jobs; North Horn: road, power line, and infrastructure construction, EIS ongoing, start of operations unknown; Willow Creek: not currently leased, if operations begin, 250–300 jobs, surface disturbance, safety issues (BLM 2004b; Chapter 4).
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)				
Phosphate production over next 20 yr (2007–2027)	5,800 acres on BLM-administered land; 14,000 acres on private land (BLM 1993; 2002a); assume 50% surface mining (i.e., 10,000 acres).	None (BLM 2002a).	None	None
Gilsonite production rate over next 20 yr (2007–2027) (tons/yr)	None (BLM 2002a).	60,000 (based on BLM projections for 2003–2017) (BLM 2002a).	None	None

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)				
Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt)	Minor to no activity (BLM 2002a).	Minor to no activity (BLM 2002a).	Uranium, vanadium, gold, copper: high potential for occurrence and development in HM area; exploration for economic quantities is continuing (BLM 2005d). One salt mine on west side of RPA to continue operations. Gypsum and salt production unlikely in next 15 yr, especially in HM area (BLM 2005d).	Gypsum: Fairly large areas in south and central parts of PA have high potential for development over next 15 yr (2005–2020) (BLM 2004b; Section 3.3.5.1). Number of acres: NA.
Salable minerals (gravel, sand, clay)	Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a); Limestone: 30,000 tons/yr (based on USFS land production, most in DM (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a).	Stone: 30 tons/yr (based on 60 tons/yr total for VPA, 2003–2017 (BLM 2002a); Sand and gravel: some production, quantity unknown (BLM 2002a).	For planning period of 2006–2020: 57 active sand and gravel disposal sites on BLM-administered land; likely to continue producing ~20,000 yd^3/yr, additional sites on public land (BLM 2005d). Assume 2 permits at 6 acres/permit, 12 acres/yr. Clay: only small-scale development. Stone: continue at current rate of about 1–1,000 tons/yr (BLM 2005d). Humate production to continue on small scale at Factory Butte in HM (BLM 2005d).	Clay: current areas of active mining would continue over next 15 yr (2005–2020), unlikely that new deposits would be developed (BLM 2004b; Section 3.3.5.1). Sand and gravel, stone, and humate: high potential areas near major paved roads would be developed 2005–2020 (BLM 2004b; Section 3.3.5.3).

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Energy Development				
Energy corridors	NA	NA	NA	NA
Electric generating utilities	NA	NA	NA	NA
Existing power plants	NA	NA	NA	Hiawatha Cogeneration Plant, Questar Pipeline Dewpoint Plant, Sunnyside Cogeneration Facility, coal-fired PacifiCorp Hunter, Huntington and Carbon plants: all provide employment, emit NO_X, use water, and decrease water quality. Planned PacifiCorp Hunter expansion: add 350 long-term jobs, increase NO_X, and SO_X emissions, use and degrade water (BLM 2004b).
Other				
Forestry	NA	NA	NA	Logging on private lands (not quantified) (BLM 2004b; Section 4.2.2).
Fire management	5,500–7,800 acres/yr prescribed burns annually, based on 11,000 acres total in VPA as projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) or 156,425 acres/decade total in VPA (BLM 2005b; Table 2.3).	5,500–7,800 acres/yr prescribed burns annually (based on no action of 11,000 acres total in VPA projected by BLM for 2002–2006 (BLM 2005b; Section 3.4) and 156,425 acres/decade total in VPA (BLM 2005b; Table 2.3).	NA	One prescribed burn of 5,000 acres every 2 yr (based on last 20 yr data) (BLM 2004b; Section 3.2.10.4).

TABLE 6.2.5-4 (Cont.)

Activity	Diamond Mountain (Western Half of Vernal PA)	Book Cliffs (Eastern Half of Vernal PA)	Henry Mountain (Southeast Portion of Richfield PA)	San Rafael (Area Similar to Price PA)
Other (Cont.)				
Land and realty	NA	NA	NA	Utah Department of Transportation: road improvements between 2006 and 2025 on US 6 between Green River and Spanish Fork (~3-mi widening, 12 mi of new asphalt). Also SR 10 corridor (5 mi) (BLM 2004b; Section 4.2.2).
Livestock	NA	NA	NA	NA
Special management areas, recreation	4–27 mi/yr nonmotorized recreational trails and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in DM.	4–27 mi/yr nonmotorized recreational trails and 54 mi/yr motorized trails would be developed total in VPA (between 2006 and 2020; BLM 2005b; Table 2.3); assume half in BC.	NA	NA
Vegetation	2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in DM.	2,300–3,400 acres/yr vegetation treated total in VPA (between 2006 and 2020; BLM 2005b; Table 4.18.2); assume half in BC.	NA	NA
Soils/watersheds	NA	NA	NA	NA
Miscellaneous	NA	NA	NA	NA

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Oil Shale and Tar Sands				
Oil shale development on PRLAs (federal lands)	None	None	None	See Vernal
Oil shale and tar sands development on nonfederal lands	Potential unknown	Potential unknown	Potential unknown	Potential unknown
Oil and Gas				
Recoverable reserves	NA	>270 million bbl (Allison 1997).	NA	NA
Potential oil wells drilled/yr over next 20 yr (2007–2027)[b]	5–21 wells (includes gas, average of 13/yr, 195 total from 2006–2020 (BLM 2005e).	Few (only 47 exploratory wells currently in GSENM; ~ 200,000 acres of old leased land are under review) (BLM 1999b).	12–40 wells (includes gas, average of 26/yr, 390 total from 2006–2020 (BLM 2005a).	190–230 oil wells drilled/yr
Potential gas wells drilled/yr over next 20 yr (2007–2027)[b]	Included with potential oil wells drilled for San Juan PA.	None (BLM 1999b).	Included with potential oil wells drilled for MOAB PA.	350–390 gas wells drilled/yr
Potential CBNG wells drilled/yr over next 20 yr (2007–2027)[b]	None (BLM 2005f)	None (BLM 1999b).	1 well (based on three 5-spot well clusters between 2006 and 2020 (BLM 2005g); assume same annual rate).	11 CBNG wells drilled/yr
Annual surface disturbance over next 20 yr (2007–2027) (acres/yr)[c]	13–320 acres/yr (includes oil and gas).	NA	33–620 acres/yr total (30–600 [oil and gas]; 3–15 CBNG (similar to 225 total acres CBNG between 2006 and 2020) (BLM 2005g).	1,400–9,400 acres/yr

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Oil and Gas (Cont.)				
Wells to be abandoned annually over next 20 yr (2007–2027)[d]	2–8 wells (includes oil and gas) (BLM 2005e).	NA	6–20 wells (BLM 2005a).	140–170 wells abandoned/yr
Seismic exploration projects[e]	150 acres/yr disturbance (based on 2,236 total over 15 yr as projected by BLM [2005e]).	NA	240 acres/yr disturbance (based on 3,600 total over 15 yr [2006–2020] as projected by BLM [BLM 2005a]).	NA (~1,500–2,100 acres/yr of temporary vegetation and habitat disturbance)[d]
Coal				
Recoverable reserves (million tons)	San Juan coal field (530,000 acres; 60% privately owned) (BLM 1991a), 77 million tons available to surface mining; no current production because of poor quality/lack of rail transport (BLM 2005f).	NA	NA (Sego Formation produced ~3 million tons up through the 1950s) (BLM 2005g).	~7.6 billion tons
Predicted production over next 20 yr (2007–2027) (million tons/yr)	None (BLM 2005f).	None (BLM 1999b).	None (BLM 2005g).	30–34 million tons/yr (approximately 87% from underground mining; 13% from surface mining)
Surface area potentially leasable (acres)	NA	NA	NA (Sego Formation may be attractive for future production because of low sulfur content, close to railway).	NA
Surface mining area potentially disturbed annually (acres/yr)	NA	NA	NA	NA

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Coal (Cont.)				
Surface area potentially disturbed for underground mining support facilities (total, 2007–2027, acres)[f]	None projected	None projected	None projected	1,000 acres total 2007–2027
Other coal impacts	None known	None known	None known	See San Rafael PA.
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals)				
Phosphate production over next 20 yr (2007–2027)	None (BLM 2005f)	None (BLM 1999b)	None (BLM 2005g)	10,000 acres surface disturbance (see DM)
Gilsonite production rate over next 20 yr (2007–2027) (tons/yr)	None (BLM 2005f)	None (BLM 1999b)	None (BLM 2005g)	60,000 tons/yr gilsonite (see BC)

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Other Minerals (e.g., phosphate, gilsonite, locatable minerals, salable minerals) (Cont.)				
Locatable minerals (e.g., precious metals/gems, uranium, bentonite, gypsum, limestone, salt)	Uranium/vanadium: 4.2 million tons in reserves in Four Corners area—estimated disturbance of 20 acres/yr for next 15 yr (2005–2020) (BLM 2005f). Gold: 5–20 acres total disturbed for next 15 yr in Recapture Creek and Johnson Creek (BLM 2005f). Limestone: 20,000–30,000 tons/yr, 20–50 acres total disturbed for next 15 yr (BLM 2005f).	Uranium/vanadium: deposits present (Allison 1997), not to be developed (BLM 1999b). Alabaster: ongoing production of 300 tons/yr—from surface, not usually quarried.	Uranium/vanadium: >1 million tons ore reserves—estimated disturbance of 10 acres/yr for next 15 yr (2005–2020) (BLM 2005g). Copper: Lisbon Valley Project—produce for 10 yr (2006–2015); disturb 110 acres/yr (1,103 total, includes 266-acre pad for leaching, processing plant, ponds, and 11-mi power line). Salt/potash: 3.3 acres/yr (50 acres disturbance total over next 15 yr [2006–2020] BLM 2005g).	Uranium/vanadium: high potential for development with at least 30 acres/yr surface disturbance; Gold: at least 5 acres/yr disturbed; Limestone: at least 20 acres/yr disturbed; Gypsum: high potential for development, acres NA; Alabaster: 300 tons/yr, acres NA; Salt: at least 3 acres/yr disturbed; Copper: at least 110 acres/yr disturbed. Total: at least 170 acres/yr disturbed.
Salable minerals (gravel, sand, clay)	Sand and gravel: 4 permits/yr producing ~127,000 yd^3/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005f). Building stone: 5–10 acres/yr over next 15 yr (2005–2020) (BLM 2005f).	Sand and gravel: limited production for local use (Allison 1997).	Sand and gravel: 4 permits/yr producing ~60,000 yd^3/yr, 6 acres/permit, thus 24 acres/yr disturbed over next 15 yr (2005–2020) (BLM 2005g). Building stone: ~0.5 acres/yr over next 15 yr (1 new facility, producing 5,000–10,000 tons/yr for 5 yr between 2006 and 2020) (BLM 2005g).	Sand and gravel: at least 60 acres/yr disturbed; Stone: at least 6 acres/yr disturbed; Clay: no new deposits to be developed.

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Energy Development				
Energy corridors	NA	NA	NA	Estimated 640 mi (271,000 acres) in Utah; a portion of the corridor is expected to be sited near the tar sands resources (DOE 2008).
Electric generating utilities	NA	NA	NA	~3,200 MW currently produced in region (98% from coal) (EIA 2007). Three new plants proposed in Utah (~1,570 MW capacity [EPA 2002]).
Existing power plants	NA	None	NA	See San Rafael PA.
Other				
Forestry	NA	NA	NA	See San Rafael PA.
Fire management	NA	NA	NA	NA (at least 13,500 acres/yr prescribed burn)
Land and realty	NA	NA	NA	See San Rafael PA (road planned).
Livestock	About 2.1 million acres used for grazing (BLM 1986d).	NA	NA	NA (about 2.1 million acres used for grazing in Monticello PA).
Special management areas, recreation	About 1.3 million acres used for recreation (BLM 1986d)	~6 acres/yr disturbed (total of 85 acres over 15 yr [2000–2014] for recreation and campsites (BLM 1999b).	NA	NA (some motorized and nonmotorized trails and campsites to be developed).

TABLE 6.2.5-4 (Cont.)

Activity	San Juan (Area Similar to Monticello PA)	Grand Staircase–Escalante NM	Moab PA	Summary for Utah PAs and GSENM
Other (Cont.)				
Vegetation	NA	1,000–3,000 acres/yr for vegetation restoration through burning (20,000 acres total for 2000–2014).	NA	At least 3,300 acres/yr vegetation treatment or burning for restoration.
Soils/watersheds	NA	<1 acre/yr (10 sites at 1 acre/site) (BLM 1999b).	NA	NA (at least 1 acre/yr disturbance)
Miscellaneous	NA	~17 acres/yr for utility and road ROWs and communications sites (260 acres total over 15 yr [2000–2014] (BLM 1999b).	NA	NA (at least 17 acres/yr disturbance)

Abbreviations: ACEC = Area of Critical Environmental Concern; BC = Book Cliffs; BCF = billion cubic feet; CBNG = coal bed natural gas; DM = Diamond Mountain; GSENM = Grand Staircase–Escalante National Monument; HM = Henry Mountain; NA = information not available; PA = planning area; RPA = Richfield Planning Area; SM = surface mining; SR = surface retort; UM = underground mining; USFS = Forest Service; VPA = Vernal Planning Area.

[a] The activities listed are those considered in addition to tar sands development on federal lands as described for Alternatives B and C. In general, values are rounded to two significant figures.

[b] Includes projections for federal lands, and, where available, nonfederal lands.

[c] Assumes a range of 2.5 to 15 acres/well for well pads, roads, and pipelines (representative range based on 2.5 acres from DOE [2006]), 3 acres from Vernal Mineral Potential Report (BLM 2002a), and 15 acres from Moab PA (BLM 2005a). The 2.5- to 15-acre range encompasses estimates for San Rafael of 7.9 acres/well + 20 acres/ancillary facility (BLM 2004b; Appendix 21); Henry Mountain (4 acres/well + 8 acres/well for roads) (BLM 2005c); and Monticello (9.6 acres/well) (BLM 2005e).

[d] Generally assumes that 25% of new wells would be abandoned (based on estimate provided for the Rawlins Wyoming Field Office [Allison 2006]). Assumes 50% for Moab (BLM 2005a) and 40% for Monticello (BLM 2005e). All surface disturbance is assumed to be reclaimed within 10 years of abandonment.

[e] If information is not available, assume approximately 1 to 2 geophysical exploration projects/50 wells drilled annually (based on Wyoming estimates); 100 acres disturbed/project (this is short-term disturbance such as crushed vegetation, uprooted brush, and minor soil disturbance; disturbance is generally unidentifiable within 1 yr). At 550 to 630 wells drilled/yr, expect 11 to 26 projects/yr for Utah overall.

[f] For areas where coal mining is ongoing and subsurface, a limited amount of surface disturbance over the 20-year study period was assumed (i.e., 500 acres).

6.2.5.2.2 Oil and Gas Development. The largest amount of oil and gas development is projected for the Vernal Planning Area, for which about 440 wells per year are predicted; the total projected maximum number of new oil and gas wells for applicable field offices in the state is 620 per year (see Table 6.2.5-4, which includes wells both on federal and nonfederal lands (projections for nonfederal lands are not available for all field offices).

6.2.5.2.3 Coal Mining. The largest coal reserves are in the Henry Mountain Planning Area, with smaller amounts in the San Rafael Planning Area (Table 6.2.5-4). Predicted production for all field offices combined is about 30 to 34 million tons per year. About half of this production would be from surface mines, and half would be from underground mines.

6.2.5.2.4 Other Minerals Development. Metals produced in Utah include copper (one mine), iron (two mines), phosphate (one mine), molybdenum (one mines), potash (three mines), silver (four mines), and uranium (one mine) (EPA 1997). In the ROI counties (Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne), only sand and gravel, gilsonite, clay, gypsum, dimension sandstone, lime, helium, and gold are produced (USGS 2004b). Phosphate production occurs in the Diamond Mountain area and gilsonite production in the Book Cliffs area. Uranium/vanadium has a high potential for development in the Henry Mountain and San Juan Planning Areas; it would result in at least 30 acres per year of surface disturbance. A limited amount of other minerals development is expected (Table 6.2.5-4).

6.2.5.2.5 Energy Development. The DOE estimates that 640 mi of corridors could be sited on public lands in Utah, with a total surface area of 356,000 acres (DOE 2008). This development would be in addition to the existing 5,120 ROWs crossing public lands in Utah as of 2005.

Table 6.2.5-5 summarizes the electric generating units operating in oil shale ROI counties in Utah in 2005, including the primary fuel source for each plant and its electric power generating capacity. Of the 3,220 MW of nameplate power available from 14 generating units, 98% was from eight coal-fired generators. As of 2000, there were also three new generating plants proposed for Utah, with a total capacity of 1,570 MW (EPA 2002).

6.2.5.2.6 Other (Oil Shale Development, Grazing, Forestry, Fire Management, and Recreation). Potential oil shale development in Utah (whether on PRLAs, other federal lands, or nonfederal lands) could affect development of tar sands resources. The assumptions used for impact-producing factors for a single oil shale facility are given in Section 4.1.

Although information is not available for every planning area, at least 13,500 acres per year are planned to be used for prescribed burns under current management practices. Large tracts of land are used for grazing in the Monticello Planning Area.

TABLE 6.2.5-5 Electric Power Generating Units in ROI Counties in Utah in 2005[a]

State	Primary Fuel	No. of Generating Units	Combined Power (MW-nameplate)
Utah	Coal	8	3,157
	Waste coal	1	58
	Water	5	5.4
	Total	14	3,220

[a] ROI counties include Carbon, Duchesne, Emery, Garfield, Grand, San Juan, Uintah, and Wayne.

Source: EIA (2007).

The BLM manages more than 8 million acres of forest lands in Utah; the majority are in the southern half of the state, including the planning areas addressed in this PEIS. Most (more than 90%) of the forests are woodlands. The net annual growth in forest lands has been estimated as 9.2 million ft^3 (BLM 2006l). The major cause of tree mortality has been fires, followed by insect damage.

6.2.5.3 Cumulative Impacts Assessment for the Possible Tar Sands Development That Could Occur under Each of the Alternatives, B and C

As stated above, and in Sections 6.2.2 and 6.2.3, with the possible exception of a change in local property values, there would be no environmental or socioeconomic impacts under Alternatives B and C from the amendment of land use plans to identify lands as available for application for commercial tar sands leasing. Therefore, there would be no cumulative impacts from these alternatives. However, direct, indirect, and cumulative impacts could occur as a result of future commercial tar sands development that could be facilitated by such land use plan amendments. The focus of this cumulative impacts assessment, then, is the impacts from this future development, rather than the impacts from the land use plan amendment decision. That is, the purpose of this cumulative impacts assessment is to discuss, in a qualitative way, how the environmental and socioeconomic conditions within the study area might be incrementally affected over the next 20 years (the study period) by tar sands development that could occur on lands made available for application for commercial leasing by the land use plan amendments under either Alternative B or C.

6.2.5.3.1 Land Use. Potential land use impacts associated with a single commercial tar sands facility include the exclusion of grazing, recreation, other mineral development land uses from lands used for tar sands development facilities and associated off-lease facilities (e.g., employer-provided housing, and ROWs). Tar sands development could also alter the quality of lands with wilderness characteristics. Tar sands development facilities would disturb up to 5,760 acres of public lands for the facilities themselves, and up to an additional 3,750 acres of lands for ROWs and employer-provided housing (locations where these facilities would be sited are unknown, but are not expected to be on public lands). While the total amount of ground disturbance for a tar sands facility using in situ technology could equal that of a facility using surface mining, surface acreage disturbed at any one time might be considerably less for in situ facilities depending on the cycle of preparation, production, and reclamation.

Table 6.2.5-6 presents estimates of the amount of land needed for other major industrial activities in the study area over the 20-year study period. These lands may be federal or non-federal lands. As this table shows, land use in Utah is characterized by an extensive amount of industrial activity that is expected to continue into the future. Depending on the number and types of tar sands facilities constructed and operating, future commercial tar sands development could contribute a substantial increment to the cumulative land use and disturbance impacts. Over a 20-year time horizon, a single tar sands facility could contribute an approximately 5 to 42% increase in land disturbance (i.e., up to about 9,500 acres for a single tar sands project compared with the range of other disturbances of 42,000 to 202,000 acres). If several tar sands leases are eventually granted within relatively close proximity to one another, this amount of leasing within a relatively small area would result in substantial changes in land use in that area. Oil shale development, if it occurs, would also contribute to cumulative land disturbance impacts. It should be noted that the projections given in Table 6.2.5-6 are very sensitive to the amount of disturbance due to oil and gas development that would occur, with the large range of possible disturbance making the estimates quite uncertain.

As discussed in Section 6.2.5.2, many public lands are currently used as ROWs for short- and long-distance energy transmission. The Draft West-Wide Energy Corridor PEIS (DOE 2008) may designate additional regional corridors on public lands for long-distance energy transmission ROWs. Under the proposed action of that PEIS, the proposed corridors include about 360,000 acres in Utah, a portion of which would fall within the tar sands development area. Not all lands designated as energy corridors would be developed and/or disturbed; however, the percent of potential disturbance is currently unknown. Should these proposed corridors be developed for energy-related ROWs, additional land use impacts in the region could be substantial.

6.2.5.3.2 Soil and Geologic Resources. Tar sands development could result in impacts on soil and geologic resources by increasing soil removal, soil compaction, and erosion. Erosion of exposed soils could also lead to increased sedimentation of nearby water bodies, and to the generation of fugitive dust which could affect local air quality. Project areas would remain susceptible to these impacts until completion of construction, mining, tar sands processing, and site stabilization and reclamation activities (e.g., revegetation of pipeline ROWs and surface mine reclamation). Impacts on soil and geologic resources would be limited to the specific project location as well as areas where associated off-site infrastructure (such as access roads and utility ROWs) would be located.

TABLE 6.2.5-6 Summary of Cumulative Long-Term Land Use for Tar Sands Development and Other Major Industrial Activities

Activity	Estimated Acres Disturbed[a]
Commercial tar sands development on federal or nonfederal lands[b]	Up to 9.500 per project
Commercial oil shale development on federal lands or nonfederal lands[b]	Up to 14,000 per project
Oil and gas development (acres/yr)	1,400–9,400
Coal development (acres/yr)	50
Sodium minerals (nahcolite and dawsonite) development (acres/yr)	0
Phosphate production	10,000
Proposed power plants[c]	3,100
Annual total excluding tar sands and oil shale development	14,600–22,600
20-year totals, excluding tar sands and oil shale development	42,000–202,000
Single tar sands facility percent of 20-year total	5–42

[a] Except where otherwise indicated, average estimates are the maximum projected totals from Table 6.2.5-4.

[b] Acreage estimates represent the maximum possible disturbance for individual tar sands facilities (Section 5.1) and oil shale facilities (Section 4.1).

[c] The acreages represent the estimated footprint of projected new power plant development as discussed in Section 6.2.5.2, assuming all would be coal-fired plants requiring 3,000 acres per 1,500 MW of capacity.

Oil and gas development, other minerals development, oil shale development, and construction of additional power plants would cause similar impacts on soil and geologic resources in the Utah study area. Table 6.2.5-6 gives estimates of the amount of land that could be disturbed for these activities over the 20-year study period. Additional types of land use could also disturb soil. These would include, but not be limited to, agricultural development, grazing, recreation, forestry, and residential development. The potential impacts from these have not been quantified. Also as discussed in Section 6.2.5.2.4, large areas might be designated as energy corridors, and their development would also contribute to total soil disturbance. All these activities may result in soil being displaced, stockpiled, eroded, or compacted through various site activities. The disturbance could yield increased sediment to surface waters, and, in areas with high salinity in the soils, the salt content in surface water may also increase.

Impacts on soil and geologic resources from tar sands development could add a substantial increment to cumulative impacts on this resource. Impacts would increase with increasing numbers of tar sands facilities. A single facility could be associated with soil disturbance of up to about 9,500 acres.

6.2.5.3.3 Paleontological Resources. Disturbances from tar sands development, combined with other surface-disturbing development activities, could uncover and/or destroy fossils on BLM-administered land and on other lands. Given the surface disturbance projected from tar sands development and from other activities (Table 6.2.5-6) in the study area during the 20-year study period, it is likely that many sites will require paleontological evaluations and mitigations. Assuming that these evaluations and mitigations are conducted in accordance with existing regulations, there would be increased knowledge of paleontological resources in the region and increased protection of resources based on this knowledge. However, there would inevitably be some loss of information from individual sites and some impacts. Resources lost from tar sands leasing and development would be in addition to those losses from other activities discussed in this section. Unless a concentration of unique resources is found to exist within a small area, and that area was the location of tar sands development, these individual site losses from construction and operation of a tar sands facility would be unlikely to have a major incremental adverse impact on paleontological resources in the study area.

6.2.5.3.4 Water Resources. Many activities projected to occur in the study area could increase sediment and dissolved solid loads in streams downstream of disturbed sites (e.g., ROW construction and other construction projects, mining, and construction of access roads and river crossings). After the protective layers of soils are disturbed, the soils become vulnerable to erosion by surface runoff. Leaching from mine tailings and waste, overburden piles, and source rock piles would potentially bring organic and metal contaminants to nearby streams. Potential leaks (or spills) of oil or other petroleum products from pipelines would be additional risks for contamination of surface water resources. Modification of surface drainage and water extraction could also cause flow regime and morphological changes of stream channels. Most of the impacts would occur in the vicinity of the water bodies close to project sites and would be incremental.

If oil and gas development, mining activities, and power plant construction continue to grow as projected from 2007 to 2027, the disturbed areas are estimated to increase by a total of 42,000 to 202,000 acres in Utah (Table 6.2.5-6). If a single tar sands facility is developed, it will contribute about 5 to 42% of additional ground disturbance in Utah. Some of the impacts near construction sites and mining sites would be local and could be managed and mitigated. The incremental impacts on water resources caused by tar sands and ancillary facilities development could be significant relative to the other activities. The incremental and cumulative impacts would depend on the location and size of tar sands development and would be evaluated in future environmental assessments.

The water uses and losses in the Upper Colorado River Basin are shown in Figures 6.1.5-1 through 6.1.5-4. From the 1970s to the 1990s, the water uses increased, reflecting growth in agricultural and in municipal and industrial water uses (Figures 6.1.5-1 and 6.1.5-4). The export of Colorado River water to outside the Upper Colorado River Basin also increased gradually with time (Figure 6.1.5-3). From 1990 to 2000, the combined water use and losses in Colorado, Utah, and Wyoming within the Upper Colorado Basin fluctuated between 3,580 and 4,400 thousand ac-ft (Figure 6.1.5-4). This includes water losses from major and minor reservoirs, agricultural and municipal and industrial water uses, and water transfers out of the basin. From 2001 to 2004, the combined water uses and losses dropped from 4,280 to 3,400 thousand ac-ft (primarily through declining agricultural water uses) because of drought conditions (BOR 2004, 2005, 2006).

To preliminarily assess cumulative water use in the study area over the next 20 years and the potential incremental impacts of tar sands development, water use projections for oil and gas development, coal mining, and power generation are compared with water use for individual tar sands facilities and with available water in the Upper Colorado River Basin (see Table 6.2.5-7). The sustainable, annually available water in the Upper Colorado River Basin was assumed to be 6,000 thousand ac-ft/yr (SWCA 1997) (a prolonged drought condition may decrease this water availability). The total amount of legally apportioned water available to Colorado, Utah, and Wyoming is 5,280 thousand ac-ft/yr. The water transfer out of the Upper Colorado River Basin fluctuates but was assumed to remain in the same range (540 to 800 thousand ac-ft/yr) as for 1970 to 2004 (Figure 6.1.5-3). Also, the currently combined water uses for agricultural, municipal, and industrial activities were assumed to remain at the same level as those found in 1990 to 2000 (i.e., 3,600 to 4,400 thousand ac-ft/yr; Figure 6.1.5-4). This could occur as water is transferred from agricultural to municipal and industrial use. Therefore, currently available water would be between 80 and 1,140 thousand ac-ft/yr in the three states. The water requirement for individual commercial tar sands facilities is estimated to be from less than 1 to 5.4 thousand ac-ft/yr of water, depending on the technology being used, while the combined water needed for oil and gas, coal mining, and new power plants would be about 68 thousand ac ft/yr (Table 6.1.5-10). There will be additional water needed to support regional population growth, potential water exports to areas outside the Upper Colorado River Basin, new instream flow water rights for protecting endangered species, and possibly for oil shale development. The level of tar sands development that could be supported by available water over the next 20 years depends on the type of technology used, the scale of the development, and the other competing uses of water at the time of development. Another alternative to make more water available is to transfer water from current agricultural use to industrial use. Any water transfer and new water development must meet different state and federal regulations. Eventually, whether enough water is available for tar sands development depends on the results of negotiations between various parties, including water right owners, state and federal agencies, and municipal water providers as well as the developers.

TABLE 6.2.5-7 Major Water Uses in the Next 20 Years in the Three-State Study Area Compared with Use for Potential Tar Sands Development (× 1,000 ac-ft/yr)

Available Water and Water Use	Annual Volume
Amount of legally available water from the Colorado River	5,280
Consumption uses, including export, agricultural, M&I, and evaporation	4,140–5,200
Range of net amount available	80–1,140
Water use estimates	
Commercial tar sands development on federal or nonfederal lands (individual 20,000 bbl/day tar sands facility)[a]	<1–5.4
Commercial oil shale development on federal or nonfederal lands (individual 200,000 bbl/day in situ facility and ancillary facilities, including power plant)[a]	19–35
Commercial oil shale development on federal or nonfederal lands (individual 50,000 bbl/day surface mine/surface retort or underground mine/surface retort facility and ancillary facilities)[a]	4.9–7.4
Other development	
Oil and gas[b]	1.6
Coal mining[c]	13.4
Power plants[d]	53
Total other development	68

[a] Includes processing and human consumption.

[b] Assumes that 3,000 wells are drilled per year and that each uses 0.55 ac-ft of water.

[c] Assumes 82 million tons of production per year; 20 million gal of water per million tons of coal mined is assumed for coal preparation, and 35 million gal of water per million tons of coal mined is assumed for dust control.

[d] Assumes a total of 9,940 MW new production from coal-fired power plants; water consumption of 8,000 ac-ft/yr per 1,500 MW (see Section 6.1.5.1-4).

Sources: SWCA (1997); BOR (2004, 2005, 2006).

Meeting the water requirements also depends on how many facilities are constructed, the technologies being used, and the locations of the sites. Using water conservation practices and transferring agricultural water rights to industrial rights (including tar sands development) could make more water available if extensive tar sands development is desired. Currently, most of the water use in the Upper Colorado River Basin is for agricultural purposes. The agricultural component ranges from 55% in the Upper Main Stem (Colorado River and its tributaries above the mouth of the Green River) to 87% in the San Juan–Colorado area (Colorado River and its tributaries below the mouth of the Green River and above Lee Ferry, Arizona) (BOR 2004, 2005, and 2006).

6.2.5.3.5 Air Quality. Air resources in and around the study area would be affected by subsequent commercial development of tar sands. Local, short-term air quality impacts could be incurred as a result of PM and exhaust emission releases during construction activities. Similar short-term impacts could also occur in other areas where electric transmission or oil pipeline ROWs and other infrastructure would be developed. Longer-term impacts on local and regional air quality could occur during normal project operations, such as mining and processing of the tar sands, and construction and operation of off-lease infrastructure, resulting in emissions of criteria pollutants and HAPs.

Oil and gas development, other minerals development, and other activities (e.g., agricultural development and residential development) would all involve impacts on local air quality during land clearing and construction because of increased PM emissions and exhaust emissions from construction equipment. There could also be regional air quality impacts if these activities involved long-term emissions of criteria pollutants or HAPs at substantial levels. The incremental impact of tar sands development activities to total cumulative impacts would be assessed during future site-specific NEPA analyses.

6.2.5.3.6 Noise. Noise is a transient problem; its impacts do not accumulate in the environment as do air and water pollutants. Dissipation mechanisms, such as geometric spreading, ground effects, and air absorption, dissipate noise energy within short distances form noise sources. However, cumulative noise impacts could occur with oil shale and tar sands development on federal and nonfederal lands, oil and gas development, surface and underground mining of coal, production of other minerals, and energy development (see Table 6.2.5-4); such impacts would depend critically on site-specific considerations and the proximity of the operations being considered to each other. The cumulative impacts of sufficiently separated noise sources are essentially the same as the noise impacts of each source considered separately. For example, the cumulative impacts of a tar sands production facility and a gas or oil well field could be considerably different if the pumps and wells associated with the two facilities were only a mile apart than if they were separated by even a few miles.

Cumulative impacts also depend upon which phases in the lifetime of the sources being considered are occurring simultaneously. For example, construction associated with a tar sands facility would cause only a slight cumulative increase in the preexisting noise levels associated with a pumping station on an oil pipeline, while operation of the tar sands facility could cause a large increase over the preexisting levels around the facility and along nearby roads.

The construction noise impacts discussed in Section 5.7 are based on general considerations and are applicable to a wide range of construction projects. For many tar sands development projects, the leased area would be large enough that noise levels would be below EPA guideline levels at the site boundaries. Because of the probable large distance between projects, it is unlikely that construction of tar sands facilities would cause a substantial incremental increase in noise impacts over those associated with existing and reasonably foreseeable future projects. However, the construction of large-scale commercial tar sands projects involving the drilling of many wells could produce higher noise levels, with cumulative impacts. Also, if tar sands development is close to other projects and construction and worker vehicles from both projects use the same roads, there could be cumulative noise increases due to increased traffic on local roads. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

As noted in Section 5.7, adverse noise impacts could be associated with commercial tar sands facilities. Drilling and pumping in oil and gas recovery fields could also contribute to high cumulative noise levels, and mining operations could cause high noise levels in the vicinity of the mine. If these other activities occur in close proximity to tar sands development operations, the possibility of substantial cumulative impacts exists. However, these impacts cannot be estimated at this time given the lack of quantitative estimates for tar sands facilities and the lack of data on specific locations of other development activities. An estimate of cumulative impacts must be made during the assessment of site-specific impacts.

6.2.5.3.7 Ecological Resources. Cumulative impacts of commercial tar sands development on ecological resources in the three-state study area would result from the past, present, and future impacts of a wide variety of human activities, including agricultural development and production, grazing activities, range management, timber harvest and management, residential and commercial development, recreational activities, water resource development projects, mineral resource development, and energy development. The current status of ecological resources as described in Section 3.7 reflects the cumulative impacts of past and present activities. This section focuses on the incremental impacts of the tar sands development alternatives and a set of reasonably foreseeable future actions that are expected to occur or that could occur over the next 20 years if commercial tar sands projects are developed. Reasonably foreseeable future projects include oil and gas development, coal mining, mining of metals and minerals, energy transmission, electrical generation, and other activities, including grazing, fire management, forestry, and recreation as described in Section 6.2.4.2.

The cumulative impacts of greatest concern on ecological resources in the study area include loss or degradation of habitat and habitat fragmentation related to land disturbance, loss of individuals in populations (especially those of rare species), and changes in the availability and quality of surface water resources. All other factors described in Section 4.8.1 have the potential to contribute to cumulative impacts, but their contributions would be relatively minor and more localized.

Section 6.2.4.2 presents available information on the projected levels of development for major activities in the study area. Major increases in land disturbance from reasonably foreseeable projects total approximately 200,000 acres for the projected 20-year study period (Table 6.2.5-6). Land disturbance associated with individual commercial tar sands facilities could be up to about 9,500 acres.

Water depletions associated with reasonably foreseeable future actions over the next 20 years represent significant increases in cumulative water use in the study area (more than 68,000 ac-ft/yr of the 80,000 to 1.1 million ac-ft/yr potentially available). Existing water uses represent about 4.1 to 5.2 million ac-ft/yr. Water consumption associated with individual commercial tar sands development facilities would range from less than 1,000 to 5,400 ac-ft/yr; water consumption associated with individual commercial oil shale development facilities would range from 5,000 to 35,000 ac-ft/yr (see Table 6.2.5-6).

Cumulative impacts on aquatic resources; plant communities and habitats; wildlife; and threatened, endangered, and sensitive species are discussed below.

Aquatic Resources. The analysis of cumulative impacts on aquatic habitats and the organisms that inhabit those habitats considered the potential impacts of tar sands development in Utah together with impacts from other anticipated development activities as described in Section 6.2.4.2. The types of impacting factors associated with these activities would be similar to those described for the direct and indirect effects of tar sands development, including (1) direct disturbance of aquatic habitats; (2) sedimentation of aquatic habitats as a consequence of soil erosion from nearby areas; (3) changes in water quantity or water quality as a result of changes in surface runoff patterns, depletions or discharges of water into nearby aquatic habitats, or releases of contaminants into nearby aquatic systems; or (4) changes in human access to aquatic habitats.

Direct disturbance of aquatic habitats can result from activities that occur within water bodies or within the active channel of streams and rivers. Such disturbance can occur as a result of mineral (e.g., gravel) extraction from streambeds; construction of stream crossings for pipelines, transmission lines, and roads; driving vehicles through or using heavy machinery within active channels; and from livestock that walk through waterways. There is a potential for all of these activities to occur within STSAs, although it is generally anticipated that the related impacts would be relatively small and localized. Activities such as oil and gas development, mining, energy development, grazing, fires and fire management, and logging all affect erosion potential by disturbing soils and removing or altering vegetated cover. Such activities associated with other future projects are expected to result in a considerable increase in land disturbance in the vicinity of STSAs over the 20-year project time frame and could result in a considerable increase in sediments entering aquatic habitats.

As described in Section 5.8.1.1, construction activities for tar sands development could also directly disturb aquatic habitats and alter the potential for erosion and sedimentation within affected areas, depending upon the specific locations of leased parcels; the routes selected for transmission lines, roads, and pipelines; and the configuration of structures used for crossing those habitats. Although the direct disturbance and sedimentation of aquatic habitats resulting from tar sands development would likely be somewhat localized, such development could contribute substantially to the cumulative level of such impacts within affected watersheds.

In the absence of project-specific information, it was assumed that the potential for direct habitat disturbance and soil erosion and the resulting sediment loading of nearby aquatic habitats would be proportional to the amount of surface disturbance, the condition of disturbed lands at any given time, the proximity to aquatic habitats, and measures implemented to control impacts of erosion and sedimentation. Individual tar sands projects may contribute substantially to additional surface disturbance over the 20-year development period as compared with other activities planned within the study area, depending on location and size.

Activities within stream channels and the construction or placement of roads, culverts, and water diversion devices across or in waterways have a potential to fragment aquatic habitats by blocking upstream or downstream movements of aquatic organisms as identified in Section 5.8.1.1. From a cumulative standpoint, some roadways, dams, water diversion devices, pipeline crossings, and other structures associated with existing development activities in the drainages associated with the STSAs may already contribute to such habitat fragmentation, and a large increase in such infrastructure would likely increase aquatic habitat fragmentation in the future. Areas surrounding and within the tar sands areas for which future allocation alternatives are being considered in this PEIS currently contain a large proportion of oil and gas wells, and the associated structures (such as roads and pipelines) that occur within the Green River basin and the addition of tar sands development would be expected to further increase such fragmentation. The application of appropriate mitigation measures, such as controls on the designs of stream crossings, would reduce the potential for significant cumulative impacts to occur.

From a cumulative perspective, water quality within the vicinity of STSAs could also be affected by many human activities that introduce excess nutrients or contaminants into water bodies, including oil and gas development, coal mining, the construction of additional power plants, and grazing of livestock. Tar sands development has the potential to contribute to the degradation of water quality through the introduction of contaminants, either as leachate from spent tar sands or from spills or releases of oil, lubricants, and herbicides.

Within the arid regions of Utah where proposed tar sands development would occur, water availability is of great concern and results in conflicts over balancing water needs for current and future development with water needed to maintain ecological conditions in aquatic habitats. The anticipated water needs for individual tar sands facilities would range from less than 1,000 to 5,000 ac-ft/yr. One or more tar sands facilities utilizing amounts of water at the higher end of the range could contribute to adverse cumulative impacts on water availability.

Cumulative impacts on fisheries could result from increased public access to remote areas via newly constructed access roads and utility corridors and due to the increased population levels that are likely to occur over the 20-year study period as a combined result of the reasonably foreseeable actions. The BLM has some limited means of mitigating the effects of increased fishing pressure, The State of Utah routinely monitors the condition of specific fisheries within the state and establishes and enforces regulations to maintain or improve the condition of those fisheries. Examples of regulations include limits on open fishing seasons and on the numbers, sizes, and species of fish that can be harvested from specific bodies of water. The state can also close streams to fishing. Assuming that the effects of such regulations are monitored and adjusted effectively, the overall incremental and cumulative impacts on fishery resources associated with increased access under the tar sands development alternatives are expected to be minor.

Plant Communities and Habitats. Since the 1700s, wetland habitats have been severely impacted throughout the lower 48 states as a result of drainage and fill activities associated with agriculture, resource extraction, urban development, and other human activities; however, the rate of loss throughout the United States is currently much lower than historic levels (Dahl 1990). Losses of wetland habitat have been fairly high in the states of Colorado, Utah, and Wyoming. From the 1780s to 1980s, wetland losses in Colorado have been estimated to be approximately 50%, losses in Utah about 30%, and losses in Wyoming about 38% (Dahl 1990). Over the past several decades, federal agencies, such as the BLM, and state and private organizations have made considerable efforts to protect and restore wetlands and riparian habitats, and ongoing and planned wetland and riparian management programs are expected to continue to contribute to the improvement in wetland and riparian habitat function (BLM 2005j).

Human activities have also been impacting terrestrial habitats in Colorado, Utah, and Wyoming for many years. Species composition and diversity have been affected by fire suppression, heavy grazing, introduction of invasive species, and other factors (BLM 2005j). Habitat losses, fragmentation, and degradation have historically resulted from oil and gas development, mining, and other resource extraction activities that disturb surface soils. Although the BLM and other land management agencies have made considerable advances in habitat protection and restoration, ongoing resource extraction and other land uses are expected to continue to result in losses or changes to plant communities and habitats.

The factors that would affect plant communities and habitats as a result of tar sands development activities are also associated with a number of other activities that occur both within and outside of the STSAs. The ecoregions and associated plant communities that include the STSAs extend well beyond the STSA boundaries, and activities that occur outside the STSAs can also affect these habitats. Direct losses of habitat can occur as a result of oil and gas development, coal mining, mining of metals and minerals, energy development, and other activities. Approximately 200,000 acres could be directly impacted in Utah. Native plant communities can also be indirectly impacted or degraded by these activities. Impacts on water quality, surface water or groundwater flows, or air quality, could adversely affect terrestrial or wetland plant communities, and changes in community characteristics, such as species composition or distribution, could result from vegetation disturbances related to some activities, such as grazing. Commercial tar sands development would constitute a substantial incremental increase to the impacts associated with other foreseeable activities.

Wildlife. This section evaluates the potential cumulative impacts of tar sands development on wildlife, including wild horses and burros. The focus is on the incremental impacts of tar sands development alternatives and a set of reasonably foreseeable federal and nonfederal activities as described in Section 6.2.5.2 that could occur over the 20-year study period. In addition to these activities, natural events (e.g., floods, droughts, and fires), disease, predation, and fluctuations in prey are among the natural phenomena that contribute to cumulative impacts on wildlife.

In general, the types of cumulative impacts on wildlife would be similar to the direct and indirect impacts associated with tar sands development (Section 5.8.1.3). Thus, cumulative impacts on wildlife resources would include (1) habitat loss, alteration, fragmentation, or enhancement; (2) disturbance or displacement; (3) mortality; (4) obstruction to movement; and (5) exposure to contaminants. The effects of these actions may include (1) immediate physical injury or death; (2) increased energy expenditures or changes in physiological condition that may reduce survival or reproduction rates; or (3) long-term changes in behavior, including the traditional use of ranges. Potential differences between cumulative impacts on wildlife and the impacts arising from the tar sands development activities alone would depend on the intensity (magnitude), scale (geographic area), duration, timing, and frequency of development activities. Although habitat protection and restoration activities are incorporated into most projects, some losses or modifications to habitats are expected from most activities. Even without the potential impacts of commercial tar sands development, the projected major increases in land disturbance and water depletions resulting from other reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on wildlife.

Cumulative impacts of greatest concern on wildlife and their habitats include loss or degradation of habitat and habitat fragmentation related to land disturbance and changes in the availability and quality of surface water resources. The cumulative effects of numerous land use activities (e.g., livestock grazing, crop production, and energy development and associated infrastructure) have caused widespread habitat loss and fragmentation of sagebrush ecosystems (Knick et al. 2003). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (i.e., functional habitat loss) would also contribute to the cumulative loss of habitat associated with facility development. Also, developments could further obstruct wildlife movements. Habitat loss and fragmentation can be particularly devastating to sagebrush-dependent species such as sage grouse and to big game species or other wildlife that have large home ranges or that make annual migrations among various habitats. Impacting factors can act synergistically and compound the importance of cumulative impacts. For instance, developments can result in extensive fragmentation that may leave only small, isolated areas of native vegetation. These areas are often more prone to invasive plant species and grazing by livestock, wild horses, or feral animals (BLM 2005i; Hobbs 2001).

Wildlife disturbance and mortality associated with activities such as recreation also could have significant and widespread impacts because of the high number of recreation use days. For example, more than 1.3 million visitor days were spent hunting, and nearly 1.6 million visitor days were spent snowmobiling or other winter motorized traveling on BLM-administered lands within Colorado, Utah, and Wyoming during FY 2004 (BLM 2005i). The other impacting factors discussed above have the potential to contribute to cumulative impacts, but their contribution would be relatively minor and more localized.

Other industrial developments could result in more workers within remote areas and increased public access because of new roads and ROWs. Increased access could result in increased hunting pressure and illegal poaching, depending on the locations and extent of development projects. Repeated intrusions (e.g., from recreationists) within a specific area have been shown to cause progressive declines in avian richness and abundance (Riffell et al. 1996). Traffic associated with industrial activities and recreation could result in additional roadkills. Also, structures associated with other industrial activities could increase the number of bird collisions. Increased densities of predators and scavengers attracted to areas of human activity may result in increased predation pressure on prey populations. Increased predation would be in addition to impacts associated with habitat loss, displacement, roadkills, collisions with structures and transmission lines, and other factors.

Site-specific mitigation, standard operating procedures, wildlife-related stipulations, reclamation and rehabilitation, and monitoring would minimize cumulative impacts on wildlife and their habitats (BLM 2005i, 2006q; DOI and USDA 2006; WGFD 2004). These would reduce the contribution of tar sands impacts to cumulative impacts throughout the project area. Also, implementation of state comprehensive wildlife conservation strategies and regional conservation plans would provide means of proactively minimizing cumulative impacts on wildlife and their habitats. For example, the *Heart of the West Conservation Plan* (Jones et al. 2004) identifies areas where habitat is critical for the continued viability of key species and communities and areas where development can occur with low risk to the welfare of ecosystems. The plan also presents means of restoring and maintaining the health and function of lands within the study region. Management of game populations and enforcement of hunting laws have reduced the risk of declines in the number of game species compared with historic levels (BLM 2005i).

Threatened, Endangered, and Sensitive Species. In general, the cumulative impacts on threatened, endangered, and sensitive species would be similar to those described for other ecological resources. However, for many of the species, there would be a difference in the potential consequence of the impacts. Because of their small populations, threatened, endangered, and sensitive species are far more vulnerable to impacts than more common and widespread species.

The current status and distribution of ESA-listed species, BLM-designated sensitive species, and state-listed species are presented in Section 3.7. Current status and distribution reflect the cumulative effects of past and present human activities and natural limiting factors. Some species are considered threatened, endangered, or sensitive in the area because cumulative impacts have resulted in a reduction in numbers that have increased the chances the species would be come extinct in the near future (e.g., black-footed ferret, Canada lynx, and whooping crane). Other species (e.g., Graham’s beardtongue) are considered vulnerable because their specific ecological requirements result in limited distributions and smaller population sizes that are less resilient. For either group of species, any incremental addition to cumulative impacts could be considered significant.

The potential direct and indirect impacts of commercial tar sands on threatened, endangered, and sensitive species are listed in Table 5.8.1-4 and discussed in Section 5.8.1.4. The evaluation in that section indicates the potential for adverse impacts for most of the species in the study area. Contributions to cumulative impact are associated with direct effects (e.g., vegetation clearing, habitat fragmentation, and water depletion) and indirect effects (e.g., sedimentation from runoff, fugitive dust, and disruption of groundwater flow patterns). Even without the potential impacts of commercial tar sands development, the projected major increases in land disturbance and water depletions resulting from reasonably foreseeable future activities, taken together with the impacts of past and present actions, could result in significant cumulative impacts on these species.

Each alternative would require adherence to BLM policy on the protection of sensitive species and project-specific ESA Section 7 consultation with the USFWS. These latter consultations must include a consideration of direct, indirect, and cumulative effects on listed species under the ESA. Adherence to BLM policy and consultation with the USFWS are expected to reduce, but not eliminate, the contribution of commercial oil shale development to cumulative impacts both under NEPA and the ESA.

6.2.5.3.8 Visual Resources. Visual impacts associated with construction and operation of commercial tar sands projects that may occur on federal and nonfederal lands in Utah would likely have cumulative impacts in the context of other development activities underway or planned in the affected areas, as described in Section 6.2.5.2. These development activities could have large visual impacts where concentrated development activity occurred. Where construction and operation of a commercial tar sands project on federal lands occurred in the same areas as these other development activities, the visual absorption capability of some landscapes could be exceeded. Incremental visual impacts may be of particular concern where tar sands projects, related infrastructure, and other development activities would be located near sensitive visual resources in landscapes with low visual absorption capability, and/or where the tar sands and other development would be located in the viewsheds of visually sensitive linear features such as scenic and historic trails, highways, or scenic rivers. Careful facilities siting and application of mitigation measures along with conformance with BLM VRM classes would protect visual values in more sensitive areas from large impacts associated directly with the tar sands projects. However, the addition of the impacts from the tar sands projects to the impacts from other development activities could considerably degrade visual qualities. For VRM Classes I through III, the classifications would likely change; Class IV areas would likely degrade further. Also, the VRM classes of surrounding areas within view of the facilities may change.

Further cumulative visual impacts could occur because the presence of the tar sands projects would likely bring workers and their families to live in local communities and to recreate in the surrounding areas. Also, the roads and other infrastructure associated with the projects could cause increased visitation and usage of remote areas (e.g., OHV use). The increases in population and access could result in urbanized development that would contrast sharply with more natural-appearing existing landscapes; add to visual clutter around existing urbanized areas; increase visible human and vehicular activity in remote areas; degrade air quality (thereby negatively affecting long-distance views); and result in litter, erosion, and other visual changes that would not harmonize with the naturally occurring forms, lines, colors, and textures of existing landscapes.

6.2.5.3.9 Cultural Resources. Disturbances from tar sands development, combined with other surface-disturbing development activities, could uncover or destroy cultural resource sites on BLM-administered land and on other lands. Given the large areas of surface disturbance projected from tar sands development and from other activities (Table 6.2.5-6) in the study area during the 20-year study period, it is likely that many sites would require cultural resource evaluations and subsequent mitigative actions. Conducted according to professional standards, these evaluations and mitigations would increase knowledge about cultural resources in the region. However, there would inevitably be some loss of information about individual sites. Unless a concentration of unique resources is found to exist within a small area and that area was the location of tar sands development, these individual site losses from construction and operation of an oil shale facility would be unlikely to have a major incremental adverse impact on cultural resources in the area.

6.2.5.3.10 Socioeconomics. Economic impacts can be measured in terms of changes in employment in the study area in which tar sands resources are located. Because of the relative economic importance of tar sands developments in small rural economies and the consequent lack of available local labor and economic infrastructure, tar sands developments may mean a large influx of population. As population increases are likely to be rapid, with local communities unable to quickly absorb new residents, there would also be impacts on housing in the study area.

The impacts of tar sands development include wage and salary expenditures associated with the construction and operation of the facilities, material procurement and wage and salary expenditures associated with the construction of temporary housing in the ROI for workers and family members, and wage and salary spending associated with indirect workers required to provide goods and services resulting from increases in economic activity in the ROI. Overall, tar sands development could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 550 jobs during the construction of temporary housing, and about 1,800 jobs during construction of tar sands facilities. Operations would create about 750 jobs [see Table 5.11.1-1.])

Population in-migration would occur also with tar sands resource development, with workers required to move into the region during construction and operation of tar sands facilities. Workers would also be required to move into the region to facilitate the demand for goods and services resulting from the spending of tar sands worker and housing construction worker wages and salaries.

A substantial number of oil and gas wells are projected for the area beginning in 2008, producing about 8,900 direct jobs, and an estimated 23,000 total (direct and indirect) jobs in each year through 2027 (Minnesota IMPLAN Group, Inc. 2007). Development of coal resources in the three-state area is also expected to produce 15,000 direct jobs, and 33,000 total jobs each year between 2008 and 2027. Oil and gas and coal development alone could result in an increase of about 10 to 20% in total employment in the region over 20 years, and in a population increase of about 2 to 4%, if these activities would require population in-migration. It is not known whether development of oil and gas and coal resources in the three-state region would require the in-migration of construction and operations workers, or the construction of additional temporary housing.

If oil shale development occurs, it could produce a substantial number of jobs, depending on the scale of development (e.g., for an individual facility, about 600 jobs during the construction of temporary housing, and a range of about 2,200 to 2,900 jobs during construction. Operations would create between 780 and 3,300 jobs, depending on the technology used [see Table 4.11.1-1].)

Rapid population growth in small rural communities hosting large resource development projects could also produce social and psychological disruption, together with the undermining of established community social structures (see Section 5.11.1.2). Various studies have suggested that social disruption may occur in small rural communities when annual population increases are between 5 and 15%.

On the basis of the employment estimates given above, reasonably foreseeable oil and gas and coal production in the study area is estimated to have a larger socioeconomic impact than a single tar sands facility would have. However, depending on the future level of tar sands development and given the estimated population increases due to construction and operation of a single tar sands facility, there may be substantial incremental socioeconomic impacts (e.g., interruption of community services, impacts on availability of housing, social disruption, decreases in property value and loss of employment and income in the recreation sector) from tar sands development when considered in conjunction with the other ongoing and reasonably foreseeable activities in the study area.

Cumulative impacts on transportation systems and traffic levels would be related to both employment and freight requirements to service projects. Overall, tar sands development could produce a substantial number of jobs, depending on the scale of development (see above). Transportation impacts would be additive to other activities taking place on private and public lands. Substantial increases in traffic flow and in transportation infrastructure maintenance requirements would be expected to support tar sands operations.

6.2.5.3.11 Environmental Justice. Construction and operation of tar sands facilities and employer-provided housing could impact environmental justice if any adverse health and environmental impacts resulting from either phase of development were high, and if these impacts would disproportionately affect minority and low-income populations. Disproportionality is determined by comparing the proximity of high and adverse impacts with the location of low-income and minority populations. As described in Sections 6.2.5.3.1 through 6.2.5.3.10, tar sands development in conjunction with other ongoing and reasonably foreseeable activities, may potentially have high and adverse effects on several resources, including local demographics, social disruption, property values, noise and visual impacts, and land use and water quality, and air quality.

There are a number of census block groups in Utah with low-income and minority populations, where the minority population exceeds 50% of the total population in each block group. There are also block groups in the state where the minority share of total block group population exceeds the state average by more than 20 percentage points (see Section 3.10). Given the potential for high and adverse incremental impacts on a number of resource areas from tar sands development in conjunction with oil, gas, coal, and potential oil shale development, and given the existence of environmental justice populations in the state, impacts on these resources could disproportionately affect minority and low-income populations. Of particular importance would be the impact of large increases in population in small rural communities on social disruption, the undermining of local community social structures, and the resulting deterioration in quality of life. The impacts of facility operations on air and water quality and on the demand for water in the region could also be important. Impacts on low-income and minority populations may also occur with the development of transmission lines associated with tar sands facilities in each state, depending on the location of these infrastructures. Land use and visual environmental justice impacts might be significant depending on the locations of land parcels impacted by all these activities. Cumulative impacts on environmental justice would be evaluated in future NEPA analyses when the locations and sizes of the projects in relation to low-income and minority populations are known.

6.2.5.3.12 Hazardous Materials and Waste Management

Wastes Associated with Oil and Gas Development. Table 6.2.5-4 estimates that an average maximum of 230 oil wells would be drilled per year among the seven Utah study areas addressed in this analysis. Oil and gas development can involve three basic stages: exploration, well development, and production. Exploration and locating and characterizing the petroleum resource can involve the installation of a relatively small number of small-bore wells to collect geologic cores for inspection and analysis. Increasingly, exploration is conducted with nonintrusive technologies, and wastes associated with exploration are limited and inconsequential.

Well development produces the greatest volume and array of wastes. Wells drilled on BLM-administered lands would be subject to the requirements and BMPs contained in the BLM's Gold Book (DOI and USDA 2006) and any additional requirements established as lease stipulations by the BLM field office. Waste management for wells installed on private property is expected to be in accordance with accepted industry practice. Each well installed would generate well development fluid wastes and waste cuttings, some of which may have oil contamination from the formation being exploited. However, unless the well progresses through previously contaminated subsurface zones or encounters contaminated groundwater, the waste typically associated with well installation would not exhibit hazardous character and can be expected to be managed according to standard practices. Well development fluids[11] would be

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[11] Well development fluids are water-based (most frequently used), petroleum-based (used primarily in very deep wells where high temperatures may be encountered [usually > 10,000 ft], or in directional drilling where greater lubricity is required for the drill bit), or composed entirely of synthetic chemicals (e.g., linear alkyl olefins, synthetic paraffins, and alkybenzenes). They perform a number of functions, including cooling and lubricating the drill bit, carrying cuttings up the borehole to the surface, and temporarily filling the well bore with material that is sufficiently dense to prevent the premature inflow of groundwater, other fluids (e.g., oil), or subsurface materials that would collapse the borehole before casings are installed. Development fluids will also typically contain various other chemicals, such as naturally occurring clays (referred to as drilling muds), dispersants, corrosion inhibitors, flocculants, surfactants, and biocides, to enhance their overall performance.

collected on-site for reuse and/or disposal; free water separated from development fluids and drilling muds would be verified as being free of unexpected contamination and released to the ground surface; drilling muds such as bentonite clays would be accumulated on-site for recovery and reuse; and drill cuttings would be verified as being free of contamination and disposed of at the land surface, usually in the vicinity of the well.[12] Special management would be required for development fluids, drilling muds, and produced water that exhibit contamination from naturally occurring radioactive materials (NORM) or brackish character. All NORM-contaminated wastes would be collected and delivered to properly permitted treatment and disposal facilities. Brackish water would either be reinjected down the well (or an injection well) or collected for delivery to treatment facilities. Likewise, downhole equipment removed from the well and found to have naturally occurring radioactive materials (NORM) contamination would be managed in the same manner. It is assumed that all of the drill rigs used for well development would be portable and would not undergo routine servicing (except for maintenance of fluid levels) at the well site. No wastes associated with drill rig operation and maintenance (e.g., maintenance of the rig's diesel engine) are expected to be generated at wellheads, but may be generated elsewhere in the study area where the rigs are serviced.

Products recovered from oil and gas wells are typically complex mixtures of oil, hydrocarbon gases, other gases such as H_2S, water, suspended solids such as sand and silt, chemicals injected to enhance recovery, and water/oil emulsions. Actions to separate these phases are performed at the wellhead or at a central processing facility.

Produced water (water recovered from the oil- or gas-bearing formations or other subsurface formations) is by far the largest volume of waste produced during well production. Produced water will typically be discharged back down the well or through a second injection well completed in the same formation. Produced water can also be used for nonpotable purposes such as fugitive dust control, provided it is free of contamination from polar organics (e.g., benzene, naphthalene, toluene, and phenanthrene), inorganics (e.g., lead, arsenic, and sulfide), or NORM and exhibits no brackish character. Produced water may also need special management because of high concentrations of sodium, chloride, calcium, or magnesium. Discharge of high salinity waters to the ground surface or surface waters would be prohibited, and capture and treatment or reinjection would be required.

The exact natures and volumes of well development–related wastes would depend on numerous site-specific factors; however, reliable approximations are possible. Over the study period, it is projected that about 3,000 wells per year would be installed in the study area, resulting in the generation of large volumes of development fluids and produced water. Some tar sands facilities might also generate large volumes of produced water. If all the wastes are managed appropriately, incremental cumulative impacts from disposal of these wastes should be minimal. All of the wastes are expected to be managed in much the same manner as are the wastes of these types currently being generated within the study area.

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[12] Although drill cuttings will, in most cases, be nonhazardous, care must nevertheless be exercised in their disposal so as not to significantly alter surface drainage patterns or release sediments to area surface waters.

Wastes Associated with Mining of Coal and Other Minerals. Wastes associated with coal mining include landscape wastes from clearing active mine areas, solid industrial wastes resulting from the maintenance and repair of mining equipment, overburden soils (topsoils and subsoils) removed to gain access to the coal resource,[13] and domestic solid wastes resulting from support of the workforce,[14] produced water, and wastes from coal preparation (e.g., shale, coal fines, and other impurities). Produced water would likely require treatment because of the leaching of metals from the coal resource or to adjust its pH. Treatment might result in the generation of metal-bearing sludge that would require off-site disposal in most instances. Coal preparation wastes are typically disposed of on-site or stockpiled for later use in mine reclamation.

Recoverable coal deposits exist primarily in two study areas, Henry Mountain and San Rafael. Projected coal production within those two study areas over the entirety of the study period (2007 to 2027) is projected to be 25 million tons per year at Henry Mountain and anywhere between 4.8 to 9 million tons per year from deposits with the San Rafael Study area. The amounts of solid wastes generated are proportional to total coal mined, but would vary significantly with the particular mining techniques employed and the extent of coal preparation occurring at the mine site. Tar sands development using surface mining would generate similar waste streams to those produced during coal mining. At the PEIS level, it is not possible to equate the nature or volumes of solid wastes within tons of coal or tar sands mined. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Only limited production of noncoal minerals is projected to occur. Phosphate mining is expected to occur only in the Diamond Mountain study area; gilsonite is expected to occur within the Book Cliffs area only (at 60,000 tons/yr). Although there is high potential for occurrence of uranium, vanadium, gold, and copper in the Henry Mountain study area, no significant production is predicted; gypsum production is expected to occur only in the San Rafael study area. However, stone, sand, and gravel would occur throughout all of the study areas.

Mineral (e.g., copper, gold, and silver) mining and processing can generate wastes during recovery (i.e., mining), beneficiation (separation of mined material), and processing. Recovery can result in large volumes of overburden materials needing management, as discussed above for coal mining. Although those materials are generally not considered waste they must be managed properly to avoid adverse impacts. Beneficiation can result in the generation of relatively large volumes of potentially hazardous material. This material, referred to as tailings, is processed through dump leaching, in which solutions containing strong acids or cyanides are sprayed onto

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[13] Although overburden must be managed carefully to avoid adverse impacts (primarily increased sediment loading to area surface water bodies due to erosion), it is not considered a waste; it is typically stockpiled over the active life of the coal mining operation and replaced (in the order of the original soil horizon) as part of mine reclamation.

[14] It is assumed that the workforce would not be quartered at or near the coal mine but instead would live in nearby communities. Consequently, wastes related to workforce support would be minimal, consisting primarily of kitchen/food preparation solid wastes, small amounts of administrative (office) solid wastes, and small amounts of sanitary wastes.

the tailings to "leach" the metal of interest for capture. The tailings can be voluminous (EPA 1994) and hazardous. Processing of the mineral ore involves a variety of chemical and physical manipulations that produce a wide variety of wastes, many of them capable of producing significant adverse environmental impacts if not managed properly. In 1985, the EPA published Reports to Congress on the environmental aspects of noncoal-mining activities; the reports provide relatively comprehensive discussions of possible environmental impacts, including the types of wastes resulting from typical recovery, beneficiation, and processing schemes for selected metals (EPA 1985).

Phosphate mining involves a complex array of washing, flotation, and separation actions to produce the desired product, each step also resulting in waste. The EPA has published a report in which typical phosphate mining and beneficiation activities are defined (EPA 1994). After brush and overburden removal to expose the phosphate deposit known as a matrix ore (mixture of clays and phosphate), draglines excavate the matrix ore and deliver it for beneficiation and processing. This is accomplished through a series of washing steps, followed by a floatation step, augmented by the addition of a mixture of fatty acids and re-refined oil and ammonium hydroxide (for pH adjustment). Sulfuric acid and amines are used to further separate and purify products recovered from the initial floatation steps. The solids recovered from initial floatation steps are technically "tailings." However, clays and other minerals such as magnesium oxide are also recovered from floatation steps and are typically sold as by-product materials rather than disposed of as wastes. Solids recovered from final floatation steps are typically managed as wastes, although some beneficial uses (e.g., construction materials and fill) have been identified. The phosphate solution recovered from the final floatation steps is dewatered to produce the final product. Most chemicals added to enhance floatation can be recovered for reuse, but many become contaminants in tailings wastes. Those tailings not put to beneficial use are typically disposed of on the mine site.

Similar to development of metallic ores and phosphate, tar sands development could generate produced water and large volumes of overburden; however, tailings would not be generated. Cumulative impacts of hazardous materials generation and waste management would be evaluated in future NEPA analyses when the locations and sizes of the projects are known.

Wastes Associated with Designation and Development of Energy Corridors. The designation of energy corridors within the study area would not, in and of itself, have any waste consequences. Waste would however, be generated during actual corridor development for gas and liquid pipelines and for electric power transmission systems on public and private lands.

Solid wastes associated with gas and liquid pipelines and with power transmission systems would be generated during construction, operation, and decommissioning. The majority of wastes would be generated during the construction phases. Construction wastes would include wastes generated during preparation of the ROW (consisting primarily of removed vegetation) and during installation of the pipeline or cables (primarily, maintenance-related wastes for vehicles and equipment, dunnage, packaging, some chemical cleaner wastes). Support of the workforce would result in the production of domestic solid wastes and sanitary wastewaters. It is expected that the majority of construction-related wastes would be nonhazardous and would be managed in existing local landfills or in existing municipal or specially built sewage treatment facilities.

Operational wastes result from the maintenance of equipment (e.g., change-outs of lubricating oils, coolants, and hydraulic fluids from equipment utilizing such materials, and sludge from the periodic cleaning of the insides of the pipelines through the use of pigs. The frequency of cleaning and the amount of waste generated is a function of the commodity being transported, with the greatest amounts of pipeline cleaning–related wastes generated for pipelines conveying crude oil.

Solid wastes associated with the decommissioning of pipelines or power transmission systems include wastes from the cleaning of equipment, as well as some of the pipeline components. For pipelines, it is expected that much of the underground pipeline may be abandoned in place and for those pipeline components that are removed, the majority would be put into service in other pipeline systems or sold for scrap. As during the construction phase, solid domestic and sanitary wastes would be generated (albeit in lesser amounts since decommissioning is expected to take substantially less time than initial construction) in support of the workforce, and all such wastes would likely be managed or disposed of in existing facilities. Finally, a certain volume of remedial wastes can be expected to result from the cleanup of spills or leaks that were not removed during operation or occurred during decommissioning.

The construction of gas and liquid pipeline ROWs and transmission ROWs to support tar sands development would generate similar types of waste to those discussed above. Large numbers of gas and liquid ROWs are already present on public lands in the study area, and many more areas may be designated as corridors for ROWs during the study period (see Section 6.2.4.2). Incremental impacts from waste generation and disposal would depend on the level of tar sands development and would be assessed in future site-specific environmental evaluations.

Wastes Associated with Oil Shale Development. Wastes that would be generated from oil shale development would be of the same nature as those described in Section 4.13 Incremental impacts from waste generation and disposal due to tar sands development would depend on the level of tar sands development and would be assessed in future site-specific environmental evaluations.

6.2.5.3.13 Health and Safety. Given the large amount of development for oil and gas, coal mining, and other mineral production projected in the study area over 20 years, many workers will be needed. The types of industries being developed, especially mining, have been associated with relatively high numbers of worker injuries and fatalities in the past (see Section 5.14). Tar sands production activities would add to worker injuries and fatalities in proportion to the level of development. Without more detailed information on future production levels for tar sands as well as the other industries, quantitative estimates of incremental health and safety impacts due to tar sands development are not possible. However, all these industries are required by law to protect worker health and safety using adequate engineering controls and personal protective devices.

6.2.6 Other NEPA Considerations

6.2.6.1 Unavoidable Adverse Impacts

The amendment of land use plans to identify public lands as available for application for leasing for commercial tar sands development would not result in unavoidable adverse environmental impacts under either Alternative B or C, but there may be impacts on land values. Under both Alternatives B and C, the future development of commercial tar sands projects could also result in unavoidable adverse impacts on natural resources. The magnitude of these unavoidable adverse impacts, as well as the degree to which they could be mitigated, would vary by project type and location. Many of the project-specific impacts could be reduced through implementation of the mitigation practices identified in this PEIS (see Chapter 5).

6.2.6.1.1 Land Use. No adverse impacts on land use would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. However, the future development of commercial tar sands projects within the areas identified as available for leasing would result in unavoidable changes in land use in the areas undergoing project development. Land uses that could be affected by the construction and operation of commercial tar sands projects may include livestock grazing, agriculture, oil and gas leasing, minerals extraction, and recreation.

6.2.6.1.2 Soil, Geologic, and Paleontological Resources. No adverse impacts on geologic and paleontological resources would occur under either Alternative B or C from the identification of lands available for application for leasing and the associated land use plan development. Unavoidable adverse impacts could occur in the future under either alternative as a result of commercial project construction and operation. Project construction could result in unavoidable impacts on natural topography, soil erosion, drainage patterns, and slopes, as well as damage or destroy paleontological resources within project footprints. Project construction could also result in the compaction, excavation, and removal of soil from the project area. The likelihood, magnitude, and extent of unavoidable impacts could be reduced under both alternatives through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.3 Water Resources. The identification of lands available for application for leasing and associated land use plan amendments would not adversely impact water resources (either surface water or groundwater) under either alternative. Unavoidable adverse impacts could occur as a result of construction and operation of commercial tar sands projects in the lease areas. Water quality could be impacted as a result of soil erosion from construction sites; runoff from mine areas, tar sands processing, and waste storage locations; and accidental spills of hazardous liquids (such as fuels, lubricating oils, solvents, and other industrial liquids) and accidental oil spills from project-related pipelines. Although there is a potential for unavoidable adverse impacts on water resources from future commercial development under both alternatives, the likelihood, magnitude, and extent of impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.4 Air Quality and Ambient Noise Levels. No adverse impacts on air quality or ambient noise would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could be incurred during the construction and operation of future commercial tar sands projects in the lease areas under either alternative. Construction, clearing and grading, trenching, excavation and blasting, and construction vehicle traffic would result in fugitive dust and vehicle emissions as well as increased ambient noise levels in construction locations. During project operations, unavoidable air impacts would occur primarily during operation of mining and tar sands processing facilities and equipment and associated vehicular traffic. Noise impacts could also be incurred as the result of these activities, as well as from the operation of pipeline compressor stations. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.5 Ecological Resources. No adverse impacts on ecological resources would occur as a result of the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under Alternatives B and C as a result of commercial development of tar sands projects. The construction and operation of project facilities, as well as the maintenance of project-related utility, pipeline, and transportation ROWs under each alternative could result in unavoidable temporary and permanent changes in aquatic resources, plant communities and habitats, wildlife, and threatened and endangered species.

Ecological resources immediately within a project footprint would be destroyed during clearing, grading, and construction activities. Unavoidable impacts on wildlife could include habitat loss, disturbance and/or displacement, mortality, and obstruction to movement. Increased noise during project construction and operation could disrupt local wildlife foraging and breeding of some wildlife. Aquatic biota and habitats could be affected by siltation resulting from runoff from areas of disturbed soils and from accidental releases of hazardous materials from construction and operations equipment (such as fuels) and from an accidental oil pipeline release. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.6 Visual Resources. No adverse impacts on visual resources would occur from the identification of lands available for application for leasing and associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts would occur under both alternatives during the construction and operation of future commercial tar sands projects. Under both alternatives, short-term impacts could occur during construction. Fugitive dust and the presence of construction equipment and crews would be visible in the vicinity of the construction site, potentially affecting local viewsheds and recreational experiences. Because project-specific ROWs and infrastructure (e.g., electricity transmission towers, pipelines and compressor stations, surface mines, and tar sands processing facilities) would be visible throughout the lifespan of any project, there could be long-term unavoidable impacts on some viewsheds and the recreational experiences of visitors in those viewsheds. The likelihood, magnitude, and extent of unavoidable adverse impacts could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.7 Cultural Resources. No adverse impacts on cultural resources would occur from identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. However, leasing itself has the potential to impact cultural resources to the extent that the terms of the lease would limit an agency's ability to avoid, minimize, or mitigate adverse effects of proposed commercial tar sands development on cultural properties. Unavoidable adverse impacts could occur as a result of the development of commercial tar sands projects in areas identified as available for application for leasing under Alternatives B and C. Under both alternatives, cultural resources could be destroyed by construction activities such as clearing and grading, mining, facility construction, and pipeline trenching. Development of new ROWs could also increase access to previously inaccessible areas, which could lead to vandalism of both known and undiscovered cultural sites. The likelihood, magnitude, and extent of unavoidable adverse impacts on cultural resources could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.8 Socioeconomics and Environmental Justice. With the exception noted regarding potential impacts on land values, the identification of lands as available for application for commercial leasing under Alternatives A, B, or C would not result in any adverse socioeconomic, transportation, or environmental justice impacts. Unavoidable adverse social and environmental justice impacts could occur under Alternatives B and C as a result of construction and operation of commercial tar sands facilities and the associated transportation infrastructure and employer-provided housing. Rapid population growth following the in-migration of construction and operations workers associated with tar sands and ancillary facilities into communities could lead to the undermining of local community social structures with contrasting beliefs and value systems among the local population and in-migrants, and consequently, to a range of changes in social and community life, including increases in crime, alcoholism, drug use, etc. Impacts may also occur in association with the degradation of air and water quality, increases in traffic and congestion, visual resources, and removal of land from traditional uses during commercial project development. Many of these impacts would affect quality of life for the general population in many communities, in addition to that of low-income and minority populations residing in the vicinity of commercial tar sands developments. Although many locations of cultural significance to Tribal groups may have been protected or identified, impacts of commercial tar sands developments may also occur with the alteration of, or restricted access to, water and visual resources, and the degradation or migration of particular animal species and the resulting impacts on subsistence and traditional landscape-based activities important to Tribal groups.

6.2.6.1.9 Hazardous Materials and Waste Management. No adverse impacts from hazardous materials and waste management would occur from the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial tar sands projects in the areas identified under Alternatives B and C. Construction and operations of tar sands projects would result in the use of hazardous materials and the generation of hazardous and nonhazardous wastes, including materials typically utilized during construction and operations (e.g., fuels, lubricating oils, hydraulic fluids, glycol-based coolants and solvents, adhesives, corrosion control coatings, and herbicides for vegetation clearing). During construction, nonhazardous landscape wastes would be generated. In general, the appropriate management of these materials would result in only minor impacts. Disposal of spent tar sands within the leased area could result in unavoidable adverse impacts. The likelihood, magnitude, and extent of unavoidable adverse impacts from hazardous materials and waste management could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.1.10 Health and Safety. No adverse impacts on health and safety would occur from the identification of lands available for application for leasing and the associated land use plan amendments under either Alternative B or C. Unavoidable adverse impacts could occur as a result of the potential future development of commercial tar sands projects in the areas identified under Alternatives B and C. Hazards for workers at tar sands development facilities include risks of accidental injuries or fatalities, lung disease caused by inhalation of particulates and other hazardous substances, and hearing loss. A comprehensive facility health and safety plan and worker safety training would be required as part of the plan of development for every proposed commercial tar sands project. The likelihood, magnitude, and extent of unavoidable adverse impacts on health and safety could be reduced under each alternative through the implementation of appropriate project- and location-specific mitigation measures.

6.2.6.2 Short-Term Uses of the Environment and Long-Term Productivity

The amendment of land use plans to identify lands available for application for leasing for commercial tar sands development would not affect the short-term uses or long-term productivity of the environment. The impacts (short- and long-term) from utilization of resources associated with project development under Alternatives B and C are presented in Chapter 5. For this PEIS, *short-term* refers primarily to the period of construction of a commercial tar sands project; generally it is during this time that the most extensive environmental impacts would occur. *Long-term* refers primarily to the 20-year time frame considered within this PEIS.

Within the 20-year time frame considered in the PEIS, the development of tar sands projects would not require the short-term disturbance or long-term alteration of a major amount of federal and nonfederal land under either Alternative B or C. Future development of commercial tar sands projects under Alternative B or C would result in the local, short- and long-term disturbance of most resources. There would be little difference in the types of impacts that could result from future project development under either of the two alternatives. Under these alternatives, land clearing and grading and construction activities would disturb surface soils, wildlife and their habitats, and affect local air and water quality, visual resources, noise levels, and recreational activities within individual project footprints. Similar effects could be expected on other federal and nonfederal lands where project-related infrastructure (such as utility and pipeline ROWs, and worker residences) would be located. Short-term construction-related disturbance of biota (and their habitats) could result in long-term reductions in biological productivity within the project areas.

The long-term presence of commercial tar sands projects and associated ROWs could affect long-term land use within and in the vicinity of any commercially developed lease areas, as well as on both federal and nonfederal lands where support infrastructure (e.g., ROWs and employer-provided housing) would be located, especially if previous land use activities in those areas are determined to be incompatible with commercial tar sands projects. The lands and surrounding areas associated with Alternatives B and C currently support a variety of land uses (depending on their specific locations), including livestock grazing, agriculture, recreation, oil and gas leasing, and minerals extraction. Commercial tar sands projects under both alternatives could also affect long-term quality and use of visual resources and affect recreational use on federal and nonfederal lands. While some recreational activities (such as OHV use) could experience long-term increases in activity as a result of new ROWs into previously inaccessible areas, changes in the types and patterns of recreational usage can be positive or negative, depending on the subjective values of the interested and affected public.

6.2.6.3 Irreversible and Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitments of resources associated with the implementation of the two tar sands alternatives evaluated in this PEIS. A resource commitment is considered *irreversible* when direct and indirect impacts from its use limit future use options. Irreversible commitments apply primarily to nonrenewable resources, such as cultural resources, and to those resources that are renewable only over long periods of time, such as soil productivity or forest health. A resource commitment is considered *irretrievable* when the use or consumption of the resource renders it neither renewable nor recoverable for future use. Irretrievable commitments apply to the loss of production, harvest, or use of natural resources.

The amendment of land use plans to identify lands available for application for leasing for commercial tar sands development would not result in the irreversible or irretrievable commitment of resources. However, irreversible and irretrievable commitments of resources could occur as a result of future commercial tar sands projects that are authorized, constructed, and operated. The nature and magnitude of these commitments would depend on the specific location of the project development as well as its specific design and operational requirements. The commitment of resources would be identical for any specific project located in the same lease area under either of the two alternatives.

The construction of future commercial tar sands projects under either of the alternatives could result in the consumption of sands, gravels, tar sands, and other geologic resources, as well as fuel, structural steel, and other materials. Water resources could also be consumed during construction, although water use would be temporary and largely limited to on-site concrete mixing and dust abatement activities.

In general, the impact on biological resources from future project construction and operation would not constitute an irreversible and irretrievable commitment of resources. During project construction and operation, individual animals would be impacted. Site-specific and species-specific analyses and mitigation conducted at the project level during authorization would make adverse impacts on entire populations unlikely. However, if adverse impacts occurred to threatened or endangered species, these impacts would likely constitute an irreversible and irretrievable commitment of resources.

The clearing of project areas (including off-lease locations where utility and pipeline ROWs, and employer-provided housing would be located) would result in the direct loss of vegetation and habitats within the construction footprints, which would be irretrievable in areas where project infrastructure would be constructed and operated. While habitat would be impacted during project construction, implementation of project-specific mitigation measures (such as habitat restoration) would reduce these impacts over time. However, habitats within project infrastructure footprints (such as buildings and surface mines) would be irretrievably committed with the development and operation of commercial tar sands projects.

Cultural and paleontological resources are nonrenewable, and any disturbance of these resources would constitute an irreversible and irretrievable commitment of resources. However, consideration and implementation of mitigation could minimize the potential for impacts on these resources. Access to previously inaccessible areas could lead to vandalism of both known and unknown cultural and paleontological resources, thereby rendering them irretrievable. Impacts on visual resources could constitute an irreversible and irretrievable commitment of resources, but these impacts could also be lowered somewhat through the consideration and implementation of the mitigation measures.

6.2.6.4 Mitigation of Adverse Impacts

Following the amendment of land use plans to identify areas available for application for leasing for commercial tar sands development, future development of commercial tar sands projects within the lease areas could result in adverse impacts on many resources (see Chapter 5). The nature, extent, magnitude, and duration of any project-related impacts would be directly determined by (1) the project location, (2) the nature and quality of the resources at and in the vicinity of project site (and its associated infrastructure), and (3) the technology used and the plan of development for the project. Many of the impacts may be reduced or avoided through the implementation of appropriate site- and project-specific mitigation measures. Development of individual commercial tar sands projects would require additional project-specific NEPA analyses and the identification of location-, project- and resource-specific mitigation measures, and mitigation measures would be identified as lease stipulations by the BLM for any authorized commercial development. Chapter 5 of this PEIS identifies many types of resource-specific mitigation measures that could be implemented during project planning, construction, and operation.

6.3 ENDANGERED SPECIES ACT SECTION 7 REQUIREMENTS

Section 7 of the ESA directs each federal agency, in consultation with the USFWS or the National Marine Fisheries Service (NMFS), as appropriate, to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any listed threatened or endangered species or result in the destruction or adverse modification of critical habitat.[15] Under Section 7 of the ESA, those agencies that authorize, fund, or carry out the federal action are commonly known as "action agencies." If an action agency determines that its federal action "may affect" listed species or critical habitat, it must consult with the USFWS and/or NMFS, depending on the species that could be affected by the action.[16] If an action agency determines that the federal action will have no effect on listed species or critical habitat, the agency will make a "no effect" determination. In that case, the action agency does not initiate consultation with the USFWS and/or NMFS and its obligations under Section 7 are complete.

In complying with its duty under Section 7, the BLM, as the action agency, has examined the potential effects on listed species and designated critical habitat of amending land use plans to identify lands as available for application for commercial leases for oil shale or tar sands development. The BLM also examined the recent direction and analysis recently provided by the USFWS regarding compliance with Section 7, concerning emissions of greenhouse gases, and any effects they may cause to listed species and designated critical habitats, in particular the polar bear (Caswell 2008; Hall 2008). As a result of these examinations, the BLM has determined that its proposed action of amending land use plans would have no effect on these species or on designated critical habitat. This determination is based on the following.

1. The amendment of land use plans to identify lands as available for application for commercial leasing for oil shale or tar sands development would have no impact on the environment. The amendments do not commit the BLM to a particular course of action or authorize any ground-disturbing activity; they merely allow the BLM to consider granting leases—in the future—for oil shale or tar sands development, nor do land use plan amendments result in

[15] See ESA § 7; 16 USC 1536.

[16] See 50 CFR 402.2, 402.13-14.

future implementation actions that may cause emission of greenhouse gases (Caswell 2008).

2. The amendment of land use plans for such purpose does not create any legal right that would allow ground-disturbing activities without further agency decision making and compliance with applicable statutes, including the ESA and NEPA.

3. Before the BLM issues a lease or approves any ground-disturbing activity, the BLM will analyze the effects of the proposed action and ensure compliance with the ESA.

The BLM did not reach its "no effect" determination because listed species and critical habitat are unlikely to be present in lands described in the land use plan amendments. To the contrary, Tables 4.8.1-6 and 5.8.1-6 identify the listed species that occur in the states of Colorado, Utah, and Wyoming where the land use plan amendments would be completed for either oil shale or tar sands leasing. Portions of the designated areas are occupied by listed species or contain designated critical habitat. The BLM considered preparing a biological assessment (BA) through a consultation with the USFWS. After discussing various approaches, the BLM determined, however, that the administrative action of amending land use plans would not affect listed species or designated critical habitat.

Preparing a BA before a lease or site-specific project had been proposed would be based largely on conjecture and speculation. There would be simply no way to know before such a proposal is made whether the impacts to be assessed would be those that would actually occur as a result of a proposal by a future proponent. Further, without knowing the specifics of when and where a project would occur, it would be impossible to know what species, if any, would be affected by the project. The BLM considered whether it made sense to make assumptions for the purposes of a BA, but determined such assumptions would be speculative and not linked to the federal action of amending land use plans. Any BA would be a speculative assessment of effects from future *site-specific projects*, not of the current proposed action.

This is not to say that there would be no Section 7 consultations (including preparation of BAs or biological opinions (BOs) where appropriate) on future actions that may affect listed species or critical habitat. On the contrary, the BLM fully expects that if an application for a lease, permit, or other authorization is received by the BLM for oil shale or tar sands development within lands identified as available for application, procedures to comply with Section 7 of the ESA would be initiated at that time. This may take the form of consultation with the USFWS; preparation of a BA by the BLM; issuance of a BO by the USFWS; a "may affect, not likely to adversely affect" determination with USFWS concurrence; or a "no effect" determination by the BLM. At such time, any BA, BO, concurrence, or "no effect" determination would be made based on a full record describing the proposed lease, project, site, method of construction, and other relevant information, all features lacking at the present time.

6.4 REFERENCES

Note to Reader: This list of references identifies Web pages and associated URLs where reference data were obtained. It is likely that at the time of publication of this PEIS, some of these Web pages may no longer be available or their URL addresses may have changed.

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