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

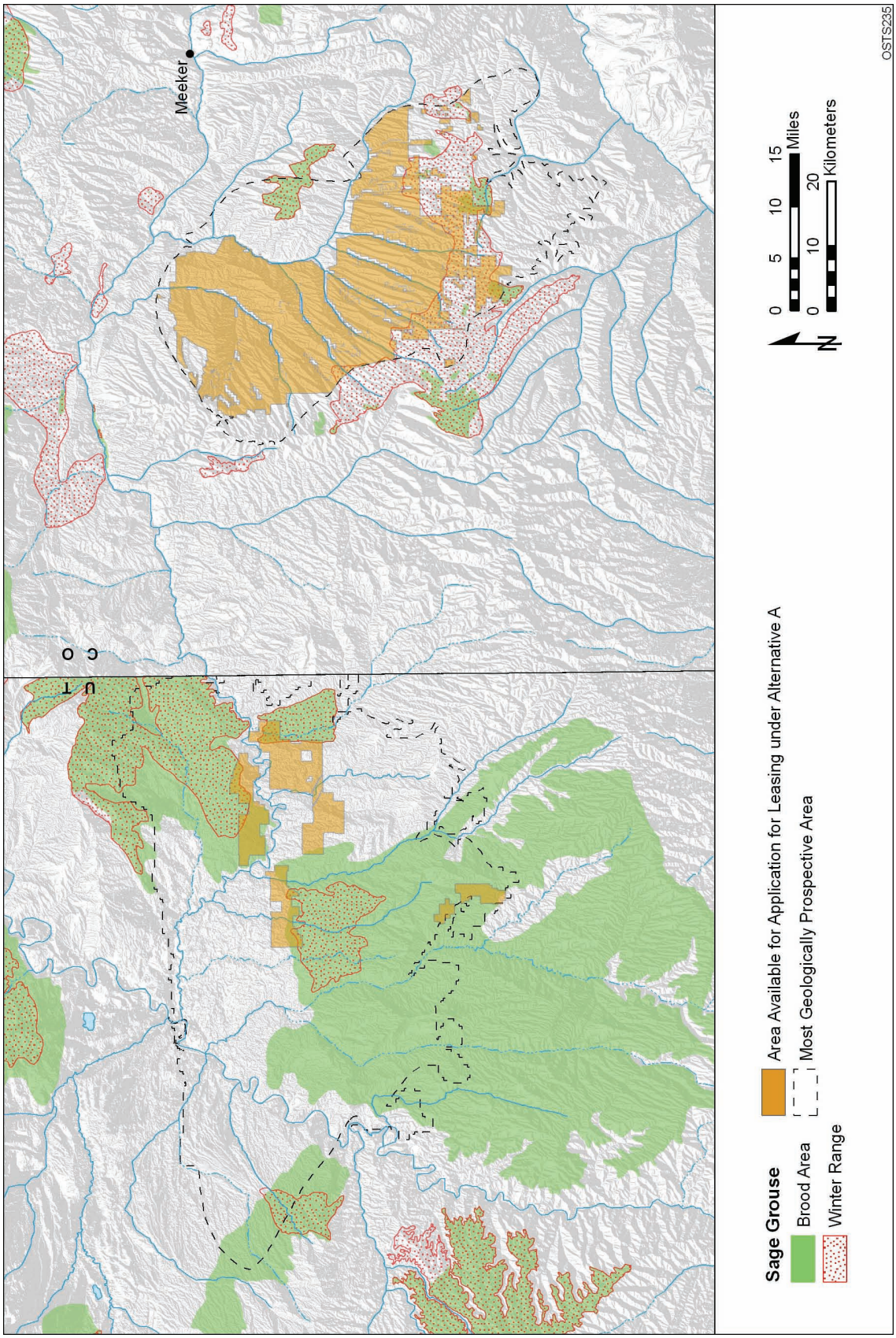

FIGURE 6.1.1-1 Overlap of Lands Available for Leasing under Alternative A with the Known Distribution of the Greater Sage-Grouse

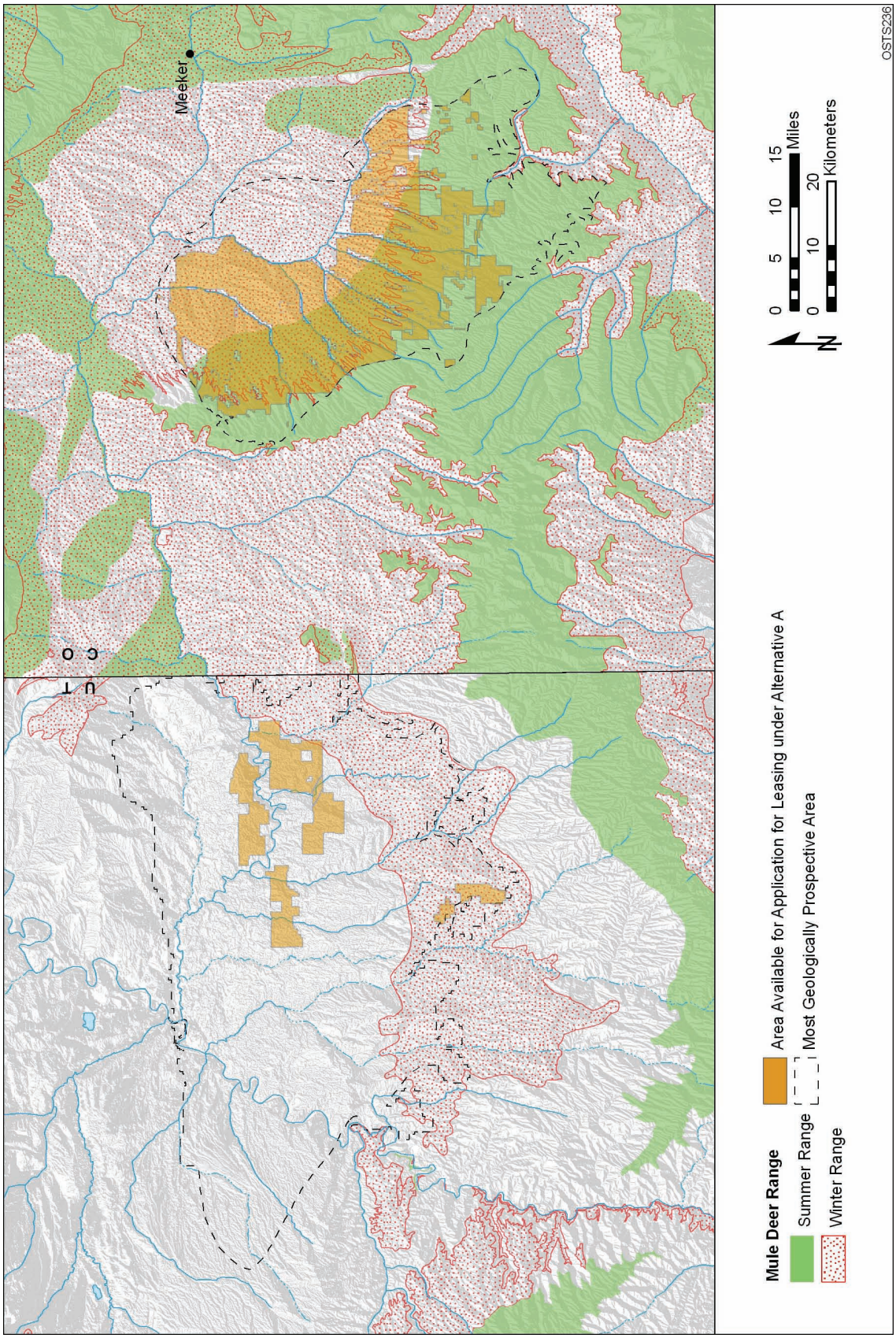

FIGURE 6.1.1-2 Overlap of Lands Available for Leasing under Alternative A with the Summer and Winter Ranges of the Mule Deer

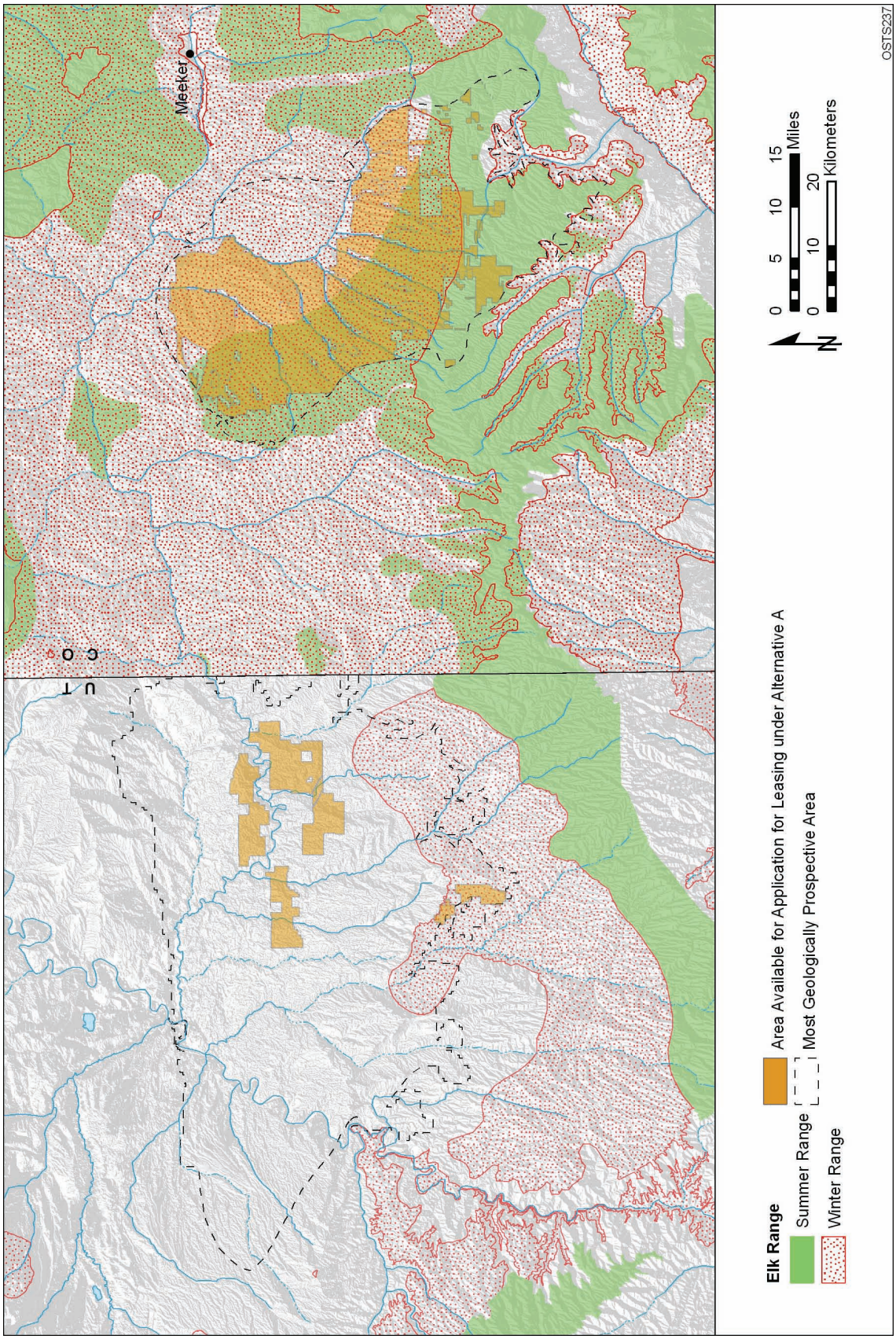

FIGURE 6.1.1-3 Overlap of Lands Available for Application for Leasing under Alternative A with the Summer and Winter Ranges of the Elk

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.

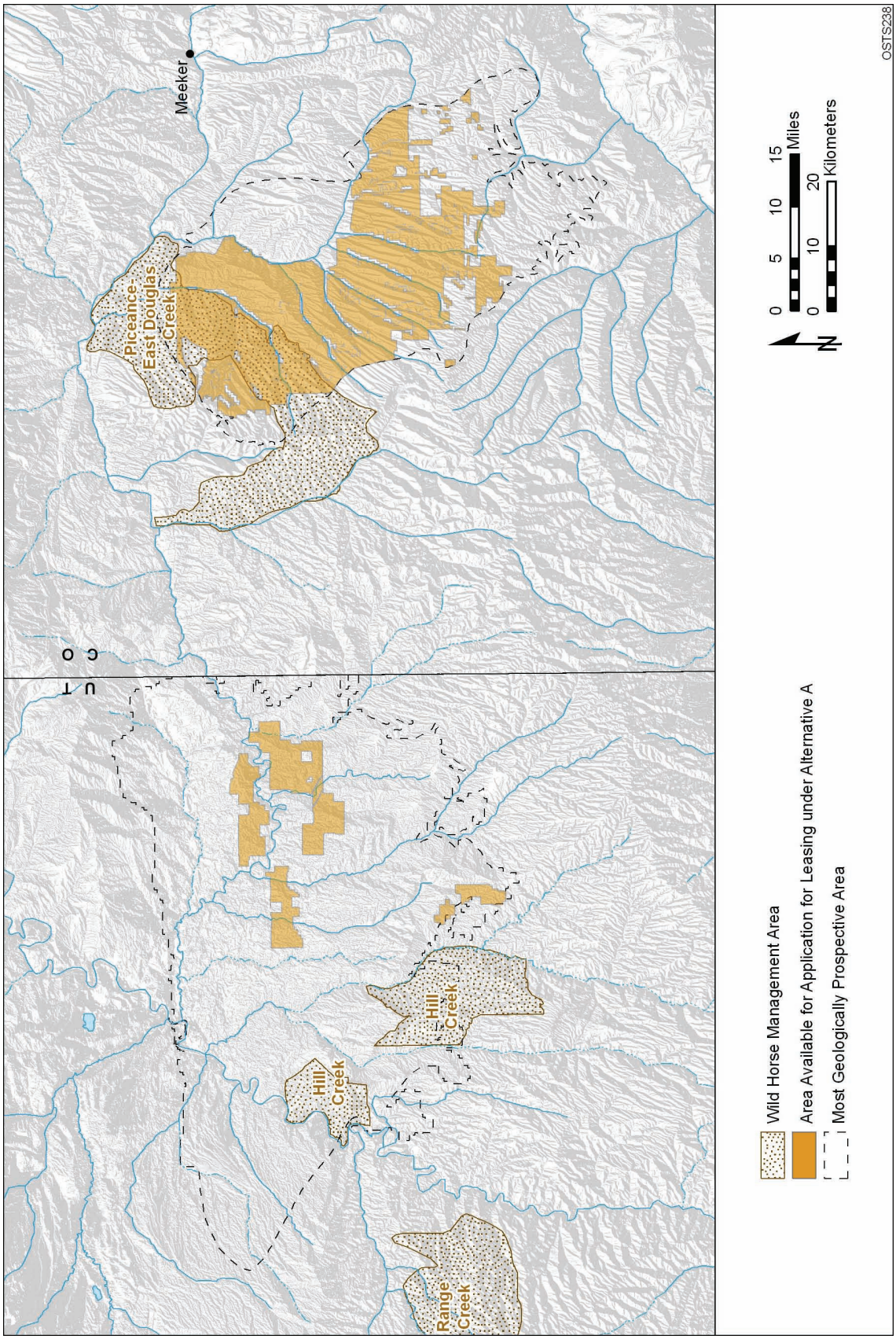

FIGURE 6.1.1-4 Overlap of Lands Made Available for Application for Leasing under Alternative A with Wild Horse Herd Management Areas

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

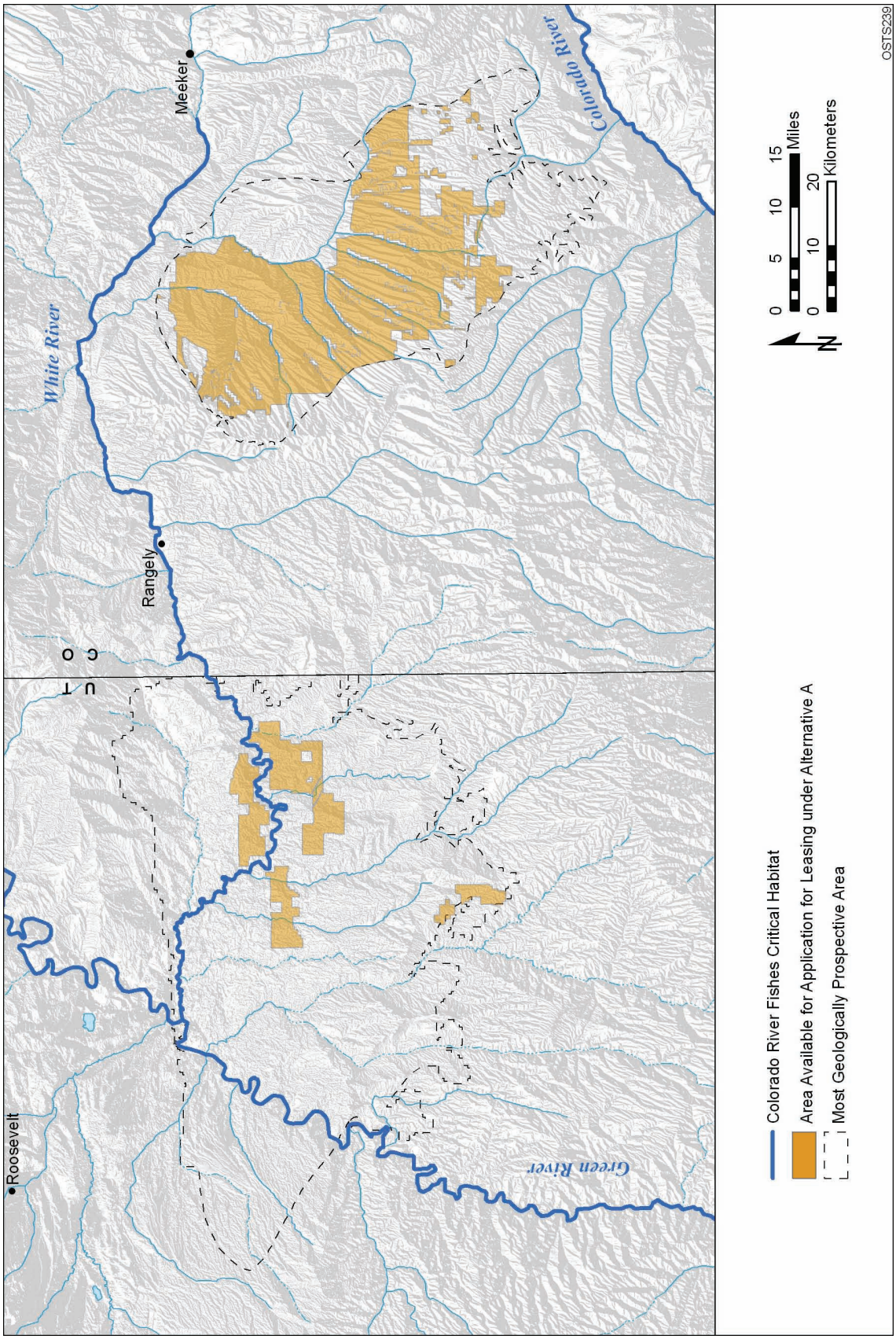

FIGURE 6.1.1-5 Designated Critical Habitat of Endangered River Fishes That Cross Lands Made Available for Application for Leasing under Alternative A

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.

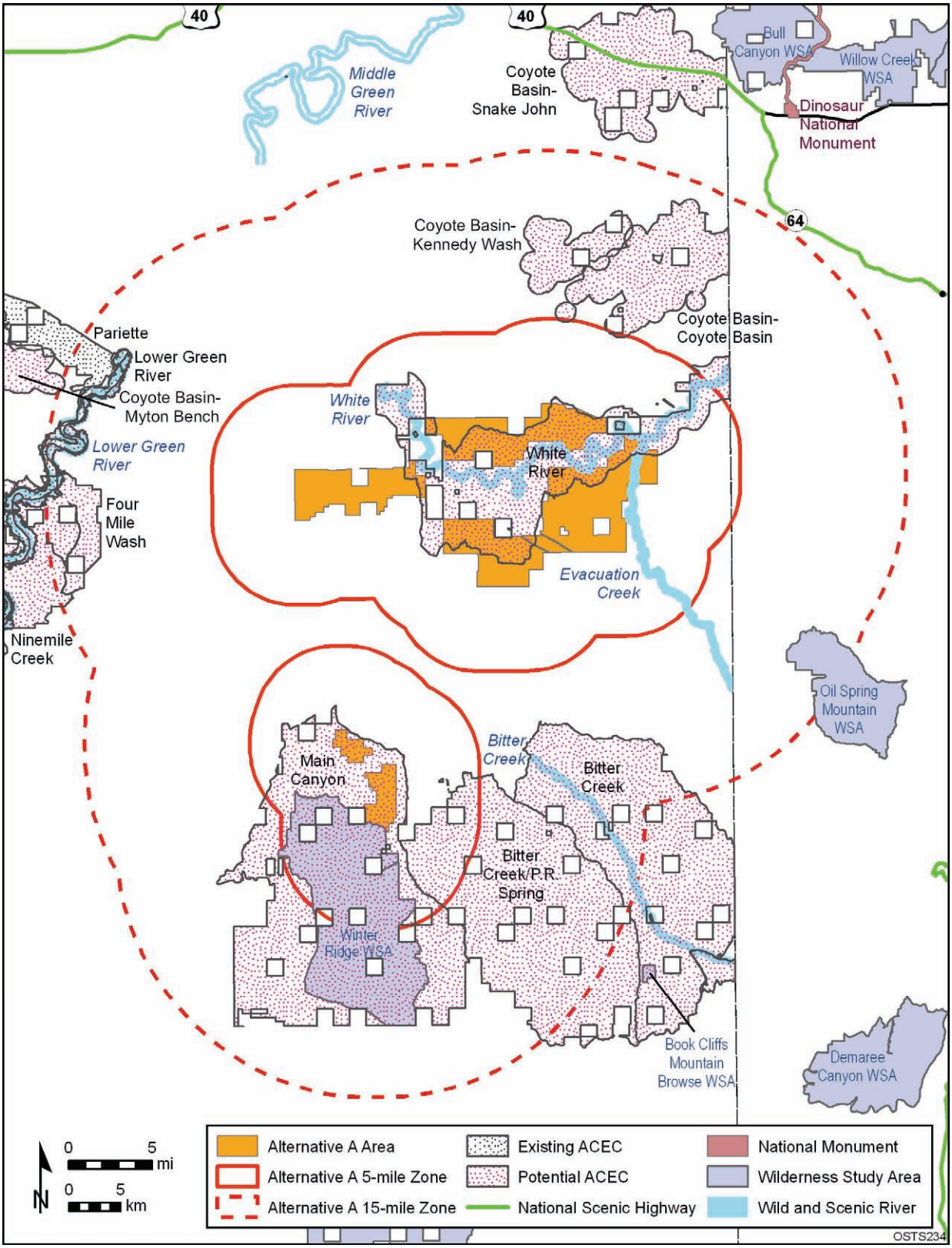

FIGURE 6.1.1-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Utah

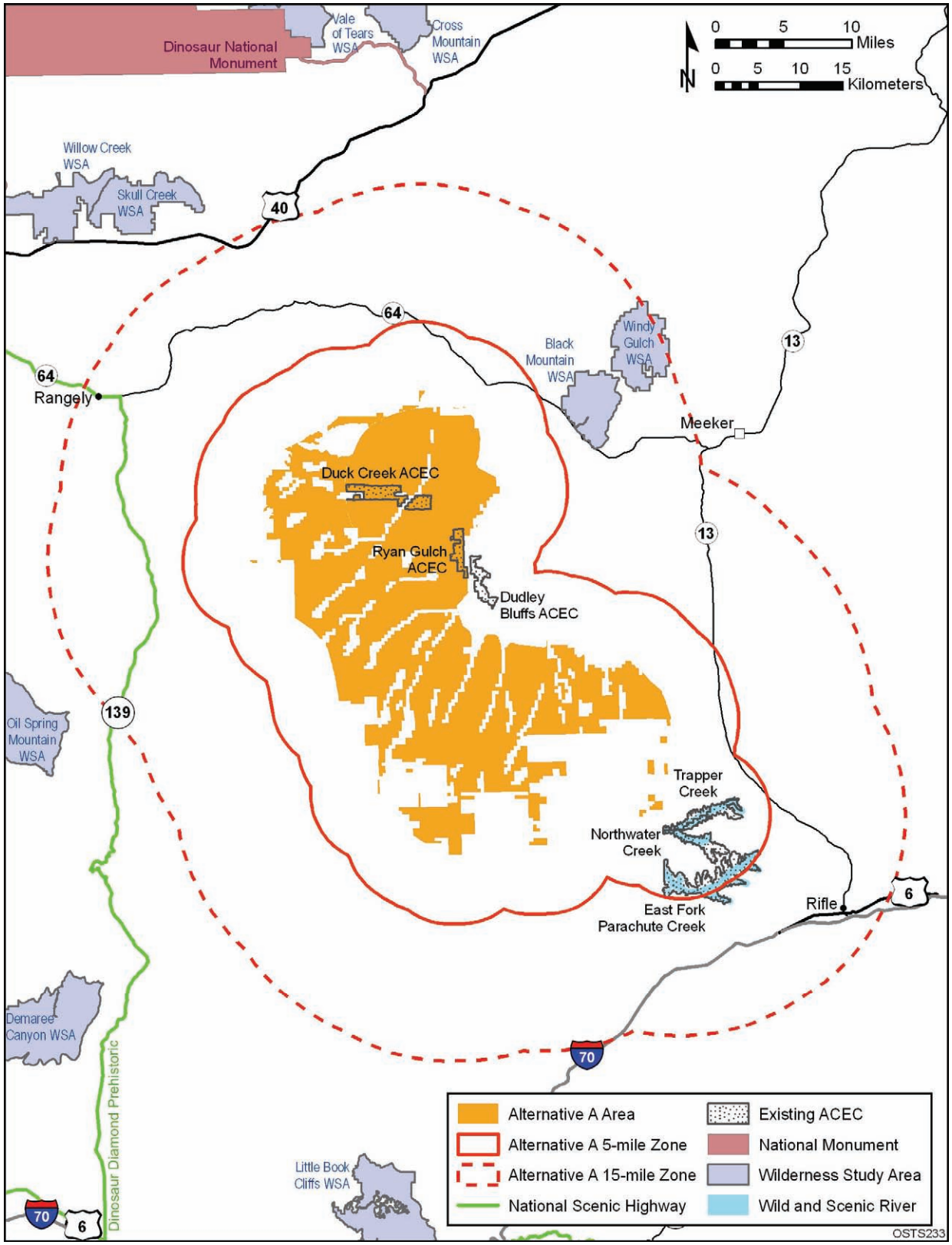

FIGURE 6.1.1-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative A in Colorado

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]

Parameter	Year 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]

	Year					
Parameter	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

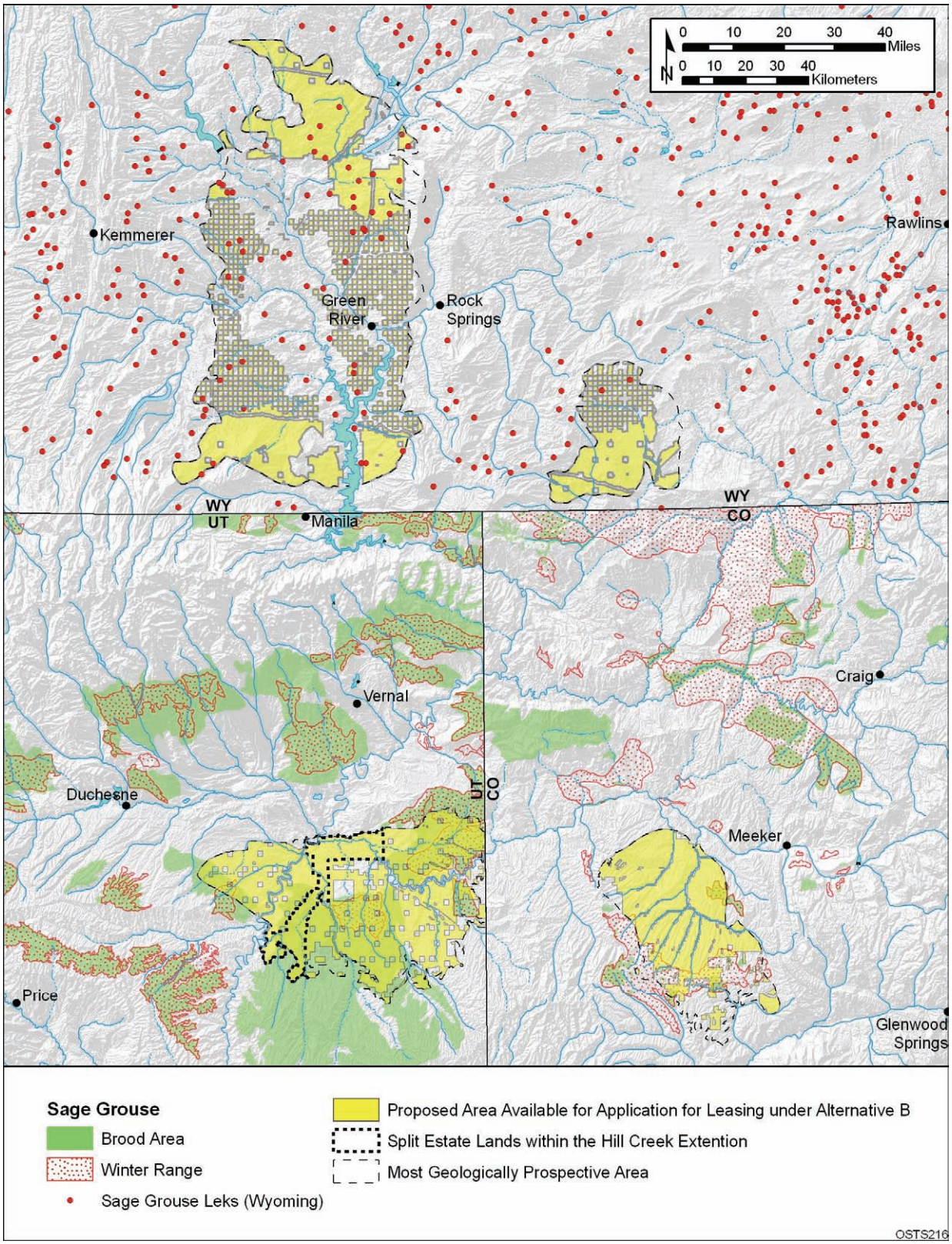

FIGURE 6.1.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse

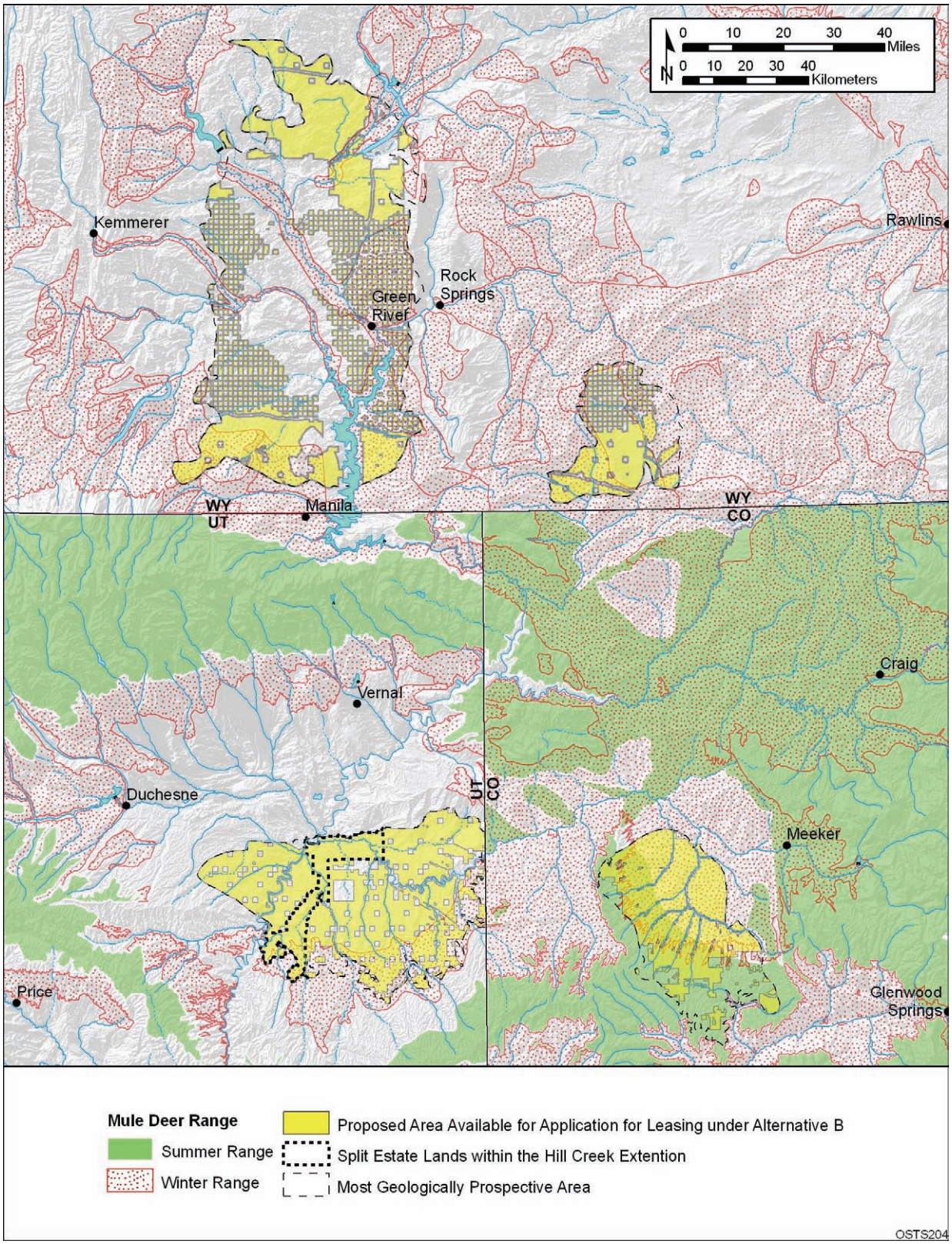

FIGURE 6.1.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer

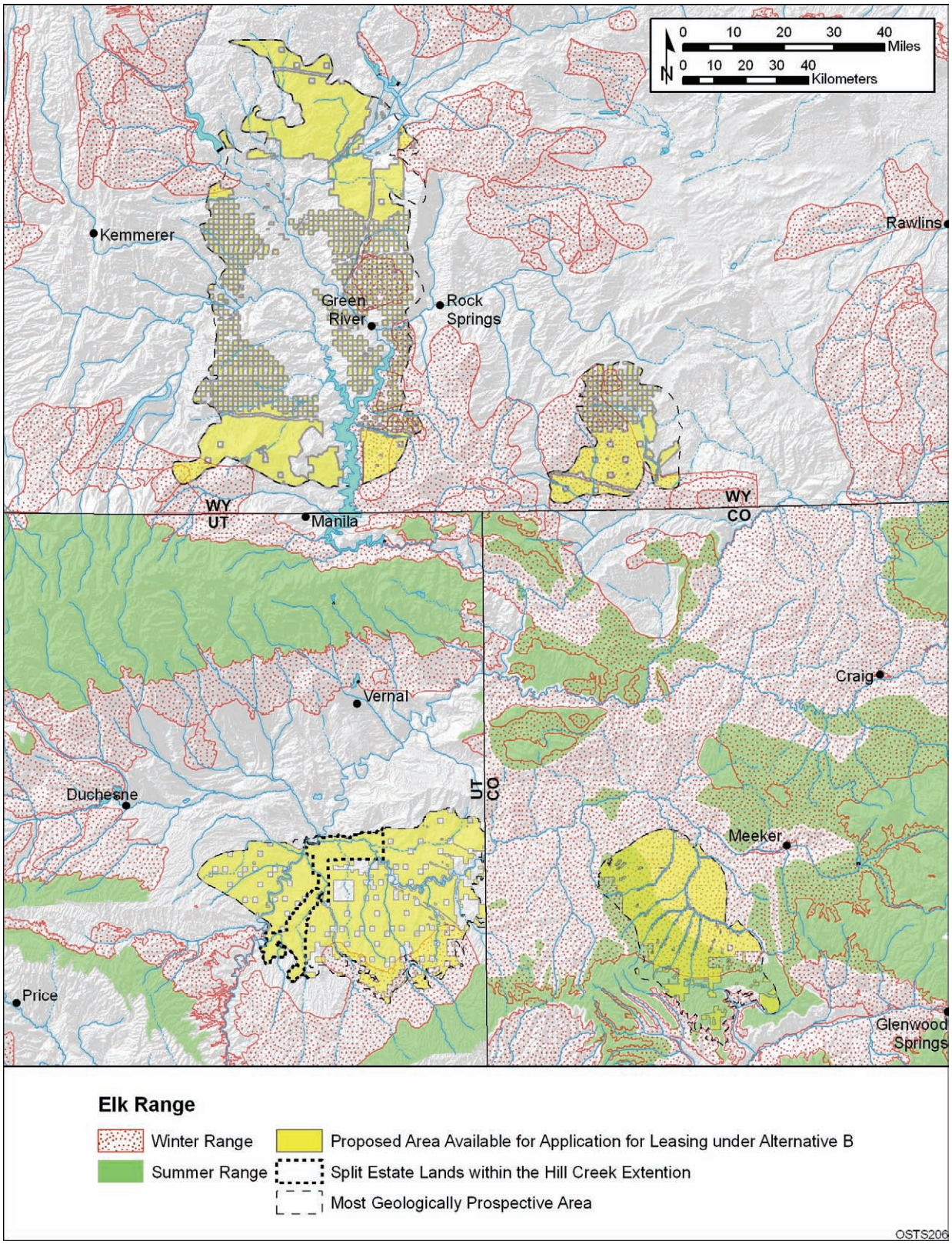

FIGURE 6.1.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk

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.

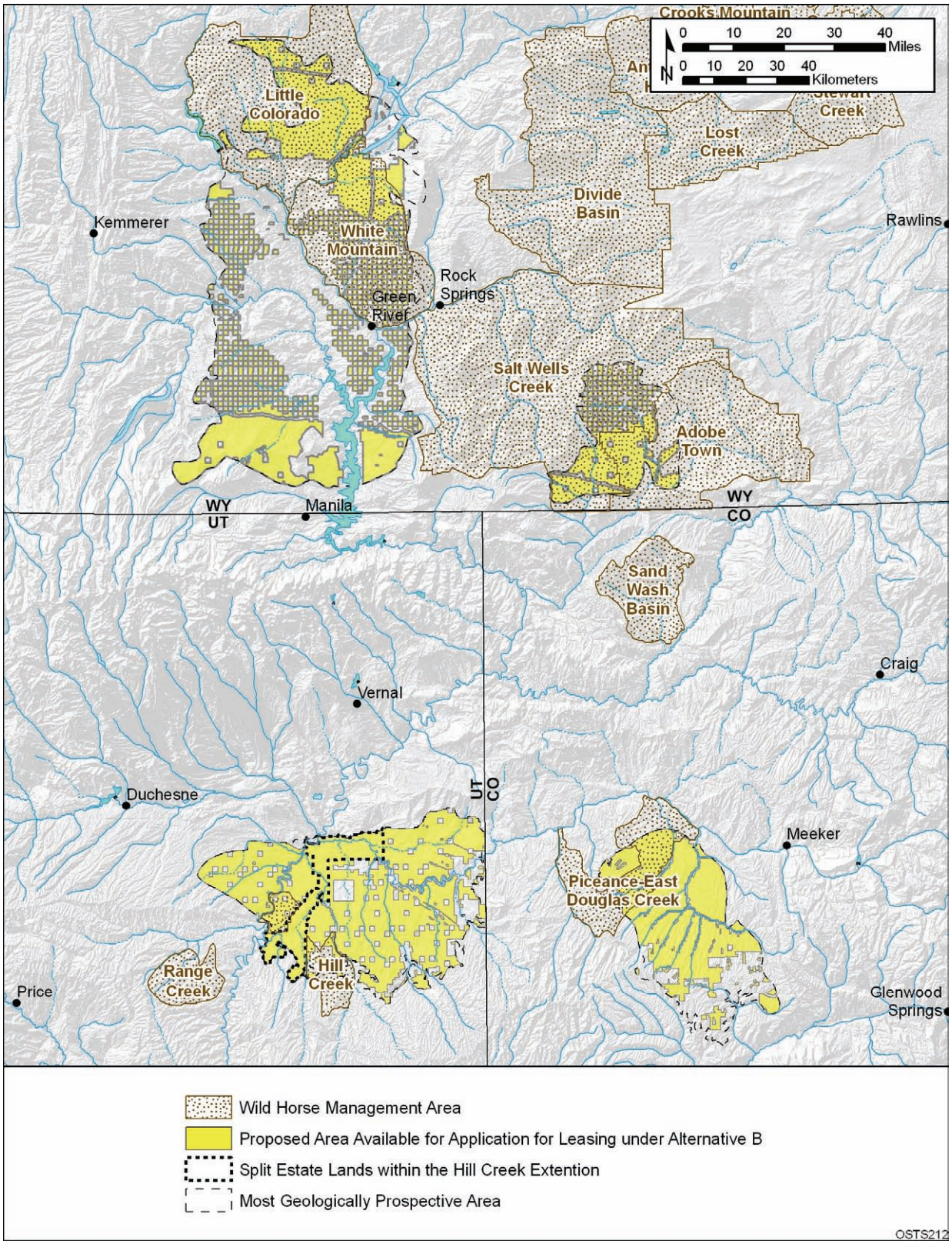

FIGURE 6.1.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas

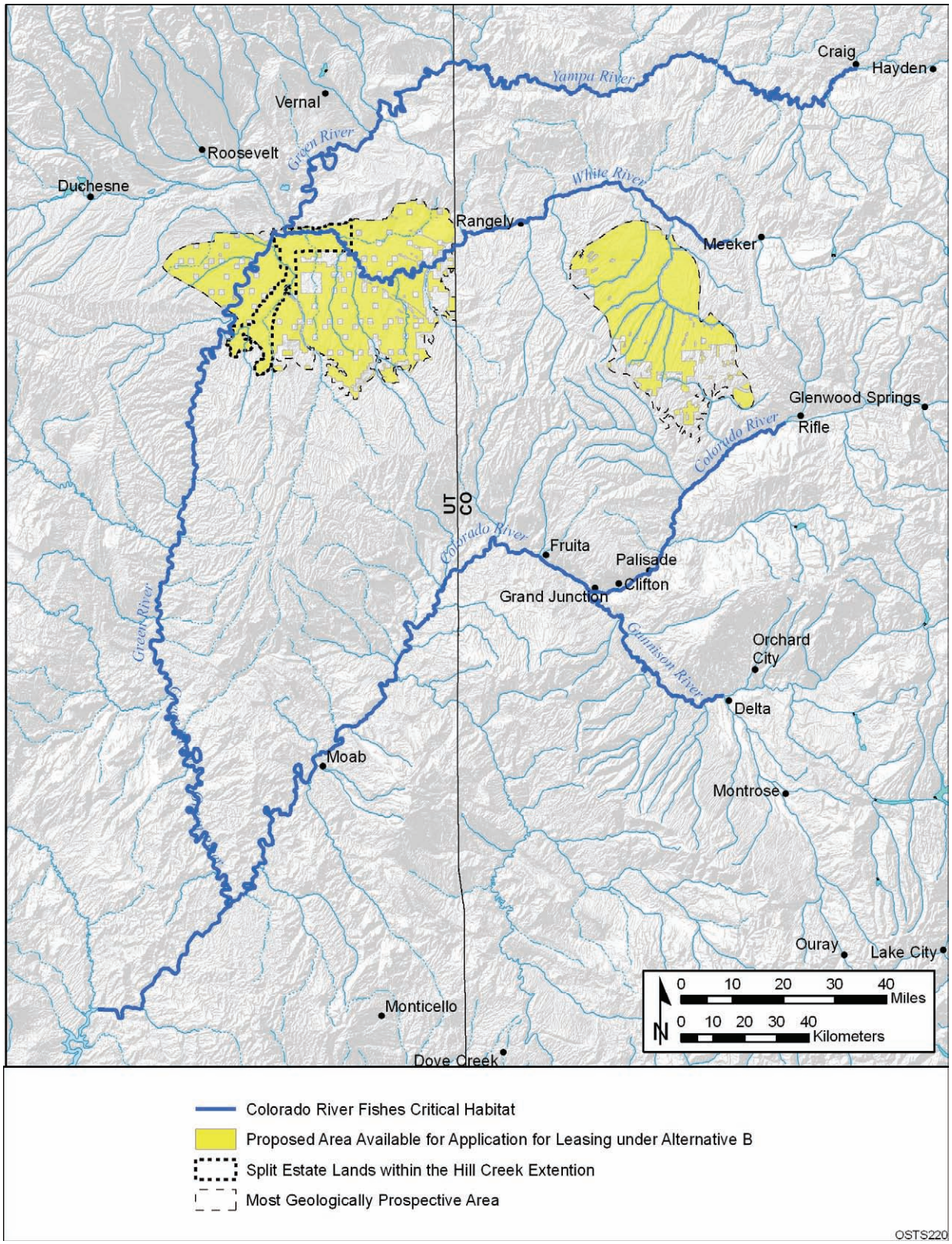

FIGURE 6.1.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B

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

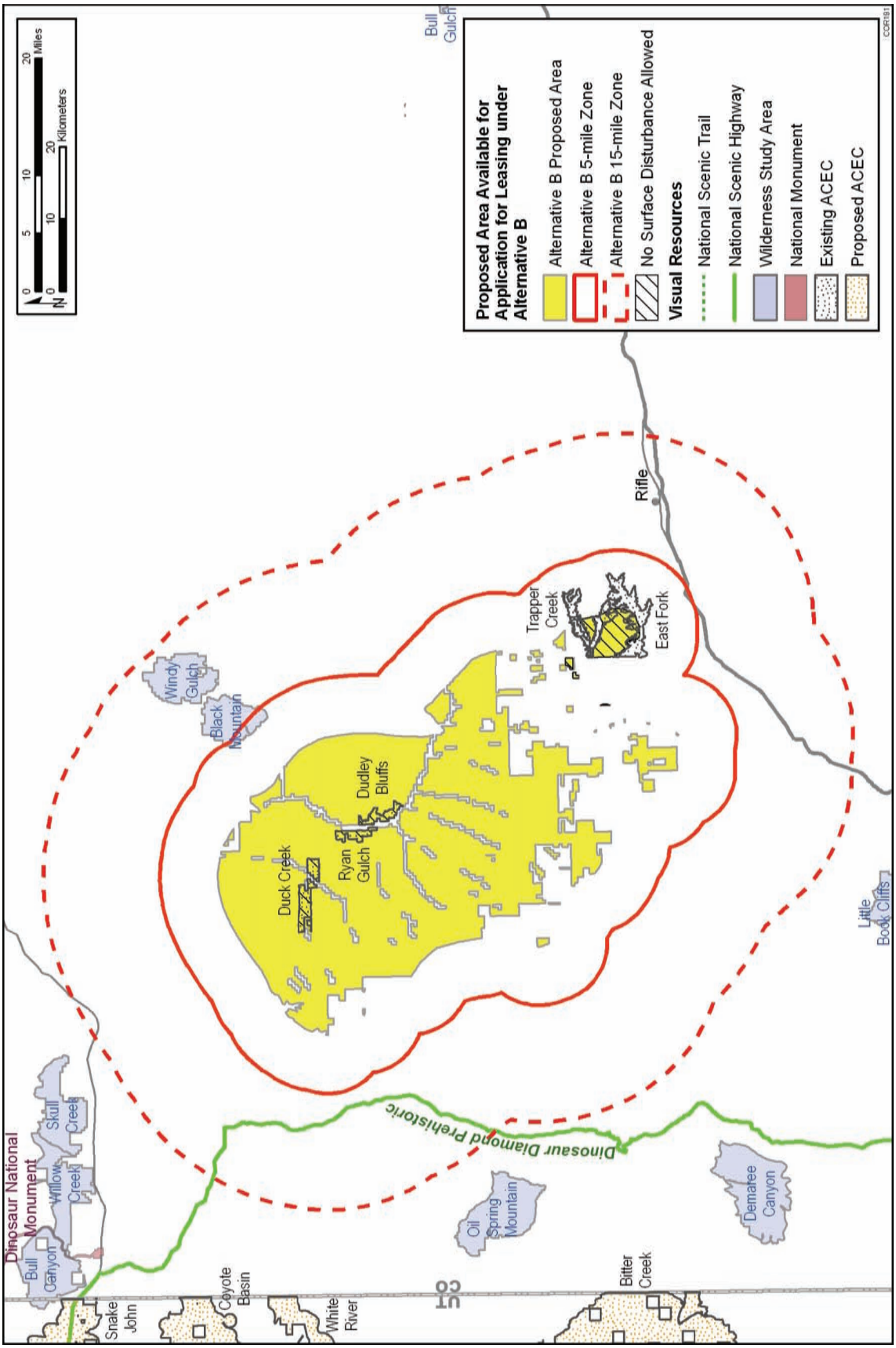

FIGURE 6.1.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Colorado

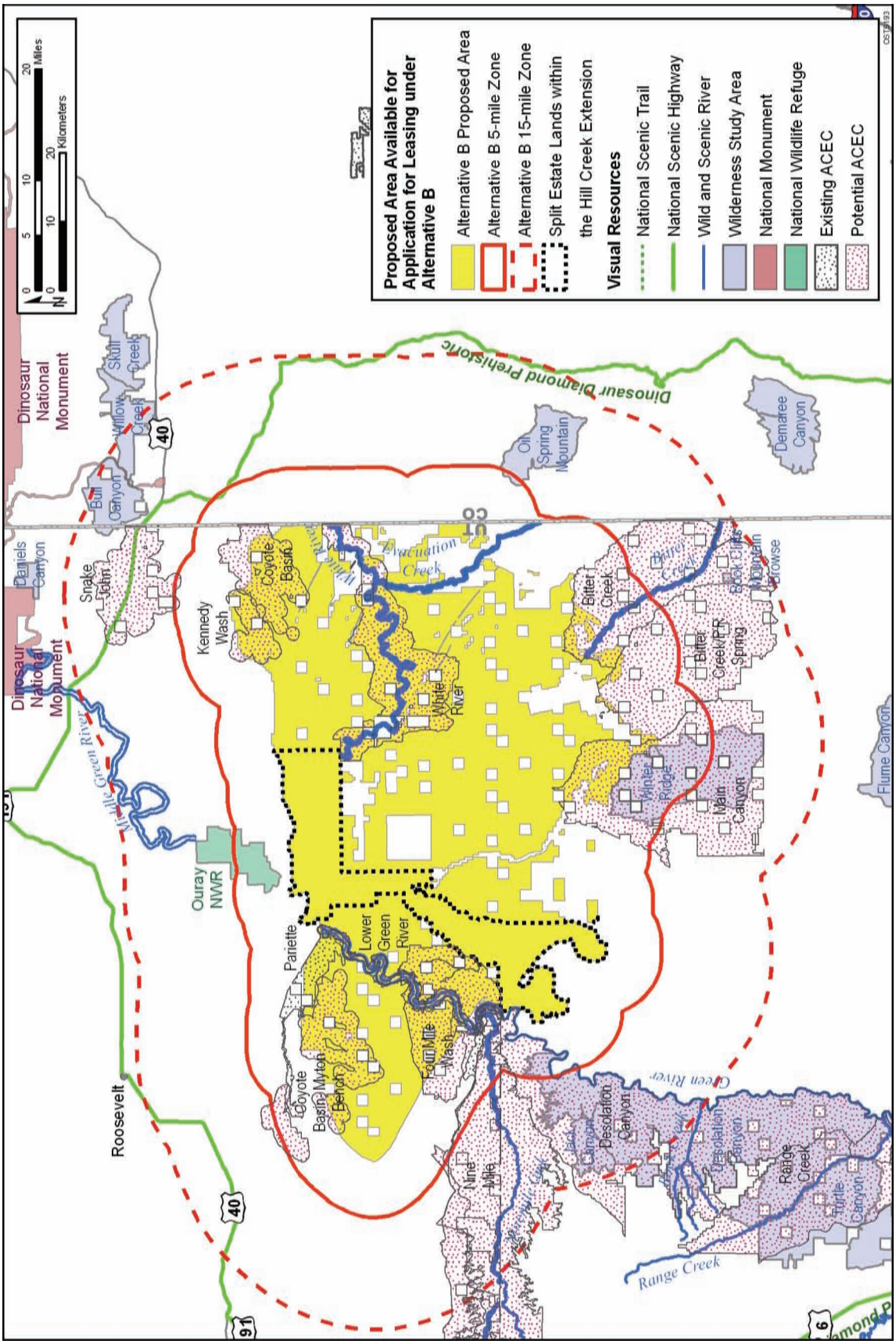

FIGURE 6.1.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Utah

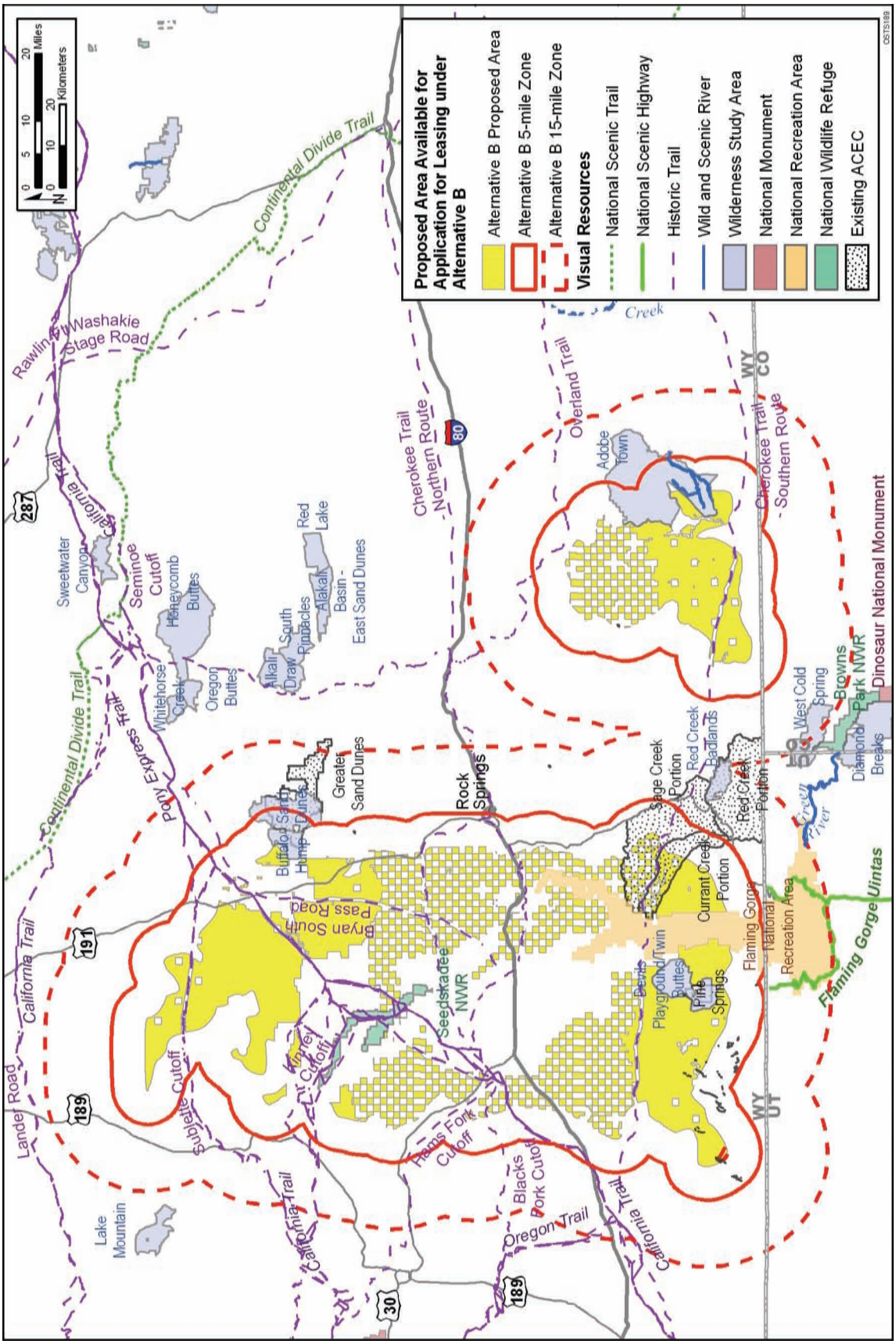

FIGURE 6.1.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B in Wyoming

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.

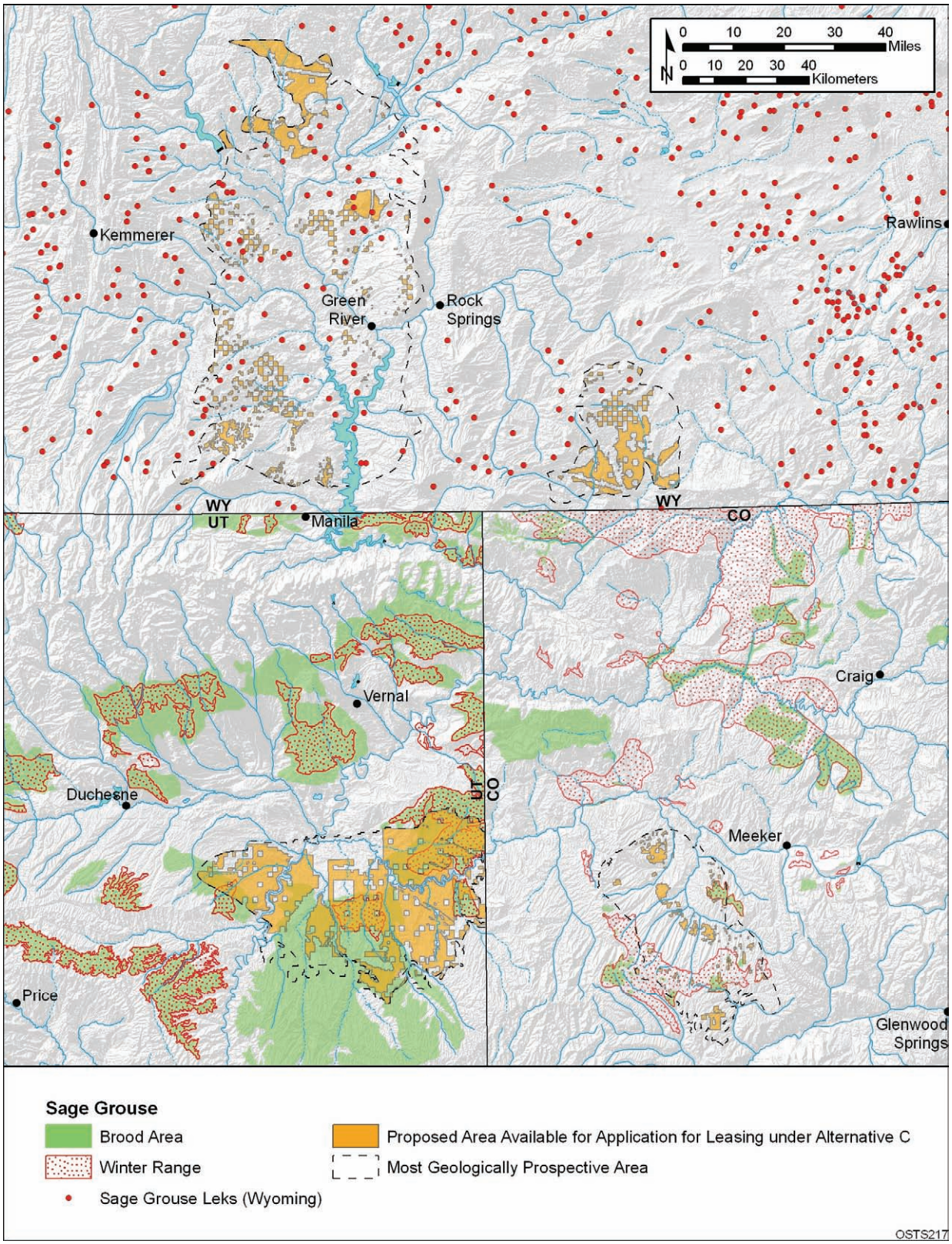

FIGURE 6.1.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse

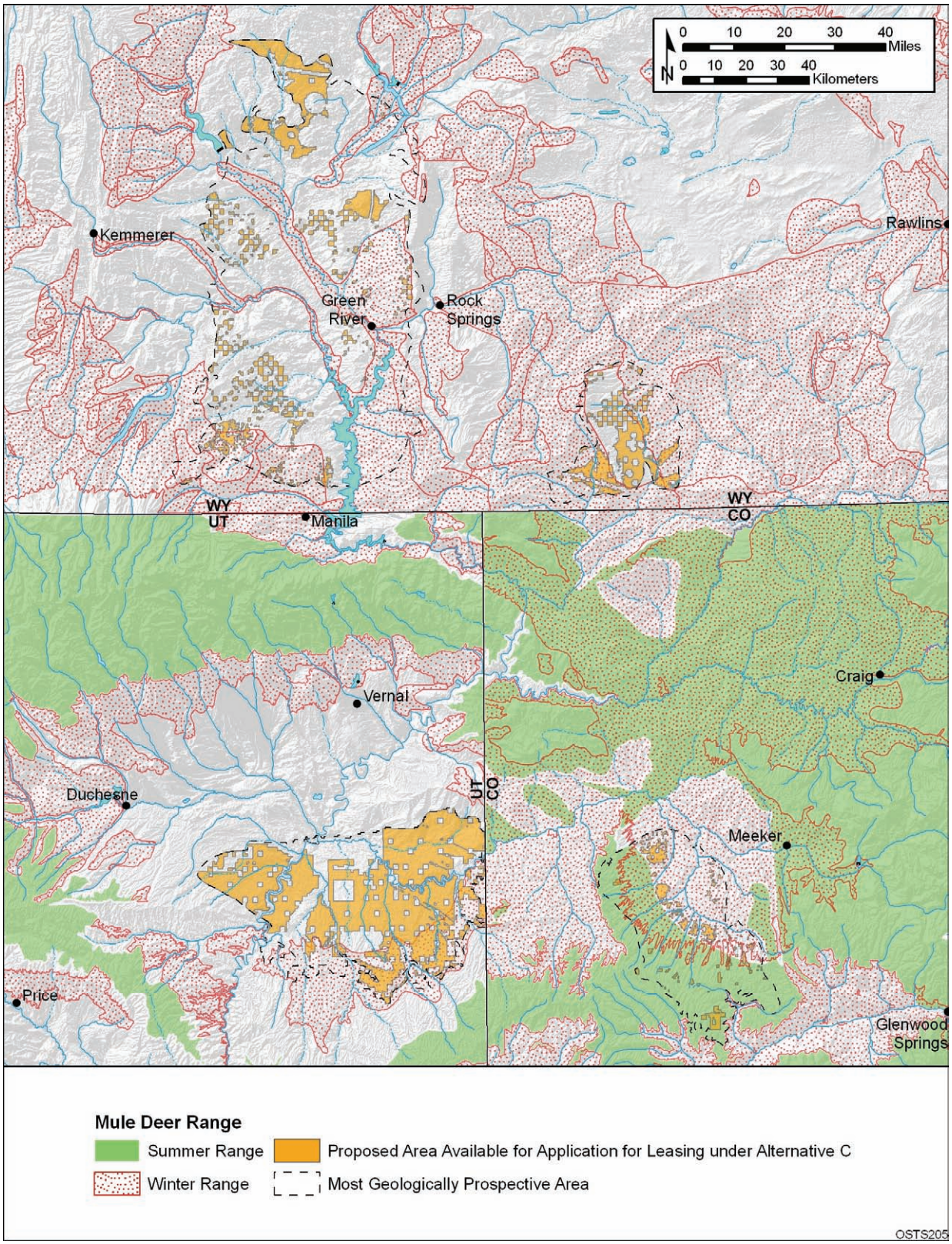

FIGURE 6.1.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer

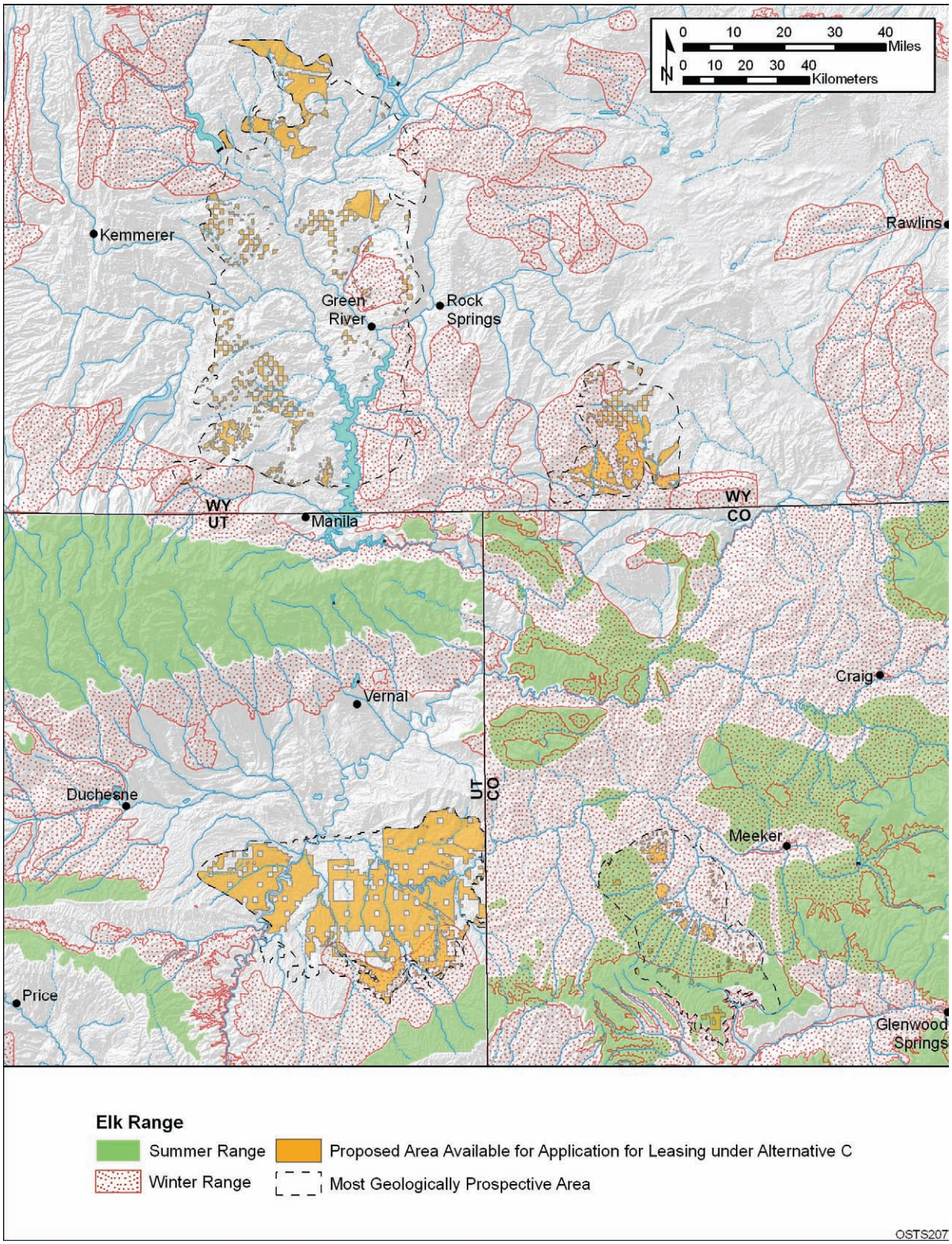

FIGURE 6.1.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk

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

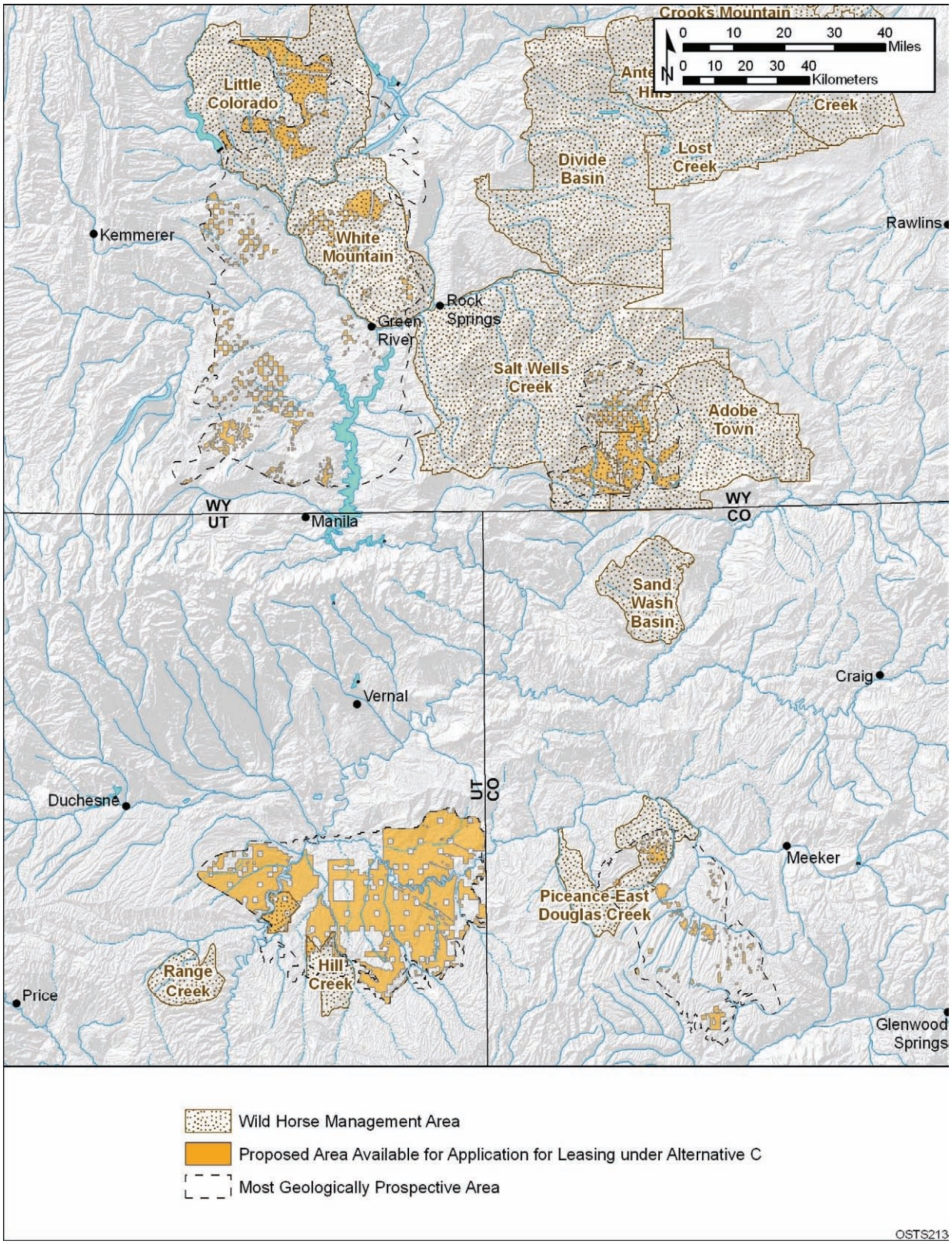

FIGURE 6.1.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas

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

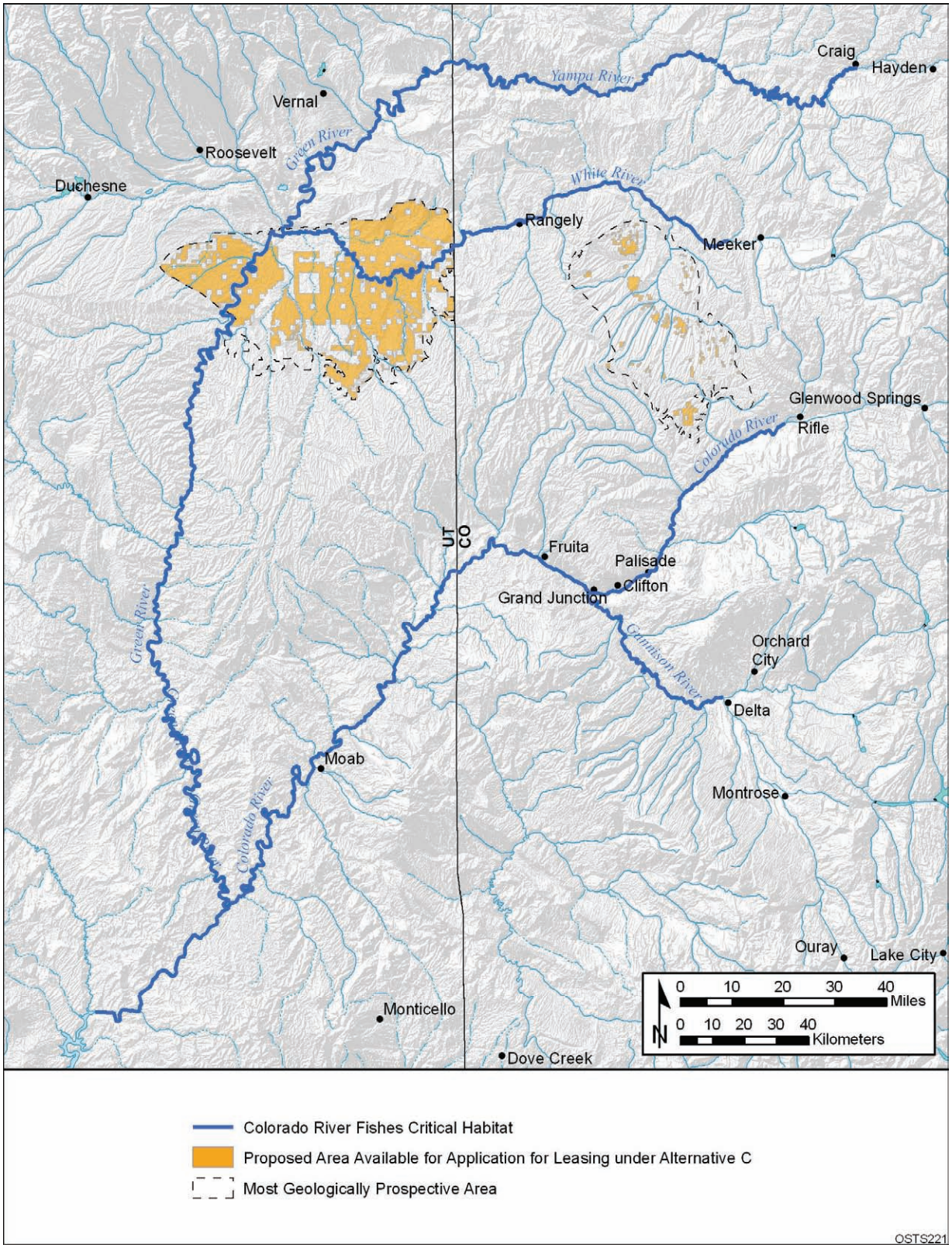

FIGURE 6.1.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C

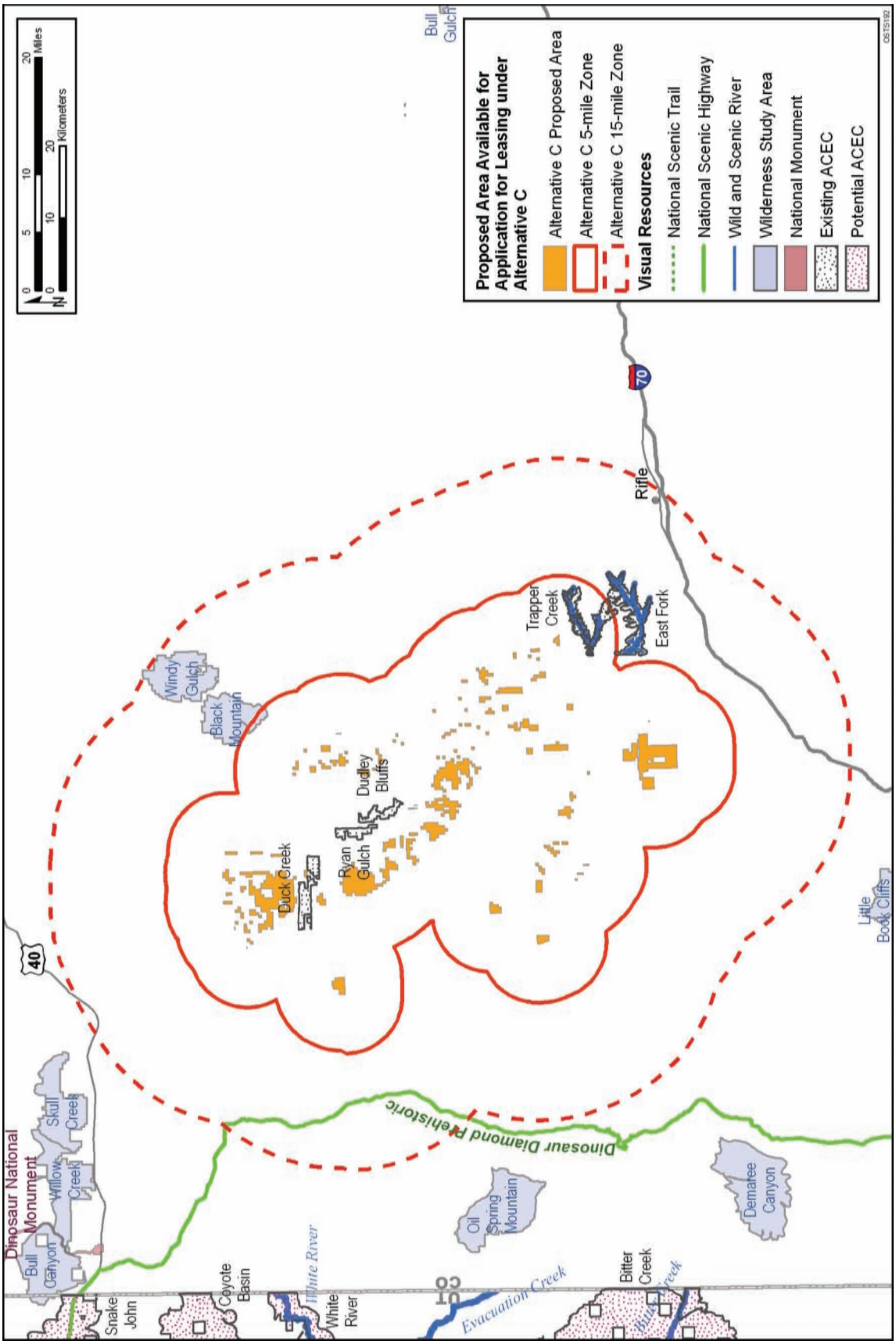

FIGURE 6.1.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Colorado

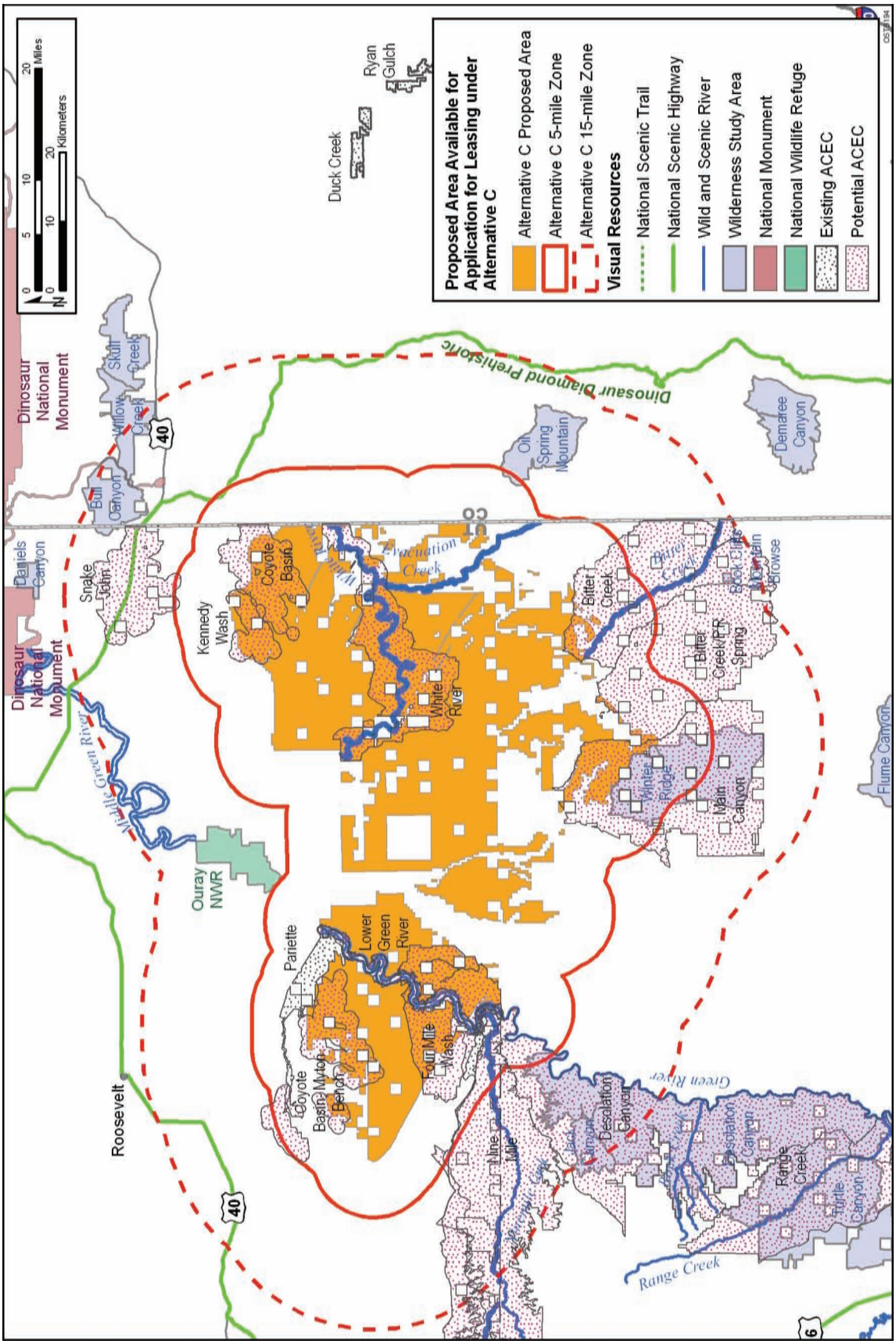

FIGURE 6.1.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Utah

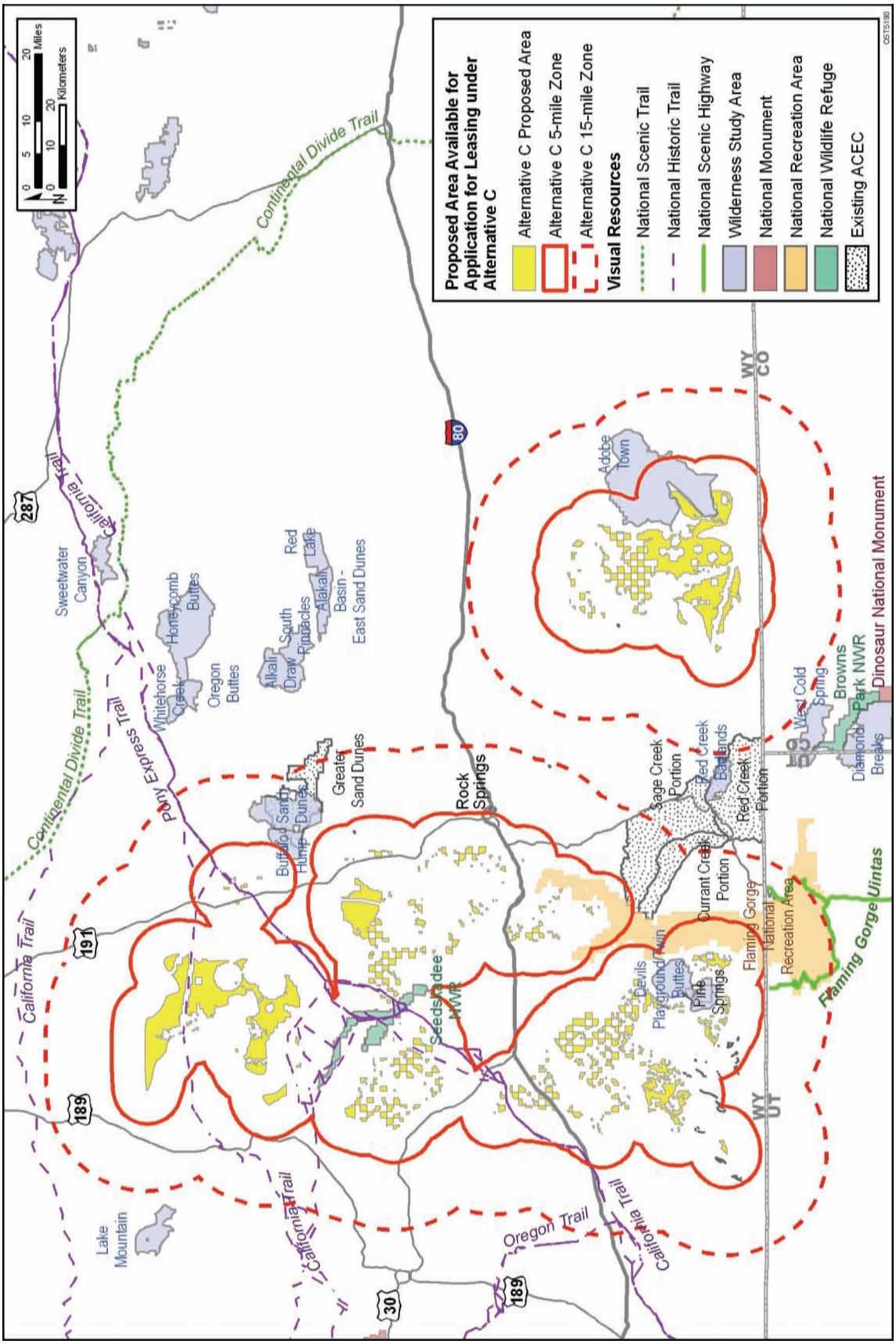

FIGURE 6.1.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C in Wyoming

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

	Total Land Area (acres) Available for Leasing Where Future Commercial Oil Shale Development Could Impact Wildlife Habitat Identified in BLM Land Use Plans		
Wildlife Habitat	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.)

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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).

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.)

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]	
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	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]	
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.)

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]	
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.)

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]	
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]

Activity	Individual Wyoming Field Offices			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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.)

Activity	Individual Wyoming Field Offices			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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			Summary for Field Offices
	Kemmerer	Green River/Rock Springs	Great Divide/Rawlins	
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.

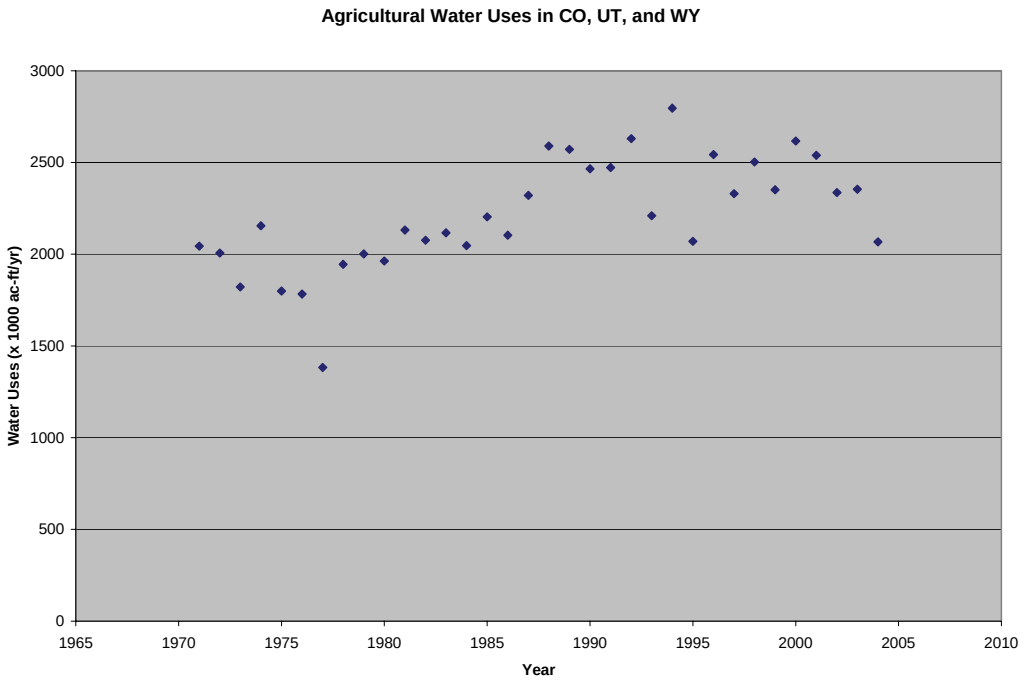

FIGURE 6.1.5-1 Agricultural Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

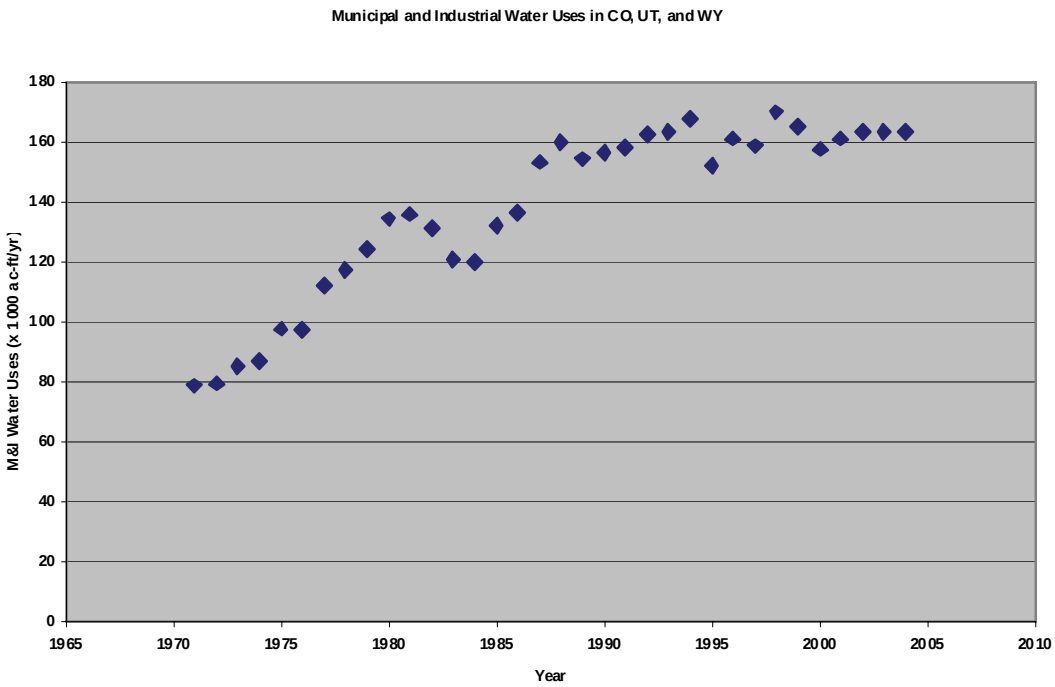

FIGURE 6.1.5-2 Municipal and Industrial Water Uses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

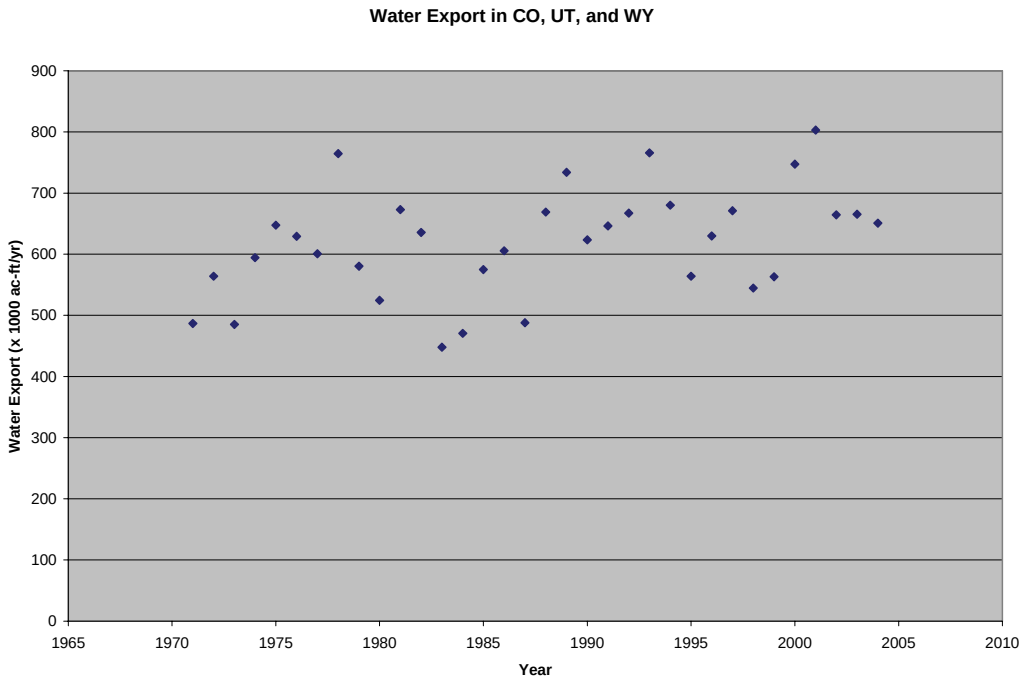

FIGURE 6.1.5-3 Water Exports from the Upper Colorado River Basin in Colorado, Utah, and Wyoming from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

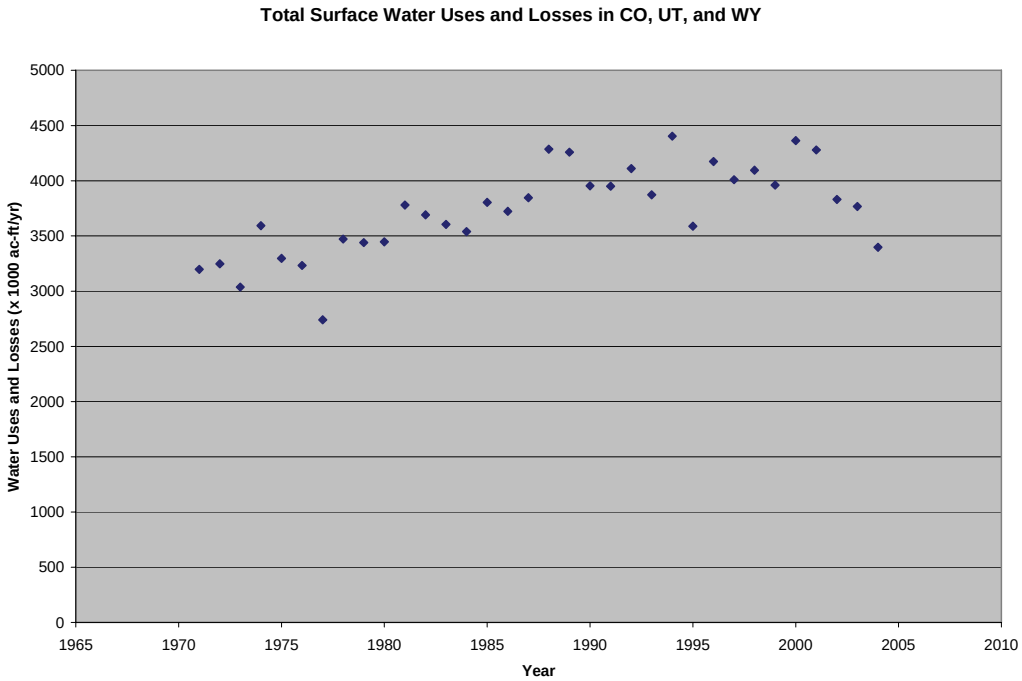

FIGURE 6.1.5-4 Combined Water Uses and Losses in Colorado, Utah, and Wyoming in the Upper Colorado River Basin from 1970 through 2004 (Sources: BOR 2004, 2005, 2006)

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]

	Amount of Overlap (acres)	
Potential ACEC	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.

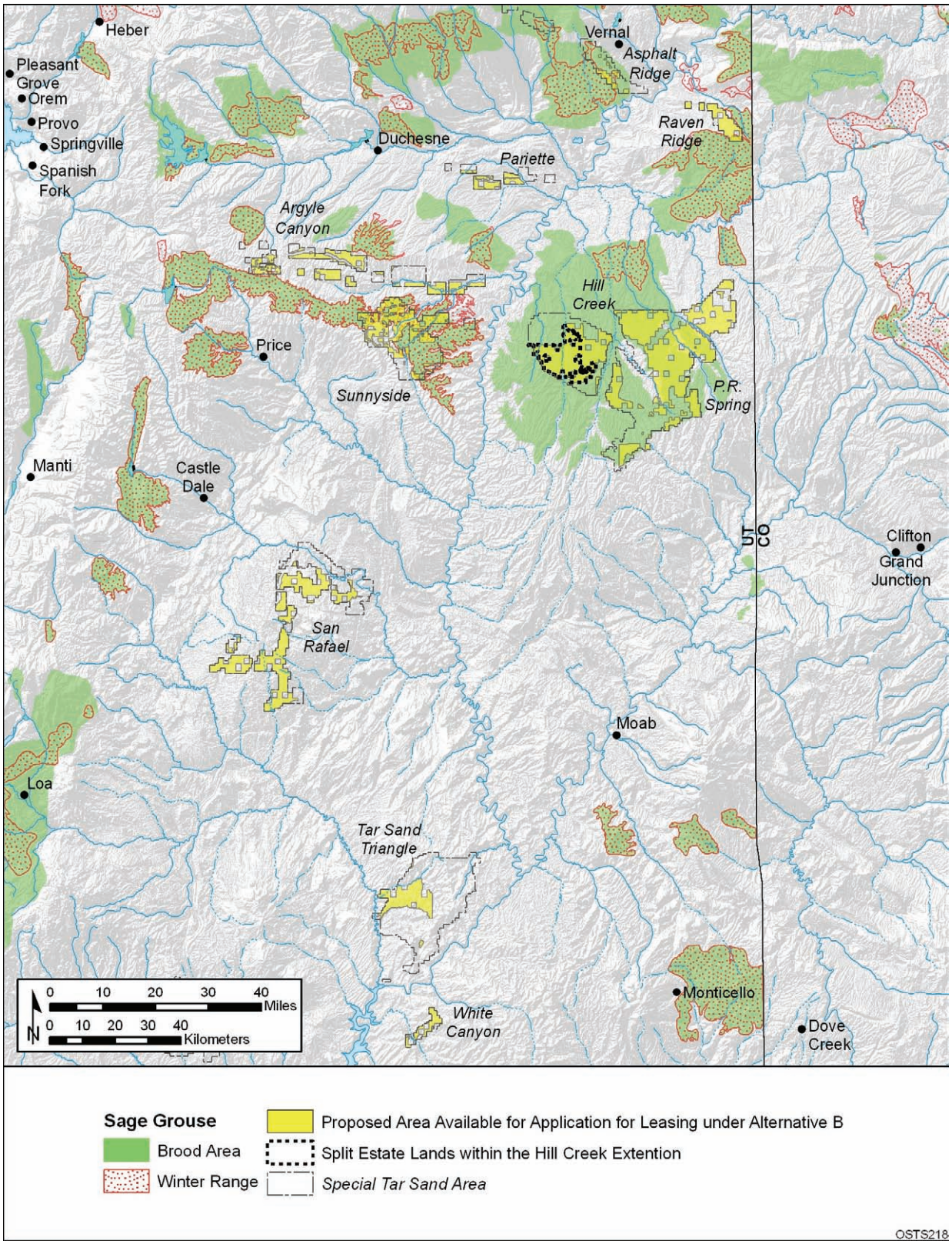

FIGURE 6.2.2-1 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Known Distribution of the Greater Sage-Grouse

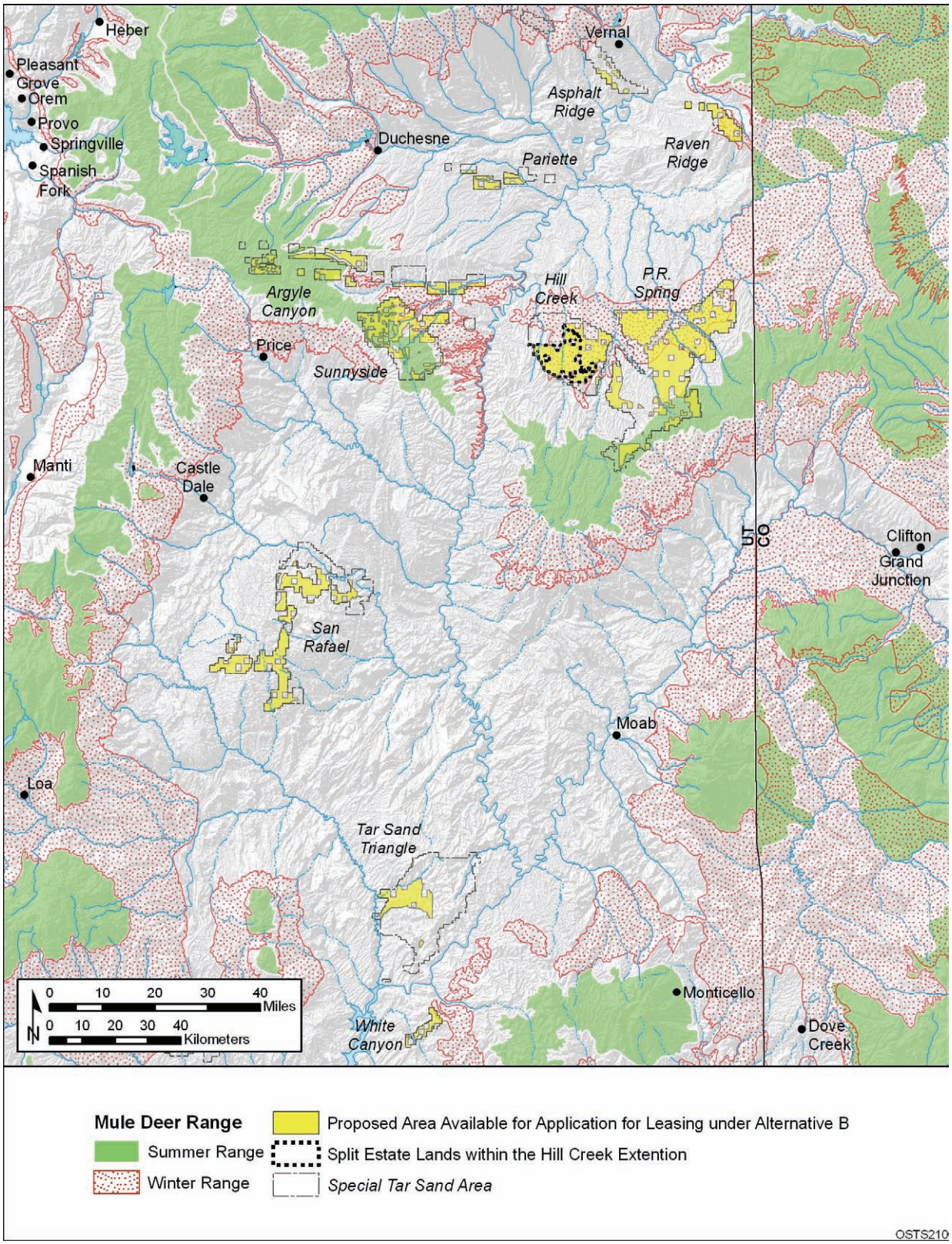

FIGURE 6.2.2-2 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Mule Deer

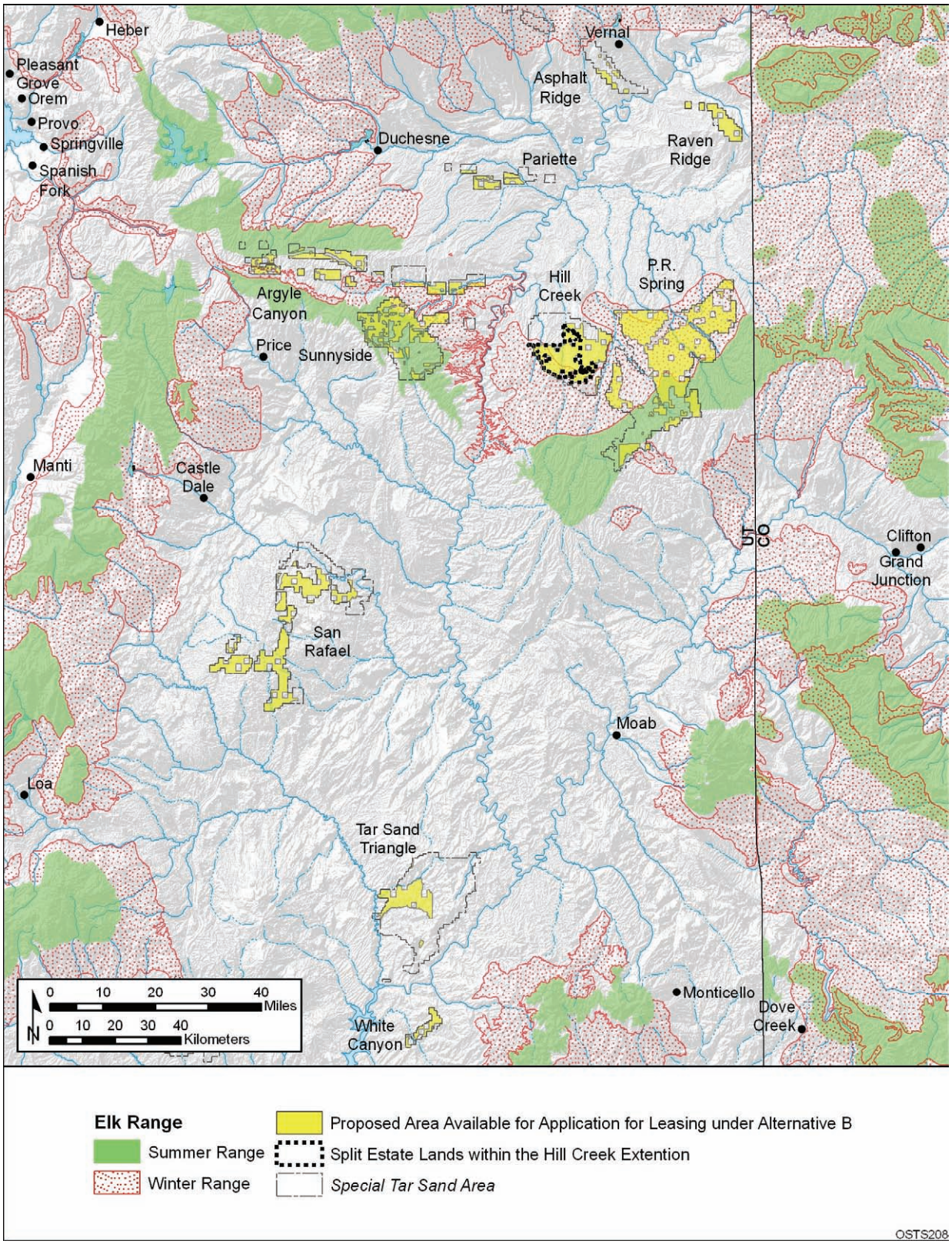

FIGURE 6.2.2-3 Overlap of Lands Made Available for Application for Leasing under Alternative B with the Summer and Winter Ranges of the Elk

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.

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.

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

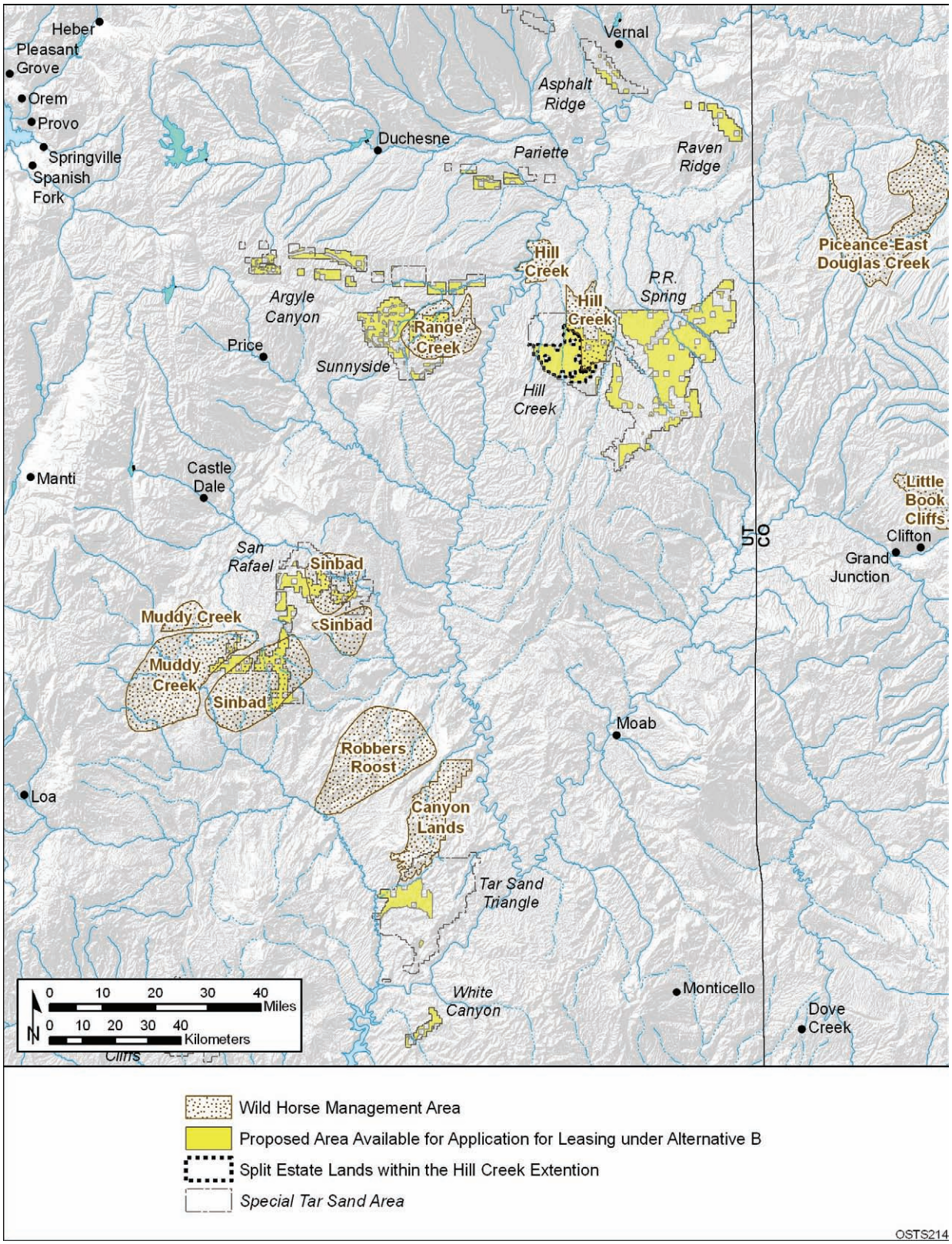

FIGURE 6.2.2-4 Overlap of Lands Made Available for Application for Leasing under Alternative B with Wild Horse Herd Management Areas

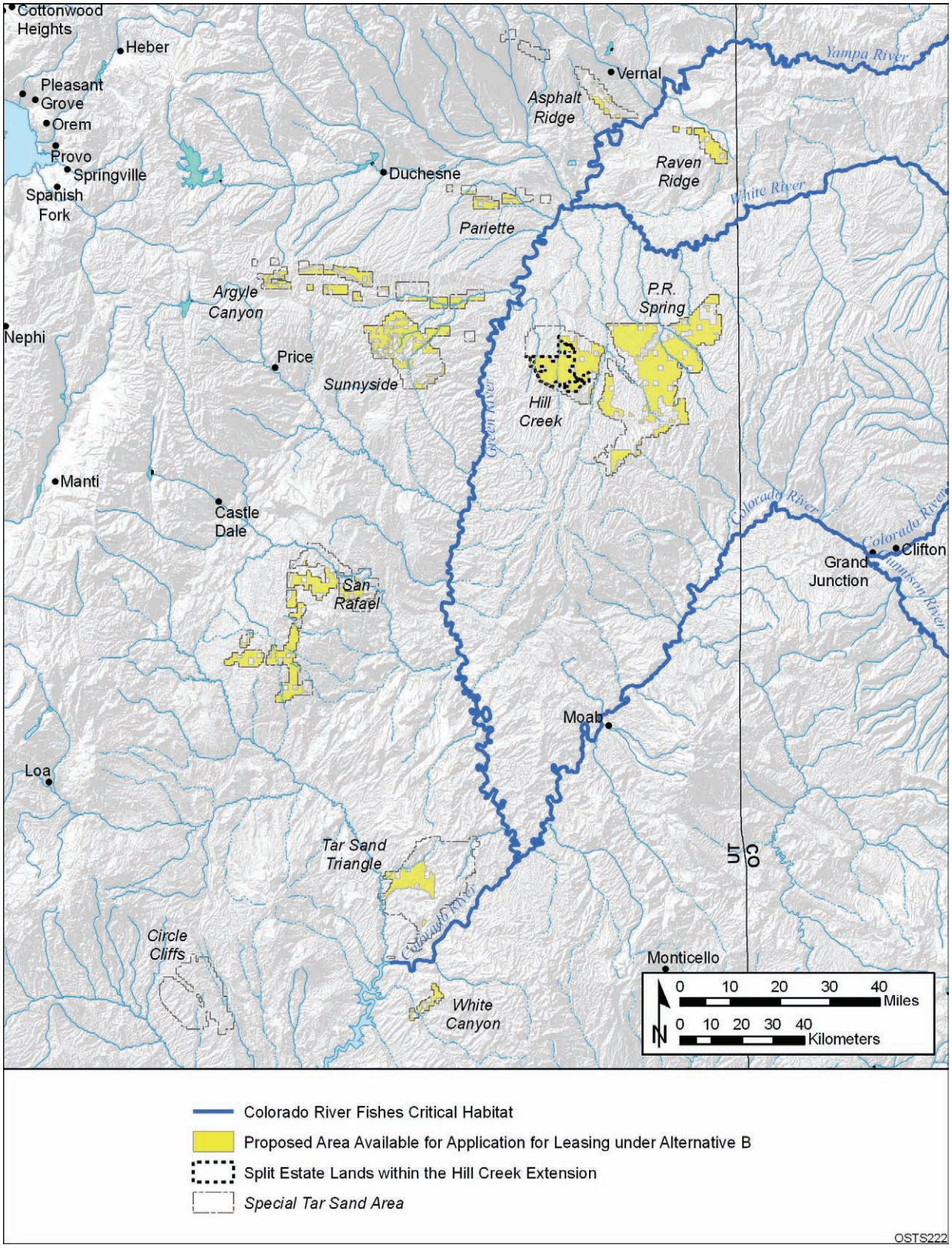

FIGURE 6.2.2-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative B

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,

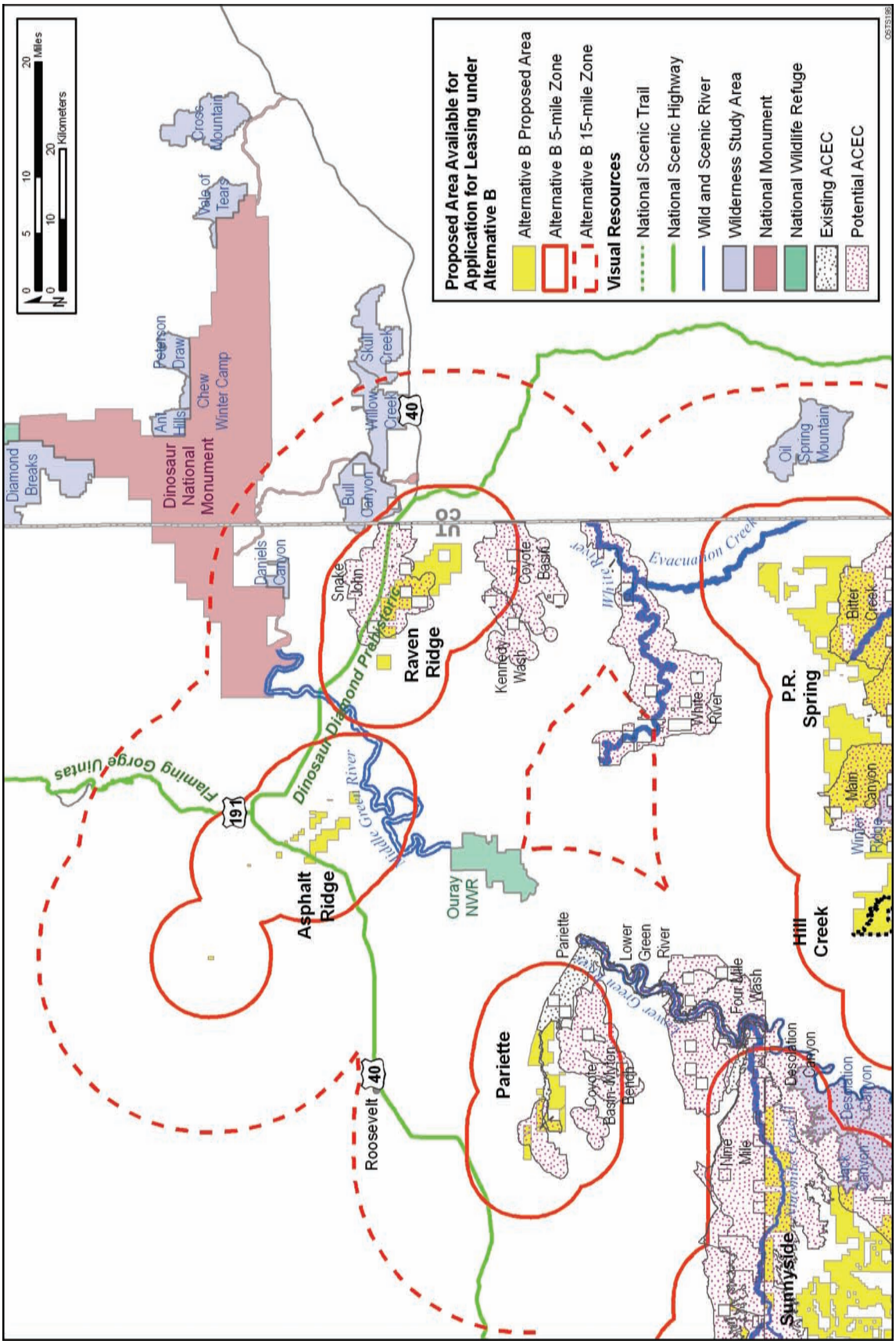

FIGURE 6.2.2-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Asphalt Ridge, Pariette, and Raven Ridge STSAs

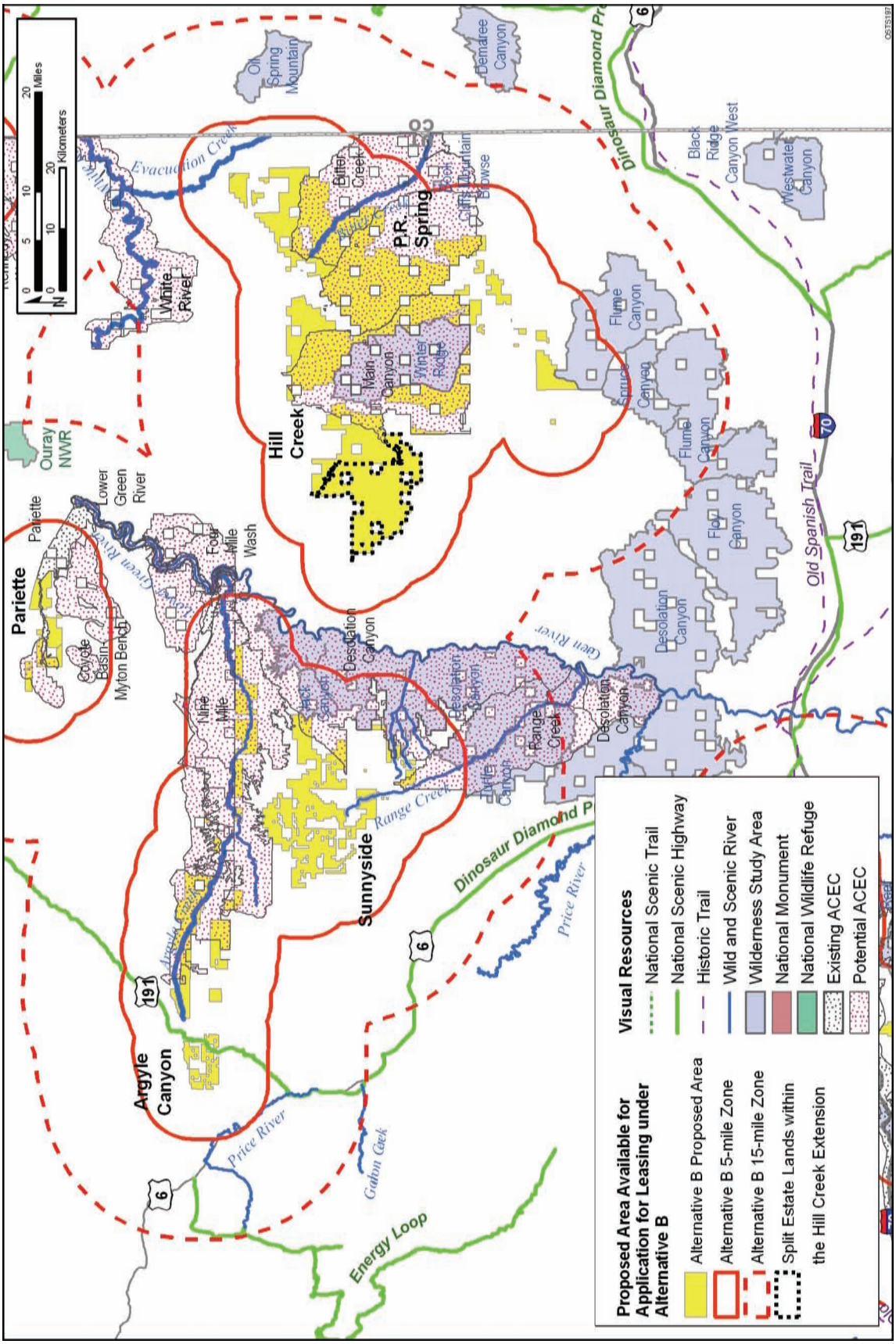

FIGURE 6.2.2-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Argyle Canyon, Hill Creek, P.R. Spring, and Sunnyside STSAs

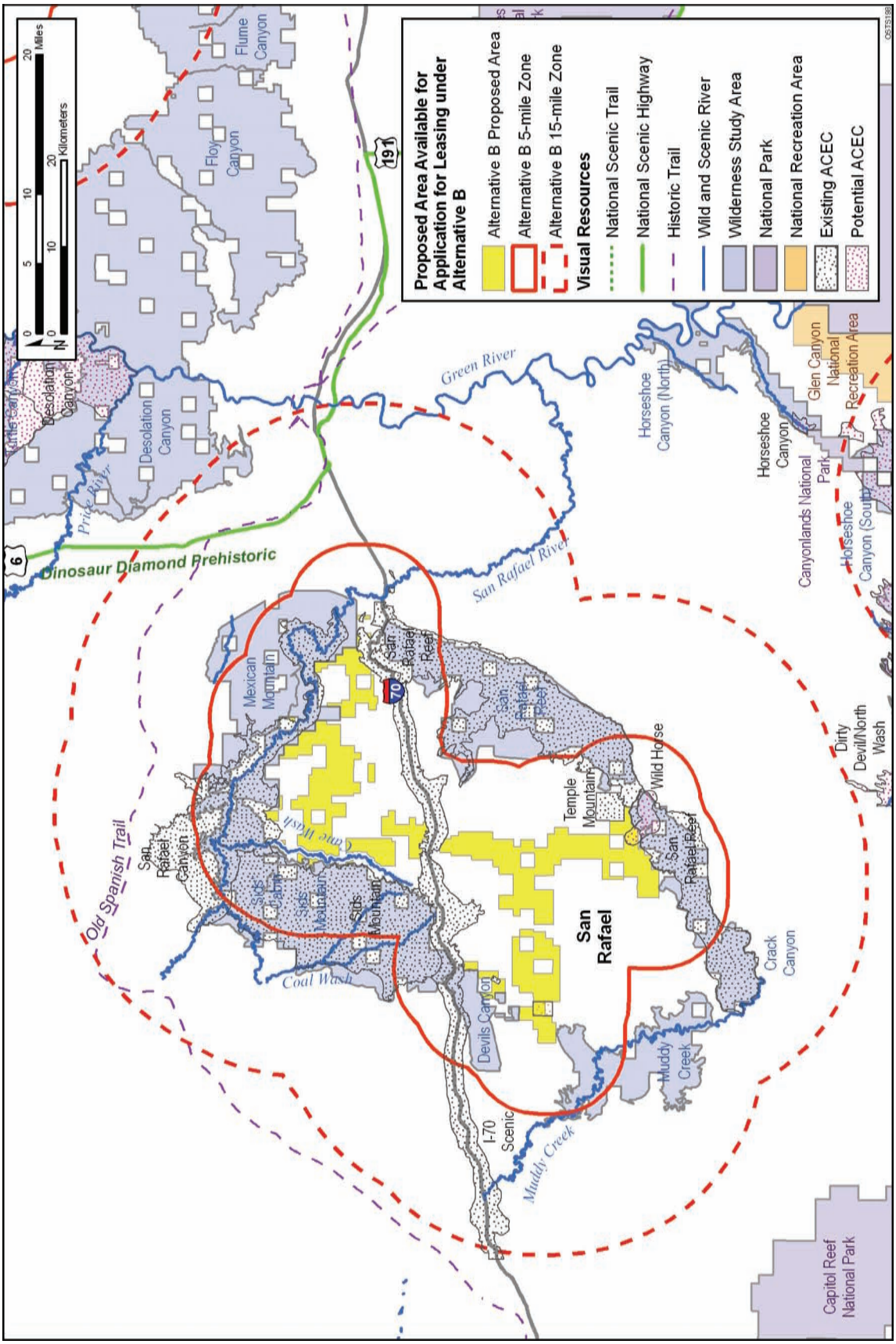

FIGURE 6.2.2-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the San Rafael STSA

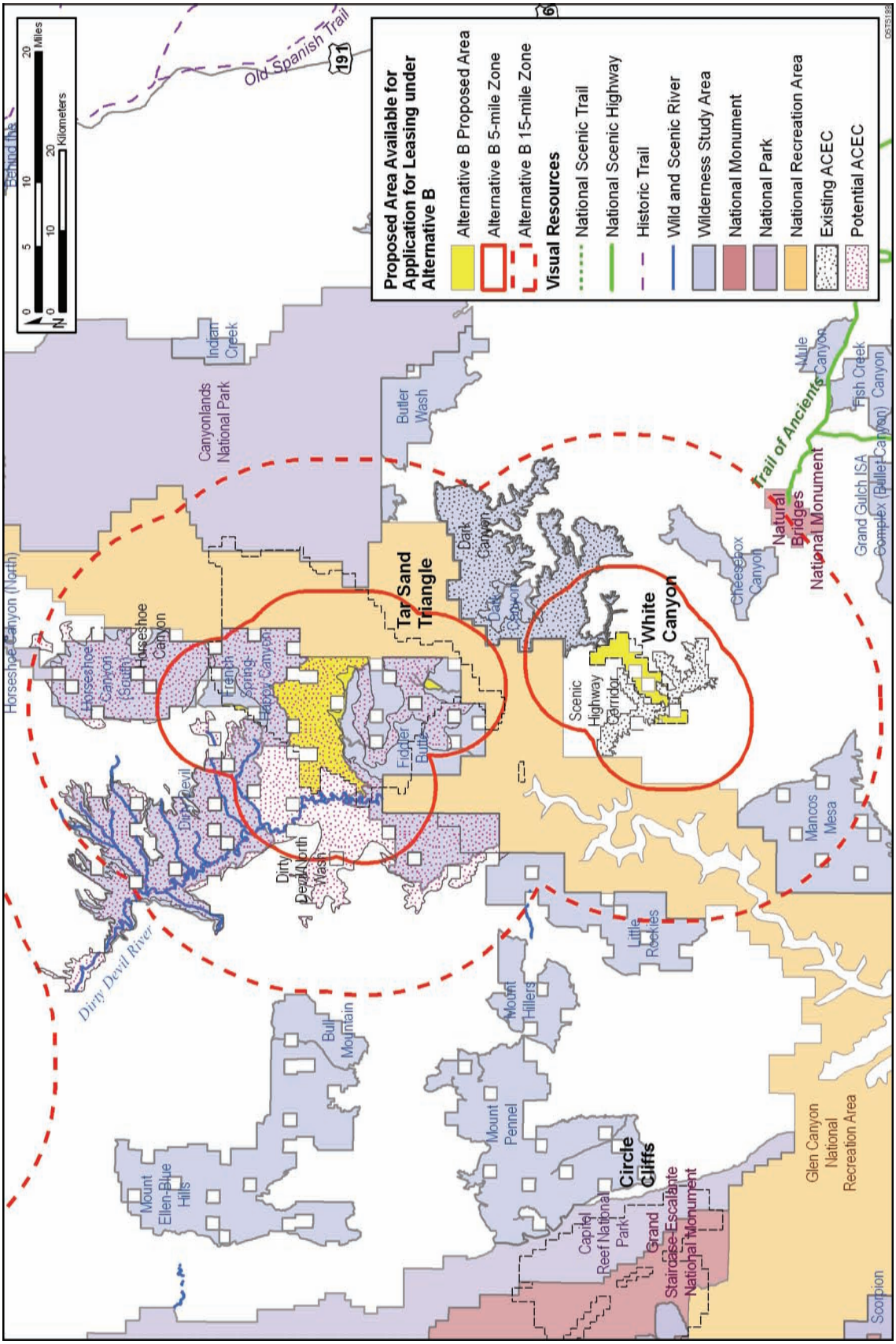

FIGURE 6.2.2-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative B for the Tar Sand Triangle and White Canyon STSAs

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).

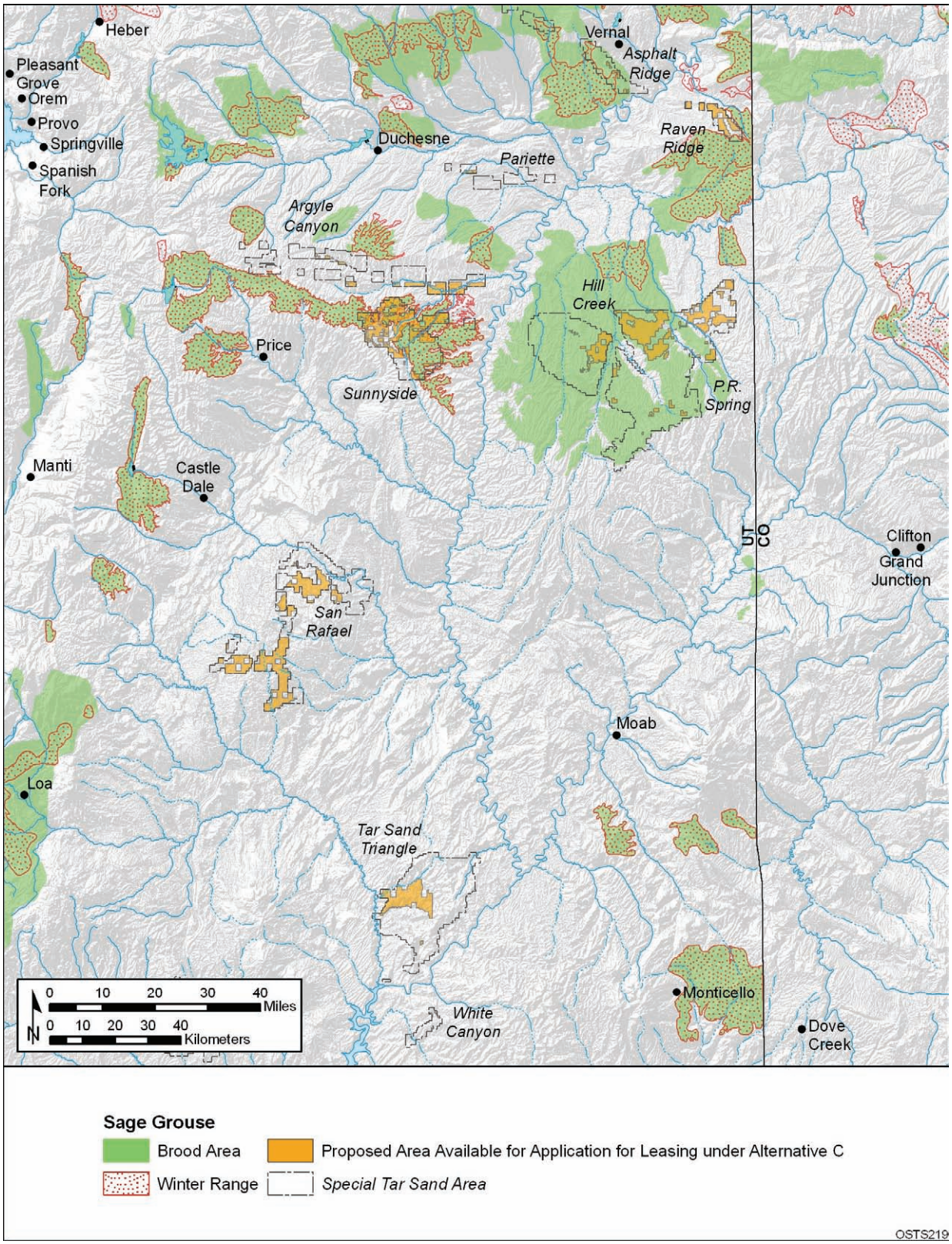

FIGURE 6.2.3-1 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Known Distribution of the Greater Sage-Grouse

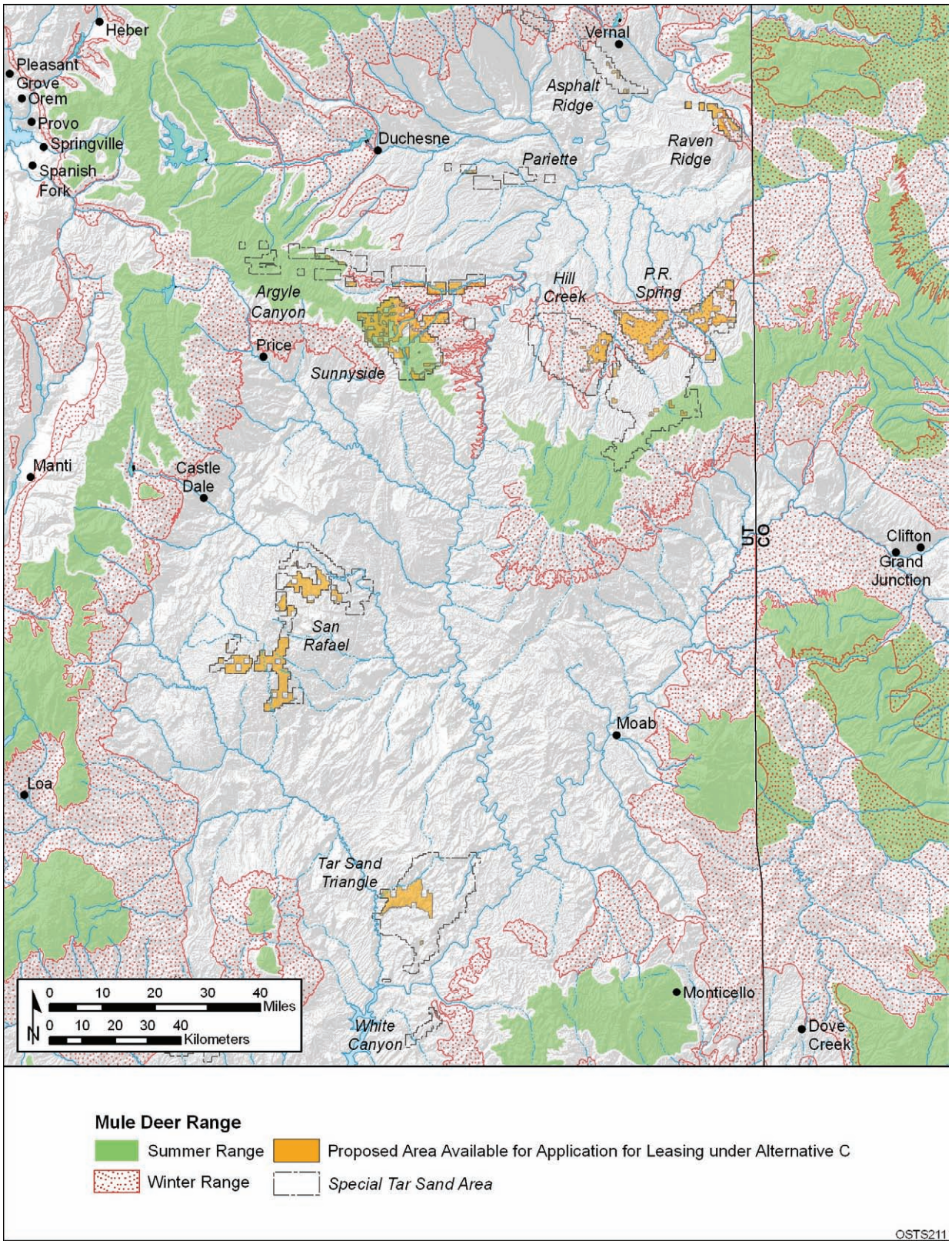

FIGURE 6.2.3-2 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Mule Deer

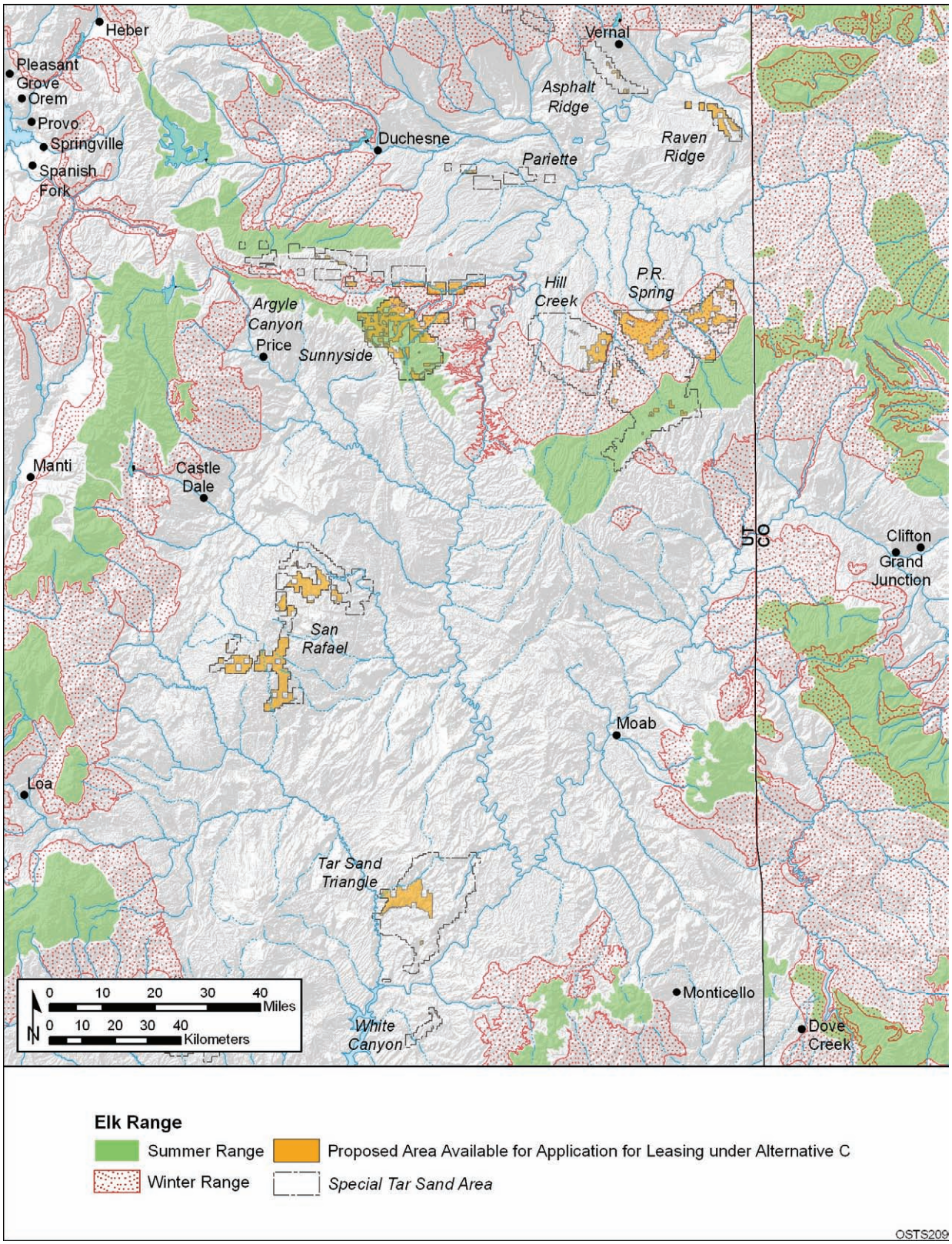

FIGURE 6.2.3-3 Overlap of Lands Made Available for Application for Leasing under Alternative C with the Summer and Winter Ranges of the Elk

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.

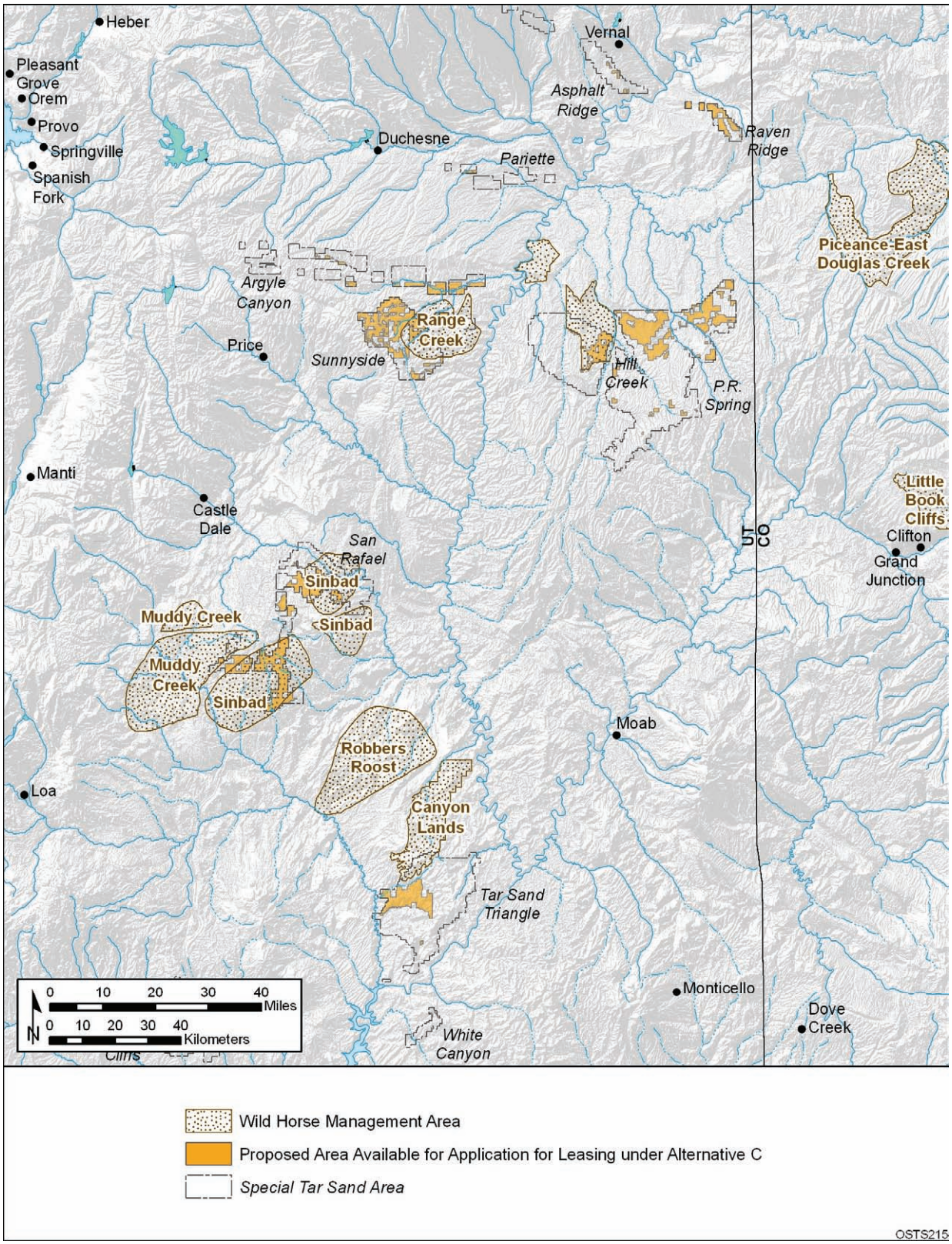

FIGURE 6.2.3-4 Overlap of Lands Made Available for Application for Leasing under Alternative C with Wild Horse Herd Management Areas

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

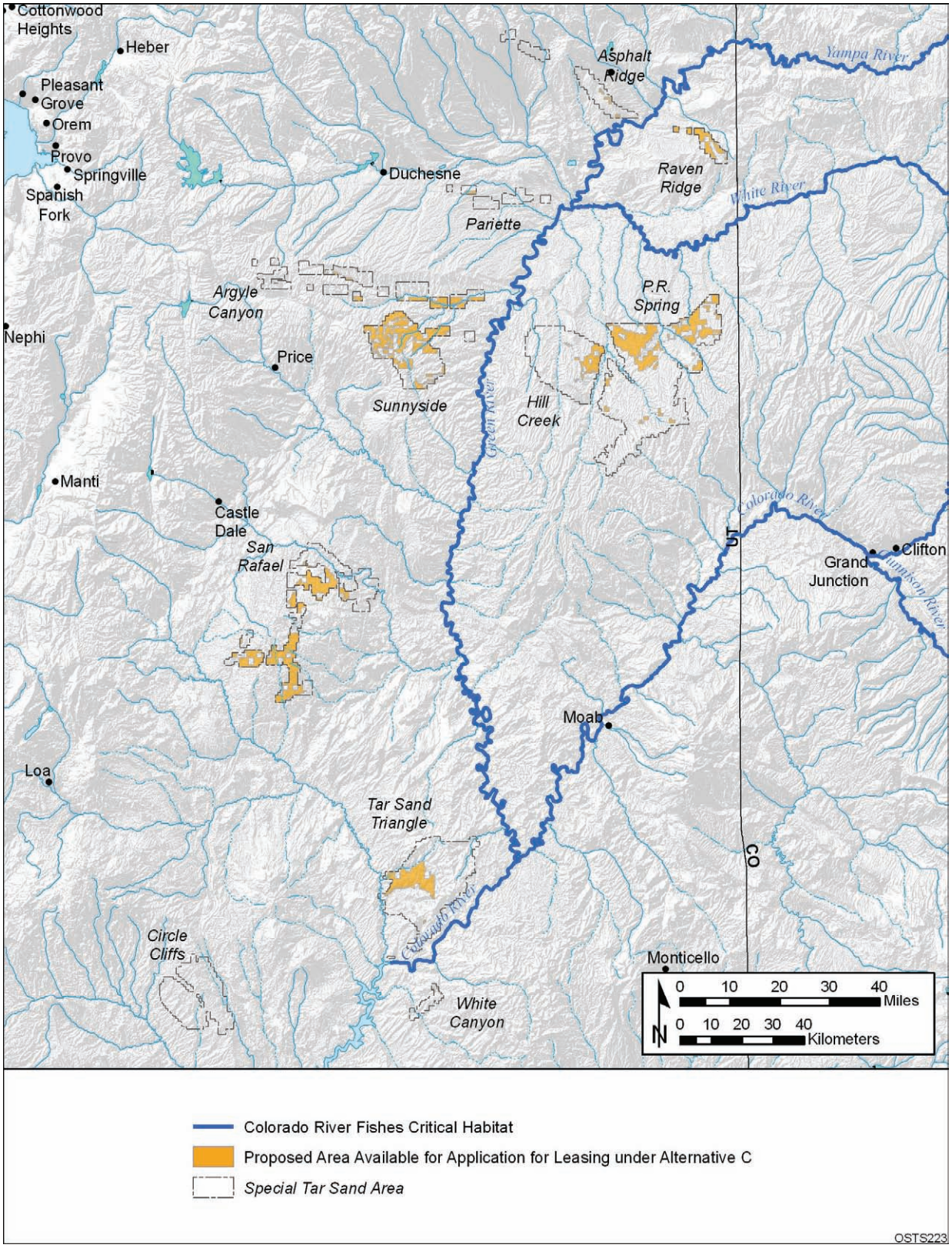

FIGURE 6.2.3-5 Designated Critical Habitat of Endangered Colorado River Fishes That Cross Lands Made Available for Application for Leasing under Alternative C

- 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.

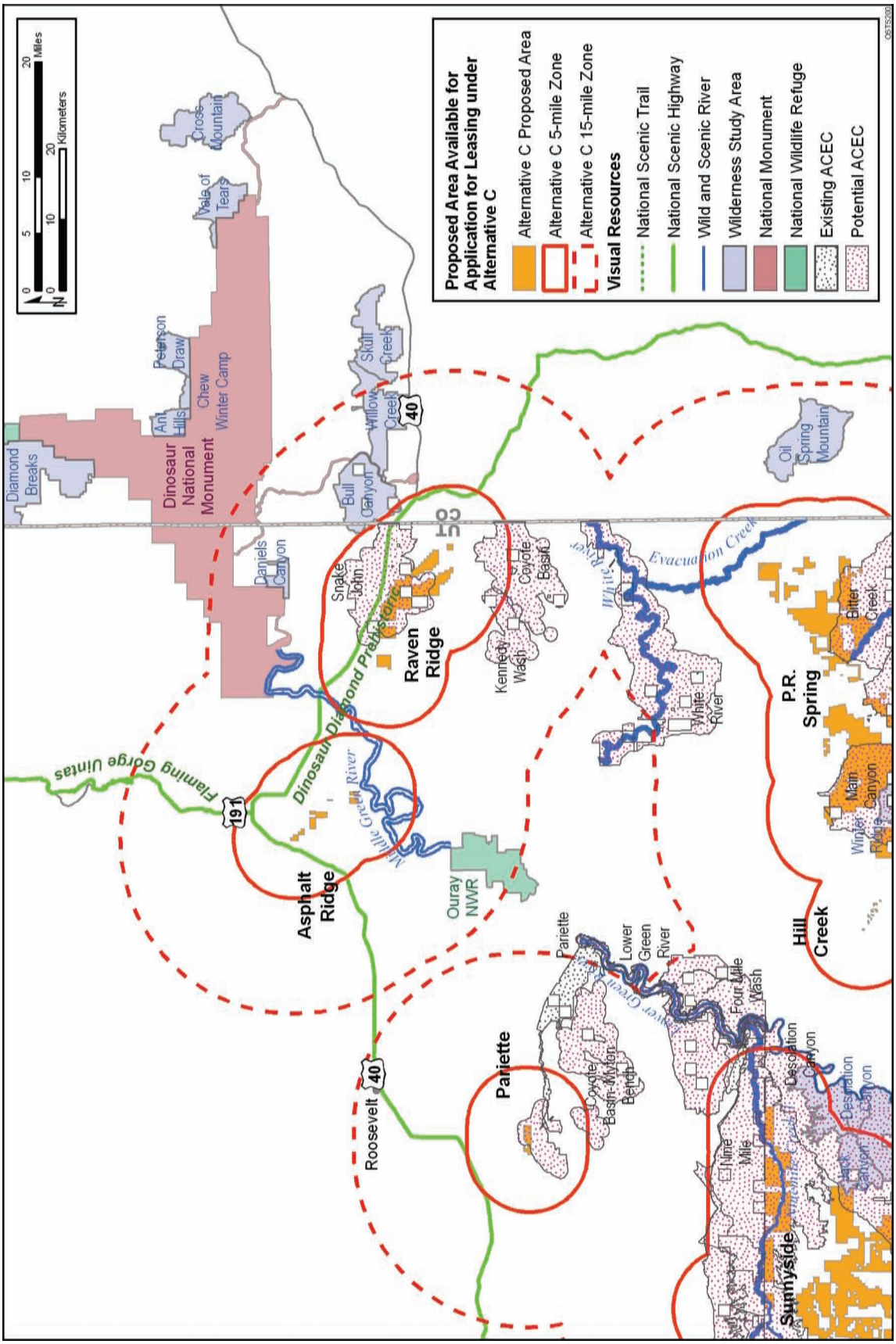

FIGURE 6.2.3-6 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Asphalt Ridge, Pariette, and Raven Ridge STSAs

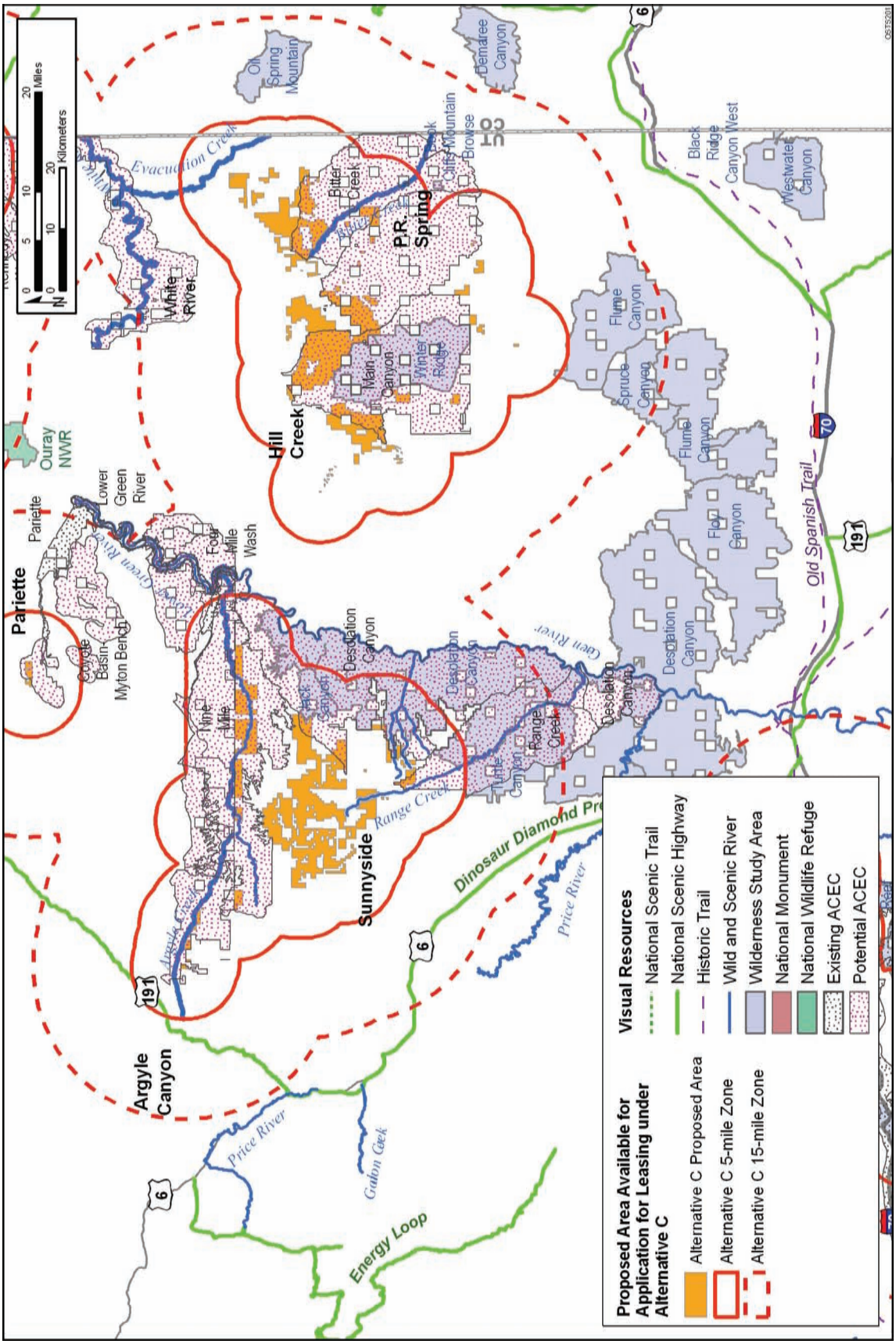

FIGURE 6.2.3-7 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Hill Creek, P.R. Spring, and Sunnyside STSAs

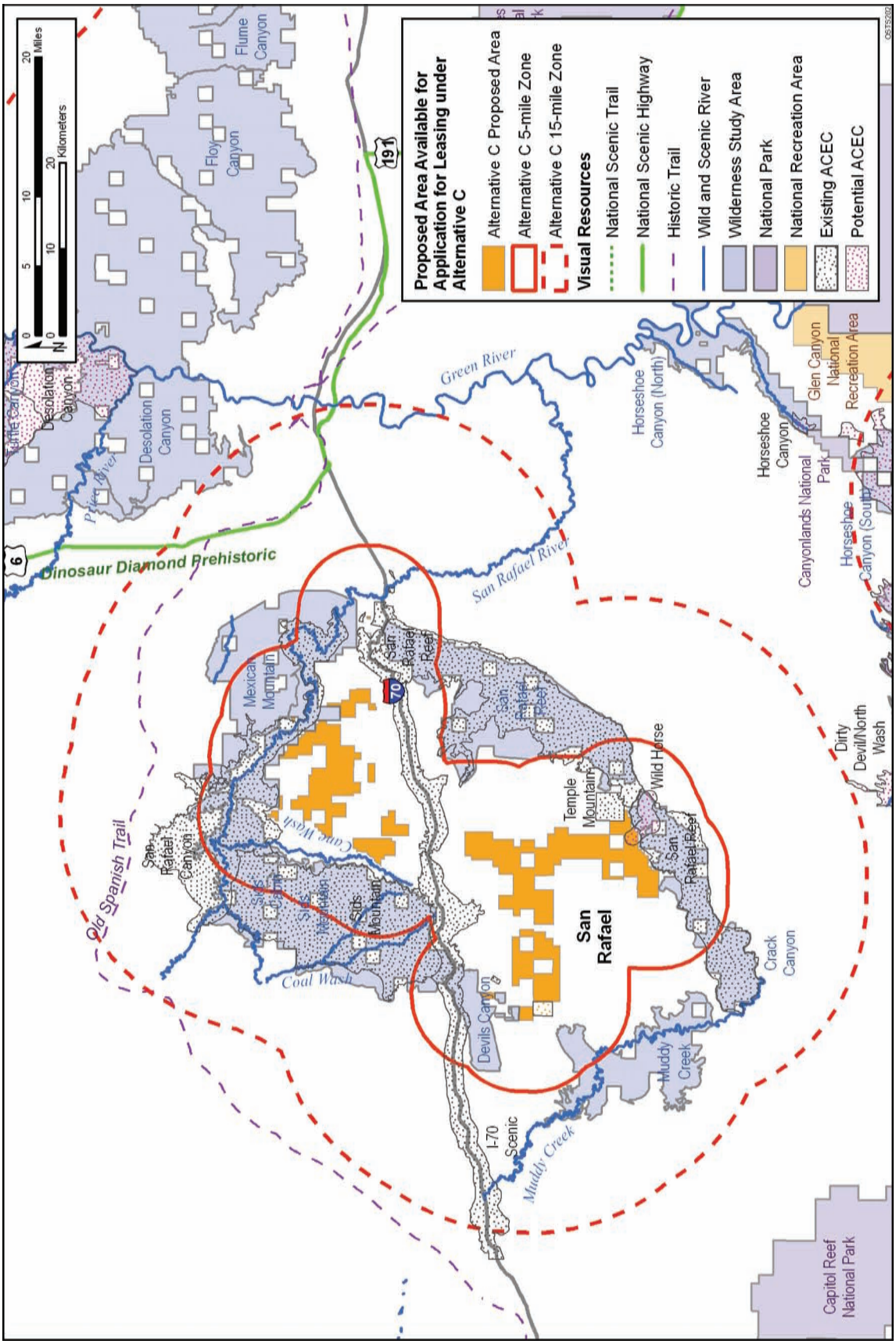

FIGURE 6.2.3-8 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the San Rafael STSA

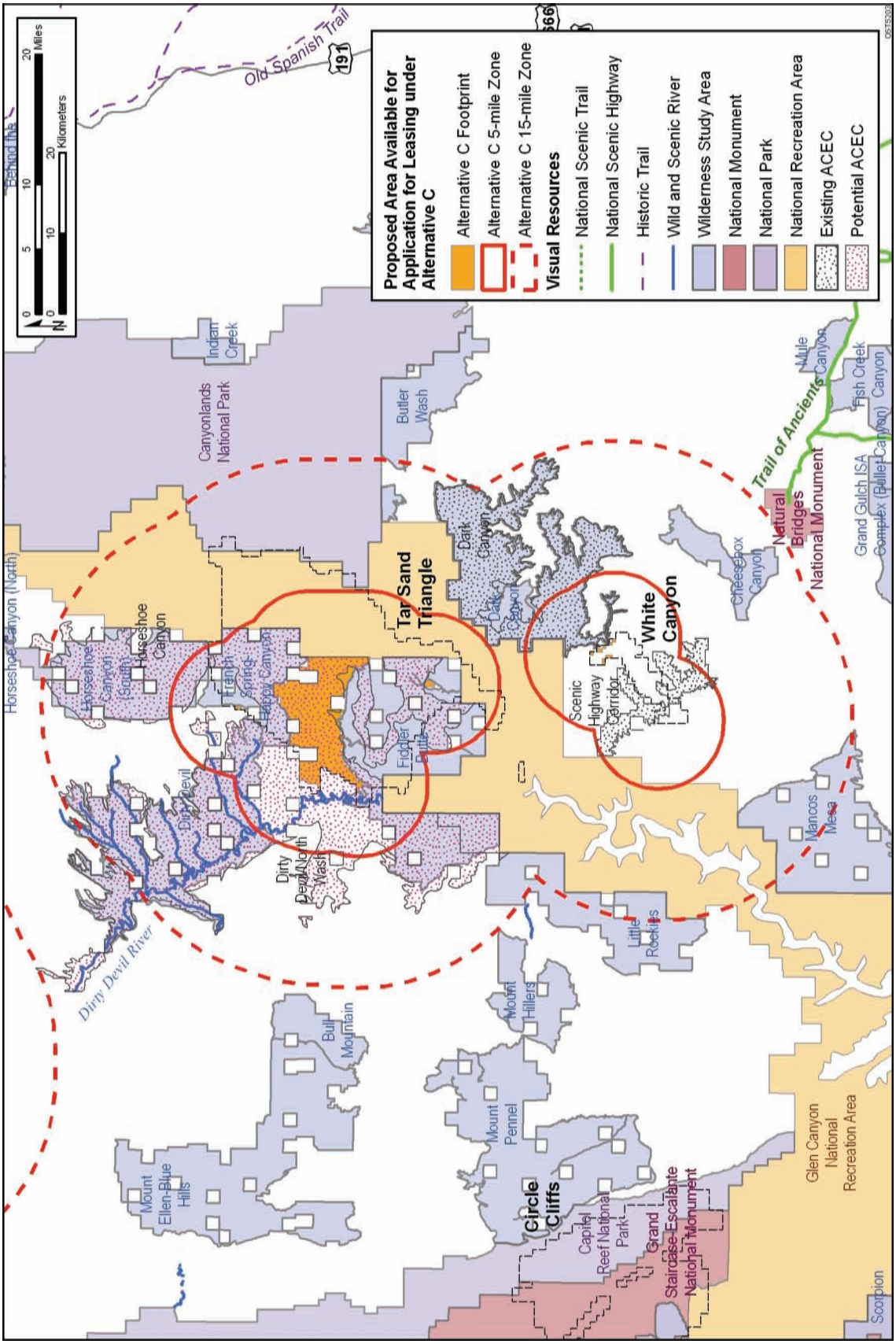

FIGURE 6.2.3-9 Scenic Resource Areas within the 5-mi and 15-mi Zones around the Lands Made Available for Application for Leasing under Alternative C for the Tar Sand Triangle and White Canyon STSAs

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.)

[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

[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

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