CHAPTER 3

AFFECTED ENVIRONMENT

Page

CHAPTER 3

AFFECTED ENVIRONMENT

3.0 INTRODUCTION

The Affected Environment chapter of this environmental impact statement (EIS) for the proposed Atlantic Rim Natural Gas Project discusses environmental, social, and economic factors as they currently exist within the Atlantic Rim Project Area (ARPA). The material presented here has been guided by management issues identified by the Bureau of Land Management (BLM), Great Divide Resource Area (GDRA), public scoping, and by interdisciplinary field analysis of the area.

This proposal could potentially affect critical elements of the human environment as listed in BLM's National Environmental Policy Act (NEPA) Handbook H-1790-1 (USDI-BLM 1988). The critical elements of the human environment, their status in the ARPA and their potential to be affected by the proposed project are listed in Table 3-1.

Table 3-1. Critical Elements of the Human Environment[1], Atlantic Rim Natural Gas Project, Carbon County, Wyoming.

Element	Status on the ARPA	Addressed in text of EIS
Air quality	Potentially affected	Yes
Areas of critical environmental concern	Potentially affected	Yes
Cultural resources	Potentially affected	Yes
Environmental justice	Potentially affected	Yes
Prime or unique farmlands	None present	No
Floodplains	None present	Yes
Native American religious concerns	Potentially affected	Yes
Noxious weeds	Potentially affected	Yes
Threatened and endangered species	Potentially affected	Yes
Hazardous or solid wastes	Potentially affected	Yes
Water quality (surface and ground water)	Potentially affected	Yes
Wild and scenic rivers	None present	No
Wetlands/riparian zones	Potentially affected	Yes
Wilderness	None present	No

[1] As listed in BLM *National Environmental Policy Act Handbook H-1790-1* (BLM 1988) and subsequent Executive Order

CHAPTER 3: AFFECTED ENVIRONMENT

In addition to the critical elements, this EIS discusses potential effects of the project on geology/paleontology/soils, water resources, vegetation, wildlife, special status species, noise, visual resources, recreation and socioeconomic considerations.

3.1 GEOLOGY / MINERALS / PALEONTOLOGY

3.1.1 Geology Resources

3.1.1.1 Regional Geologic Overview

The ARPA straddles the west margin of the Continental Divide and lies within the southeastern arm of the Great Divide Basin sub-basin region of the Greater Green River Basin (Johnson 1985) of southernmost central Wyoming. Structurally, rocks in the ARPA dip generally northwest, west, and southwest off the arcuate structural high of the Sierra Madre Range westward into the eastern edges of the Greater Green River and Washakie structural basins.

The west flank of the Sierra Madre is bounded by a major eastward dipping reverse fault system along which it was elevated over the eastern edge of the Greater Green River Basin (including the Washakie Basin) during the Laramide Orogeny which occurred in the late Cretaceous to Early Tertiary time. These reverse faults are not exposed at the surface, but rather lie buried beneath Early Tertiary sediments filling the basin. The Washakie Basin to the west, into which the surface rocks dip, is bound by east-west oriented structural highs, the Wamsutter Arch and Cherokee Ridge, to the north and south, respectively. The structural axis of Cherokee Ridge trends along the Wyoming-Colorado State line and separates the extreme southeastern arm of the Greater Green River Basin of Wyoming from the Sand Wash Basin of Colorado. Numerous faults occur along Cherokee Ridge, many of which show evidence of recurrent motion throughout the last 20 million years. None of these, however, show any indication of Quaternary movement (Case et al. 1994).

Geologic mapping by the USGS and Wyoming Geologic Survey (Weitz and Love 1952, Love 1970, Love and Christiansen 1985, Love et al. 1993, Roehler 1973, 1977, 1985) document that the ARPA is underlain at the surface by sedimentary deposits of Quaternary, Tertiary and Late Cretaceous age. These deposits are underlain by Phanerozoic age sedimentary rocks of Cretaceous to Cambrian age, which are in turn underlain by Precambrian metamorphic bedrock that comprises part of the ancient North American craton and exceeds 2 billion years in age.

Information on geologic units preserved at the surface and beneath the project is provided in Table 3-2. Rock terminology for the Cretaceous (Mesaverde Group) is complicated in that scientific studies of these rocks reference a number of different formations within the ARPA. Although the Wyoming Chart of Stratigraphic Nomenclature lists the Almond, Ericson, Rock Springs, and Blair formations within the Mesaverde Group in the Washakie Basin, alternative terminology has been used for these same rocks by authors describing the coals of the Mesaverde. Rock equivalent names for the Ericson Sandstone include the Williams Fork Formation or Pine Ridge Sandstone; for the Rock Springs Formation include the Allen Ridge Sandstone Formations; and for the Blair Formation, the Haystacks Mountain Formation.

Additional details on surface deposits are provided below.

Table 3-2. Surface and subsurface geologic deposits – Atlantic Rim Project Area.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Surface Deposits			
Unnamed Quaternary Deposits	Holocene-Pleistocene	Eolian/fluvial/ landslide. Sand, gravel, clays, weathered in place residuum from exposed outcrops	None reported within area, economic deposits of windblown sand reported 20-30 miles NNE of the town of Baggs, Wyoming, just east of the project area
Browns Park Formation	Miocene	Alluvial fan/volcanic, Polymictic conglomerates, tuffaceous sandstone and mudstones	Vertebrate and plant fossils (BLM Condtion 2). No mineral resources reported within area. Uranium produced in adjacent areas (Ketchum Buttes, Miller Hill, Poison Basin).
Wasatch Formation	Early Eocene	Terrestrial:fluvial/flood plain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale and coal.	Vertebrate, invertebrate and plant fossils (BLM Condition 2). Coal. Petroleum in subsurface. Uranium reported in adjacent areas near Wamsutter Creston and Latham
Fort Union Formation	Paleocene	Terrestrial: fluvial/flood plain/swamp, chiefly somber colored sandstones, mudstones, carbonaceous shales and coals.	Vertebrates, invertebate and plant fossils (BLM Condition 2). Coal. Coalbed Natural Gas.
Lance Formation	Late Cretaceous	Terrestrial: fluvial/flood plain/swamp, brown and gray sandstone , shale and mudstone, coals, and carbonaceous shales.	Vertebrate, invertebrate and plant fossil (BLM Condition 2). Coal. Coalbed Natural Gas.
Fox Hills Sandstone	Late Cretaceous	Marine: shoreline, light-colored sandstone and gray sandy shale	Vertebrate and invertebrate fossils (BLM Condition 3). No mineral resources reported.
Lewis Shale	Late Cretaceous	Marine: nearshore to offshore, gray shale containing gray, brown sandstones.	Invertebrate fossils. Petroleum in Espy Field.

Table 3-2. Continued.

Geologic Deposit		Geologic Age	Environment/Lithology	Resources
Mesaverde Group	Almond Formation	Late Cretaceous	Marine, Terrestrial, deltaic: white and brown sandstone, sandy shale, coal, carbonaceous shale	Vertebrate, invertebrate and plant fossils (BLM Condition 2) Coal. Coalbed Natural Gas. Petroleum in Baldy Butte, Cherokee Creek, Cow Creek, Creston, Deep Gulch, Espy, Savery Fields.
	Ericson Sandstone (=Pine Ridge or Williams Fork Formation)	Late Cretaceous	Marine: coastal plain, estuary/beach , white sandstone, lenticular conglomerate, coal	
	Rock Springs (=Allen Ridge or Iles) Formation	Late Cretaceous	Terrestrial, coastal plain white to brown sandstone, shale, mudstone, coal	
	Blair (=Haystack Mountains) Formation	Late Cretaceous	Marine:	
Subsurface				
Steele Shale (includes Shannon, Sussex Sandstones)		Late Cretaceous	Marine, gray shale, with numerous bentonites, sandstone	Petroleum in Browning Cherokee Creek, Cow Creek, Deep Creek, Deep Gulch, Sierra Madre Fields.
Niobrara Formation		Late Cretaceous	Marine, light-colored limestone, gray limey shale	Petroleum in Espy Field.
Frontier Formation		Late Cretaceous	Marine: deltaic, gray sandstone and sandy shale	Petroleum in Browns Hill, Cherokee Creek, Cow Creek, Deep Gulch, Sugar Creek Fields.
Mowry Shale		Late Cretaceous	Marine: silver-gray, hard siliceous shale, with abundant fish scales and bentonites	Bentonites, mined about 10 miles east of area.
Muddy Sandstone		Early Cretaceous	Marine: deltaic, gray to brown sandstone, conglomeratic	Petroleum in Browning, Deep Creek, Sugar Creek Fields.
Thermopolis Shale		Early Cretaceous	Marine, black, soft, fissile shale	None reported, oil and gas source rock

Table 3-2. Continued.

Geologic Deposit	Geologic Age	Environment/Lithology	Resources
Cloverly Formation (=Dakota Sandstone)	Early Cretaceous	Terrestrial, variegated mudstone, bentonitic, conglomeratic sandstone	Petroleum in Browning, Cherokee Creek Fields.
Morrison Formation	Jurassic	Terrestrial, varicolored mudstones, white sandstone, bentonite	Petroleum in Browning Field.
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone	none reported
Nugget Sandstone	Triassic to Jurassic	Eolian, gray to red, massive to cross-bedded sandstone	Petroleum in Cow Creek, Deep Gulch Fields.
Chugwater Formation	Triassic	Terrestrial/mud flat, red shale and siltstone, sandstone	Petroleum in Browning Field.
Goose Egg Formation	Permian to Triassic	Marine, gray to olive dolomitic siltstone; red sandstone and siltstone, gypsum, halite, purple to white dolomite and limestone	none reported
Tensleep Sandstone	Pennsylvanian	Marine, white to gray sandstone with limestone and dolomite	Petroleum in Browning, Espy, Sugar Creek Fields.
Amsden Formation	Mississippian to Pennsylvanian	Marine, red and green shale and dolomite, persistent red to brown sandstone at base	none reported
Madison Limestone	Mississippian	Marine, glue-gray massive limestone and dolomite	none reported
Flathead Sandstone	Cambrian	Marine/shoreline, red, banded, quartzose sandstone	none reported
unnamed metamorphic rocks	Precambrian	Igneous/metamorphic, granitic and/or intrusive	none in area but in Sierra Madre contain ores of uranium, copper, silver, lead, zinc, gold, and barium industrial (building and decorative) grades of quartzite, marble, and granite

3.1.1.2 Quaternary Deposits

Quaternary deposits in the ARPA include widespread deposits of alluvium, colluvium and slope wash; eolian sand dunes; residuum developed on formations of Cretaceous (Lance and Lewis Formation and Mesaverde Group), Paleocene (Fort Union Formation), and Eocene (Wasatch Formation) age; and mass movement (including landslide) debris.

Tertiary – Browns Park Formation

The Miocene Browns Park Formation unconformably overlies all older rocks exposed at the surface within the ARPA, with its largest area of outcrop developed in the S1/2, T13N:R90W, where it overlies the Lewis Shale, Lance, Fort Union, and Wasatch Formations with angular unconformity. The Browns Park Formation continues north into the E1/3 of T14N:R90W, and the SE1/4 T15N:R90W, where it overlies the Mesaverde Group and Lewis Shale. Two large outliers of Browns Park Formation cap ridges form the highest elevations in the ARPA, in the SE1/4, T17N:R90W, and the SE1/4, T18N:R90W, where they overlie truncated hogbacks expressed in the Mesaverde Group. Regionally, the Browns Park Formation consists of up to 1,000 feet (305m) of polymictic conglomerate (especially at the base of the formation), derived from Precambrian and Paleozoic sources, and tuffaceous sandstones and mudstones (Ritzma, 1949). Mudstones of the formation are known to be rich in montmorillonite, a swelling clay, and as a result, it is extensively involved in mass movement (earth flow) in some areas.

Tertiary – Wasatch Formation

Outliers of Tertiary age rocks are exposed at three places within the ARPA: (1) just northeast of the town of Baggs, in Sec. 35, T13N:R91W, where it overlies the Paleocene Fort Union Formation; and (2) as two distinct outliers capping the highest hills in the E1/2, T14N:R91W, overlying rocks of the Upper Cretaceous Lance Formation and Lewis Shale with angular unconformity.

These outliers include flat-lying sandstones and variegated mudstones of obvious Tertiary age that lie with marked angular unconformity on underlying older rocks. (Weitz and Love 1952) mapped the outlier rocks as the Wasatch Formation of Eocene age. Later, Love and Christiansen (1985) mapped them as rocks of the Browns Park Formation of Miocene age. The presence of well-indurated sandstones and variegated (including red) mudstones in these Tertiary deposits, which are like the Wasatch Formation (main body Member) and very unlike the Browns Park Formation, suggests the deposits are correctly identified as the Wasatch Formation. This interpretation is supported by the occurrence of rocks of the Wasatch Formation at the same elevation (about 7,200 feet) as these deposits a few miles to the west of Wyoming State Highway 789 at Flat Top Mountain. The nearest rocks of the Browns Park Formation occur several miles to the east at much higher elevations (7,600+ feet).

Regionally, the main body of the Wasatch Formation consists of up to 2,130 feet (650m) of drab to variegated mudstone, gray sandstone, carbonaceous shale, and coal (Bradley 1964, Sullivan 1980, Roehler 1985) that accumulated in alluvial channels and back swamps, as well as, on more distal floodplains. Mudstones and shales of the formation are readily eroded into badlands, but most of the sandstones are resistant and form prominent outcrops.

Tertiary – Fort Union Formation

The Paleocene Fort Union Formation is exposed in an arcuate outcrop that borders the entire western margin of the ARPA. Within this area proper, however, the formation is exposed only in a few minor areas, located in: the NE1/4, T13N:R91W and the C of T14N:R91W; in the NE1/4, T15N:R92W and the C of T16N:R92W; in the extreme NW1/4, T17N:R91W and NE1/4, T18N:R91W; and in the SW1/4, T19N:R90W.

Regionally, the Fort Union consists of up to 3,400 feet (1,037m) of discontinuous drab mudstones, sandstones, carbonaceous shales, and coal that accumulated in alluvial channels and floodplain back swamps (Sanders 1975). As much as 1,500 feet (457m) of Fort Union are exposed in the Riner Quadrangle, a few miles north of the project area (Sanders 1974). Like the Wasatch Formation, mudstones and shales of the formation readily eroded into badlands in places, and the sandstones are relatively resistant and form prominent outcrops.

The contact of the Fort Union Formation with the underlying Upper Cretaceous Lance Formation is everywhere marked by a pronounced angular unconformity and generally a thick channel sandstone (Roehler 1993). It is unknown if the Tertiary-Cretaceous boundary is preserved in the area, but certainly earliest Paleocene rocks are (See Section 3.1.3).

Upper Cretaceous – Lance Formation

The Latest Cretaceous Lance Formation consists of about 2,890 feet (881m) of interbedded gray sandstone and mudstone, carbonaceous shale and coal, and the formation crops out over the majority of the western part of the ARPA (Hettinger et al. 1991, Hettinger and Kirschbaum 1991). The sandstones of the formation are relatively resistant to erosion, so where the stratigraphy of the formation is dominated by them, a series of resistant ridges and high cliffs, or both are developed. In areas dominated by mudstones and shale the formation is largely eroded flat and soil and vegetation covered. In most places in the ARPA the Lance does not have a tendency to erode into badlands.

Regionally, the Lance overlies the Fox Hills Sandstone (Smith 1961, Gill et al. 1970, Hettinger et al. 1991, Roehler 1993), which is included in the Lewis Shale on many maps. To the east the Fox Hills may be absent, and the Lance directly overlies the Lewis Shale (Weitz and Love 1952, Love and Christiansen 1985). Further eastward, Lance rocks correlate with the Medicine Bow Formation (Merewether 1971) and farther west, the Lance thins to less than 197 feet (60m) on the west side of the Washakie Basin (Roehler 1985).

Upper Cretaceous – Lewis Shale

The Lance Formation is underlain by the Lewis Shale, and this relatively nonresistant unit occupies nearly all of the central part of the ARPA. The Lewis Shale consists chiefly of up to 1,500 feet (457m) of near shore marine shale, and thin, discontinuous stringer sandstones (Smith 1961, Roehler 1993). With the exception of the uppermost part of the formation, which contains a series of laterally extensive sandstones that weather to ridges and small cliffs, the Lewis Shale is not very resistant to erosion and forms a broad strike valley.

The Lewis Shale interfingers westward into the upper part of the Mesaverde Group, the Fox Hills Sandstone, and the lower part of the Lance Formation. Within the ARPA, the Lewis Shale is underlain in surface sections by the Mesaverde Group; however, farther north and east (seaward), along the Sierra Madre Range and in the Laramie Basin, the Lewis Shale directly overlies the Steele Shale (Ritzma 1949, Roehler 1993).

Upper Cretaceous – Mesaverde Group

The Mesaverde Group is the oldest rock unit exposed within the ARPA and forms all surface outcrop of the eastern region of that area, with the exception of a few places where it is unconformably overlain by much younger Miocene rocks of the Browns Park Formation. The group consists of 1,125-2,000 feet (343-610m) of massive beach and shelf sandstones, interbedded with minor amounts of shale, carbonaceous shale, mudstone, and coal. The upper part of the group is dominated by sandstones, which are relatively resistant to erosion, and form prominent dip slopes that dip westward, forming the eastern boundary of the ARPA. Atlantic Rim, from which the project name is derived, is a series of these dip slope sandstones developed in the northeastern part of the area.

In the region of the ARPA, the Mesaverde is subdivided into three formations, from top to bottom, the Almond Formation, the Ericson (=Pine Ridge) Sandstone, and the Rock Springs (=Allen Ridge) Formation (Roehler 1993). All of these units intertongue to the east and north with the Steele Shale. The Ericson Sandstone and Rock Springs Formation are the lateral equivalents of the Williams Fork Formation and Iles Formation, respectively, in the Sand Wash Basin of Colorado, which contain important coal and potentially important coalbed natural gas resources. The terminology Williams Fork and Iles formations have been extended into Wyoming by authors describing subsurface coal deposits.

3.1.1.3 Geologic Hazards

Of known naturally occurring geologic hazards, fault generated earthquakes, floods, landslides or other mass movements among others, the most likely to affect the project area are mass movements that could be initiated on steep slopes. There are no known faults with evidence of Quaternary movement or earthquake epicenters mapped within the area (NEIC 2003, WGS 2003). A 4.3 Richter magnitude earthquake occurred April 4, 1999, a few miles northwest of the western boundary of the ARPA. The epicenter of this earthquake was located near Baldy Butte in T17N:R92W (41.45˚N, 107.74˚W). No other earthquake epicenters have been recorded in or immediately adjacent to the area in the past 100 years, indicating that this quake was probably an unusual event and that the area may not be very seismically active.

Pyrophoricity

Pyrophoricity (spontaneous combustion) has been cited as a potential hazard of coal gas development. Spontaneous combustion of coal has long been a concern for mankind and shallow coal mine fires in areas of abandoned mines are today still an environmental concern throughout the world (Lyman and Volkmer 2001).

Although spontaneous combustion of coal is unlikely to occur in naturally exposed outcrops of coal, because by the time coal is exposed by erosion it is already too degassed to ignite spontaneously (Coates and Heffern 1999), the presence of naturally occurring outcrops of clinker and baked shale show that it has happened in the past in the ARPA. Studies of in-situ coal gasification (UCG) conducted during the 1970s in Wyoming suggest that even under extreme efforts to maintain combustion (by injecting air into the burn zones) in underground coals ignited in bore holes, coal burning away from the ignition area cannot be sustained. Loss of permeability associated with plugging of fissures by tar and combustion products resulted in the fires burning themselves out rather quickly. In their study of Powder River Basin coalbed natural gas wells, Lyman and Volkmer (1999) found that spontaneous combustion of coal beds during coalbed natural gas production is unlikely because completion methods, although "open-hole", configure the well to keep air, necessary for combustion, out of the system. "Even where the coal has been completely dewatered, insufficient oxygen is present for oxidation to be carried forward." After coal gas extraction is complete, CBNG wells leave no underground voids susceptible to subsidence and associated coal ignition as seen in abandoned underground mines, which are susceptible to spontaneous ignition.

Subsidence

Ground subsidence (resulting from withdrawal of coalbed natural gas related water) has also been cited as a potential hazard of CBNG development. A number of documented cases have demonstrated the association of withdrawal of underground fluids and subsidence. The best examples include specific sites in the San Joaquin Valley in California, Las Vegas, New Orleans, Houston, and Mexico City. Subsidence in these areas is chiefly related to removal of water for human consumption or agricultural use. Removal of water from underlying saturated, chiefly unconsolidated, and porous sand and gravel aquifers, lowers the water table and causes the previously saturated zones to compress, causing subsidence. Saturated unconsolidated sands and gravels and porous clays can compress significantly; in some cases as much as 29 feet of subsidence has resulted. The subsurface geologic conditions in the ARPA, however, differ significantly from these areas. The bedrock underlying the area is compacted and consolidated, and porosity is much lower. In comparison, unconsolidated sands and gravels and clays have porosity values as high as 50% and 88%, respectively (Poland 1984), whereas, values for consolidated clay (shale) and sand (sandstone) in the ARPA have porosity values as high as 10% and 30%, respectively (Freeze and Cherry 1979). Calculations of modeled ground subsidence associated with CBNG production for the Wyodak coal in the Powder River Basin, near Gillette, indicate that subsidence of less than ½ inch (1.27 cm) can be expected (Case et al. 2002). However, strata from which the CBNG would be withdrawn from in the ARPA occur much deeper in the subsurface than those in the Powder River Basin and any subsidence would be attenuated because of that increased depth and is not considered significant.

Mass Movement

Quaternary landslides occur primarily along the eastern edge of the project area, including from north to south, along the west side of Separation Peak, Atlantic Rim, Bridger Pass, Sand Hills, Cow Creek Butte, and along the east side of Muddy Mountain (Case and Larsen 1991). One of the largest of the mapped landslides occupies about 20 square miles of area in sections 25 and 26, T14N:R90W (Weitz and Love 1952). The displaced material includes rocks derived from the Miocene Browns Park Formation and underlying Lewis Shale and emplaced by movement from the southeast to the northwest. Similarly, most of the landslides mapped along the eastern boundary of the area are developed in the Browns Park Formation which contains tuffaceous and bentonitic clay beds rich in montmorillonite that are susceptible to swelling and mass movement when water saturated, especially where exposed on steep or undercut slopes.

Additional landslide debris is mapped around Doty Mountain (T17N:R91W), Wildhorse Butte (T14N:R91W) and Muddy Mountain (T13N:R89W). Mass movement in these areas is associated with steep slopes developed in the Lance Formation, Wasatch Formation, and Lewis Formation, respectively, all of which contain clay-rich shale beds that are also susceptible to mass movement when water saturated, especially where exposed on steep or undercut slopes.

3.1.2 Mineral Resources

Mineral resources within ARPA region include locatable mineral deposits of basal and precious metals, bentonite, gypsum, limestone, uranium, zeolite, gravel, and clinker, and leasable minerals such as oil, gas, coal, and coalbed natural gas.

3.1.2.1 Locatable Minerals

No economic deposits of locatable minerals are known to occur within the ARPA. Economic deposits of Quaternary windblown sand are developed 20-30 miles north-northeast of the town of Baggs, Wyoming, just east of the project area (Harris 1996). These are continuations of dune deposits that occur in the east central parts of the ARPA, but that are probably not thick enough to be economic.

Uranium-bearing prospects occur in the Browns Park Formation in: (1) the Ketchum Buttes District, adjacent to the ARPA in the NW1/4, T15N:R89W; (2) the Miller Hill Prospect, about ten miles south-southwest of Rawlins, in T18N:R88-89W; and (3) in the Poison Basin Uranium District, about ten miles west of the town of Baggs (Harris et al. 1985). Economically significant shows of uranium occur in coals of the main body of the Wasatch Formation north of Wamsutter, Wyoming (Masursky 1962), and in the region around the towns of Creston and Latham (Harris et al. 1985, Harris and King 1993), about fifteen miles west of the north edge of the ARPA. Uranium is also known in arkoses of the Battle Spring Formation of the central Great Divide Basin (Pipiringos 1961), which is in part equivalent to the upper part of the Wasatch Formation, which is exposed just west of the project boundary.

Gravel, preserved as Quaternary terrace and channel remnants, and clinker, associated with burnt coal seams occur at several locations within the ARPA. Some of these have been locally exploited and developed as gravel (W/2 Sec. 26, T14N:R91W and W/2, SW/4 Sec. 2, T14N: R90W) and clinker ("scoria") pits (W/2 Sec. 6, T15N:R91W, and NE/4 Sec. 1, T15N: R92W); other gravels (center of NW/4 Sec. 28, T16N:R92W and N/2 Sec. 22, T17N:R92W) and clinker (N/2 Sec. 5, T17N:R91W and SE/4, SE/4,SE/4 Sec. 35, T18N:R91W) have not.

3.1.2.2 Leasable Minerals

Coal and coalbed natural gas occur in Tertiary and Cretaceous age geologic formations, and oil and gas occur in geologic formations of Cretaceous, Jurassic, Triassic, and Pennsylvanian age underlying the project area.

Coal and Coalbed Natural Gas

<u>Fort Union Formation</u>

The Fort Union Formation of south and southwest Wyoming constitutes an enormous, largely untapped reserve of coal. Coals occur throughout the formation, but are thickest and most continuous in its lower part (the lower coal bearing unit) (Smith et al. 1972, Sanders 1974, 1975, Beaumont 1979, Edson 1979, Hettinger and Brown 1979, Honey and Roberts 1989, Honey and Hettinger 1989, Honey 1990, Jones 1991, Hettinger et al. 1991).

Within and adjacent to the ARPA, coal seams of the Fort Union comprise the Red Rim and China Butte coals. These coals are best developed from the southernmost parts of T21N:R90W (a few miles south of I-80) southward to T15N:R92W. From there southward to T13N:R91W the coals become discontinuous and spotty in distribution. Both the Red Rim and China Butte coals have high known mineral deposit area (KMDA) values (>$1 million based on 1981 prices). Together they include about 26,234 leasable acres.

Studies of the Fort Union Formation coals in the ARPA and adjacent areas have been conducted by Sanders (1974, 1975), Edson (1979), Honey and Hettinger (1989), Honey and Roberts (1989), and Honey (1990). As many as 10 coals seams have been mapped in the subsurface with individual seams averaging 10 to 20 feet thick, but thickening to as much as 40 feet. Net coal thickness increases in the subsurface southward toward the Baggs area where it may reach a maximum of about 75 feet. Thicker Fort Union coals have been interpreted to have accumulated in flood plains above and on the flanks of major Paleocene age, south to north oriented river systems. Thinner coal seams accumulated away from these main trunk streams.

The Fort Union Formation is a primary coalbed natural gas target in the southeastern Greater Green River Basin, but the formation crops out at the surface only in the western most part of the project area, so few if any of the coal beds which dip westward are buried deep enough to be candidates for development. Deeper buried coal beds east and south of the area have ash free gas contents generally less than 100 scf/ton, but ranging from 9 to 561 scf/ton. Scott et al. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County, Wyoming, underlying the project area, to be less than 2 bcf/mi^2 near the eastern margins of its subcrop to 6 to 8 bcf/mi^2 in deeper buried areas north and west of Baggs, Wyoming. These values may be enhanced by migration of gasses into the area from deeper parts of the basin. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, Fort Union coals rank as subbituminous high volatile C bituminous and high volatile B bituminous.

Lance Formation

Coals occur discontinuously in outcrop in the Lance Formation from I-80 south to about T15N. Averaging about 5 feet in thickness, but ranging from a few inches to 22 feet thick, coals are thicker, more abundant, and laterally extensive in the lower part of the formation. The coals have limited lateral extent and usually cannot be traced more than a few hundred to several thousand feet. Lance Formation coal beds are minor coalbed natural gas targets (Scott et al. 1994).

Mesaverde Group

Coals occur in outcrops in the Mesaverde Group in several places along the western edge of the Sierra Madre. These are best developed high in the Mesaverde Group near its contact with the overlying Lewis Shale in exposures along the eastern edge of the ARPA (Atlantic Rim and Green River Coal Fields) and in T15-16N:R90-91W (an unnamed coal field). These fields have moderate KMDA value (less than $1 million, based on 1981 prices) and include about 230,400 leasable acres. Coals are also developed sporadically lower in the Mesaverde Group (Allen Ridge Sandstone), but these coals are thin and discontinuous, and areas containing them are rated as having a low KMDA value. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, the Mesaverde coals underlying the ARPA rank as high volatile C bituminous, high volatile B bituminous and high volatile A bituminous.

Coals in the Ericson Sandstone (=Pine Ridge Sandstone or Williams Fork Formation) include the thickest and most extensive coals of the Upper Cretaceous in the Greater Green River Basin and are the basin's prime CBNG targets. The maximum net coal thickness of about 220 feet, contained in 40 individual coal beds, occurs near Craig, Colorado. The coal beds thin in a westerly and northerly direction, so that in the southeastern part of Carbon County, underlying the ARPA, net coal thicknesses range from 40 to 90 feet (12 to 18m). These coals are interpreted to have accumulated in coastal plain environments and fluvial dominated, wave modified deltas, along a southwest-northeast oriented strand (beach) line that faced southeastward into the Cretaceous epicontinental seaway. Three depositional coal cycles are represented that accumulated in response to progradation as a result of sea level drop or changes in delta location, or both. The thickest coals in these cycles overlie shoreline sandstones with thinner and less continuous coals developed between deltaic distributary channel sandstones.

Gas content values for coals developed in the Ericson Sandstone (=Pine Ridge Sandstone or Williams Fork Formation) range from less than 1 to more than 540 scf/ton, but are generally less than 200 scf/ton. Samples from the Sand Wash Basin indicate a gradual increase in gas content with increasing burial, but that coal rank does not increase significantly with depth. Gas contents of samples taken shallower than 1,000 feet are less than 20 scf/ton suggesting that coalbed gases may have migrated out of the system because either confining pressures were low, the over-lying seals were absent, or both. Analysis of 36 coal samples from six wells provided a gas dryness range from 0.79 to 1.0 with an average of 0.95; carbon dioxide content of less than 1 to more than 25%, with an average of 6.7%; and a nitrogen content of less than 1 to 20% with an average of 4%. Coals having a high carbon dioxide content are characterized by high C1-C1-5 values.

Based on gas content values, Scott et al. (1994) estimated coal gas reserves in the western and southwestern parts of Carbon County, Wyoming, underlying the ARPA, to be less than or equal to 10 bcf/mi^2 near the eastern margins of its subcrop and 8 to 40 bcf/mi^2 in the extreme southwestern corner of the county.

Coals in the Rock Springs Formation (Allen Ridge Sandstone or Iles Formation) are thinner and not as well developed as those in the Pine Ridge and the formation is considered a minor coal-bearing unit and CBNG target. A maximum net coal thickness of 32 feet occurs in the easternmost part of the Great Divide Basin, but most other places it is typically less than 15 feet. These coals are interpreted to have accumulated in a variety of swampy environments above shoreline sandstones and in flood plains adjacent to delta river channels.

Based on samples from wells primarily in the Rock Springs Uplift, gas content values in the Rock Springs Formation (= Allen Ridge Sandstone or Iles Formation) range from 0 to more than 650 scf/ton. No estimates of total coal gas reserves are available for this unit.

Oil and Gas

The ARPA and adjacent areas to the west have produced significant quantities of oil and natural gas. Production is chiefly from Cretaceous geologic units including the Mesaverde Group, Steele Shale, Niobrara Shale, Frontier Formation, Muddy Sandstone, and Cloverly Formation. In addition, Jurassic rocks of the Morrison Formation, Triassic rocks of the Chugwater Formation, and Pennsylvanian rocks of the Tensleep Sandstone have proved productive. Oil and gas fields of interest (The Oil and Gas Fields Symposium committee 1957 1979, 1992, Gregory and DeBruin 1991, DeBruin and Boyd 1991, DeBruin 1996, Cronoble 1969, DeBruin 1993, Kaiser et al. 1994) include the Baldy Butte (T17N:R92W), Browning (T14N:R91W), Browns Hill (T16N:R90-91W), Cherokee Creek (T15N:R91W), Cow Creek (T16N:R92W), Deep Creek (T16N:R90-91W), Deep Gulch (T16N:R91W), Dixon (T12-13N:R90W), Espy

(T19N:R89W), Sierra Madre (T13N:R89-90W), and Sugar Creek (T19N:R90W). Oil and gas are produced from combined stratigraphic and faulted structural (anticlinal) traps.

3.1.3 Paleontologic Resources

Known paleontologic resources within sedimentary deposits in the project area record the history of animal and plant life in Wyoming during the early part of the Cenozoic Era (Paleocene and Eocene Epochs) and latest part of the Mesozoic (Cretaceous Period) Era. Potential fossil resources could extend this record into the late Cretaceous Period and middle Cenozoic Era (Miocene).

As described above, mapping documents eight geologic deposits exposed at the surface in the project area. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene to Pleistocene) age, (2) Browns Park Formation of Miocene age, (3) Wasatch Formation of early Eocene age, (4) Fort Union Formation of Paleocene age, (5) Lance Formation of Latest Cretaceous age, (6) Fox Hills Sandstone of latest Cretaceous age, (7) Lewis Shale of Latest Cretaceous age, and (8) Mesaverde Group of Late Cretaceous age.

With the exception of the Holocene deposits that are probably too young to contain fossils, all sedimentary rock units exposed in the project area are known to produce or have the potential to produce scientifically significant vertebrate fossil resources. Scientifically significant fossil vertebrates have been recovered from the Wasatch (Morris 1954, Honey 1988, Roehler 1972, 1991 a-b, 1992 a-c, 1993, Roehler et al. 1988), Fort Union (Rigby 1980, Winterfeld 1981), and Lance Formations (Dorf 1942, Estes 1964, Clemens 1966, Clemens et al. 1979, Breithaupt 1982 and 1985, Weishample 1992, Archibald 1993, Lillegraven 2002, Honey 2003) within the ARPA or immediately adjacent areas.

Specifically, 15 fossil vertebrate localities are known to occur within the ARPA in the Lance Formation and 17 fossil vertebrate localities are known to occur within the Fort Union Formation. The Lance Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T18N:R20W), Doty Mountain (T17N:R91-92W), Peach Orchard Flat (T15N:R91W) and Blue Gap (T15N:R91W) 7.5 minute Quadrangles. The Fort Union Formation localities occur in the Separation Peak (T20N:R90W), Fillmore Ranch (T19N:R91W), Duck Lake (T16-17N:R91-91W), Mexican Flats (T16N:R92W) and Blue Gap (T15-16N:R91-92W) 7.5 minute Quadrangles. Localities from both the Lance and Fort Union Formations produce a wide variety of fossil vertebrate remains, including those of mammals, reptiles, amphibians, and fish. Of great importance is the occurrence within the Fort Union Formation of some of the oldest known Paleocene age fossil vertebrates in the world, which are considered to be of Puercan age, and are very rare (Honey 2003).

Vertebrate fossils of scientific significance have also been found in deposits of the Browns Park Formation (McGrew 1951 and 1976, Bradley 1964, Montagne 1991), and Mesaverde Group (Breithaupt 1985, Case 1987, Clemens and Lillegraven 1986, Lillegraven and McKenna 1986) in other areas of Wyoming and Colorado, but not within the ARPA. Vertebrate fossils of limited significance have been identified in the Fox Hills and Lewis Shale exposed on the Rocks Springs Uplift (Winterfeld 1978, Breithaupt 1985). Information on the geologic deposits exposed in the project area and the BLM Paleontologic Condition they satisfy are summarized in Table 3-2.

3.2 CLIMATE AND AIR QUALITY

3.2.1 Climate

The Atlantic Rim Project Area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, windy conditions, with limited rainfall and long, cold winters. The nearest meteorological measurements were collected at Baggs, Wyoming (1979-2000), approximately 3 miles southwest of the project area at an elevation of 6,240 ft (WRCC 2003). Because of the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably.

The annual average total precipitation at Baggs is 10.7 inches, ranging from 18.5 inches (1983) to 4.6 inches (1989). Precipitation is evenly distributed throughout the year, with minor peaks in May, July, and October. An average of 38.8 inches of snow falls during the year (annual high 104.0 inches in 1983), with December and January the snowiest months. Table 3-3 shows the mean monthly temperature ranges and total precipitation amounts.

The Baggs region has cool temperatures with average daily temperatures (in degrees Fahrenheit; °F) ranging between 3 °F (low) and 33 °F (high) in mid winter and between 56 °F (low) and 75 °F (high) in mid summer. Extreme temperatures have ranged from –50 °F to 100 °F (both occurring in 1984). The frost-free period (at 32 °F) generally occurs from mid-May to mid-September.

Table 3-3. Mean Monthly Temperature Ranges and Total Precipitation Amounts.

Month	Average Temperature Range (°F)	Total Precipitation (inches)
January	5-33	0.56
February	9-36	0.43
March	20-47	0.44
April	28-59	0.82
May	34-68	1.52
June	41-79	0.89
July	48-86	1.33
August	46-84	0.99
September	38-74	1.14
October	27-61	1.39
November	16-43	0.66
December	7-34	0.54
ANNUAL	42.6 (mean)	10.71 (mean)

Source: (WRCC 2003)

The project area is subject to strong and gusty winds, reflecting channeling and mountain valley flows due to complex terrain. During the winter months strong winds are often accompanied by snow, producing blizzard conditions and drifting snow. The closest comprehensive wind measurements are collected at the Rawlins, Wyoming, airport nearly 60 miles north-northeast of the project area. However, hourly wind data measurements for December 1994 through November 1995 were collected near Baggs, Wyoming during the Mount Zirkel Wilderness Area

Visibility Study. Due to the proximity to the project area, these data (rather than the more distant Rawlins wind data) were used to describe the wind flow patterns in the region. Figure 3-1 shows the relative frequency of winds, with radial distributions by speed class, indicating the direction of the wind source. Table 3-4 provides the wind direction distribution in a tabular format. From this information, it is evident that the winds originate from the south to southwest nearly 37 percent of the time. The annual mean wind speed is nearly 10 mph.

Table 3-4. Wind Direction Frequency Distribution for Baggs, WY.

Wind Direction	Percent of Occurrence
N	5.2
NNE	3.8
NE	2.7
ENE	3.8
E	4.8
ESE	8.9
SE	6.9
SSE	7.6
S	13.8
SSW	13.4
SW	10.0
WSW	5.1
W	4.4
WNW	4.0
NW	2.6
NNW	3.1

Source: South Baggs meteorological data collected December 1994 - November 1995.

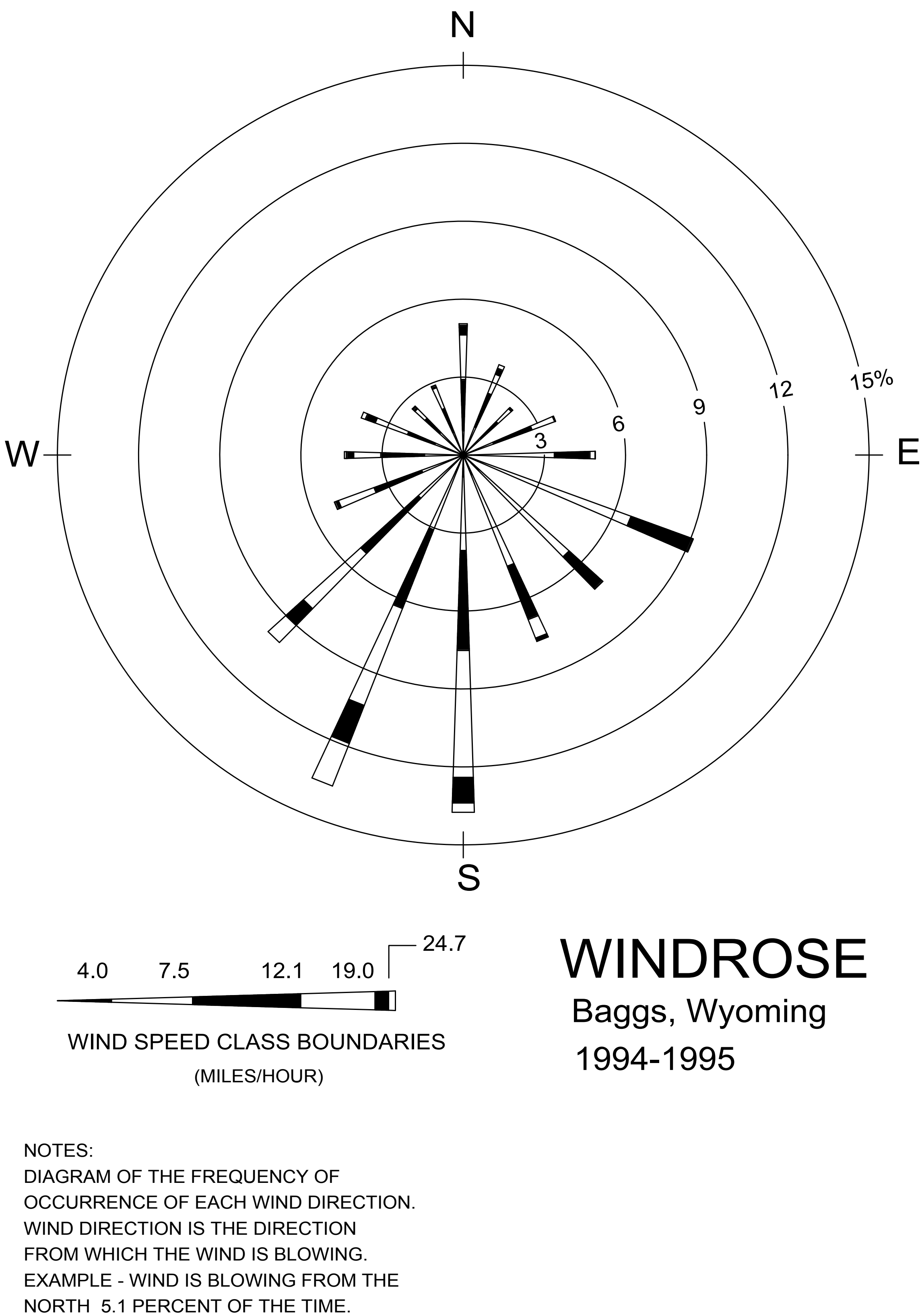
The frequency and strength of the winds greatly affect the dispersion and transport of air pollutants. Because of the strong winds in the project area, the potential for atmospheric dispersion is relatively high (although nighttime cooling would enhance stable air, inhibiting air pollutant mixing and transport). Dispersion conditions would be the greatest to the north and along the ridge and mountain tops.

Table 3-5 shows the frequency distribution of wind speed and atmospheric stability class. The atmospheric stability class is the measure of atmospheric turbulence, which directly affects pollutant dispersion. The stability classes are divided into six categories designated “A” (unstable) through “F” (very stable). The “D” (neutral) stability class occurs more than half of the time.

Table 3-5. Wind Speed and Stability Class Distribution.

Wind Speed (miles/hour)	Percent of Occurrence	Stability Class	Percent of Occurrence
0-4.0	6.4	A (unstable)	6.0
4.0-7.5	33.0	B	8.2
7.5-12.1	29.8	C	14.8
12.1-19.0	21.7	D (neutral)	56.6
19.0-24.7	5.4	E	9.9
Greater than 24.7	3.7	F (very stable)	4.5

Source: South Baggs meteorological data collected December 1994 - November 1995.



Source: South Baggs meteorological data collected December 1994 - November 1995.

Figure 3-1. Wind Rose for the Atlantic Rim Natural Gas Project Area.

3.2.2 Air Quality

The Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) are health-based criteria for the maximum acceptable concentrations of air pollutants at all locations to which the public has access. Although specific air quality monitoring has not been conducted within the project area, regional air quality monitoring has been conducted within the cumulative study area. Air pollutants measured in the region for which ambient air quality standards exist include: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter less than 10 microns in effective diameter (PM_{10}), particulate matter less than 2.5 microns in effective diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). Background pollutant concentrations for these pollutants are compared to the WAAQS and NAAQS in Table 3-6.

As shown in Table 3-6, regional background values are well below established standards, and all areas within the cumulative study area are designated as attainment for all criteria pollutants. Background air quality concentrations are combined with modeled project-related air quality impacts of the same averaging time periods, and the total predicted impacts are compared to applicable air quality standards.

Federal air quality regulations adopted and enforced by WDEQ-AQD limit incremental emissions increases to specific levels defined by the classification of air quality in an area. The Prevention of Significant Deterioration (PSD) Program is designed to limit the incremental increase of specific air pollutant concentrations above a legally defined baseline level. The incremental increase depends upon the area's classification. Four PSD Class I areas are identified as sensitive areas within the cumulative impact assessment area: the Bridger, Fitzpatrick, Mount Zirkel and Rawah Wilderness Areas. Strict limitations on the additional amount of air pollution allowed from major emitting facilities in PSD Class I areas are applied. These limitations are quantified as Class I PSD Increments, which are compared to impacts from cumulative regional sources, and Proposed Class I PSD Significance Levels, which are compared to impacts from individual emission sources to determine their singular significance. The remainder of the cumulative impact assessment area is classified PSD Class II, where similar but less stringent incremental air quality limits apply. The Popo Agie and Savage Run Wilderness Areas, Dinosaur National Monument, and the Wind River Roadless Area are PSD Class II areas, which have been identified as sensitive areas within the cumulative study area. PSD Class I and Class II Areas are shown in Appendix M. Regional background pollutant concentrations, as well as NAAQS, WAAQS, and PSD Class II Increments, are presented in Table 3-6.

All NEPA analysis comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis. The determination of PSD increment consumption is an air quality regulatory agency responsibility. Such an analysis would be conducted as part of the New Source Review process for a major source, as would an evaluation of potential impacts to Air Quality Related Values (AQRV) such as visibility, aquatic ecosystems, flora, fauna, etc. performed under the direction of WDEQ-AQD in consultation with Federal Land Managers, or would be conducted to determine minor source increment consumption.

Table 3-6. Air Pollutant Background Concentrations, Wyoming and National Ambient Air Quality Standards, and Prevention of Significant Deterioration (PSD) Increments (μg/m[3]).

Pollutant/Averaging Time	Measured Background Concentration	Wyoming and National Ambient Air Quality Standards	Incremental Increase Above Legal Baseline PSD Class I	PSD Class II
Carbon Monoxide (CO) [1]				
1-hour	3,336	40,000	n/a	n/a
8-hour	1,381	10,000	n/a	n/a
Nitrogen dioxide (NO_2) [2]				
Annual	3.4	100	2.5	25
Ozone [3]				
1-hour	169	235	n/a	n/a
8-hour	147	157		
Particulate Matter (PM_{10}) [4]				
24-Hour	47	150	8	30
Annual	16	50	4	17
Particulate Matter ($PM_{2.5}$) [4]				
24-Hour	15	65	n/a	n/a
Annual	5	15	n/a	n/a
Sulfur dioxide (SO_2) [5]				
3-hour (National)	132	1,300	25	512
24-hour (National)	43	365	5	91
24-hour (Wyoming)	43	260	5	91
Annual (National)	9	80	2	20
Annual (Wyoming)	9	60	2	20

[1] Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).
[2] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (ARS 2002).
[3] Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).
[4] Background data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2002. These data have been determined by WDEQ-AQD to be the most representative co-located PM_{10} and $PM_{2.5}$ data available.
[5] Background data collected at LaBarge Study Area for the Northwest Pipeline Craven Creek Site 1982-1983.

There are two types of visible impairment caused by emission sources, plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background such as a landscape feature. Regional haze occurs when pollutants from more diffuse emission sources become well mixed in the atmosphere causing a general alteration in the appearance of landscape features, changing the color or contrast between the landscape features or causing features of a view to disappear. Plume impairment calculations, which consider contrast and color difference, are generally performed when an emissions source is within 50 km of a view whereas impacts of regional haze, or visibility impairment, are considered at 50 km and beyond.

Visibility impairment is often referred to in terms of either atmospheric light extinction coefficient or visual range. Atmospheric light extinction is the sum of light scattering due to scattering and absorption by gases and particles in the atmosphere. Visibility impairment is measured in terms of change in light extinction or change in deciview (dv). A dv change of 1 to 2 (equivalent to a 10% to 20% change in extinction) represents a small but perceptible change in visibility. Visual range, referred to as standard visual range (SVR), is the farthest distance at which an observer can just see a black object viewed against the horizon sky. The higher the SVR, the better the visibility. Visibility within the cumulative study area is considered very good, with an average SVR of over 150 km (Malm 2000). However, the potential for visibility impairment to current conditions at the PSD Class I and Class II Areas identified within the cumulative study area has been identified as a concern.

In 1985 the Interagency Monitoring of PROtected Visual Environments (IMPROVE) monitoring program was initiated to establish current visibility conditions, track changes and establish long–term trends in visibility, and to determine the causal mechanisms of visibility impairment in the National Parks and Wilderness Areas. IMPROVE is a cooperative measurement effort composed of representatives from the EPA, NPS, USDA Forest Service, BLM, U.S. Fish and Wildlife Service (USFWS), and state agencies. The IMPROVE network began with 20 monitoring sites in 1987 and now includes over 140 sites representing Class I parks and wilderness areas across the nation

Within the cumulative study area there are currently four IMPROVE visibility monitoring sites, the Bridger Wilderness Area and Brooklyn Lake sites in Wyoming and the Mount Zirkel Wilderness Area and Rocky Mountain National Park sites in Colorado. Table 3-7 provides 2001 baseline visibility conditions monitored at these four sites (CIRA 2003).

Table 3-7. 2001 Standard Visual Range Data.

Site	***Standard Visual Range (km)***	
	Average Condition	20^{th} Percent Cleanest Days
Bridger Wilderness Area	181	272
Brooklyn Lake	184	283
Mount Zirkel Wilderness Area	175	249
Rocky Mountain National Park	154	275

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and it is reported as the mass of material deposited on an area per year (kilograms per hectare per year). Air pollutants are deposited by wet deposition (precipitation) and dry deposition (gravitational settling of pollutants). Background wet and dry atmospheric acid deposition impacts have been monitored at the National Acid Deposition Program (NADP) National Trends Network (NTN) and Clean Air Status and Trends Network (CASTNET) stations near Pinedale and Centennial/Brooklyn Lake, Wyoming. Total deposition (wet and dry) reported as total sulfur and total nitrogen deposition for Pinedale, 2003 and Centennial/Brooklyn Lake, 2002 are provided in Table 3-8.

Table 3-8. 2001 Measured Acid Deposition Data (kg/ha-yr).

Site Location	Nitrogen Deposition	Sulfur Deposition
Pinedale	1.4	0.65
Centennial/Brooklyn Lake	2.7	0.84

Total deposition levels of concern (LOC) have been estimated for several areas, including the Bridger Wilderness Area (USDA-FS 1989). The “red line” LOC is defined as the total deposition that the area can tolerate, and the “green line” LOC is defined as the acceptable level of total deposition. Cumulative impacts plus background are compared to these LOCs. The Bridger Wilderness nitrogen deposition red line LOC is 10 kg/ha-yr and nitrogen deposition green line LOC is 3-5 kg/ha-yr. The Bridger Wilderness sulfur deposition red line LOC is 20 kg/ha-yr and sulfur deposition green line is 5 kg/ha-yr.

Site-specific lake chemistry background data (pH, acid neutralizing capacity, elemental concentrations, etc.) have been collected by the U.S. Geological Survey (Water Quality Division) in several high mountain lakes in the nearby Wilderness Areas. Lakes for which background data were collected are shown in Appendix M: PSD Class I and Class II Sensitive Areas and Sensitive Lakes. Lake acidification is measured in terms of change in acid neutralizing capacity (ANC), which is the lake’s buffering capacity to resist acidification from atmospheric deposition of acid compounds such as sulfates and nitrates. Measured baseline ANC data for sensitive lakes within the cumulative study domain are provided in Table 3-9.

Lakes with ANC values ranging from 25 to 100 microequivalents per liter (μeq/l) are considered to be sensitive to atmospheric deposition, lakes with ANC values ranging from 10 to 25 μeq/l are considered very sensitive, and lakes with ANC values less than 10 μeq/l are considered extremely sensitive.

The USDA Forest Service has identified specific AQRV “Level of Acceptable Change” (LAC) values which are used to evaluate potential air quality impacts from deposition within their wilderness areas (USDA-FS 2000). The USDA Forest Service has identified a LAC of no greater than 1 (μeq/l) change in ANC (from human causes) for lakes with existing ANC levels less than 25 μeq/l. A limit of 10 percent change in ANC reduction was adopted for lakes with existing ANC greater than 25 μeq/l.

Table 3-9. Background ANC Values for Acid Sensitive Lakes.

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg/Min-Sec)	10th Percentile Lowest ANC Value[1] (µeq/l)	Number of Samples	Monitoring Period
Bridger	Black Joe	42°44'22"	109°10'16"	67.0	61	1984-2003
Bridger	Deep	42°43'10"	109°10'15"	59.9	58	1984-2003
Bridger	Hobbs	43°02'08"	109°40'20"	69.9	65	1984-2003
Bridger	Lazy Boy	43°19'57"	109°43'47"	18.8	1	1997
Bridger	Upper Frozen	42°41'13"	109°09'39"	5.0	6	1997-2003
Fitzpatrick	Ross Lake	43°22'41"	109°39'30"	53.5	44	1988-2003
(GLEES)	West Glacier Lake	41°22'38"	106°15'31"	35.2	14	1988-1996
Mount Zirkel	Lake Elbert	40°38'3"	106°42'25"	51.9	55	1985-2003
Mount Zirkel	Seven Lakes	40°53'45"	106°40'55"	36.2	55	1985-2003
Mount Zirkel	Summit Lake	40°32'43"	106°40'55"	47.3	95	1985-2003
Popo Agie	Lower Saddlebag	42°37'24"	108°59'38"	55.5	43	1989-2003
Rawah	Island Lake	40°37'38"	105°56'26"	68.7	15	1996-2002
Rawah	Kelly Lake	40°37'32"	105°57'34"	181.1	13	1995-2002
Rawah	Rawah #4 Lake	40°40'16"	105°57'28"	41.2	13	1996-2002

[1] 10th Percentile Lowest ANC Values reported

3.3 SOILS

3.3.1 Introduction

Vegetation type, growth form, composition, distribution, and density in the ARPA are principally governed by the biological, chemical, and physical properties of the parent soil and precipitation régime. The complex relationship of these two essential natural resources ultimately controls habitat quantity and quality for the fauna and flora of Wyoming.

Parent materials in the ARPA include the marine sandstones and shales of the Lewis Formation (Upper Cretaceous), the largely fluvial conglomerates, sandstones, mudstones, shales and coals of the Lance Formation (Upper Cretaceous) and Fort Union Formation (Paleocene), the fluvial sandstones and variegated mudstones of the Wasatch Formation (Eocene), and the conglomerates, sandstones, and volcaniclastic mudstones of the Brown's Park Formation (Miocene). Slopewash debris and alluvium derived from those units also constitute parent materials for colluvial and alluvial soils. A large area known as the "Sand Hills" (series of Holocene-age sand dunes) occurs in the central part of the ARPA.

The ARPA is typical of a desert intermontane basin with physiography dominated by: (1) hogbacks and strike valleys, (2) flat-topped stripped bedrock surfaces (strath terraces), (3) pebble/gravel/cobble stream terraces, (4) alluvial fan deposits, and (5) alluvium along the principal drainages.

Surface elevations within the ARPA range from 8,294 feet (2,529m) in Sec. 13, T18N:R90W, to about 6,500 feet (1,982m). Several Mesaverde Formation hogbacks above Separation and Jep Canyon reach elevations exceeding 8,000 feet (2,438m). Prominent landmarks include Cow Creek Butte (7,929 feet/2,417m) developed in the Brown's Park Formation (NE1/4 Sec. 15, T16N:R90W) and Muddy Mountain (7,904 feet/2,409m), developed on a Lance Formation hogback (NE1/4 Sec. 8, T13N:R90W). The lowest point (6,420 feet/1,957m) occurs on Peach Orchard Flat in the flood plain alluvium of Muddy Creek (Sec. 31, T15N:R91W).

Slopes within the project area are generally level to undulating (0 to 10 percent), broken by areas of steeper (10 to 40 percent) and very steep slope to vertical faces (rock outcrops).

Maximum slope over a three-mile intersect is about 7% grade (1,100 feet rise in 15,840 ground feet in the S1/2 T18N:R90W) and the minimum slope nears 0% grade in the NE ¼ T16N:R92W, and at a few other sites.

3.3.2 Project Area Soils

Texas Resource Consultants (TRC)(1981) and Wells *et al*. (1981) surveyed and described the dominant soil series, associations, and complexes encompassed within the project area at a third order level of detail. Each of these soil survey efforts was conducted for the BLM, in cooperation with the NRCS, then Soil Conservation Service (SCS). Interpretation ratings were developed for each map unit based upon the "Soil 5" filled out for the soil series which were based upon standards and procedures of the SCS National Soils Handbook, the SCS Guide for Interpreting Engineering Uses of Soils, the PCA Soils Primer, and Wischmeier and Smith (1978). Some areas are not mapped currently, which cover 8,634 acres or 3% of the Project Area.

According to the soil surveys, a total of 152 soil Complexes, Associations, Taxadjuncts, and Variant map units occur within the ARPA. A total of 96 soil series, in various degrees of composition, comprise the 152 map units. For these soils, soil depth ranges from shallow to deep, soil drainage from somewhat poor to somewhat excessive, permeability ranges from slow to rapid, water capacity ranges from very low to high, runoff from slow to rapid, and susceptibility to water and wind erosion ranges from slight to very severe. Basically, the soils are highly variable across this broad area.

3.3.3 Project Area Soil Limitations

Project area soil properties and limitations are discussed below. The topsoil category of poor and fair with "excess salt" as rationale (41,215 acres) provides good indication where potential reclamation problems may occur (Appendix M: Topsoils with Excess Salts). Severe wind and water erosion from these excess salt soils may increase the total salt load to the individual watershed and eventually to the Upper Colorado River System. A soil with a moderate or severe limitation or a fair or poor suitability does not mean the soil can not be used for a particular use. It does mean that if the soil is used, it may be more costly and difficult to accomplish the particular use.

Table 3-10 summarizes the data for these five categories and their individual ranking criteria for the contiguous ARPA. Table 3-11 shows these five categories as they relate to each of the twenty-one 6th level HUCs. Four of the five categories of concern are color-coded orange for three HUCs indicating that a high level of attention for any project-related activities within these HUCs is warranted. Eleven HUCs are ranked with three orange categories and eight deserve the same high attention because of size and overlapping sensitivities. None of the 21 HUCs have all categories in the green range.

Soil Texture and Strength

Clay and sandy soils have low strength under load and present severe limitations on road placement, construction, and maintenance (Appendix M: Soils with Severe Road Rating). A limitation is also placed on structure location and construction. Low-strength soils account for about 234,755 acres within the project area, or about 87% of the total land surface area of the ARPA.

Shallow soils and very shallow soils comprise about 33,700 acres within the project area. These present difficulty in reclamation pipeline placement. About 45,445 acres (Good topsoil ranking) have moderate permeability.

Soil Salinity and Sodicity

Most of the soil series in the ARPA overlay alkaline sub-soils which affects germination, plant growth, and species composition.

A biological source that exacerbates this problem is the recent invasion and establishment of halogeton (*Halogeton glomeratus*) in the ARPA and surrounding areas. Halogeton, an annual plant, is an aggressive invader of newly disturbed sites with alkaline to saline soils. Plant tissues accumulate salts from lower soil horizons. The salts leach from dead plant material, increasing topsoil salinity and favoring halogeton seed germination and establishment.

Erosion Potential

Soils with severe water erosion potential (high in clay content or are shallow over bedrock) exist on 64,260 acres within the ARPA. This figure increases by 13,328 acres when the moderate to severe rating is added and 148,918 acres when the slight to severe rating is added.

Soils with severe wind erosion potential (soils with sandy surface textures) encompass about 5,674 acres. However, this increases by about 17,000 acres if the moderate to severe rating is added. These soils can be difficult to reclaim and stabilize once disturbed.

Soils with high runoff potential (high in clay content, slopes, or shallow over bedrock) exist on 105,156 acres within the ARPA (Appendix M: Soils with High Runoff Potential). This figure increases to 197,418 acres when the moderate to high rating is added. These soils can also be difficult to reclaim and stabilize once disturbed. These soils contribute to sediment and salt loading into the watersheds.

Reclamation Potential

Reclamation potential is predominantly poor to fair in the ARPA. Poor and fair topsoils occupy approximately 210,992 acres, or 79% of the total land surface area of the ARPA (Appendix M: Soils with Poor/Fair Topsoil Ratings). High clay content soils occur on about 158,833 acres (61%) and saline soils on about 41,215 acres (16%). In these areas, successful revegetation may require additional efforts to meet BLM reclamation guidelines and time requirements.

3.3.4 Biological Soils Crusts

In general, biological soil crusts are poorly developed or absent within the ARPA. The most common crust component observed is the ground lichen, *Xanthoparmelia chlorochroa*, commonly called Parmelia.

3.3.5 Existing Soil Disturbances

Chapter 2 discusses the amount and nature of existing disturbances within the ARPA. Briefly, existing project-related disturbances to the soil resource includes about 600 acres, or 0.2% of the total land surface area of the ARPA. The majority of this total is 315 acres attributed to 210 gas well sites. Existing roads account for about 247 acres; compressor stations, 13 acres; transfer pumping stations, 1.0 acre; containment ponds, 25 acres; and deep injection well sites, 4 acres.

Table 3-10 Total Area (acres) of Soil Factors of Concern within the ARPA.[A]

Factor	Category	Acres[B]	% Total Area[B]
Water Erosion	No Data	8,171	3.2
	Slight	17,534	6.7
	Slight to Moderate	9,336	3.6
	Slight to Severe	148,918	56.9
	Moderate to Severe	13,328	5.1
	Severe	64,260	24.6
Wind Erosion	No Data	8,171	3.2
	Slight	23,427	9.0
	Slight to Moderate	82,771	31.7
	Moderate	124,523	47.7
	Moderate to Severe	16,982	6.5
	Severe	5,674	2.2
Runoff Potential	No Data	9,465	3.7
	Low	4,422	1.7
	Low to Moderate	3,567	1.4
	Low to High	12,930	5.0
	Moderate	33,744	12.9
	Moderate to High	92,262	35.3
	High	105,156	40.2
Topsoil Rating	No Data	5,111	2.0
	Poor	88,971	34.1
	Fair	122,021	46.7
	Good	45,445	17.4
Topsoil Rationale	No Data	5,111	2.0
(Poor and Fair)	Excess Salt	41,215	15.8
	Large Stones	6,512	2.5
	Too Clayey	158,833	60.8
	Too Sandy	2,574	1.0
	Wet	1,859	0.8
Road Rating	No Data	5,111	2.0
	Moderate	177,331	67.8
	Moderate to Severe	1,937	0.8
	Severe	77,169	29.5
Road Rationale	No Data	5,111	2.0
	Depth to Bedrock	17,736	6.8
	Low Strength	234,755	89.8
	Shrink-Swell Clays	58	0.1
	Too Sandy	2,438	1.0
	Wet	1,450.7	0.6

[A] Based on BLM analysis of soil survey data provided by Texas Resource Consultants (1981) and Wells et al. (1981).
[B] Acreage and percent total acres calculated on available soils data (261,550 acres) within the 270,180 acre project area.

Table 3-11. Total Area of Soil Factors of Concern by Sub-watersheds within the Atlantic Rim Project Area.[A]

HUC Name	Total Area Of HUC in ARPA (Ac.)	Water Erosion (Slight/Severe Moderate/Severe Severe)	Wind Erosion (Moderate/Severe Severe)	Runoff Potential (Low/High Moderate/High High)	Topsoil Rating (Poor)	Road Rating (Moderate/Severe Severe)
1. Dry Cow Creek	39,997	35,168	6,603	33,809	35,277	15,373
2. Cow Creek	25,027	18,650	470	17,097	16,071	5,056
3. Muddy Creek-Alamosa Gulch	21,439	19,102	1,723	19,702	13,517	3,420
4. Cherokee Creek	22,806	21,137	32	17,309	19,197	10,266
5. Deep Creek	22,791	21,329	0	18,760	19,206	13,575
6. Wild Cow Creek	21,060	15,682	354	13,758	14,746	8,599
7. Little Snake River-Cottonwood Creek	17,422	16,350	68	14,071	14,612	5,682
8. Separation Creek-Scotty Canyon	15,722	14,191	1,529	13,364	12,235	3,145
9. Upper Fillmore Creek	13,989	13,051	943	13,044	11,513	571
10. Muddy Creek-Blue Gap Draw	11,419	7,409	404	9,385	9,250	3,499
11. Hadsell Draw	11,158	9,747	1,443	9,972	8,418	656
12. Muddy Creek-Coal Mine Draw	8,871	7,296	581	7,988	7,230	447
13. Upper Sugar Creek	8,028	3,122	13	2,648	4,731	439
14. Little Snake River-Dutch Joe Creek	7,489	7,040	0	6,906	5,860	304
15. Muddy Creek-Antelope Creek	7,429	5,646	262	6,078	5,702	2,759
16. Muddy Creek-Robber's Gulch	7,162	5,355	0	5,384	5,085	1,523
17. Separation Creek-Red Rim	3,818	2,089	568	3,542	3,378	1,998
18. Lower Savery Creek	2,468	2,608	0	2,285	2,468	1,795
19. Bird Gulch	2,073	2,073	0	86	2,073	0
20. Lower Barrel Springs Draw	9	6	0	6	0	0
21. Middle Savery Creek	5	5	0	0	5	0
Totals	**270,182**	**227,056**	**14,993**	**215,197**	**210,574**	**79,107**

[A] Color code based on proportion (%) of the total area of each HUC that the category of concern represents. Arbitrary classification is: **GREEN** 0-20%, **YELLOW** 21-50%, **ORANGE** 51-100%.

3.4 WATER RESOURCES

Surface waters include resources in three major drainage basins: the Colorado River Basin, the Missouri River Basin, and the Great Divide Basin. The project area is predominantly within the Colorado River Basin (~75%) and drained by the intermittent Muddy Creek, a tributary of the Little Snake River. Within the ARPA, Muddy Creek's named tributaries, which are ephemeral, include Deep Creek, Cherokee Creek, Wild Cow Creek, and Cow Creek (and its named tributaries Dry Cow Creek and Deep Gulch), as well as its unnamed ephemeral tributaries. Some minor unnamed and named ephemeral tributaries of the Little Snake River (i.e., Cottonwood Creek and Dutch Joe Creek) drain the southern-most portion of the ARPA. A portion of the project area is also drained into the Savory Creek drainage, a main tributary to the Little Snake. A small part of the northeastern portion of the ARPA is in the upper portion of Sugar Creek an ephemeral stream within the Missouri River Basin. Separation Creek, a named ephemeral stream within the Great Divide Basin, and Filmore Creek drains the northwestern portion of the ARPA. There are a number of named and unnamed seeps and springs, as well as numerous man-made ephemeral and intermittent livestock reservoirs and ponds. The perennial Little Snake River is the most important surface water resource in the general vicinity and falls immediately outside of the southern boundary of the project area. The Little Snake River is part of the Yampa-White river system within the Colorado River Basin, Muddy Creek joins the Little Snake just above Baggs Wyoming. The Yampa-White river system is important for native fish recovery programs for the humpback chub, bonytail, Colorado pikeminnow, and razorback sucker. The Colorado River is probably one of the most utilized river systems in the west with innumerable municipal, industrial, and agricultural uses.

Groundwater resources include deep and shallow, confined (artesian) and unconfined (water table) aquifers. The unconfined aquifers are generally shallow, “blanket” type deposits of Quaternary or Tertiary age and are generally found 400 – 600 ft. below the ground surface. Alluvial and glacial gravel deposits fall into this category. Artesian aquifers are confined by relatively impermeable rocks and are generally in the deeper formations, such as the Mesa Verde. Water in an artesian aquifer is under hydraulic pressure and will rise above the top of the aquifer. A well tapping an artesian aquifer will flow at the surface provided the hydraulic pressure is sufficient. Most of the geologic formations of pre-Oligocene age in the area contain water under artesian pressure (Welder and McGreevy 1966).

3.4.1 Climate and Precipitation

Meteorological data from Western Regional Climate Center (WRCC) for the Rawlins (No. 487533), Baggs (No. 480484), Dixon (No. 482610), and Wamsutter (No. 489459) weather stations are all relevant to the characterization of water resources in the Atlantic Rim Project Area. Due to the size of the project area and the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably. Atlantic Rim at 7,000 to 8,500 ft in elevation forms a portion of the Continental Divide and is the most significant topographic feature within the project area. The northern portion of the ARPA is within the Great Divide Basin, which is approximately 3,815 square miles in area (or 3.9 percent of the land area in the state of Wyoming), and the climate within this internally drained basin is more arid than the balance of the project area. The Continental Divide splits east to west around the Great Divide Basin making it one of the highest and largest closed basins in the world.

The period of record for the Rawlins station (elevation of 6,740 feet) is 1951 to 2005. The period of record for the Baggs station (elevation of 6,240 feet) is 1979 to 2005. The Dixon station (elevation of 6,370 feet) has a period of record from 1922 to 1978, while the Wamsutter station (elevation of 6,820 feet) has a period of record from 1948 to 2004. The closest comprehensive recording weather station is at the Rawlins airport; located approximately 9 miles northeast of the northeastern corner of the project area. The Baggs station is located approximately three miles southwest of the southwestern corner of the project area, the Dixon station is located approximately two miles south of the southern edge of the project area, and the Wamsutter station is located approximately 25 miles to the northwest of the project area. The locations of Rawlins, Baggs, and Wamsutter, Wyoming relative to the ARPA are shown on Appendix M: Area Map.

Climate. The Atlantic Rim Project Area is located in a continental dry, cold-temperature-boreal climate (Trewartha 1968). This climate is characterized by a deficiency of precipitation (i.e., evaporation exceeds precipitation), and generally has cold temperatures where fewer than eight months of the year have an average temperature greater than 50° F, with warm summer days, cool summer nights, and bitterly cold winters. Strong and prolonged winds periodically sweep the project area throughout the year, being especially prevalent in winter. The project area is typically cool, having an average annual minimum temperature ranging between 26° F and 31° F, an average annual maximum temperature ranging from 55° F to 59° F, and an average annual temperature of about 42° F. The frost-free period (at or above 32° F throughout the day) generally occurs from mid-May to mid-September.

Precipitation. Mean annual precipitation is about 9 -12 inches in the project area depending on elevation. Rawlins and Baggs have an annual average of 9.1 inches and 10.4 inches, respectively. Mean annual precipitation is 10.3 inches at Dixon and 6.8 inches at Wamsutter. Although no long-term data is available for precipitation along the topographically higher Atlantic Rim in the northern portion of the project area, precipitation can be assumed to increase with elevation and has been estimated in the past as 12 inches (HSI, 1981).

Precipitation is somewhat evenly distributed throughout the year with May being the wettest month (1.5 inches at Baggs and 1.3 inches at Rawlins) followed by June, July, and October. January is the driest month (0.5 inches at both Baggs and Rawlins). The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the 50-year, 24-hour precipitation rate ranges from 2.2 inches to 2.6 inches in the project area (Miller et al. 1973). Average total snowfall depth for the year at Baggs and Rawlins is approximately 38 inches and 52 inches, respectively, with the greatest snowfall occurring in December and January (WRCC 2005). Due to the effect of ablation and snow drifting, a discontinuous snow cover is usually present during the winter. Significant accumulation of snow normally occurs at the higher elevations along the Atlantic Rim. Snow drifts in the headwaters of drainages provide critical water storage for shallow springs, streams and stockponds used as water sources in the late summer.

Precipitation in this region varies significantly from year to year. For example, at Rawlins, the month of May has had as little as 0.03 inch and January as much as 1.9 inches of precipitation. The greatest annual precipitation recorded at Rawlins was 12.6 inches in 1998, while the least was 4.9 inches in 1954 (WRCC 2005).

Other Climate Characteristics. Mean annual pan evaporation for this portion of southern Wyoming is about 75 inches, while the mean annual lake evaporation is around 55 inches. The potential annual evapotranspiration is roughly 20 inches (Martner 1986). Compared to the average annual precipitation of 10 inches, this gives an average annual deficit of approximately 10 inches.

The ARPA is subject to frequent winds. The wind is often strong and gusty, reflecting and channeling flows in response to complex terrain. During the winter months, strong winds are often accompanied by snow, producing blizzard conditions and drifting snow. The region experiences extreme wind gusts, especially during thunderstorm activity. Distinct diurnal changes occur, with surface wind speeds generally increasing during the day and decreasing during the night. In the northern portion of the project area, westerly winds dominate the winter climate and are generally due to cold fronts moving over the Interstate 80 corridor, a relatively low portion of the Continental Divide. In the central and southern portion of the project area, winds are generally out of the south or southwest, funneled out of the Little Snake River valley into the Muddy Creek drainage. Violent weather is relatively common in the area; thunderstorms occur an average of 30 days per year and hail an average of three days per year.

These meteorological and climatological characteristics of the project area combine to produce a predominantly dry, cool, and windy climate punctuated by quick, intense precipitation events.

3.4.2 Surface Water Quantity

The Continental Divide splits the ARPA into three major drainage basins. One leg of the Continental Divide runs east and west across the northern portion of the project area. Drainage south of this divide flows south and west to the Little Snake River (Hydrologic Unit Code [HUC] 14050003) in the Colorado River Basin. A second leg of the Continental Divide runs north, dividing the northern portion of the project area. Drainage west of this divide flows north to Separation Lake in the closed Great Divide Basin (HUC 14040200). Drainage east of this divide flows northeast to the North Platte River (HUC 10180002) in the Missouri River Basin. The Continental Divide and the three major drainage basins are depicted in Appendix M: Watershed Basins.

The locations of all USGS surface water gaging stations (both active and discontinued) within and near the ARPA are shown in Appendix M: Surface Waters and Monitoring Stations. Table 3-12 summarizes the available streamflow data from these stations. With the exception of Muddy Creek Station No. 09258980 and North Platte River Station No. 06630000, none of the other nearby gaging stations is currently in use. Data collection has been discontinued for at least the last eight years or was generally short lived or seasonal at the inactive stations. The average flow conditions presented in Table 3-12 therefore do not necessarily represent current flow conditions. As discussed in the climate section, precipitation is highly variable with small and large patterns of drought. However, sufficient data are available to compare flows streams relative to each other.

In 2004, the RFO-BLM sponsored USGS surface water gaging Station No. 09258980, Muddy Creek below Young Draw near Baggs. This station site is located immediately upstream of the discontinued USGS Station No. 09259000, Muddy Creek near Baggs (period of record 1987–1991). The gage was moved in effort to compensate for increased irrigation return flow occurring between the two sites and to reinitiate water quality and quantity monitoring of Muddy Creek. The new surface water monitoring station on Muddy Creek currently records streamflow and conductivity. The streamflow data from these two stations is comparable. Beginning in 2006, the USGS plans to collect water quality samples periodically at Station No. 09258980 in effort to develop a relationship between specific conductance and TDS concentration, and the gage would most likely be maintained throughout the life of the Atlantic Rim project.

Table 3-12. Flow statistics from USGS gaging stations located within and near the ARPA.

Station Name	Station Number	Drainage area (sq. mi.)	Period of Record	Mean Flow[1] (cfs)	Average Annual Runoff (ac-ft/yr)	Median Flow[2] (cfs)	Min. Flow[2] (cfs)	Max. Flow[2] (cfs) Date
Colorado River Basin								
Little Snake River near Dixon	09257000	988	10/1/10 - 9/30/23 10/1/38 - 9/30/71 4/1/72 - 9/30/97[3]	514	372,400	100	0	10,400 5/16/84
Muddy Creek near Baggs	09259000	1,257 (1,187)[4]	10/1/8 - 9/30/91	14.8	10,690	2.8	0.03	632 3/23/88
Muddy Creek below Young Draw near Baggs	09258980	1,150	4/17/04 - present	19.1	13,828	3.7	0.13	236 1/12/05
Savery Creek near Savery	09256000	330	10/1/41 - 9/30/72 3/27/85 - 9/30/92	103	74,390	30	0	2,440 5/4/52
Missouri River Basin								
North Platte River above Seminoe Reservoir, near Sinclair[5]	06630000	4,175 (4,061)[4]	7/1/39 - 9/30/00	1,140	825,800	450	70	14,800 6/11/86
Great Divide Basin								
Separation Creek near Riner	09216527	53	10/1/75 - 9/30/81	1.8	1,300	0	0	76 4/20/80
Separation Creek at upper station near Riner	09216525	42	7/1/75 - 9/30/75	1.3	na	0.8	0.5	21 9/11/75

Source: USGS 2005

[1] Over period of record

[2] Of mean daily values

[3] Daily flow measurements were only made from April through October during this time; not included in calculation of mean or median flow.

[4] Contributing drainage area

[5] Not depicted on Appendix M: Surface Waters and Monitoring Stations.

3.4.2.1 Colorado River Basin

The ARPA is predominantly drained by Muddy Creek, a tributary of the Little Snake River. The Little Snake River flows east to west just south of the project area. The Little Snake River drains the largest basin in the Yampa River Basin (Driver et al. 1984) in northwest Colorado (Appendix M: Watershed Basins). The Yampa River flows southwest to its confluence with the Green River in Colorado. The Green River drains to the Colorado River, which ultimately drains into the Pacific Ocean.

Approximately 75 percent of the ARPA is drained by Muddy Creek. Muddy Creek (HUC 14050004) flows from east to west and then south across the project area to its confluence with the Little Snake River near Baggs. The primary Muddy Creek ephemeral tributaries within the ARPA are include, from upstream to downstream, Cow Creek (and its tributaries Dry Cow Creek and Deep Gulch), Wild Cow Creek, Cherokee Creek, and Deep Creek (Appendix M: HUC Boundaries). These four tributaries experience intermittent streamflow in portions due to the presence of springs, seeps, and flowing wells in their headwater areas, similar to Muddy Creek, but are predominantly ephemeral and flow only in response to snowmelt and rainfall. There are also numerous unnamed, ephemeral tributaries of Muddy Creek within the project area.

The extreme southeast margin of the ARPA drains to the Little Snake River via Savery Creek. The main channel of Savery Creek flows north to south immediately east of the ARPA. The headwaters of two named ephemeral tributaries of Savery Creek, Negro Creek and Loco Creek, originate in the ARPA.

Muddy Creek is described as a high-elevation, cold-desert stream. Muddy Creek originates in the Sierra Madre Range, which is located immediately east of the ARPA, and extends to the Red Desert, immediately west of the ARPA. The watershed encompasses approximately 182 square miles, ranges in elevation from about 6,300 feet to about 8,200 feet, and extends from the Sierra Madre Range (to the east of the ARPA) to the Red Desert (to the west of the ARPA). The upland watershed is dominated by sagebrush and riparian vegetation within the valley is primarily willow and greasewood in addition to sedges and rushes (Beatty 2005).

Beatty (2005) divided Muddy Creek into two major segments, upper Muddy Creek and lower Muddy Creek. The upper segment is identified as that portion of the watershed upstream of a large headcut stabilization structure that is located in T.17N., R.92W., located just downstream of where Muddy Creek crosses the ARPA boundary and just upstream of where Muddy Creek crosses Highway 789. The four primary tributaries mentioned above are within the lower segment, which extends from the large headcut stabilization structure to the Little Snake River confluence. Lower Muddy Creek is highly erosional and has abundant channel incision (Beatty 2005). Channel substates consist predominantly of very fine-grained sediments (sands, silts and clays) in the lower segment, while most of the rock substrates (gravels and cobbles) occur in the upper segment. In addition, a large wetland complex occurs on the reach of Muddy Creek that lies west of Highway 789, in T.16N., R.92W. This wetland area (George Dew Irrigated Meadows) consists of impoundments, man-made channels, vertical drop structures, headgate structures for water diversion, overflow spillways, and a braided stream channel network (Beatty 2005).

Streamflow in Muddy Creek and its tributaries varies with location along the drainage. An appreciable amount of snow accumulates at the higher elevations of the watershed, particularly in the more protected areas having pronounced gullies and canyons; therefore, the snowmelt during the spring months accounts for a significant runoff event from tributaries draining these headwaters areas. Spring snowmelt runoff generally occurs from March through mid-June. Additional high flow events can occur in response to precipitation events occurring during the summer and fall months. Numerous springs occur within the ARPA and they contribute perennial low flows to the headwater tributaries; however, losses to seepage and evapotranspiration deplete these flows so the downstream reach of Muddy Creek generally has intermittent flows.

Wetland habitat has been created around a number of flowing wells within the ARPA, but like springs, their contribution to streamflow is relatively insignificant due to seepage and evapotranspiration losses. A discussion on springs and flowing wells in the ARPA is included in the groundwater section. The relative yield from rainstorms becomes more significant in the lower elevations of the drainage basin. Base flow and intermittency commonly occurs from July through September, but can occur as early as April (Goertler 1992). Particularly within the lower segment of the Muddy Creek basin, tributary channels are generally dry and prone to flashy, periodic flood events from isolated thunderstorm systems from May to October.

Of the four nearby Colorado River Basin gaging stations (Table 3-12); the Muddy Creek stations measure runoff from the largest drainage area. However, the average flow in Muddy Creek near Baggs, which is at its mouth, is much less than that measured at the Little Snake River or Savery Creek gaging stations. This is because the headwaters of the Little Snake and portions of Savery Creek are in the Sierra Madre range. The Average (mean) Muddy Creek flow during the period of record at the discontinued site was 14.8 cubic feet per second (cfs) and 19.1 cfs at the active site, as compared to 514 cfs in the upper Little Snake River and 103 cfs in Savery Creek. In general, Muddy Creek experiences higher individual events and lower annual water yield due to climate conditions discussed previously.

Unit runoff, calculated by dividing the average annual runoff into the effective drainage area, is much lower in Muddy Creek. Unit runoff in the Muddy Creek drainage basin was about 0.2 inches per year, as compared to 7.1 inches per year in the upper Little Snake River drainage basin and 4.2 inches per year in the Savery Creek basin. The calculated median flows, which discount the effect of short-duration, high-volume flood events, are 2.8 cfs and 3.7 cfs at the two Muddy Creek stations, and 100 cfs and 30 cfs at the Little Snake River and Savery Creek stations, respectively. Excluding the active Muddy Creek gaging station, the median flow rates of the three Colorado River Basin stations were calculated only during the time period in which all three stations were active: October 1, 1987 through September 30, 1991, excluding the months of November through March. During this time period, the median flows in Muddy Creek, Little Snake River, and Savery Creek were 6.9 cfs, 13.5 cfs, and 25 cfs, respectively. These calculations demonstrate that some of the differences between the average flow and median calculations presented in Table 3-12 may be caused by climactic differences between the differing periods of record. Because precipitation varies significantly from year to year, runoff varies significantly as well.

Much of the Muddy Creek watershed is managed by the BLM (Section 3.6) and the land has historically been managed primarily for its range resources (agricultural uses, primarily grazing), as well as wildlife habitat, energy exploration, development, and transportation, and recreational uses. Given these land uses and the area's unique geographic location and climatic characteristics, the Muddy Creek watershed has been extensively studied from water availability, water quality, and aquatic biology viewpoints.

A partial list of citations for this research in Muddy Creek follows:

Three native warm water fish species listed as BLM sensitive species and co-exist in portions of both upper and lower Muddy Creek within the ARPA. These species have been extensively studied to determine habitat associations, life history and interactions with non-native fish species (Quist et al., in press; Bower 2005). The lower portions of Muddy Creek have been studied to determine the role of anthropogenic disturbances as well as the distribution and life history of native fishes (Beatty 2005).

Extensive cooperative management projects have been undertaken to improve watershed conditions and the RFO-BLM has been a strong participant in many of these efforts in conjunction with water conservation districts, local government and land owners (Thompson, 2001; NARCS, 2000; Hicks and Warren, 1992 and1997; BLM, 1987; Hicks et al. 1996; and Fanning, 1986).

There has also been extensive research into surface–groundwater interactions, riparian system function, geomorphology, sediment dynamics and other basic research (Peterson, 1993; Goetler, 1992; Middleton, 1992; Skinner et al., 1989 and 1991, and Dolan and Wesche, 1987).

3.4.2.2 Great Divide Basin

The northwest portion of the ARPA (roughly 20 percent) drains into the Great Divide Basin via Separation Creek, including its tributary, Fillmore Creek. Separation Creek flows north to Separation Lake, which is a depression having no outlet and is located about 15 miles north of Rawlins. The Great Divide Basin is a closed basin – bounded by the Continental Divide on all sides and has no hydrologic outlet (USGS 1976; Seaber et al. 1987). The Great Divide Basin is a relatively shallow depression with isolated buttes, pan-like depressions, and sparse vegetation. Numerous ephemeral streams flow somewhat toward the center of the Great Divide Basin before disappearing in the soil or ending in natural or man-made impoundments. There are some spring-fed systems like Battle Springs Flat and unique alkaline wetland systems around Chain Lakes. In general Streams within the Great Divide Basin are ephemeral but can be intermittent in sections. These systems flow mainly in response to direct runoff from rainstorms and snowmelt (Lowham et al. 1976).

Springs provide some flow in the upstream reaches of the Separation Creek; however, groundwater inflow is not sufficient to maintain flow without snowmelt and rainfall. Some peak flows estimated for the creek in the downstream reaches are 39 cfs for a 2-year flood and 420 cfs for a 50-year flood. Estimated annual discharge for downstream reaches of Separation Creek is 2,500 acre-feet (Larson and Zimmerman 1981).

Separation Creek is classified by the WDEQ as a Class 4C stream (WDEQ 2005), defined as those waters that do not support fisheries or other aquatic life uses and it is not protected for those uses. It is however protected for agricultural, wildlife watering, and recreational uses. Beaver have greatly affected the streamflow, water quality, and aquatic habitat within the upper-most reaches of Separation Creek within Jep Canyon. The springs and seeps in Jep Canyon are not able to sustain streamflow throughout the year; however, they do sustain many of the beaver ponds in the headwater areas (Larson and Zimmerman 1981).

Groundwater is the most reliable source of water in Upper Separation Creek Basin. Springs and windmills presently supply water to wildlife and livestock (Larson and Zimmerman 1981).

3.4.2.3 Missouri River Basin

The northeast portion (roughly five percent) of the ARPA drains into the North Platte River via Sugar Creek. Although the USGS does not maintain a gaging station on Sugar Creek, limited instantaneous flow data are available from USEPA and Wyoming Department of Environmental Quality (WDEQ) monitoring stations near Rawlins (WRDS 2004). According to 14 instantaneous flow measurements collected at two stations during 1973, 1975, and 1976, Sugar Creek was flowing between 1 and 3 cfs, with a mean flow of 2.1 cfs. Sugar Creek drains the northwestern slope of the Atlantic Rim.

The headwaters of Little Sage Creek, a tributary to Sage Creek, begin at the eastern edge of the ARPA; an extremely small portion of the ARPA. The mainstem of Sage Creek begins east of the ARPA and flows northeast to its confluence with the North Platte River between Saratoga and Rawlins, Wyoming. Limited flow data are available from two BLM gaging stations on Little Sage Creek (WRDS 2004). Based on 36 instantaneous flow measurements recorded during May through November, 1978, and May through September, 1979, the average Little Sage Creek flow during these months was 1.8 cfs, and the median flow was 0.8 cfs.

3.4.3 Surface Water Rights

Based on a review of Wyoming State Engineer's Office (SEO) surface water rights, there are 195 permitted surface water rights within the originally scoped portion of the ARPA. Table 3-13 summarizes the rights according to designated uses. A second surface water rights search was performed for each of the major drainage basins intersecting the scoped ARPA. Table 3-14 summarizes the rights within each basin.

The Wyoming Game and Fish Department (WGFD) maintains a database of lakes, reservoirs, and ponds in the state (WGFD 2004a). A search of the most recent WGFD database revealed the presence of 14 reservoirs and ponds in the scoped ARPA. The waterbodies varied from 0.5 acres to 20 acres. Seven were owned or controlled by the USDI-BLM, six by private individuals, and one by the state of Wyoming. Table 3-15 lists the reservoirs and ponds catalogued by the WGFD.

Table 3-13 Surface water rights within the ARPA.

SEO Use Designation	Surface Water Rights
Stock	161
Irrigation	12
Stock and irrigation	4
Domestic supply (in addition to stock and/or irrigation use)	10
Industrial	1
Reservoir supply	3
Wildlife and fish propagation	4
Total surface water rights within the ARPA	**195**

Table 3-14. Surface water rights within major drainage areas.

SEO Use Designation	Muddy Creek	Savery Creek	Separation Creek[1]	Sage Creek	Sugar Creek
Stock	272	145	43	51	22
Irrigation	26	60	7	36	13
Stock and irrigation	8	7	6	4	6
Domestic supply (in addition to stock and/or irrigation use)	12	18	3	16	15
Industrial - pollution control and flood control	13	9		1	6
Municipal				14	31
Reservoir supply	2	1		3	1
Railroad and steam supply				13	2
Wetland, wildlife, and fish propagation	9	3		1	
Mining		9			
Power development		2		1	2
Recreation		2	1	1	
(none listed)	2	1		1	
Totals by Drainage Area	344	257	60	142	98

[1] to confluence with Fillmore Creek

3.4.4 Waters of the United States

The surface water features in the ARPA, except those within the internally drained Great Divide Basin, qualify as Waters of the U.S. Waters of the U.S. include the territorial seas; interstate waters; navigable waterways (such as lakes, rivers, and streams), special aquatic sites, and wetlands that are, have been, or could be used for travel, commerce, or industrial purposes; tributaries; and impoundments of such waters. All channels that carry surface flows and that show signs of active water movement are Waters of the U.S. Similarly, all open bodies of water (except ponds and lakes created on upland sites and used exclusively for agricultural and industrial activities or aesthetic amenities) are Waters of the U.S. (USEPA 33 CFR § 328.3(a)). Such areas are regulated by the USEPA and the U.S. Army Corps of Engineers (ACOE). Many of the drainage channels identified on the USGS topographic maps are vegetated swales, which are not considered to be Waters of the U.S. by the ACOE. Any activity that involves discharge of dredge or fill material into or excavation of such areas is subject to regulation by the ACOE pursuant to Section 404 of the CWA. Activities that modify the morphology of stream channels are also subject to regulation by the Wyoming SEO. Special aquatic sites and wetlands are discussed in greater detail in the Vegetation Section (Section 3.5).

Table 3-15. Reservoirs, lakes, and ponds in the ARPA.

Water Body	Source Water	Acres	Ownership
Brazel Reservoir	Dry Cow Creek	1	USDI-BLM
Doty Mountain Reservoir	Dry Cow Creek	20	USDI-BLM
Dry Cow Reservoir	Dry Cow Creek	2	USDI-BLM
Horse Gulch Reservoir	Muddy Creek	3	Private
J-O Reservoir	Cow Creek	8	State
J-O Reservoir #1	Dry Cow Creek	1.5	Private
J-O Reservoir #2	Dry Cow Creek	2	Private
J-O Reservoir #3	Dry Cow Creek	3	Private
J-O Reservoir #4	Dry Cow Creek	1	Private
Lower Deep Gulch Pond	Cow Creek	3	USDI-BLM
Retention Reservoir	Deep Creek	5	USDI-BLM
Smiley Draw Reservoir	Cherokee Creek	6	USDI-BLM
Willie Reservoir	Loco Creek	2.5	Private
Willow Road Pond	Dry Cow Creek	0.5	USDI-BLM

Source: WGFD (2000)

3.4.5 Surface Water Quality

Various federal and state agencies, including the USGS, USDI-BLM, USEPA, and WDEQ have measured the surface water quality in and around the ARPA. Surface water samples have been analyzed for physical and chemical properties, salinity, major ions, metals, radionuclides, and/or specific toxins. The locations of these agencies' surface water quality sampling sites in and around the ARPA are depicted in Appendix M: Surface Waters and Monitoring Stations. The chemical analyses of most surface water samples that have been collected within the ARPA can be accessed through the State of Wyoming's Water Resources Data System (at web site http://www.wrds.uwyo.edu/) and the USGS's database (at web site http://waterdata.usgs.gov/usa/nwis/).

In the arid, high plains of southwestern Wyoming, surface water quality, like streamflow, is variable both spatially and temporally. Perennial stream water quality is generally of better quality than that of the ephemeral and intermittent streams. The quality of runoff is largely dependent upon the rates of salts, sediments, and organic materials that accumulate in the dry stream channels between periods of runoff. Factors that can govern the rate of buildup of these materials are the basin's physical characteristics, land uses, and season of the year. Periodic flushing of accumulated salts and sediments from the ephemeral and intermittent streams occurs during flow events, which is the only time that water quality samples can be collected, accounting for greater concentrations of dissolved and suspended solids recorded in the analyses. In general, when quantity of runoff decreases, the quality decreases. In less arid areas having more flushing and less evaporation, coupled with more baseflow, the action of flushing and sharp fluctuations of water quality would be less significant (Larson and Zimmerman 1981, Lowham et al. 1982).

Water quality is classified by the State of Wyoming based on beneficial uses. Table 3-16 and 3-17 show the classifications of Wyoming surface waters located in or near the ARPA.

Table 3-16. Classification of Wyoming surface waters.

	Drinking Water	Game Fish	Non-Game Fish	Fish Consumption	Other Aquatic Life	Recreation	Wildlife	Agriculture	Industry	Scenic Value
1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

3.4.5.1 Baseline Water Quality Data

A summary of the water quality data from each of seven USGS surface water sampling stations located in the Little Snake River watershed within the scoped ARPA (two on Little Snake River, three on Muddy Creek, and one each on Cow Creek and Dry Cow Creek) for the respective periods of record are shown on Table 3-18. The two Little Snake River stations represent perennial stream surface water quality in the area, the three Muddy Creek stations represent intermittent stream surface water quality in the ARPA, while the water quality in ephemeral streams is represented by the Cow and Dry Cow Creek monitoring stations.

Table 3-17. Classification of streams in the ARPA.

Surface Water	Classification
Colorado River Basin	
Little Snake River	2AB
Muddy Creek (mouth to Sec. 29, T.17N., R.89W.)	2C
Muddy Creek (remainder)	2AB
McKinney Creek	2AB
Cow Creek	2C
Dry Cow Creek	3B
Wild Cow Creek	2C
Cherokee Creek	2C
Deep Creek	3B
Savery Creek	2AB
Loco Creek	2C
Negro Creek	3B
Missouri River Basin	
Separation Creek	4C
North Platte River Basin	
North Platte River (Sage Creek to Colorado state line)	1
North Platte River (Kortes Dam to Sage Creek)	2AB
Sage Creek	2AB
Little Sage Creek	2C
Sugar Creek	3B

Source: WDEQ (2005a)

Table 3-18. Surface water quality in the ARPA.

	USGS Surface Water Quality Station						
	Little Snake River	**Little Snake River**	**Muddy Creek**	**Muddy Creek**	**Muddy Creek**	**Cow Creek**	**Dry Cow Creek**
Station Number	**09257000**	**09259050**	**09258900**	**09259000**	**09258980**	**09115080**	**09258200**
Sample period	1957-1988	1980-1997	1976-1978	1957-1991	May 2005-present[1]	1978-1979	1975-1980
Number of samples[2]	107	100	3	41	nm	20	9
pH	8.1	8.1	8.6	8.2	nm	9.2	8.6
Conductance, μmhos/cm (mean)	$259_{(34)}$	$366_{(90)}$	$1,350_{(2)}$	$966_{(35)}$	$1,300_{(111)}$	$2,925_{(18)}$	$2,162_{(5)}$
Conductance, μmhos/cm (min.)	82	87	600	529	598	700	460
Conductance, μmhos/cm (max.)	460	855	2,100	1,790	3,550	7,500	3,800
TDS (mean)	$158_{(9)}$	$243_{(17)}$	$913_{(2)}$	$346_{(1)}$	nm	$1,801_{(6)}$	$292_{(1)}$
TDS (min.)	46	87	396	346	nm	561	292
TDS (max.)	260	540	1,430	346	nm	3,013	292
Suspended solids[3] (mean)	$154_{(101)}$	$228_{(25)}$	$6,198_{(2)}$	$3,191_{(41)}$	nm	$133_{(6)}$	$1111_{(9)}$
Suspended solids[3] (min.)	4	6	195	7	nm	30	8
Suspended solids[3] (max.)	1,180	852	12,200	22,500	nm	315	6,180
Turbidity, JTU	13	167	1,260	nm	nm	284	1,013
Calcium	30	34	54	42	nm	19	9
Magnesium	8	12	44	40	nm	31	4
Potassium	2	2	7	9	nm	11	4
Sodium	11	26	200	286	nm	560	98
Bicarbonate	159	190	373	308	nm	870	170
Sulfate	25	54	380	320	nm	181	65
Chloride	3	2	65	32	nm	132	21
Iron, μg/L	74	164	105	nm	nm	2,903	200
Hardness ($CaCO_3$)	111	151	315	270	nm	174	37
Dissolved Oxygen	9	10	11	10	nm	9	11

[1] Daily mean values analyzed: May 27, 2005 to September 14, 2005.
[2] Total number of grab samples analyzed; not every parameter was analyzed in every sample.
[3] Total concentration; except as noted here, all reported values represent dissolved concentrations.
All units are mg/L except as noted.
nm = not measured
(34) = Number of samples analyzed for that parameter.

As Table 3-18 indicates, considerably more measurements of specific conductance have been recorded than total dissolved solids (TDS) concentrations at these seven surface water sampling stations. For individual streams, a good relationship can commonly be established between specific conductance and total dissolved solids concentration. In general, as ionic concentrations increase, conductance increases (Hem 1970). Therefore, specific conductance measurements of streams in the project area are related to the dissolved solids concentrations. The USGS intends to collect periodic TDS concentration samples at Muddy Creek Station No. 09258980 beginning in 2006 so that a relationship between conductivity, which is presently monitored hourly on a real-time basis continuously, and TDS concentration can be determined.

Surface water quality within the Muddy Creek drainage basin, like streamflow, is variable both spatially and temporally. The ephemeral stream water quality, represented by the two Muddy Creek tributaries, is characterized by high and widely variable conductance and TDS concentrations (ranging from about 560 mg/L to over 3,000 mg/L), and the predominant ions are sodium and bicarbonate. The intermittent stream water quality, represented by Muddy Creek, is characterized by moderate conductance and TDS concentrations (ranging from around 350 mg/L to 1,400 mg/L), and the predominant ions are sodium, sulfate, and bicarbonate. The perennial stream water quality, represented by Little Snake River, is characterized by significantly reduced conductance and TDS concentrations (ranging from around 50 mg/L to 550 mg/L), and the water type is calcium bicarbonate. Note that limited samples were available from the ephemeral tributaries, and the samples that were available tended not to always coincide with the infrequent flood events. Short-duration flood events in response to precipitation or snow melt typically cause an abrupt, temporary increase in the concentration of dissolved constituents followed by a decrease due to the flushing of the channels and basin surface and a dilution effect. The larger variation and relatively higher conductance values measured in the ephemeral streams, where baseflow is responsible for a small part of the overall streamflow, illustrates the how the quality of runoff from those stream reaches is influenced by the flushing of salts by flood events.

Based upon the historical USGS surface water quality analyses (Table 3-18), the average TDS concentration in the perennial Little Snake River below Baggs was about 250 mg/L, compared to roughly 900 mg/L in the intermittent Muddy Creek just upstream of its confluence with the Little Snake River, and almost 2,000 mg/L in the ephemeral Cow Creek near its mouth. Though a limited number of TDS analyses are available from Muddy Creek at Station No. 09259000, the average TDS concentration at this location was estimated using a regression analysis of conductance values recorded at that station and at Station No. 09258980.

As indicated in Table 3-18, surface waters in the ARPA are of moderately basic (or high) pH (8.1 to 9.2) and have a moderate concentration of dissolved oxygen (9 to 11 mg/L). WDEQ/WQD (2005) defines 9.0 as the upper pH limit for full aquatic life support. Hardness varied between soft (37 mg/l $CaCO_3$) in Cow Creek to hard (315 mg/l $CaCO_3$) in Muddy Creek.

As the name Muddy Creek implies, the suspended solids concentration is typically high. Suspended sediment concentrations, like total dissolved solids concentrations, are greater in the ephemeral and intermittent streams than the perennial Little Snake River. This, in part, is apparently the result of a flushing action similar to the flushing of salts. The ephemeral and intermittent channels, as well as the basin's surface, that have periods of no flow accumulate loose material due to weathering, bank caving, livestock and wildlife movement, and wind deposits. This loose material is then readily picked up by the turbulent first flows of a flood event. Once the channels and basin surface have been flushed, then the suspended sediment concentration is dependent upon the magnitude of the runoff event and the erodability of the land surface and stream channel. As stated in the Reclamation Potential discussion in Section 3.3, poor to fair topsoils occupy approximately 81.5 percent of the total land surface of the ARPA; therefore, reclamation potential is fair to poor. This is due to factors including steep slopes and high clay and silt content soils that can cause moderate to severe water and wind erosion and have moderate to high runoff potential. The relatively high total suspended solids (TSS) concentrations recorded in Muddy Creek flows (concentrations averaging about 6,200 mg/L and a high value of 12,200 mg/L) are indicative of the relatively high percentage of the land surface in the basin that has high (40 percent in the ARPA) or moderate to high (about 35 percent in the ARPA) runoff potential (Section 3.3).

Turbidity varied from 13 Jackson turbidity units (JTU) in Little Snake River to 1,260 JTU in Muddy Creek. The moderate to high turbidity measurements were likely caused by the moderate to high measurements of suspended sediment (predominantly clay particles and organics).

Table 3-19 presents a summary of all Muddy Creek water quality samples that were available from the State of Wyoming's WRDS database prior to installation of the new USGS Station No. 09258980 in 2004. Constituent concentrations on Table 3-19 represent the geometric mean of all the respective water quality constituents over the period of record (being 1933, 1976, 1978, 1979, and 1986 through 1993) at 16 separate water quality sampling stations throughout the Muddy Creek drainage basin (Appendix M: Surface Waters and Monitoring Stations). The average specific conductance is moderate at 599 micromhos per centimeter (µmhos/cm), pH is slightly basic at 8.2, the TDS concentration is 442 mg/L, and the water is a calcium-bicarbonate type. High TSS (maximum concentration of 22,500 mg/L), coupled with high fecal coliform bacteria concentrations indicate that Muddy Creek would likely require disinfection and filtration if it were to be used as a potable supply. Naturally occurring radionuclides may also restrict the use of Muddy Creek as a drinking water supply. Mean uranium, gross alpha, and gross beta concentrations were 11 micrograms per liter (µg/L), 22 picocuries per liter (pCi/L), and 4.6 pCi/L, respectively. It is important to emphasize that the values in Table 3-19 do not necessarily represent the surface water quality at any particular location within the Muddy Creek drainage basin during any particular season of the year, but rather, are the composite representation of Muddy Creek water quality.

Figure 3-2 compares the major ion characterization of each surface waterway. The major ion concentrations from Table 3-19 are plotted on Figure 3-2 for Muddy Creek, as were the geometric means of the major ions determined from all water samples that have been collected from the other streams depicted. Ephemeral Dry Cow Creek, Cow Creek, Wild Cow Creek, and Little Sage Creek exhibited sodium dominance, while the intermittent Muddy Creek and the perennial Little Snake River and North Platte River exhibited calcium dominance. With the exception of Separation Creek, which is sulfate dominant, all surface waterways exhibited bicarbonate anion dominance.

Table 3-19. Muddy Creek water quality.

Parameter	Unit	Mean [1]	Count	Max	Min
Specific conductance	µmhos/cm	599	128	2,450	324
Total dissolved solids	mg/L	442	31	1,430	227
Total suspended solids	mg/L	144	56	22,500	0.2
Turbidity	NTU	23	86	2,500	1.1
pH	standard units	8.2	137	8.7	7.2
Dissolved oxygen	mg/L	9.0	71	17.6	4.0
Hardness as $CaCO_3$	mg/L	258	134	555	100
Alkalinity as $CaCO_3$	mg/L	182	113	992	83
Calcium	mg/L	76	136	171	22
Magnesium	mg/L	12	136	84	3.9
Sodium	mg/L	15	135	300	0.3
Potassium	mg/L	4.3	135	51	1.6
Sodium adsorption ratio	none	0.43	135	10	0.01
Sulfate	mg/l	116	136	668	1.1
Chloride	mg/L	12	106	359	0.7
Bicarbonate	mg/L	214	135	2729	109
Carbonate	mg/L	1.2	115	47	< 1
Fluoride	mg/L	0.3	100	2.8	< 0.1
Silica	mg/L	15	8	39	5.6
Coliforms, fecal	count/100 mL	78	41	1,650	3
Aluminum, dissolved	µg/L	50 [2]	1	< 100	< 100
Arsenic, dissolved	µg/L	2.0	1	2	2
Barium, dissolved	µg/L	50	1	< 100	< 100
Beryllim, dissolved	µg/L	nm [3]	nm	nm	nm
Boron, dissolved	µg/L	64	5	360	10
Cadmium, dissolved	µg/L	0.5	1	< 1	< 1
Chromium, dissolved	µg/L	0.5	1	< 1	< 1
Cobalt, dissolved	µg/L	nm	nm	nm	nm
Copper, dissolved	µg/L	1.0	1	< 2	< 2
Iron, dissolved	µg/L	51	9	200	< 30
Lead, dissolved	µg/L	0.5	1	< 1	< 1
Mangansese, dissolved	µg/L	21	5	90	< 10
Mercury, dissolved	µg/L	0.25	1	< 0.5	< 0.5
Molybdenum, dissolved	µg/L	8	1	8	8
Selenium, dissolved	µg/L	3	1	3	3
Silver, dissolved	µg/L	0.5	1	< 1	< 1
Uranium, dissolved	µg/L	11	2	16	6.9
Zinc, dissolved	µg/L	10	1	< 20	< 20
Radium 226	pCi/L	0.5	2	1.2	0.17
Gross alpha	pCi/L	22	2	23	22
Gross beta	pCi/L	4.6	2	6.5	3.3

Source: WRDS (2002)
[1] geometric mean
[2] assumed half of detection limits for samples reporting "no detect"
[3] nm = not measured

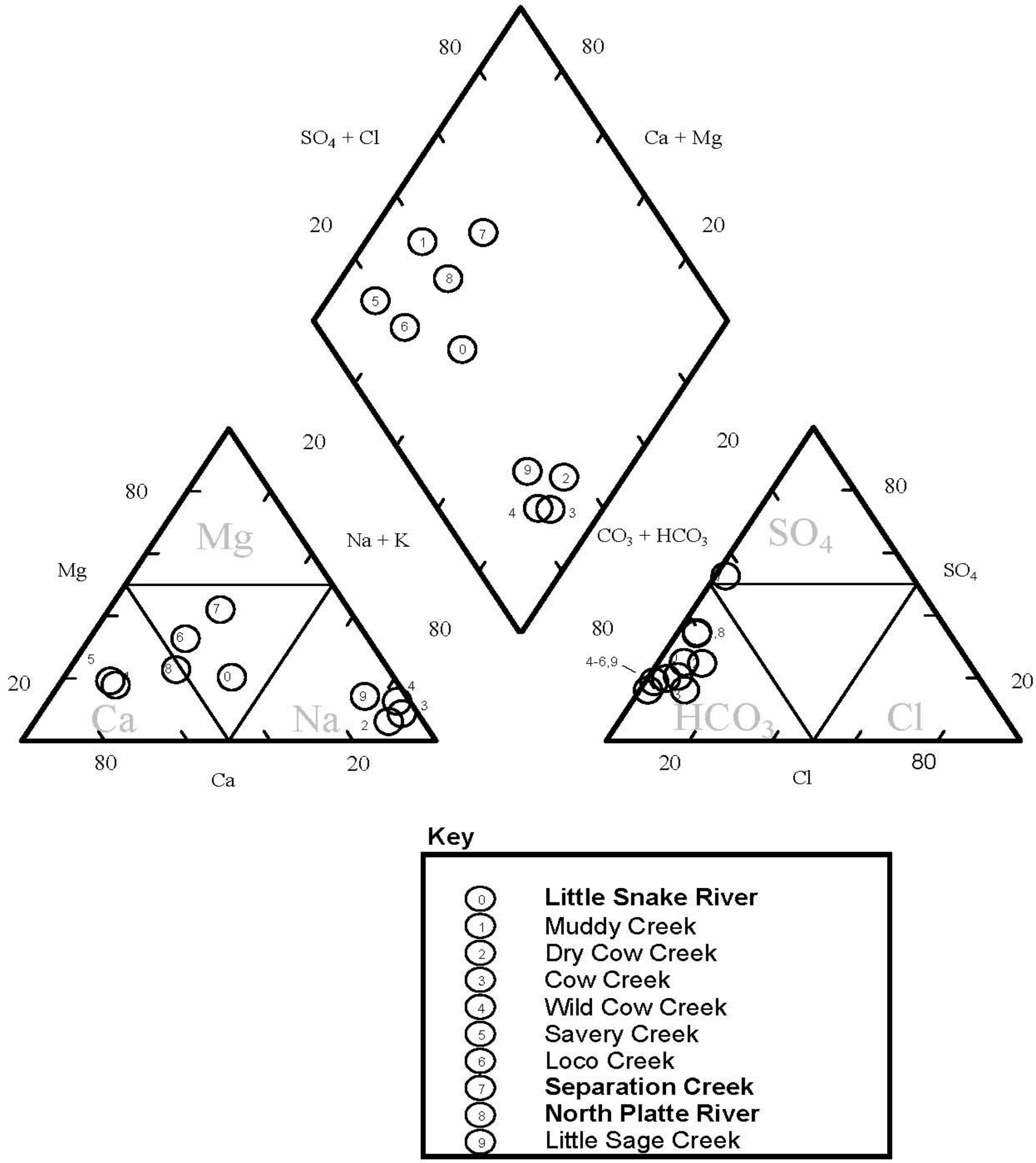
Figure 3-3 compares the irrigation suitability of the streams in and around the ARPA. Again, geometric means of the specific conductance and sodium adsorption ratio (SAR) values were determined from all water quality samples available from the State of Wyoming's WRDS database for these streams (WRDS 2002). The figure combines USDA (1954) and Ayers and Wescott (1985) information on classifying irrigation waters. The irrigation suitability is a function of SAR and salinity as measured by specific conductance. The perennial and intermittent streams are all in the C1-S2 category. The low salinity (C1) classification indicates that the water can be used for all crops and soils where salt toxicity is concerned. The moderate sodium (S2) classification indicates that the water may cause clay particles in irrigated soils to swell and disperse, and thereby reduce soil infiltration rate. The ephemeral streams in the ARPA are generally in the C2-S2 category, indicating that the yield of salt-sensitive crops may be reduced.

When flows are available and based on average values, Muddy Creek is moderately suitable as an irrigation water supply. As shown on Figure 3-3, Muddy Creek does not pose a salinity hazard to irrigated crops. However, due to the flashy flows and limited data it would be difficult to be very confident about this determination. Muddy Creek in general is a good supply of water for livestock and wildlife when it flows, and would be suitable for crops such as native hay.

Numerous miscellaneous surface water quality samples were obtained from various locations within the upper Separation Creek watershed, both within and outside of the ARPA, as part of the Separation Creek study by Larson and Zimmerman (1981). Snowmelt is the principal source of streamflow. Specific conductance measured at USGS Station No. 09216527 (Appendix M: Surface Waters and Monitoring Stations) ranged from 200 to 2,000 μmhos/cm (or a TDS concentration of about 1,400 mg/L). Surface water in Separation Creek tends to be slightly to highly alkaline, having and average pH of 8.0. Total phosphorous concentration averaged 0.16 mg/L, which is slightly above the EPA criterion for stream protection (0.1 mg/L). Separation Creek carries and deposits sediments to the center of the Great Divide Basin. Suspended sediments are predominantly comprised of clay and silt. Separation Creek has an average suspended sediment concentration of 506 mg/L. The chemical quality of upper Separation Creek streamflow was found by Larson and Zimmerman (1981) to be suitable for its present uses, which are livestock watering and irrigation of native hay.

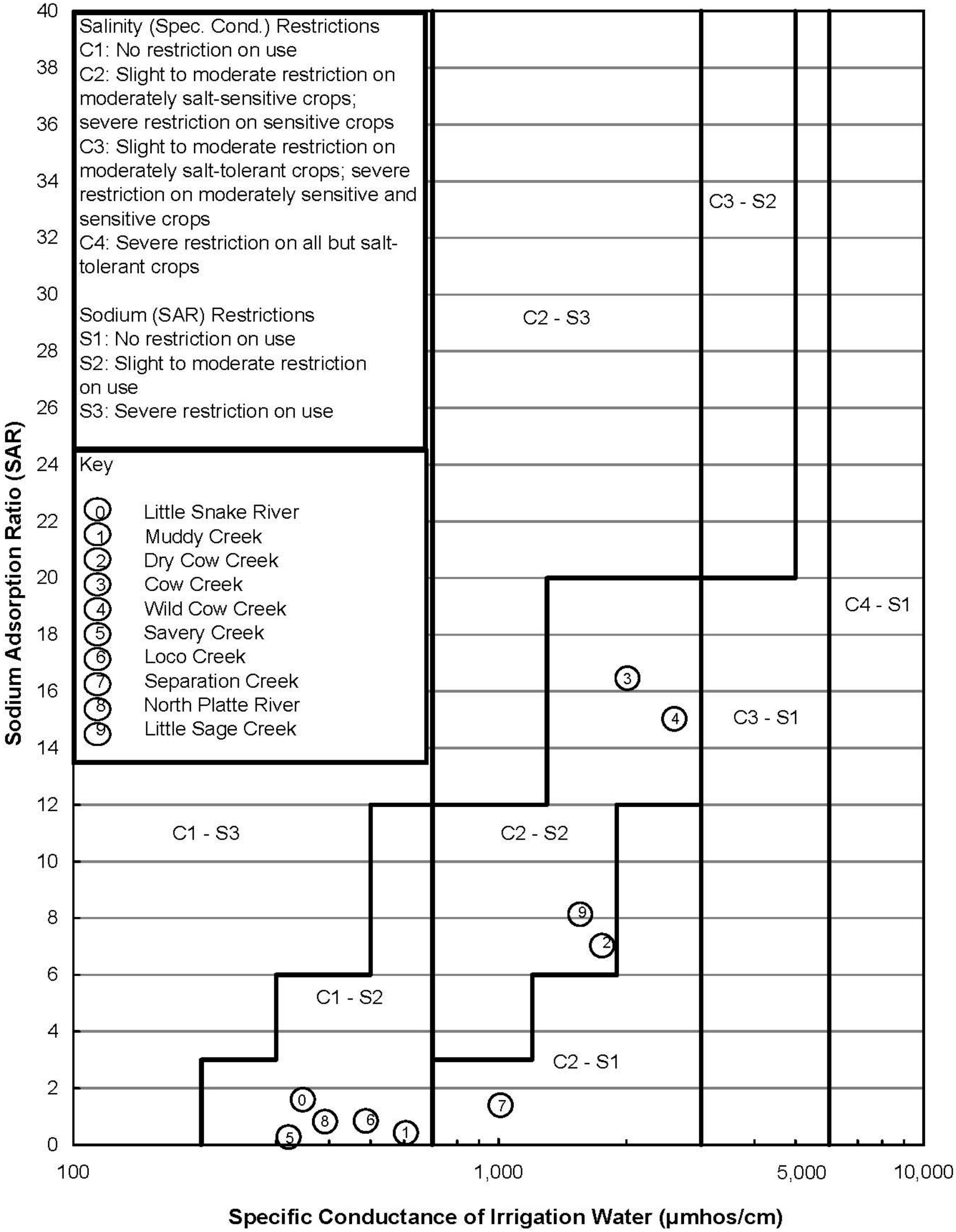
3.4.5.2 Waterbodies with Impairments or Threats

Various streams in the ARPA are identified in WDEQ's 2004 Wyoming 305(b) Water Quality Assessment Report to the USEPA (WDEQ 2004b) as having water quality impairments or threats. Table 3-20 summarizes the streams and potential problem parameters as listed on Wyoming's 303(d) list of waterbodies with water quality threats. Threatened or impaired stream segments in and around the ARPA are depicted in Appendix M. Impaired or threatened streams in the Little Snake River watershed (HUC 1405003 and 1405004) include portions of Muddy Creek, McKinney Creek, West Fork Loco Creek, Savery Creek, Haggarty Creek, and West Fork Battle Creek. According to the 2004 305(b) report, unstable stream channels and loss of riparian functions threaten aquatic life uses in Muddy Creek and McKinney Creek.



Data source: WRDS (2002)

Figure 3-2. Major ion composition of streams in and around the ARPA.



Note: Figure modified from USDA Agriculture Handbook 60 (1954) to include Hanson et al. (1999) classification lines

Figure 3-3. Irrigation suitability of streams in and around the ARPA.

The Little Snake River Conservation District (LSRCD) has been addressing these problems with the cooperation of the USDI-BLM, landowners, grazing permittees, WGFD, and other stakeholders since 1992. Several 319 watershed improvement projects have been implemented, including developing upland water supplies, developing wetlands, re-establishing flood plains, cross fencing, and managing grazing and vegetation. Additional watershed improvement projects have been coordinated by WGFD. These projects resulted in improvements to stream stability, aquatic habitat and riparian areas. As a result, Muddy Creek and Littlefield Creek above their confluence, and McKinney Creek above Eagle Creek are now meeting their aquatic life uses. Because of the improved water quality, Colorado River cutthroat trout have been re-introduced into their former habitat in Littlefield Creek (USDI-BLM 2004a).

Water development projects have been implemented on the reach of Muddy Creek lying west of Highway 789 to address physical degradation of the stream channel, which threatens its aquatic life use support. This reach of Muddy Creek is also on Table C of the 303(d) list. Implementation measures include wetland development, re-establishment of the floodplain and irrigation water management. Results of this project show an improving trend in riparian condition and bank stability above Red Wash, according to the LSRCD.

However, habitat degradation has been identified by the BLM and LSRCD as a serious water quality concern on Muddy Creek, from Red Wash downstream to the Little Snake River. The habitat degradation is likely caused by season long riparian grazing, exacerbated by accelerated erosion associated with oil and gas activities. Several grazing management BMPs are being implemented in much of this lower watershed, including changes in length, timing and duration of grazing and cross fencing (USDI-BLM 2004a).

The upper portions of Muddy Creek and McKinney Creek to the confluence of Eagle Creek have been listed as having threats based on habitat degradation for non-game fish, coldwater fish and aquatic life. Changes in upland runoff, hydrology and/or increased sedimentation could reduce habitat for non-game fish, coldwater fish and aquatic life. Habitat for these species includes pools and riffles. With increased sediment loads riffles can become silted in and pools can fill, degrading the habitat. Changes in upland runoff conditions can increase peak flow conditions and may reduce base flows critical for maintaining late season pool habitats. Current road densities in these areas are less than 2 mi/sqmi, and accounts for a small amount of sediment delivery. Changes in grazing practices have generally improved vegetation conditions and improved rainfall/runoff conditions.

In Savery Creek and West Fork Loco Creek, physical degradation of the stream channels is threatening full aquatic life use support. The LSRCD is currently implementing a 319 watershed improvement project to address the threats. Portions of Haggarty Creek and West Fork Battle Creek, both east of the ARPA, are included on the 2004 303(d) list of impaired streams due to high copper, silver, and cadmium concentrations. The sources of the metals have been identified as natural and the Ferris-Haggarty Mine, which is located near the headwaters of Haggarty Creek.

Table 3-20. 2004 303(d) Waterbodies with Impairments or Threats.

Surface Water	Impairments or Threats	Location	Impairments/ Threats	Use Impaired/ Threatened	Date	Priority
Little Snake River Basin (HUC 14050003 and HUC 14050004)						
Muddy Creek	Threats	West of State Hwy 789	Habitat degradation; salinity	Non-game fishery; aquatic life	1996	Low
Muddy Creek	Threats	Above Alamosa Gulch to Littlefield Creek	Habitat degradation	Cold water fishery; aquatic life	1996	Low
McKinney Creek	Threats	Above Muddy Creek to Eagle Creek	Habitat degradation	Cold water fishery; aquatic life	1996	Low
Savery Creek	Threats	Below Little Sandstone Creek to Little Snake R.	Habitat degradation	Cold water fishery; aquatic life	1998	Low
Loco Creek West Fork	Threats	All of West Fork watershed above Loco Creek	Habitat degradation; nutrients; temperature	Cold water fishery; aquatic life	1996	Low
Haggarty Creek	Impairments	From Ferris-Haggarty Mine to W. Fk. Battle Ck.	Copper, silver, and cadmium	Cold water fishery; aquatic life	1996	Low
West Fork Battle Creek	Impairments	From Battle Creek to Haggarty Creek	Copper	Cold water fishery; aquatic life	2000	Low
Missouri River Basin (HUC 10180002)						
Sage Creek	Threats	From confluence with North Platte River to State Hwy 71	Habitat degradation	Cold water fishery; aquatic life	1996	Low

Source: WDEQ (2005)

In the Upper North Platte River basin (HUC 10180002), the only stream currently listed as impaired or threatened is Sage Creek. According to the 2004 305(b) report, this creek has naturally high sediment load due to the erosive soils and arid climate in the watershed. A 319 watershed project was instated in 1997 by the Saratoga-Encampment-Rawlins Conservation District (SERCD) in cooperation with the USDI-BLM, NRCS, WGFD, and landowners. The project has resulted in reduced sediment loading through a combination of short duration grazing, riparian and drifts fencing, upland water development, improved road management, grade control structures, and vegetation filtering.

WDEQ classifies Wyoming surface water resources according to quality and degree of protection. Table 3-16 summarizes the classification system based on acceptable uses. Table 3-17 lists the DEQ classification of surface waters in the ARPA. The Little Snake River, Savery Creek, Sage Creek, and the North Platte River have been included with streams in the ARPA for comparison purposes.

3.4.5.3 Salinity Issues in the Colorado River Basin

The majority of the ARPA is located in the Colorado River Basin and, as such, point source discharge permits are subject to provisions of the Colorado River Basin Salinity Control Forum. As one of the seven member states of the forum, Wyoming reviews point and nonpoint sources of salinity in the Wyoming portion of the Colorado River Basin through a watershed protection program administered by the WDEQ/WQD (CRBSCF 1999).

In a study of mechanisms affecting salt pickup and transport in surface runoff, and possible means of reducing salinity in runoff from rangelands in the upper Colorado River Basin, Bentley and others (1978) determined that properly implemented control measures may be able to reduce erosion and salinity (Lowham et al. 1982).

3.4.5.4 Current POD Conditions

During the month of April 2005 a monitoring project was undertaken to evaluate the nine PODs approved during the IDP (See Appendix A). PODs were qualitatively evaluated for quality of road construction, reclamation success and general impacts related to surface hydrology. Copies of pictures used for the assessment can be available upon request from the Rawlins BLM Hydrologist.

Northern PODs (Dormant, Red Rim, Jolly A and B) – The farthest northern POD, Dormant, was never developed, a few test wells were put in but it is basically undisturbed.

- The Record of Decision (ROD) for Red Rim was signed in April of 2004 and was drilled mostly in 2004. Many of the areas had not been fully reclaimed by the spring of 2005.
- Pipelines along roads were bermed on the outslope side causing water to pool and hamper reclamation.
- Culverts were generally placed on drainages with very no armoring on the downhill side, this would lead to gullying downstream of the culverts.
- Seeding was generally ineffective due to wind erosion and lack of moisture.
- There were some smashed culverts and generally poor sizing of culverts leading to rilling and gulley formation.
- Weeds were present in many locations, especially at the older Jolly Roger PODs, were interim reclamation was generally unsuccessful.
- Road ROWs had signs of rillling due to inadequate reclamation.
- Some of the newer roads had inadequate drainage features such as wing ditches and culverts leading to gully formation in the ditches along the roads.
- Most of the poorer examples of pad sites were on private or fee land and therefore it should not be assumed that BLM standards will apply to all types of land ownership.

Middle PODs (Doty Mountain, Blue Sky, Sun Dog and Cow Creek) – Doty Mountain is in generally steeper terrain and was drilled mostly in late 2004 and therefore was not reclaimed in April of 2005. Sun Dog, Blue Sky and Cow Creek are generally older, although have had some recent inflill.

- Many of the PODs without reclamation were showing riling and gullying in response to snow melt from the pad sites.
- Some culverts were improperly placed and have silted in.
- Many of the roads were inadequately designed for drainage features and have excessive erosion in ditches and around culverts. Some of these features have been subsequently fixed however there are still plenty of problems to fix as of October 2005.
- Cow Creek POD has problems with pump leaks on one of the fee wells that is forming a gulley, they have inadequate road surfacing, not enough road drainage features and some poor reclamation.
- Sun dog POD is in some poor vegetation that has made reclamation difficult. Prairie dogs have been burrowing into road surfaces and many of the areas have had very poor reclamation.
- There were some smashed culverts and there were not graveled surfaces for the turnaround for trucks visiting the sites.
- Wind rows and berms along roads have interfered with road drainages. Some areas have not been successfully recontoured.
- The pad for 12-8 is closer to Dry Cow Creek than the avoidance area of 500 feet. Gullies have formed that go directly into the drainage complete with a glory hole eating into the pad surface.
- Blue sky POD has had virtually no reclamation along the road ROWs, due to the poor soils, this can be seen from the greasewood. Efforts have largely left these areas as denuded, with exception of weed, and they are rilling and forming gullies in the road ditches.
- There are plenty of fresh tire tracks on areas that are suppose to be reclaimed. Some of the well heads are leaking.
- Compressor sites have generally poor reclamation and have weeds.

Southern PODs (Brown Cow and Muddy Mountain) – Muddy Mountain POD has not been drilled, and only half of Brown Cow has been drilled.

3.4.5.5 Surface Discharge of Produced Water at the Cow Creek POD

This project does not propose any surface discharge of produced water from non-federal leases into facilities on private land, it is therefore assumed all water produced from the coal formation would be re-injected with the exception of off-set uses for flowing wells as described for Cow Creek. Surface discharge at the Cow Creek POD can be expected to continue through the life of the project according to the WYPDES permit # WY0042145 and #WY0035858 which allows for 1.34 tons/day and 180,600 gallons/day of total discharge under both permits.

As an offset for an oil well (as defined by the Colorado River Salinity Control Forum) and the permit allows for the same volume of water and salt as was discharged by the oil well plugged (1x-12). This discharge is in to a reservoir on Dry Cow Creek; this reservoir would be improved and maintained according to this use. The discharge permit is currently being modified to allow for water releases from the reservoir in a similar manner as what occurred historically when 1X-12 was in operation; however volume restrictions would still be in place. The permit would have a new point of compliance upstream of the confluence with Cow Creek. This point of compliance would be monitored for flow, according to the permit it should only have water during storm events, i.e. in response to natural precipitation and not a result of project discharges.

3.4.6 Groundwater

The ARPA occurs in the Colorado Plateau and Wyoming Basin groundwater regions described by Heath (1984), the Upper Colorado River Basin groundwater region described by Freethey (1987), or Washakie Basin described by Collentine et al. (1981) and Welder and McGreevy (1966). Groundwater resources include deep and shallow, confined and unconfined aquifers. Site-specific groundwater data for the ARPA are limited. Existing information comes primarily from oil and gas well records from the Wyoming Oil and Gas Conservation Commission, water-well records from the Wyoming SEO, from the USGS (Weigel 1987), and from the Wyoming SEO, from the USGS (Weigel 1987), from existing CBNG producing wells, and from three monitoring wells drilled to monitor pressures in producing coals and sandstone zones above and below these coals.

Regional aquifer systems pertinent to the ARPA are discussed by Heath (1984), Freethey (1987), and Driver et al. (1984). Basin-wide evaluations of hydrogeology specific to the ARPA have been investigated by Collentine et al. (1981). The most relevant hydrogeologic study specific to the ARPA is by Welder and McGreevy (1966).

3.4.6.1 Location and Quantity

Groundwater in the Washakie Basin is generally found in deep artesian aquifers, in unconfined Tertiary deposits, alluvial deposits and in isolated, saturated outcrops (Welder and McGreevy 1966). Table 3-21 summarizes the water-bearing characteristics of the geologic formations present in the project vicinity. Of the geologic units listed in the table, Welder and McGreevy (1966) suggest that those capable of producing the greatest quantity of water include the following: Quaternary alluvium; Tertiary deposits in the North Park, Browns Park, Wasatch, and Fort Union Formations; Cretaceous formations, including Mesaverde, Frontier, and Cloverly; the Sundance-Nugget Sandstone of the Jurassic Age; and the Tensleep and Madison Formations of the Paleozoic Era.

Following is a brief description of the major aquifers of the ARPA.

Quaternary aquifers in the Washakie Basin are comprised of alluvial deposits along major floodplains and isolated windblown and lake sediments. The major Quaternary aquifers in the vicinity of the ARPA occur in alluvial deposits along the Little Snake River and Muddy Creek, and in windblown segments along the Sand Hills. Groundwater flow within the sandy Quaternary aquifers is typically downward toward permeable underlying formations (Collentine et al. 1981). Ephemeral and intermittent drainages also often contain groundwater in the associated unconsolidated valley fills. Incised drainages serve as capture areas for eolian sand in reaches perpendicular with the prevailing winds. The sand-choked drainages favor rapid infiltration of rainfall and snowmelt leading to contact springs and seeps where groundwater perched in sandy surficial deposits escapes along contacts with less permeable bedrock.

Tertiary aquifers in the ARPA occur in the extensive North Park Formation east of the ARPA, the Browns Park Formation along the Little Snake River flood plain and adjacent to the Sierra Madre Uplift, the Fort Union Formation near the Muddy Creek flood plain to the west, and isolated Wasatch Formation outcrops in the center of the ARPA. Aquifers near the surface are recharged from direct downward percolation of precipitation and snowmelt and from seepage losses from streams. Deep aquifers are also recharged by these processes in outcrop and subcrop areas and from slow leakage from overlying and underlying aquifers. The extent of the Browns Park and North Park units above the eroded, dipping Cretaceous units indicates a

Table 3-21. Water-bearing characteristics of geologic formations in the Washakie Basin.

Era	Period	Geologic Unit	Thickness	Hydrologic Properties		
				Well Yield (gpm)	Transmissivity (gpd/ft)	Permeability (gpd/ft²)
Cenzoic	Quaternary		0-70	<30	168-560	21-62
		North Park Fm.				
	Tertiary	Browns Park Fm.	0-1,200	3-30	100-10,000	NM
		Wasatch Fm.	0-4,000+	30-50	150-10,000	0.04-18.2
		Fort Union Fm.	0-2,700+	3-300	<2,500	<1
Mesozoic	Upper Cretaceous	Lance Fm.	0-4,500+	<25	<20	0.007-8.2
		Fox Hills Sandstone	0-400	NM	10-20	0.9
		Lewis Shale	0-2,700+	2-252	0.03-50	0.002-0.9
		Almond Fm. (Mesaverde Group)	0-600	NM	2,000-8,000[1]	100-800[1]
		Mesaverde Group (excl. Almond Fm.)	300-2,800	<100	<3,000	NM
		Baxter Shale (incl. Steele Shale and Niobrara Fm.)	2,000-5,000+	Major regional aquitard between Mesaverde and Frontier aquifers. Hydrologic data unavailable.		
		Frontier Fm.	190-1,1900+	1-100+	<100-6,500	NM
	Lower Cretaceous	Mowry Shale	150-525	Regional aquitard. Hydrologic data unavailable.		
		Thermopolis Shale (incl. Muddy Sandstone)	20-235	Considered a leaking confining unit. Hydrologic data unavailable.		
		Cloverly Fm.	45-240	25-120	340-1,700	1-177
	Upper Jurassic	Morrison Fm.	170-450+	Confining unit between Cloverly and Sundance-Nugget aquifers. Hydrologic data unavailable.		
		Sundance Fm.	130-450+	27-35	12-3,500	NM
	Lower Jurassic-Upper Triassic	Nugget Sandstone	0-650+	35-200	<2,166	NM
	Triassic	Chugwater Fm.	900-1,500+	Confining unit between Sundance-Nugget and Paleozoic aquifers. Hydrologic data unavailable.		
Mesozoic-Paleozoic	Lower Trassic Permian	Phosphoria Fm. (incl. Goose Egg Fm.)	170-460	Probable poor water-bearing capabilities due to low permeability. Hydrologic data unavailable.		
Paleozoic	Permian-Pennsylvanian	Tensleep Fm.	0-840+	24-400	1-374	NM
	Lower and Middle Pennsylvanian	Amsden Fm.	2-260+	Probable poor water-bearing capabilities due to predominance of fine-grained sediments.		
	Mississippian	Madison Limestone	5-325+	<400	Variable	NM
Paleozoic	Cambrian	Indef. rocks	0-800+	4-250	NM	NM
Precam-brian	N/A	Igneous and metamorphic rocks	Unknown	10-20	1<1,000	Generally high in upper 200 ft of unit

Adapted from Table V-1 in Collentine et al. (1981). Formations not encountered in ARPA have been omitted.[1] From Atlantic Rim CBNG well test data.

probable significant recharge area of the underlying permeable units of the Mesaverde Group rocks of the ARPA.

The Mesaverde Group aquifers generally are deeply buried in the ARPA. Although the ability of moderate pumping to readily affect recharge and discharge of the system is somewhat limited, significant groundwater withdrawals from these units would result in large water-level declines that could eventually propagate updip into overlying unconfined Tertiary units. The proposed CBNG development is targeted principally at coal beds contained in the Almond Formation member of the late Cretaceous Mesaverde Group. The terrestrial, sandy, marginal marine Almond Formation is composed of a wide variety of heterogeneous rock types. Single, thick, widespread aquifers having uniform porosity and permeability characteristics are probably not present (Welder and McGreevy 1966). Because individual coal beds are not expected to persist for great distances laterally, drawdowns associated with CBNG well dewatering are expected to be concentrated near individual wells. Coal beds in the Mesaverde Group formations are effectively isolated from the closest adjacent aquifers by the overlying Lewis Shale and the underlying Steel or Baxter Shale confining units. Leakage across these thick sequences of marine clays is considered insignificant.

Groundwater generally flows west-southwest from the higher elevations along the Sierra Madre Uplift toward the low-lying Washakie Basin center and the major streams (Collentine et al. 1981). It would be prudent to obtain quarterly water levels from a few selected wells completed in the Almond Fm., the Brown Park Fm., and the Little Snake River Alluvium between Dixon and Savory prior to development to establish baseline conditions and to demonstrate natural climatic variations and patterns of irrigation usage.

A number of small displacements, generally east-west trending normal faults have been recognized in upper cretaceous and Lower Tertiary rocks within the ARPA. Not all fault zones are conduits to groundwater flow. Fault zones filled with clay or that have become sealed with silica or other minerals may be practically impermeable, where as those filed with crushed rock fragments can be extremely permeable. Some faults permit groundwater to circulate to great depths where it can become heated by geothermal heat sources (Groundwater Atlas (HA730-I)).

Separated from the upper Cretaceous aquifers by the impermeable Morrison Formation is the Sundance-Nugget Aquifer of the Jurassic Age. The Sundance-Nugget aquifer is comprised of permeable sandstone with minor quantities of shale, siltstone, and limestone (Collentine et al. 1981). The flow characteristics of the Sundance-Nugget aquifer are not well defined.

The final two major aquifers occur in Paleozoic Era rocks. The Tensleep Formation from the Pennsylvania Age consists of fine- to medium-grained sandstone between confining layers of the Chugwater Formation (Triassic) and the Amsden Formation (Pennsylvanian) (Collentine et al. 1981). The Madison aquifer is comprised of limestone and dolomite bordered on the top by the fine-grained Amsden Formation sediments and on the bottom by Cambrian rocks. Early Paleozoic rocks are notably absent from far southeast Wyoming and extremely thin on the west flank of the Sierra Madre uplift east of the ARPA. The zero isopach line for these Paleozoic units lies across and north of the Sierra Madre uplift indicating either non-deposition or erosion and complete removal of these units across the ancestral uplift prior to deposition of Mesozoic and Cenozoic rocks. The truncated edge of the Cambrian and Mississippian rocks lies immediately east of the ARPA according to Blackstone (1963). Wells completed within both of these Paleozoic aquifers, where present and of significant thickness, have demonstrated yields up to 400 gpm. Groundwater flow is west-southwest in the ARPA.

Driver et al. (1984) suggest that the Browns Park Formation would be the best candidate for large-scale groundwater development. Recharge to the aquifer is generally by precipitation and surface water seepage percolating through permeable overlying materials (Welder and McGreevy 1966). The major discharge channels, evaporation, and seepage to surface water generally offset the recharge such that groundwater levels are relatively stable (Welder and McGreevy 1966).

An SEO records review revealed 90 permitted non-CBNG wells and springs in the ARPA. Nine of the water rights are filed on springs. They are apportioned as follows: two domestic, six domestic/stock, 52 stock, one stock/irrigation, two stock/miscellaneous, one industrial, and 26 monitoring wells. Of the 90 permitted wells and springs, 58 reported positive yields. Geologic units and yields of the 58 wells are listed in Table 3-22. The majority of these wells were developed in the Mesaverde Group and the Browns Park Formation.

Table 3-22. Existing groundwater wells in ARPA vicinity.

Formation	Number of Wells	Yield[1] (gpm)
Browns Park Formation	12	1-25
Fort Union Formation	1	11
Lance Formation	6	1-25
Fox Hills Sandstone	2	10-15
Lewis Shale	12	3-25
Mesaverde Group	25	1-500

[1] Obtained from SEO well completion permits

3.4.6.2 Quality

Groundwater quality is related to the depth of the aquifers, flow between aquifers, rock type and length of time groundwater is in contact with the enclosing rock type. Dissolved mineral content generally increases with time. Circulation in deeply buried aquifers is generally sluggish; as such, many confined aquifers contain slightly saline to very saline water at depth. Groundwater quality is variable in the ARPA. TDS, an indicator of salinity, is generally less than 2,000 mg/l (slightly saline to saline) in the ARPA, with occasional local concentrations of less than 500 mg/l (considered fresh). Elevated TDS is caused by a variety of factors, including evapotranspiration, mixing of adjacent aquifers, the presence of soluble material, and restriction of flow by faults or impermeable formations.

Because most existing groundwater wells and the proposed CBNG wells of the Atlantic Rim project occur in Mesaverde aquifers, a detailed Mesaverde groundwater quality analysis has been included. Table 3-23 lists the major ionic composition of Mesaverde groundwater in the ARPA. Sodium and bicarbonate dominate as the major ionic species. Collentine et al. (1981) offer three possible explanations for this dominance: (1) exchange of dissolved calcium for sodium; (2) sulfate reduction resulting in bicarbonate generation; and (3) intermixing of sodium-rich, saline water from low-permeability zones within the Mesaverde or adjacent aquifers.

Table 3-23. Major ionic composition of Mesaverde Formation groundwater.

Cation	Concentration (mg/l)	Anion	Concentration (mg/l)
Sodium	513	Bicarbonate[2]	1,284
Calcium	7	Carbonate[1]	9
Magnesium	3	Chloride	56
Potassium[1]	5	Sulfate	11

[1] Potassium and carbonate concentrations were not measured in CBNG samples; values represent composite of USGS data for Mesaverde wells in project vicinity (USGS, 1980).
[2] Bicarbonate was not measured; value shown was calculated from ion balance.

In addition to conventional inorganic analysis, isotopic analysis has been performed on groundwater collected from numerous wells constructed within the interim drilling PODs. Groundwater samples from eight CBNG wells were analyzed for tritium, a radioactive isotope of hydrogen, and deuterium and ^{18}O stable isotopes of hydrogen and oxygen. The absence of tritium in groundwater is indicative of water that was isolated from the atmosphere prior to the early 1950s when large amounts of tritium were introduced into the environment through testing of nuclear devices in the atmosphere (Faure 1986). The tritium content of the eight samples indicates pre-1950s recharge. Further, the isotopic ratios of ^{18}O and deuterium indicate that the groundwater was isolated from the atmosphere when the mean temperature was approximately 10 degrees cooler than the present. Since temperatures this low are associated with the Pleistocene Epoch, which ended approximately 10,000 years ago, this information suggests that groundwater flow through the Mesaverde Group coals is sluggish and apparently not closely connected to nearby surface water supplies. Table 3-24 presents the results of isotope analysis.

Table 3-24. Isotopic analysis of Mesaverde Formation coal seam groundwater.

Well	Tritium Content (TU)	$\delta\ ^{18}O_{smow}$ (‰)	$\delta\ D_{smow}$ (‰)
Fed. 1691-16-8	<0.34	-19.32	-145.5
AR Fee 1791 231 Haystack Mtns	<0.50	-19.70	-148.4
AR Fee 1791 231 Deep Creek	<0.60	-19.60	-145.8
AR Fee 1791 231 Cherokee Creek	<0.60	-19.49	-146.7
AR Fee 1791 3-23	<0.50	-18.85	-141.7
AR Federal 1591 9I	<0.50	-19.39	-144.4
AR Fee 1890 SE9	<0.50	-19.74	-148.5
AR Federal 1591-7-8 Blue Sky	<0.60	-19.20	-142.9

T.U. = Tritium Unit. One TU is defined as one tritium atom per 1,018 hydrogen atoms.
SMOW = an international standard used for oxygen and hydrogen isotopic analysis.
0/00 is per mil or per thousand

Table 3-25 presents a comparison of Mesaverde groundwater with WDEQ use suitability standards. The composite results of the three CBNG wells analyzed indicate water that is generally suitable for livestock use, but is unsuitable for domestic supply or irrigation without treatment or dilution. Parameters with measured concentrations in excess of Wyoming drinking water standards include iron, manganese, and TDS. Calculated SAR (47.3) and residual sodium carbonate (41 meq/l) exceed the agriculture suitability limits of 8 and 1.25, respectively. Unless the water was mixed with an existing water source of lower sodium and bicarbonate and lower total salinity, irrigation could result in reduction in infiltration in the affected soil.

The confining beds slow the movement of water, and hence, movement of potential contaminants between aquifers. Although there is some downward movement of the water from the surface units, most of the groundwater movement, if any, is upward from the deeper aquifers to the shallower aquifers. Concerns have been raised for several gas field projects in southwest Wyoming regarding groundwater quality degradation due to the piercing of confining layers and vertical and horizontal migration and mixing of water of variable qualities. Data suggesting this is a current problem in the ARPA are not available. Improperly completed injection wells could be a potential source of contamination. The integrity of the annular seals of existing water supply wells is also crucial in preventing groundwater mixing where multiple aquifers are penetrated.

3.4.6.3 Springs and Flowing Wells

The project area contains numerous springs and flowing wells, which are important local water sources for livestock and wildlife. This area has had extensive exploratory development for natural gas and oil. There has also been monitoring wells installed to evaluated groundwater resources by the USGS and also private firms to evaluate potential coal mining (HSI, 1981). Some of these wells have developed casing leaks, were not plugged properly, or can be used still for monitoring.

The springs occur at two distinct geologic horizons; at the contact between the Tertiary Browns Park Formation and the underlying Upper Cretaceous Mesaverde Group, and within the Mesaverde Group itself. Springs located at the Browns Park Formation/Mesaverde Group are far more common and generally have higher yields than those issuing from units within the Mesaverde Group. The waters from the two spring types have distinctly different chemical signatures: water from the Browns Park Formation springs is low in TDS, enriched in silica, and of the calcium bicarbonate type, while water from the Mesaverde Group springs is higher in TDS, with lower silica concentrations, and of the calcium sulfate type. Table 3-26 presents a comparison of the two water types. Appendix M: Sampled Springs and Flowing Wells depicts the locations of the springs that were sampled to create Table 3-26. Based on water rights information available from the SEO, four of the sampled springs (S-2, S-3, S-4, and S-7) may possess valid water rights.

Table 3-25. Groundwater quality for Mesaverde wells in the ARPA.

Parameter	Concentration[1]	Unit	Groundwater Suitability Standards[2]		
			Domestic	Agriculture	Livestock
Aluminum	0.045	mg/l	---	5	5
Ammonia	0.9	mg/l	0.5	---	---
Arsenic	0.0006	mg/l	0.05	0.1	0.2
Barium	0.36	mg/l	1	---	---
Beryllium	<0.002	mg/l	---	0.1	---
Boron	0.25	mg/l	0.75	0.75	5
Cadmium	<0.0002	mg/l	0.01	0.01	0.05
Chloride	56	mg/l	250	100	2000
Chromium	0.002	mg/l	0.05	0.1	0.05
Cobalt	NM	mg/l	---	0.05	1
Copper	0.03	mg/l	1	0.2	0.5
Cyanide	<5	mg/l	0.2	---	---
Fluoride	1.0	mg/l	1.4 - 2.4	---	---
Hydrogen Sulfide	NM	mg/l	0.05	---	---
Iron	3.06	mg/l	0.3	5	---
Lead	0.004	mg/l	0.05	5	0.1
Lithium	NM	mg/l	---	2.5	---
Manganese	0.102	mg/l	0.05	0.2	---
Mercury	<0.0004	mg/l	0.002	---	0.00005
Nickel	0.041	mg/l	---	0.2	---
Nitrate	<0.03	mg/l	10	---	---
Nitrite	<0.03	mg/l	1	---	10
Oil & Grease[3]	<1	mg/l	Virtually Free	10	10
Phenol	65	mg/l	0.001	---	---
Selenium	<0.005	mg/l	0.01	0.02	0.05
Silver	<0.003	mg/l	0.05	---	---
Sulfate	11	mg/l	250	200	3000
TDS	1,322	mg/l	500	2000	5000
Uranium	NM	mg/l	5	5	5
Vanadium	NM	mg/l	---	0.1	0.1
Zinc	0.3	mg/l	5	2	25
pH	8.2	s.u.	6.5 - 9.0	4.5 - 9.0	6.5 - 8.5
SAR	47.3	<none>	---	8	---
RSC[4]	41	meq/l	---	1.25	---
Radium 226 + Radium 228	0.9	pCi/l	5	5	5
Strontium 90	NM	pCi/l	8	8	8
Gross alpha	NM	pCi/l	15	15	15

[1] Boron, ammonia, fluoride, and nitrate/nitrite concentrations from 11 Mesaverde groundwater wells (USGS, 1980); remaining concentrations from three Mesaverde CBNG wells in the ARPA.
[2] From WDEQ Water Quality Rules and Regulations, Chapter VIII.
[3] Reported as total petroleum hydrocarbons.
[4] Residual sodium carbonate calculated from measured calcium and magnesium concentrations and calculated bicarbonate concentration.

Two of the sampled flowing wells may have valid water rights (7 Art cot 2N and 7 Art cot 2S). Discharge from the wells contributes to wildlife habitat, furnishing water that over time has created a wetland habitat around the wells. Under direction of the NRCS, water quality sampling and analysis has been conducted on many of the flowing wells. The water type of these wells is of the sodium-bicarbonate type, which indicates water from coal seam aquifers. Groundwater associated with methane production is rich in the anion bicarbonate and almost devoid of the cations calcium and magnesium, but exhibit high concentrations of sodium

(VanVoast 2003). Table 3-27 compares water quality parameters from the flowing wells and that from wells completed in the Almond Formation coal seams. The locations of the flowing wells are depicted in Appendix M.

Table 3-26. Comparison of selected water quality parameters between springs of the Browns Park Formation and of the Mesaverde Group.

Spring Name	Geology	TDS (mg/l)	Silica (mg/l)	Water Type
S-2	Browns Park	330	18.1	calcium bicarbonate
S-3	Browns Park	210	14.9	calcium bicarbonate
S-4	Browns Park	290	11.0	calcium bicarbonate
S-7	Browns Park	329	18.0	calcium bicarbonate
WWCR-1	Mesaverde	1,030	8.1	calcium sulfate
S-5	Mesaverde	1,350	5.8	calcium sulfate
S-6	Mesaverde	1,140	5.4	calcium sulfate

Table 3-27. Comparison of selected water quality parameters in flowing wells and wells completed in the Almond Formation coal seam.

Well Name	Well Type	TDS (meq/l)	Na (meq/l)	Ca (meq/l)	HCO_3 (meq/l)	SO_4 (meq/l)
Duck Flow 2	Flowing	1,230	22.18	0.2	18.03	1.29
7 Art cot 2N	Flowing	496	6.96	1.3	7.05	1.39
7 Art cot 2S	Flowing	596	12.18	0.09	10.32	0.01
AR Fed 1691-16-8	CBNG	1,428	23.4	0.34	19.83	0.04
S & W State 1390 12-36	CBNG	1,900	32.49	0.046	31.14	ND

3.5 VEGETATION

3.5.1 Introduction

The ARPA lies within the Wyoming Basin (Level III) ecoregion, and in the further defined Rolling Sagebrush Steppe (Level IV) ecoregion (USEPA, 2003: Omernik, 1987). The semiarid Rolling Sagebrush Steppe is a vast region of rolling plains and basins, interspersed with uplifts, rims, terraces, and closer to foothills, alluvial fans, draws and drainages. Precipitation and soil parent material are the primary variables controlling plant species distribution, composition, cover and annual production.

Annual average precipitation ranges from 8 inches in the middle of the project area to around 12 inches at higher elevations at the north and south ends. Wind redistribution of winter snow onto north and east slopes may increase these levels by several inches. Most precipitation occurs from March through June as spring snow and summer rain. These all result in the Rawlins area falling between the Intermountain and Great Plains ecotone regions, which is reflected in the vegetative composition observed. The range in soils from sands to clays also adds tremendously to the diversity of vegetation.

A vegetation community map of the project area was created from local data and ground observations. Two principle cover types dominate the vegetation in the ARPA, mountain big sagebrush (50%) and Wyoming big sagebrush (34%). Other cover types include (in order of abundance): alkali sagebrush, mountain big sagebrush/bitterbrush, basin big sagebrush, mountain big sagebrush/mountain shrub mix, juniper woodland, and Wyoming big sagebrush/bitterbrush. Other cover types found in very low amounts include: aspen, badlands, greasewood, greasewood/basin big sagebrush, true mountain mahogany, serviceberry, saltbush steppe, silver sagebrush/bitterbrush, and willow-waterbirch and grassland riparian. The approximate boundaries of these cover types are shown in Appendix M: Vegetation Communities.

3.5.2 Primary Vegetation Cover Types

All principle cover types are described in the following sections except for badlands, which are mostly devoid of vegetation and not typified by any particular species.

3.5.2.1 Mountain Big Sagebrush Cover Type and Subtype Inclusions

This type of big sagebrush is found on about 136,000 acres or 50 percent of the project area. In the past, studies have identified Artemisia tridentata spp. vaseyana as mountain big sagebrush. However, the newer literature Goodrich et al. 1999, Tart and Winward 1996) recognizes two separate varieties of this subspecies, vaseyana and pauciflora. Numerous field investigations have found these two varieties are morphologically similar in form and commonly found intermixed in the same habitat. Therefore, in the ARPA it has all been mapped as mountain big sagebrush, and will be referred to as ATV.

ATV is generally found around 7,000 feet and higher elevations. It appears as a multi-branched shrub, similar to Wyoming big sagebrush (Artemisia tridentata spp. Wyomingensis (ATW)), with varying height and cover. On wind blown ridges with shallow soils, ATV is sparse in cover and only six to eight inches tall. However, on moderately deep loamy soils with higher moisture levels it may have canopy cover in excess of fifty percent and may reach three feet in height. It is a palatable species for browsing, but due to the elevation it occurs at, is typically only used on a transitional basis to and from winter habitat, and often shows only light to moderate browsing use.

Common grass species associated with the mountain big sagebrush type include thickspike wheatgrass (Elymus macrourus), bluebunch wheatgrass (Pseudoroegneria spicata), little bluegrass (Poa secunda), needle-and-thread (Hesperostipa comata), bottlebrush Squirreltail (Elymus elymoides), prairie Junegrass (Koeleria cristata), mutton bluegrass (Poa fendleriana), green needlegrass (Nassella viridula), oniongrass (Melica bulbosa), Idaho fescue (Festuca idahoensis) and spike fescue (Leucopoa kingii). Common understory shrubs include rabbitbrushes (Chrysothamnus spp.) and snowberry (Symphoricarpos oreophilus), with lesser amounts of bitterbrush (Purshia tridentata) and serviceberry (Amelanchier alnifolia). Due to the higher precipitation on these sites, forbs are diverse and very abundant. Frequently observed species include: silky lupine (Lupinus sericeus), and arrowleaf balsamroot (Balsamorhiza sagittata) intermixed with ATW on rocky, shallow slopes and ridges.

ATV/mountain shrub mix cover type is similar to the Mountain Big Sagebrush described above, with the distinction that mountain shrub species comprise five percent or more of the canopy cover. It comprises about 6 percent of the project area, or approximately 15,000 acres. In the area bordering the sandhills, the mountain shrub component is dominated by bitterbrush.

However, on the south sides of Muddy Mountain and Browns Hill, there is a mixture of bitterbrush, serviceberry, and snowberry; on rocky, shallow soils, true mountain mahogany (Cercocarpos montanus) can also be found. On the north and east slopes of Muddy Mountain, where snow deposition occurs, sites are moister and support a wider variety of species than described above, including: chokecherry (Prunus virginiana) and scattered aspen (Populus tremuloides) in the overstory, elk sedge (Carex geyeri), Ross' sedge (Carex rossii), arrowleaf balsamroot, bluebells (Mertensia spp.), Indian paintbrush (Castilleja spp.), sego lily (Calochortus nuttallianum), false dandelion (Agoseris glauca), locoweed (Astragalus spp.), buttercup (Ranunculus spp.), wild onion (Allium spp.), beardtongue (Penstemon spp.), groundsel (Senecio spp.), phlox (Phlox multiflora), sulfur buckwheat (Eriogonum umbellatum), black sagebrush (Artemisia nova), mountain brome (Bromus anomalus), elkweed (Frasera speciosa), geranium (Geranium richardsonii), bedstraw (Galium boreale), and Oregon grape (Berberis repens).

These sites are important to a wide variety of wildlife for the habitat they provide, but particularly as forage and hiding cover for mule deer and as forage, nesting and brood rearing, and roosting areas for Columbian sharp-tailed grouse. The more moist sites are not as prone to burn as drier sites, but the fuel loads in these communities will burn in wildfires or prescribed burns under the right conditions. Recovery by most species is usually good, especially by snowberry, chokecherry and true mountain mahogany. But bitterbrush, and to a lesser extent serviceberry, can be more susceptible to death loss when fires occur during the summer months.

Wildfires and prescribed burns both occur in the ATV cover type. Without rest or post-burn grazing management, sagebrush cover may return to pre-treatment levels in twenty years. However, monitoring of prescribed burns with rest or deferment after treatment indicates sagebrush recovery may take up to fifty years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity, and response to reclamation should be good (most previous reclamation efforts in this type have not been).

3.5.2.2 Wyoming Big Sagebrush and Wyoming Big Sagebrush/Bitterbrush Cover Types

Wyoming big sagebrush is the shortest subspecies of big sagebrush, but ecologically perhaps the most important. It occupies the more arid environments, generally below 7,000 feet in elevation, and provides critical habitat and forage for species like pronghorn antelope and greater sage-grouse. ATW is second only to ATV in abundance, occupying about 92,300 acres or 34 percent of the project area. Small inclusions of basin big sagebrush, saltbush steppe and greasewood occur within approximately five percent of this area. The height of ATW varies from a few inches tall to over two feet, with more vigorous and denser stands occurring in swales with deeper soils and more precipitation. On open, wind blown sites, which normally have a shallower effective rooting depth, ATW is sparser, smaller in stature, and exhibits lower productivity.

The most common grasses associated with ATW cover type are western wheatgrass (Pascopyrum smithii), thickspike wheatgrass, little bluegrass, bottlebrush squirreltail, needle-and-thread, Indian ricegrass (Achnatherum hymenoides), and threadleaf sedge (Carex filifolia). Douglas (Chrysothamnus viscidiflorus) and rubber (C. nauseosus) rabbitbrush, winterfat (Krascheninnikovia lanata), cotton horsebrush (Tetradymia canescens), prickly-pear cactus (Opuntia polyacantha) and broom snakeweed (Gutierrezia sarothrae) are common understory shrubs. Forbs are less common than in other big sagebrush communities due to the more arid conditions. However, the most frequently observed species include Hood's phlox (Phlox hoodii), Hooker sandwort (Arenaria hookeri), low buckwheat (Eriogonum ovalifolium), spring parsley (Cymopterus acaulis), locoweeds, goldenweed (Happlopappus spp.), hollyleaf clover (Trifolium gymnocarpum), wild onion, and beardtongue. On gravelly to rocky, shallow hillsides, both bluebunch wheatgrass and black sagebrush are found, in addition to higher amounts of mat forbs. On sites close to the sandhills and sandy soils adjacent to Baggs, bitterbrush co-dominates. Larkspur (Delphinium nuttallianum) and death camus (Zygadenus venenosus) are poisonous plants also occurring in this cover type.

The value of ATW as an important winter browse species cannot be over emphasized. Monitoring transect data from the crucial winter range along Muddy Creek shows severe browse use of ATW during harsh winters, with moderate to heavy use in the transition range to the east that comprises much of the project area. However, during mild winters, transition range browse use remains moderate, while crucial winter range browse use drops to light levels, allowing recovery of crucial winter habitat during more favorable weather periods.

There are very few wildfires and no prescribed burns in ATW habitat due to the sparseness of fuels to carry a fire. Recovery time for ATW to reoccupy a site after a fire occurrence is estimated at 75 to 150 years. Reclamation rates for ATW are also expected to take many years, but are currently unknown.

3.5.2.3 Alkali Sagebrush Cover Type

Alkali sagebrush (Artemisia arbuscula spp. longiloba) is a form of low sagebrush that grows on soils with high clay content. A large portion of these soils occur in the southern portion of the project area from Cherokee Creek south across Deep Creek to Cotttonwood Creek, comprising about 17,100 acres or 6 percent of the total area. Alkali sagebrush grows between 4 and 15 inches tall. Other common species found in this type are western wheatgrass, little and mutton bluegrass, bottlebrush squirreltail, Indian ricegrass, Hood’s phlox, false dandelion, hollyleaf clover, penstemon, wild onion, and biscuitroot (Lomatium spp.). Alkali sagebrush is considered palatable as forage, but use appears to be mostly light to moderate; well below use rates for Wyoming big sagebrush. Alkali sagebrush is usually killed by fire and does not resprout. Establishment from seed has been rated as "medium,” and establishment from transplants as "very good." Seed production and handling are rated as "medium" because seeds are small. Natural spread by seed and vegetatively is "good."

3.5.2.4 Basin Big Sagebrush Cover Type

Basin big sagebrush (Artemisia tridentata spp. tridentata), hereafter referred to as ATT, occurs on deeper, well drained soils on about 9,200 acres, or 3 percent of the project area. ATT is the dominant vegetation on floodplains bordering riparian habitat, and on ephemeral draws, valley sides, and leeward slopes where there is additional moisture and well developed soils. It is found in association with black greasewood (Sarcobatus vermiculatus) and as small pockets within both ATW and ATV cover types. Basin big sagebrush is the largest sagebrush in this area, with plants on drier sites ranging from three to six feet tall, and plants in floodplains reaching up to ten feet in height. ATT may have taproots up to twenty feet deep, in addition to fibrous roots near the surface to benefit from local precipitation. Palatability of ATT is generally considered lower than ATW (Winward 1993). In fact, observations during winter of 1983-84 along Muddy Creek showed severe use of ATW compared to minimal use of ATT, even though animals were starving and some herd units had 50% die-off.

Common understory species in the ATT type include: thickspike wheatgrass, basin wildrye (Leymus cinereus), little bluegrass, Kentucky bluegrass (Poa pratensis), bluebells (Mertensia spp.), lupine, locoweed, violet (Viola spp.), Louisiana sagewort (Artemisia ludovicianna), aster (Aster spp.), false dandelion (Agoseris spp.), butter cup (Ranunculus spp.), wild onion, groundsel (Senecio spp.), povertyweed (Iva axillaris), wild rose (Rosa woodsii), snowberry, rabbitbrushes, and golden currant (Ribes aureum). On some sites bitterbrush, serviceberry, and/or true mountain mahogany occurs. Since these sites are often close to water, historic and current grazing use is often very common, and in some cases, excessive. Species like Kentucky bluegrass may proliferate while more sensitive species like basin wildrye may decrease in abundance. In addition, species which thrive from disturbance like cheatgrass (Bromus tectorum) become a component of this type.

Wildfires and prescribed burns both occur in this cover type. Where other species are uncommon or without post-burn grazing management, sagebrush cover may return to pre-treatment levels in fifteen to twenty years. However, monitoring of prescribed burns with rest or deferment after treatment indicate ATT recovery may take up to fifty years to reach pre-treatment levels. Under this management, grasses and forbs are allowed to dominate the site initially, reducing the ability of sagebrush seedlings to establish themselves and out-compete other vegetation. The higher amount of moisture on these sites increases their productivity, and response to reclamation should be good (most previous reclamation efforts in this type have not been).

3.5.2.5 Juniper Woodland Cover Type

Utah juniper (Juniperus osteosperma) is the dominant tree in the juniper woodland cover type, which occurs on approximately 9,900 acres or 3 percent of the ARPA. They grow from 8 to 15 feet in height and width. Persistent stands are found on shallow, rocky soils with fractured rock substrate, where the juniper can root down to and take advantage of water that collects in these locations. Juniper will also encroach into adjacent big sagebrush stands. This cover type usually has a sparse to moderate cover of juniper trees over big sagebrush and/or true mountain mahogany. Other common understory species include bluebunch wheatgrass, Indian ricegrass, little bluegrass, Canby bluegrass (Poa canbyi), groundsel, beardtongue, phlox, goldenweed, miners candle (Cryptantha spp.), twin bladderpod (Physaria spp.), and occasionally some bitterbrush and black sagebrush.

Juniper stands occur along the western edge of the project area, adjacent to and within crucial winter range for mule deer. They provide important thermal cover and forage for mule deer and occasionally elk, as well as habitat for a variety of birds and small mammals. The stands of juniper closer to Baggs are “yarding” areas where very high densities of mule deer reside during critical winter periods. When stands of Utah juniper become too dense, the understory of native grasses, forbs and shrubs die out and are replaced with cheatgrass and annual forbs. Fire can be a useful tool in reducing juniper overstory and maintaining understory cover and composition. Where the understory is too sparse to carry a fire, some form of mechanical treatment may be needed to restore species diversity.

3.5.2.6 Aspen Woodland Cover Type

Aspen (*Populus tremuloides*) is the dominant tree in the aspen woodland cover type, which occurs on approximately 434 acres of the ARPA. They grow from five to thirty feet tall at higher elevations (usually above 7000 feet) on north and east slopes where windblown snow accumulates. This provides the moisture and deeper soils necessary to support aspen.

Common understory shrubs include snowberry, serviceberry, creeping juniper (*Juniperus communis*), and Scouler's willow (*Salix scoulerianna*). A variety of grasses and forbs often dominate the understory, with elk sedge and Columbia needlegrass (Achnatherum nelsonii) the most common. Other species include mountain brome, blue wildrye (Elymus glaucus), Kentucky bluegrass, columbine (Aquilegia spp.), waterleaf (Hydrophyllum spp.), bluebells, wild licorice (Glycyrrhiza), bedstraw, heartleaf arnica (Arnica spp.), fairybells (Disporum spp.), Solomons seal (Polygonatum spp.), yampa (Perideridia spp.), and sweet-cicely (Osmorhiza spp.). Many aspen stands are diseased, dying out, and being overtaken by serviceberry, big sagebrush and creeping juniper. The use of fire can often remove competing species and stimulate regeneration. These habitats provide diverse vertical structure for many bird species and forage/hiding cover for mule deer and elk, and support numerous other wildlife species.

3.5.2.7 Greasewood and Greasewood/Basin Big Sagebrush Cover Types

Black greasewood is the dominant species on saline soils along floodplains and ephemeral drainages, particularly along portions of Muddy Creek and Wild Cow Creek. It occupies approximately 3400 acres (1 percent) of the ARPA. This species also encroaches into the big sagebrush and saltbush steppe cover types, taking advantage of where it can find additional moisture. Although considered poisonous, it is often observed being eaten by livestock and big game species. Understory species composition is not as diverse as the big sagebrush cover types, with common species including basin wildrye, western wheatgrass, little bluegrass, bottlebrush squirreltail, inland saltgrass (Distichlis stricta), biscuitroot, wild onion, pepperweed (Lepidium spp.), and Gardner's saltbush (Atriplex gardneri). On some sites there are patches or intermixing with stands of basin big sagebrush.

3.5.2.8 True Mountain Mahogany and Serviceberry Cover Types

True mountain mahogany occurs as the dominant cover on shallow, rocky hillsides, and may be adjacent to juniper woodland. It occurs on approximately 800 acres (less than 1 percent) within the ARPA. Shrubs grow from two to seven feet tall depending on the soils and precipitation. Serviceberry occurs as the dominant cover on shallower soils. It occurs on approximately 100 acres. These species, along with bitterbrush, are highly sought out by mule deer in the fall and winter months. Health of these stands in mule deer winter concentration areas is often very poor with severe browsing on an annual basis. Common understory species are similar to those described for juniper woodlands.

3.5.2.9 Saltbush Steppe Cover Type

Gardner's saltbush is the characteristic species of this cover type, found on upland saline soils in small openings or linear 'stringer' stands within Wyoming big sagebrush or black greasewood cover types. Since most stands of this cover type are too small to delineate from other cover types, the acreage is underestimated, but would still be less than 1 percent of the ARPA if accurately tallied. These stands are sparsely vegetated, with bare soil often exceeding 60 percent of the total surface cover. Plants usually grow four to ten inches in height. Other common species in this cover type are little bluegrass, Indian ricegrass, bottlebrush squirreltail, western wheatgrass, phlox, biscuitroot, wild onion, pepperweed, winterfat, and birdsfoot sagebrush (Artemisia pedatifida). Pronghorn antelope and livestock utilize this species on a year-round basis.

3.5.2.10 Silver Sagebrush/Bitterbrush/Rabbitbrush Cover Type

This cover type occurs on 1500 acres; less than 1 percent of the project area.

3.5.2.11 Riparian Cover Types

Riparian habitat comprises approximately 250 acres within the ARPA along perennial and intermittent drainages and around seeps and springs. Although small in extent, these areas are the most diverse and productive of all vegetated sites, and therefore are extremely important for wildlife habitat and livestock forage. Three different community types can be distinguished in the project area: cottonwood/willow, willow/waterbirch, and grassland.

Cottonwood/willow riparian habitat comprises about 20 percent of the total riparian cover type, and is found in the southern portion of the ARPA along Cottonwood Creek, Youngs Draw and Deep Creek. These drainages are intermittent except below artesian wells along sections of Cottonwood Creek. Narrowleaf cottonwood (Populus angustifolia) may grow up to 50 feet tall and requires scouring runoff events to prepare seedbeds for germination. Coyote willow (Salix exigua) and wild rose are the principle understory shrubs, with basin wildrye, Kentucky bluegrass, inland saltgrass, and thickspike wheatgrass the primary understory grasses.

Willow/waterbirch riparian habitat comprises about 10 percent of the total riparian cover type, and is found along Muddy Creek north of Doty Mountain and along Separation Creek in the northern portion of the ARPA. Although intermittent in the late summer and fall months, these stream reaches are sufficiently wet to support water "loving" species. Shrub species include coyote and yellow (Salix lutea) willow, waterbirch (Betula occidentalis), shrubby cinquefoil (Potentilla fruticosa), wild rose, and golden currant. Willows are usually three to six feet tall, with waterbirch reaching 15 feet in height. Common understory grass or grass-like species are Kentucky bluegrass, inland saltgrass, redtop (Agrostis alba), streambank wheatgrass (Elymus trachycaulum), meadow barley (Hordeum brachyantherum), Baltic rush (Juncus balticus), spike-sedge (Eleocharis spp.), tufted hairgrass (Deschampsia cespitosa), northern reedgrass (Calamagrostis inexpansa), common reed (Phragmites communis), Nebraska sedge (Carex nebraskensis), beaked sedge (Carex rostrata), American bulrush (Scirpus americanus), and pondweed (Potamogeton spp.). Forbs include asters, locoweed, goldenrod (Solidago canadensis), licoriceroot (Glycyrrhiza lepidota), lettuce (Lactuca serriola), mint (Mentha arvensis), willowweed (Epilobium glandulosum), plantain (Plantago eriopoda), and strawberry potentilla (Potentilla anserina).

Grassland riparian habitat is the most common type of riparian plant community in the ARPA, totaling about 70 percent of all riparian cover types. These sites are diverse and composition depends on the quantity and quality of water supporting it. It is common for one or two species to dominate the composition of a particular site. Species are, for the most, part similar to those listed above. Although shrubs are not always present, the principle species, coyote willow, is not usually abundant. Wetter sites, like along Fillmore Creek, Cow Creek and Cherokee Creek contain more sedges. Drier sites, like those found along Dry Cow drainage, Wild Cow Creek and Deep Creek, are dominated by grasses and Baltic rush.

3.5.3 Noxious and Invasive Weeds

On 3 February 1999, Executive Order (EO) 13112 ("Invasive Species") was signed by President Clinton. The primary purpose of this EO is to prevent the introduction of invasive species and provides for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Hartman and Nelson 2000). Of these 428 plants, 24 are designated as noxious by the State of Wyoming (Rice 2002) and are shown in Table 3-28. In addition to these 24 state-designated species, Carbon County has designated halogeton (Halogeton glomeratus), plains prickly pear (Opuntia polyacantha), Geyer larkspur (Delphinium geyeri), and lupine (Lupinus spp.) as noxious (Justesen 2004). Noxious weeds are very aggressive, and invading infestations tend to exclude other native plant species and reduce the overall forage production of desirable shrubs, herbaceous grasses and forbs. The project area is vulnerable to infestations of noxious weeds, especially on newly disturbed surfaces. However, a majority of the project area contains sufficient assemblages of native plants to deter invasive, but not noxious, weed establishment in undisturbed habitat.

Noxious weeds known to occur or that have been treated within the ARPA are Russian knapweed, Canada thistle, whitetop, and musk thistle. Russian knapweed has been treated along the BLM road on the east side of Wild Horse Butte and occurs by the gate just south of the Morgan Ranch homestead. The first population appears to no longer exist and the second population needs to be field checked. Canada thistle commonly occurs along Muddy Creek, and appears to grow on the eroding banks between the riparian habitat and the upland basin big sagebrush plant community. It has not been a problem and is extensive enough to take a large scale effort to eradicate it. With greater concern for other noxious species, treatment of Canada thistle is currently on hold. Whitetop has only been documented along the county road by Cow Creek and current status needs to be field checked. Musk thistle has also been documented on the east side of Wild Horse Butte.

Halogeton, an invasive weed, has been present in the project area for many years, occurring in disturbed areas such as roadsides, old bedgrounds and corrals. These populations did not appear to be expanding with minimal expansion of disturbed surface areas. However, with expansion of disturbance as a result of the interim drilling for coalbed methane, halogeton has expanded along roads and pipelines with inadequate control treatments and reclamation.

Noxious and invasive species known to occur outside, but adjacent to the project area, include houndstongue, salt cedar, spotted knapweed and black henbane. Houndstongue is common in the Loco Creek and Savery drainages east of the south end of the ARPA. Some locations have been treated but there are too many plants to effectively treat all locations at this time. Salt cedar is found along the middle and lower sections of Muddy Creek. Treatments are planned for the fall of 2005 to eliminate the largest populations above the George Dew homestead, but further treatments would still be required to eradicate all salt cedar plants. Spotted knapweed has shown up from time to time, primarily along highways. A recent discovery documented this species along Highway 789 between milepost markers 10 and 21, and treatments would be planned to control it. Black henbane primarily occurs along roads and pipelines, and has been documented all around the project area along gas field, BLM, and county roads.

Some of these species require disturbance to become established and some do not. What appears to be more critical is the transportation of seeds along highways and roads via vehicles and construction equipment that can only be controlled by more education and/or enforcement for washing of vehicles to reduce the likelihood of seed movement.

Table 3-28. Designated Noxious Weeds in Wyoming.[1]

Scientific Name	Common Name
Agropyron repens	Quackgrass
Ambrosia tomentosa	Skeletonleaf bursage
Arctium minus	Common burdock
Cardaria draba, C. pubescens	Hoary cress, whitetop
Carduus acanthoides	Plumeless thistle
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed
Centaurea maculosa	Spotted knapweed
Centaurea repens	Russian knapweed
Chrysanthemum leucanthemum	Ox-eye daisy
Cirsium arvense	Canada thistle
Convolvulus arvensis	Field bindweed
Cynoglossum officinale	Houndstongue
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyers woad
Lepidium latifolium	Perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Linaria vulgaris	Yellow toadflax
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sonchus arvensis	Perennial sowthistle
Tamarisk spp.	Salt cedar
Hypericum perforatum	Common St. Johnswort
Tanacetum vulgare	Common tansy

[1] Designated Noxious Weeds, Wyoming Stat. § 11-5-102 (a)(xi) and Prohibited Noxious Weeds, Wyoming Stat. § 11-12-104.

3.6 RANGE RESOURCES

The ARPA overlaps 31 BLM grazing allotments (Appendix M: Grazing Allotments), totaling 574,688 acres that are permitted for 39,695 cattle and 7,421 sheep Animal Unit Months (AUMs) (Table 3-29). The season of use for each allotment varies, but most are for spring, summer and/or fall use with pastures for control of season and duration. In many cases, the boundaries of the grazing allotments extend beyond the boundaries of the ARPA. This document will focus on those allotments that are mostly within the ARPA, (listed in the table in bold) unless specifically mentioned.

There are 21 allotments within the ARPA that would be primarily affected by the proposed action or an alternative (30% allotment acres or higher within ARPA). These allotments contain 372,444 acres (64% public) and 30,462 permitted AUMs. Fourteen different livestock operations have permitted use in these allotments, with most having private (single operator) allotments. However, in Cherokee allotment, use is shared between eight permittees. The total AUMs are split into 27,671 cattle AUMs (91%) and 2,791 sheep AUMs (9%), and there is a small amount of use by ranch horses. The total permitted AUMs within these 21 allotments equal about 7.8 acres per AUM across the ARPA.

Table 3-29. Grazing Allotments and Animal Unit Months (AUMs) Currently Permitted in the Atlantic Rim Project Area.[A]

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
Adams Ranch	**199**	**67**	**39**	**6**		**6**
Airheart Pasture	**1861**	**74**	**520**	**96**		**96**
Badwater	21,777	8	10,251	802	399	1,201
Baggs Sub-Unit	**8,411**	**88**	**3,965**	**264**		**264**
Brimmer Pastures	**1,325**	**44**	**291**	**18**		**18**
Bull Canyon	7,688	26	3,833	748		748
Cherokee	**66,799**	**94**	**62,706**	**6,412**	**1,588**	**8,000**
Cottonwood Creek	**5,040**	**100**	**200**	**17**	**17**	**34**
Dad	433	9	433	94		94
Daley Ranch	26,083	13	11,305	959		959
Deep Creek Pasture	**6,172**	**100**	**1,571**	**635**		**635**
Deep Gulch	**35,452**	**60**	**26,954**	**3,597**		**3,597**
Doty Mountain	**84,008**	**67**	**59,504**	**6,976**		**6,976**
East Muddy	**6,154**	**91**	**5,484**	**301**		**301**
Fillmore	**39,923**	**61**	**17,449**	**3,374**		**3,374**
Grizzly	38,091	8	27,533	5,280		5,280
Headquarters Ranch	**612**	**97**	**142**	**25**		**25**
JO Pastures	**1,136**	**100**	**1,136**	**600**		**600**
Morgan-Boyer	11,163	9	8,260	1,002	700	1,702
Morgan Ranch	**4,930**	**100**	**2,780**	**263**		**263**
North Baggs	741	6	179	18		18
Rasmussen Sub-unit	19,411	11	4,751	792		792
Sixteen Mile	**81,509**	**31**	**37,513**	**2,442**	**1,186**	**3,628**
Smiley Draw	**3,540**	**100**	**1,345**	**226**		**226**
South LaClede	60,436	1	34,328	233	3,531	3,764
South Muddy	**1,562**	**90**	**1,562**	**103**		**103**
South Pasture	**3,880**	**95**	**497**	**89**		**89**
Sulphur Springs	22,752	21	12,832	2,096		2,096

Allotment Name	Total Acres	Allotment % in ARPA	BLM Acres and Permitted AUMs			
			Acres	Cattle AUMs	Sheep AUMs	Total AUMs
West Loco	920	67	120	30		30
West Wild Cow	3,835	100	3,502	437		437
Wild Cow	8,815	59	7,868	1,760		1,760
Totals	574,688		348,096	39,695	7,421	47,116

[A]Allotment Names in bold are those primarily affected and are discussed in text.

Cattle operations are primarily cow/calf pairs, but three allotments (Deep Gulch, Fillmore and JO Pastures) are typically used by yearlings. Use occurs during the spring, summer and/or fall months, depending on the location of the allotment and the requirements of each individual livestock operation. Each allotment is usually used for one season, or longer if use is rotated between pastures. Most ranchers calve at the home place before moving out to an allotment. However, two permittees range calve on their allotments but in pastures outside the area of the ARPA. There are also pastures with corrals essential for shipping. Use periods of these facilities varies by operation, with animals trucked in between April and June, with roundup and trucking out anytime between mid-August to September for yearlings and from October through December for cows and calves.

Sheep use is primarily during May and June for lambing, with lesser amounts of use in late September and October. In addition, sheep trail to and from desert (winter) allotments to lamb, then trail to and from the National Forest where they spend the summer. Cherokee is the principal allotment with active sheep use made by two operators. Lambing in this allotment is primarily in the Cottonwood Creek, Deep Creek, and Wild Cow Creek drainages. However, trailing of sheep occurs across Doty Mountain, East Muddy and Smiley Draw allotments. Corrals or pens for sheep may be permanent, but often are temporary and installed at the location needed to work the sheep. These are usually on the lambing grounds to shear the sheep in late April or early May or to brand, cut and dock the lambs in late May or early June.

Most ranchers have lived and worked within the project are for three to four generations. Their knowledge is extensive, not just pertinent to livestock management, but in local information such as where the snow blows free or collects, when the country opens up or when the ice comes out of the storm channels, and where and wildlife move within allotments. This information is useful in planning and reducing impacts, and ranchers should be encouraged to participate in coordinating long-term development, production and reclamation.

There are currently artesian water wells being relied upon to provide water for livestock. In the Muddy Creek watershed, there have been many cooperative projects between the ranchers, BLM, Little Snake River Conservation District, and others to improve resource management, and more recently to ensure that Standards for Healthy Rangelands are being met. Ranchers have always sought to improve their livestock management, but over the last twenty years there has been more emphasis to achieve this goal. Water developments, fencing, pasture rotations, vegetation treatments, monitoring sites, and other tools are used in range management with the cooperation of livestock operators to improve watershed cover, riparian habitat and upland plant condition. The benefits of these actions need to continue as new resource uses and development occur within the ARPA and the entire Muddy Creek watershed.

3.7 WILDLIFE AND FISHERIES

3.7.1 Wildlife

3.7.1.1 Introduction

The ARPA is located within the Rawlins Field Office. The project area encompasses 270,080 acres, which is approximately 2.3 percent of the 12-million acre resource area. Information concerning current and historical wildlife locations was obtained from several sources. The Wyoming Game and Fish Department (WGFD) Wildlife Observation System (WOS) contains records of observations for all types of wildlife (birds, mammals, reptiles, and amphibians) (WGFD 2003a). The Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming (WGFD 1999) was also used to assess the potential occurrence of species in the project area. This atlas divides Wyoming into 28 degree blocks, and the presence or absence and breeding activity of vertebrate species are documented by degree block. The ARPA is located in degree block 25. Annual big game herd unit reports from the WGFD Green River and Lander regions were used to determine big game herd unit boundaries, population objectives, seasonal ranges, and migration routes. Location records for vertebrate species of special concern, within an approximate 6-mile buffer of the project area, were obtained from the Wyoming Natural Diversity Database (WYNDD 2003). Greater sage-grouse lek and raptor nest locations were obtained from the WGFD and Rawlins, Wyoming, BLM Field Office.

3.7.1.2 Wildlife Habitat

A wide variety of wildlife habitats and their associated species occurs on the project area. Wildlife habitats that could be affected by the project include both the areas that would be physically disturbed by the construction of the gas wells, related roads, pipelines, and production facilities as well as zones of influence surrounding them. Zones of influence are defined as those areas surrounding, or associated with, project activities where impacts to a given species or its habitat could occur. The shape and extent of such zones varies with species and circumstances.

General vegetative species composition for each habitat type is characterized in Section 3.5.2 of this document.

3.7.1.3 General Wildlife

A total of 338 species have been recorded, or may occur, within the project area and surrounding region, either as residents or migrants. This species list (Appendix D) includes 248 birds, 73 mammals, and 11 reptiles, and 6 amphibians. The presence and distribution of these wildlife species were determined from published literature, unpublished data from federal and state agencies, databases from federal and state agencies, and on-site surveys conducted by HWA from 2000 - 2004. Although all of the species are important members of wild land ecosystems and communities, most are common and have wide distributions within the project area, state, and region. Consequently, the relationship of most of these species to the proposed project is not discussed in the same depth as species which are threatened, endangered, sensitive, of special economic interest, or are otherwise of high interest or unique value.

3.7.1.4 Big Game

Pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) are the big game species that occur on the ARPA. Big game populations are managed by the WGFD within areas designated as herd units and are discussed in that context. The types of big game seasonal ranges designated by WGFD (WGFD 1996) discussed in this document include winter, winter/yearlong, crucial winter, crucial winter/yearlong, and spring/summer/fall. Winter ranges are used by a substantial number of animals during winter months (November through April). Winter/yearlong ranges are occupied throughout the year but during winter they are used by additional animals that migrate from other seasonal ranges. Crucial range (i.e. crucial winter and crucial winter/yearlong) describes any seasonal range or habitat component that has been identified as a determining factor in a population's ability to maintain itself at a specified level (theoretically at or above the population objective) over the long term. Not all habitats within designated crucial winter range are of equal quality. Areas with higher quantity and quality of forage and areas that provide cover from extreme winter weather conditions provide the best quality crucial winter range habitat. Crucial ranges are typically used 8 out of 10 winters. Spring/summer/fall ranges are used before and after winter conditions persist. Areas designated as OUT (or non-use areas) contain habitats of limited or no importance to the species.

Using WGFD information that was averaged from 1997-2001, comparisons can be made about the species richness and productivity across Wyoming. When numbers for antelope, mule deer, and elk are combined for similar-sized geographic units, the harvest data for the Sierra Madre/Snowy Range area (includes the ARPA) within the RFO are similar to the Sublette region around Pinedale, which is considered the most productive big game region in the state. In addition, recreation days and the economic benefits associated with hunting were 50 percent higher for the Sierra Madre/Snowy Range area when compared to the Sublette region (Rawlins Draft RMP 2004).

Pronghorn. The ARPA is located mostly within the 1,394-mi^2 Baggs Herd Unit but also encompasses very small portions of the Bitter Creek and Iron Springs Herd Units (Appendix M: Seasonal pronghorn antelope ranges and migration routes). The project area encompasses 480 mi^2 or 39.7 percent of the Baggs Antelope Herd Unit. The Upper Colorado River Basin Standards and Guidelines Assessment 2002 failed Standard #4, Wildlife Habitat Health, and addressed pronghorn range as follows. The population objective was raised in 1994 from 7,100 to 9,000 animals. Prior to raising this objective, antelope populations had tended to be at or above objective levels in most years. Whether the current herd objective is supportable is not yet known. Principal concerns within the Baggs antelope herd are tied to the 74% winter diet overlap with mule deer, and the high levels of browse use and health of the sagebrush habitat in crucial winter range. The latter is caused by the concentration of animals in the Muddy Creek crucial winter range during severe winters and their inability to move through or under fences along Highway 789. There are 45,549 acres of antelope crucial winter range, of which 24% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). Current trends in this sagebrush community are stable. However, as populations are raised toward the higher population objective and when more severe winter weather returns to this portion of Wyoming, the trend in these communities would have to be closely watched. The transition range located on lower elevations adjacent to crucial winter range is important in receiving more use by antelope in milder winters and reducing the browsing pressure on the crucial winter range. The importance of big sagebrush to antelope can not be overstated, sagebrush comprised the majority of pronghorn diets (71% in summer and 96% in winter) (Alldredge and Deblinger 1988).

Table 3-30. Population Parameters for Big Game Herd Units within the ARPA.

Species	Herd Unit	Unit No.	Hunt Area(s)	Size (mi^2)	Population Estimate (2003)[c]	Population Objective	Density Estimate Objective[a]	Fawn:Doe Ratio
Pronghorn	Baggs	438	53, 55	1,394	8,900	9,000	6.46	43:100[b]
Pronghorn	Bitter Creek	414	57,58	2,915	12,000	25,000	8.58	36:100[b]
Mule Deer	Baggs	427	82,84, 85,100	3,440	20,500	18,700	5.44	44:100[c]
Elk	Sierra Madre	425	13,14,15, 21,108	2,425	5,100	4,200	1.73	45:100[c]
Elk	Petition	430	124	2,915	300	300	0.10	44:100[c]

[a] = No. Animals (WGFD Population Objective) per Square Mile of Occupied Habitat
[b] = Prehunt Classification
[c] = Posthunt Classification

Table 3-31. Big Game Seasonal Ranges within the Atlantic Rim Project Area.

	Seasonal Range[1] Areas (acres)						
	CWIN	CWYL	WIN	WYL	SSF	OUT	UND
Pronghorn	-	45,549	-	156,405	72,176	-	-
Mule Deer	894	73,598	-	187,815	11,824	-	-
Elk	-	40,745	197,294	16,006	-	18,640	1,447

[1]CWIN: Crucial Winter, CWYL: Crucial Winter/Yearlong, WIN: Winter, WYL: Winter/Yearlong, SSF: Spring/Summer/Fall, OUT: Non-use Areas, UND: Undefined Areas.

Mule Deer. The ARPA is located within the eastern portion of the 3,440-mi^2 Baggs Herd Unit (Appendix M: Seasonal mule deer ranges and migration routes). The boundaries for this herd unit correspond with the Bitter Creek Road on the west, Interstate 80 on the north, and the Wyoming/Colorado border on the south. Much of the eastern border follows the Continental Divide until it intersects WH 71.

The 2003 post-hunt population estimate for the Baggs Herd Unit was 20,500, but were previously as high as 27,000 in 1987, prior to a winter die-off in February 1993. This estimate is above the WGFD management objective of 18,700 (Table 3-30). However, this area is one of few in the State of Wyoming which usually supports an any deer harvest to manage deer numbers at objective levels. This is a reflection of the productivity of this deer herd and the quality of spring-summer-fall habitat that supports them. The project area is located within Hunt Areas 82, 84, and 100. Hunt Area 82 remains the most popular in the herd unit and sustains the highest levels of hunter use (WGFD 2003b). Mule deer migrate from the eastern portion of the Baggs Herd Unit to lower elevation crucial winter ranges that are located in the southern and central portions of the ARPA. Some mule deer that spend the summer near the Sandhills may migrate to winter range in the southwestern portion of the Baggs Herd Unit near Powder Rim (Porter 1999). Of particular importance is the crucial winter range located south and west of

Muddy Mountain within the ARPA. Although many mule deer migrate to other locations, this area becomes a concentration area for mule deer during severe winter conditions.

The Upper Colorado River Basin Standards and Guidelines Assessment (2002) failed Standard #4, Wildlife Habitat Health, and addressed mule deer range as follows. Of the three commonly found big game species in this watershed, deer habitat, and particularly crucial winter range, is of the highest concern. The most concentrated mule deer use occurs from Horse Mountain down to Poison Basin and north along Muddy Creek, at lower elevations. Adjacent to this area and to the north and west are areas in better condition that are used in mild winters but act more as transition habitat in severe winters. The second factor is that a much higher percentage of mule deer crucial winter range is on private lands than compared to antelope and elk crucial winter range. There are 74,492 acres of mule deer crucial winter range (Table 3-31), of which 42% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). Therefore, this should be taken into account (when possible), concerning actions occurring on lands adjacent to public lands and realize that actions taken on public lands would only affect approximately 20% of the most heavily utilized areas within the crucial winter range.

Observed habitat concerns in the mule deer crucial winter range include single species dominance by Utah juniper and big sagebrush species, mature-to-decadent age class structure of all shrub communities, poor vigor and heavy-to-severe utilization of desired shrub species, dense stands of shrubs that inhibit use and movement, and low composition of forbs on deer ranges used first in the spring. The principal area deemed not to be meeting Standard #4 for wildlife habitat is the mule deer crucial winter range located between Horse Mountain and Poison Basin and north from Baggs along Muddy Creek through the Wild Horse and Dad juniper woodlands. This area encompasses about 40,000 acres of public land.

Elk. Most of the ARPA is located within the western portion of the Sierra Madre Herd Unit. Similar to other elk herds in the State of Wyoming, the population of elk in this unit has been above objective levels for many years. However, due to liberal harvests the trend in this herd indicates the population is decreasing towards objective levels (WGFD 2004). The majority of the ARPA is identified as winter range for elk, with crucial winter range identified along the eastern and southern borders. The crucial winter range occurs at lower elevations where less snow accumulates, and on steep, south and west facing slopes that commonly blow free of snow or melt off during winter months. There are 40,745 acres of elk crucial winter range, of which 17% is on private and state lands where there are no protections against disturbance of animals during critical time periods (Appendix M: Big Game Crucial Winter Ranges). A limited amount of summer range is also located along the eastern border in the aspen, sagebrush and riparian habitats. Many elk in the Sierra Madre Herd Unit migrate from the Sierra Madre Range west to crucial winter/yearlong and winter ranges located throughout the ARPA (Appendix M: Seasonal elk ranges and migration routes). Elk diets are similar to cattle, with a preference for grass and forb species, but with increasing amounts of shrubs during the winter. The population of elk in this herd unit is also a reflection on the health of the habitat that supports them. Elk are more sensitive to human activities than pronghorn or mule deer, and they may be displaced from construction areas by 0.75 - 2 miles (Brekke 1988, Gusey 1986, Hiatt and Baker 1981).

Overlapping Big Game Crucial Winter Range. Areas of overlapping big game crucial winter range are of greater importance because they provide crucial habitat for more than one species of big game. There are several areas of overlapping big game crucial winter range located in the ARPA (Appendix M: Overlapping Crucial Winter Ranges). The combinations of overlapping big game crucial winter ranges include the following: elk/mule deer 3,038 acres; mule deer/antelope 22,637 acres. Forty percent is on private and state lands where there are no protections against disturbance of animals during critical time periods. The impacts of habitat loss within overlapping crucial winter ranges would be greater than in non-overlapping areas. The Great Divide RMP (USDI-BLM 1988) states that habitat quality will be maintained within areas of overlapping big game crucial winter ranges.

3.7.1.5 Upland Game Birds

The WGFD manages upland game birds within upland game management areas. The greater sage-grouse (*Centrocercus urophasianus*) and the Columbian sharp-tailed grouse (*Tympanuchus pahianellus columbianus*) are the main upland game bird species known to occur in the ARPA, which lies within the Sierra Madre Upland Game Management Area (UGMA #25) and includes a very small portion of the Bitter Creek Upland Game Management Area (UGMA #10).

Greater Sage-grouse. Wyoming is one of the last strongholds for greater sage-grouse in the western United States, and contains more grouse than all other states combined. Greater sage-grouse are common throughout Wyoming because their habitat remains relatively intact compared to other states. In south-central Wyoming, this is even more accentuated due to the harsh climate that has limited past habitat loss or conversion to settlements and agricultural development along river bottoms. In the past, disturbance to upland habitats was restricted to livestock grazing and vegetation treatments (primarily at higher elevations). More recent disturbance to grouse habitat has come with development of energy resources.

Greater sage-grouse lek locations were obtained from the WGFD and the RFO. There are 88 leks located in and within two miles of the ARPA (Appendix M: Greater sage-grouse leks). Leks are often in grassy areas or in more open canopy sagebrush/grass habitat. Greater sage-grouse are dependent on sagebrush environments for their year-round survival, and in particular Wyoming and mountain big sagebrush, which occupy 85% of the ARPA. This dependency includes using sagebrush as forage, nesting, brood-rearing habitat, and winter thermal cover. In addition, grouse require a variety of sagebrush habitat types to meet their life history requirements. The sagebrush habitat types in the ARPA are diverse and provide a high quality environment for greater sage-grouse that is reflected in their abundance in this area. Riparian habitats are also important for brood-rearing habitat during the summer and fall months. The proximity of these two habitats to each other increases their value.

In response to petitions to list the greater sage-grouse under the ESA, the FWS conducted a status review of this species throughout its range and on January 7, 2005 determined that it did not warrant protection under the ESA. However, FWS Director Steve Williams stated that: “At the same time, the status review clearly illustrates the need for continued efforts to conserve sage-grouse and sagebrush habitats on a long-term basis.” Greater sage-grouse populations in Wyoming have stabilized in recent. Because of continuing modifications of sagebrush habitats from fire, chemical and mechanical treatments, and development, the need exists to minimize such losses and to conserve and improve sage-grouse habitats through careful management practices. The greater sage-grouse is included on the Wyoming Sensitive Species List of the BLM State Director (USDI-BLM 2002a).

The State of Wyoming continues to hunt greater sage-grouse and contends that hunter harvest primarily consists of young birds which have a high mortality rate regardless of hunting. However, grouse harvest numbers have been reduced by shortening and moving back the hunting season dates and lowering the bag limits.

In order to protect greater sage-grouse breeding grounds, the BLM places a ¼-mile buffer around the edge of leks where controlled surface use (CSU) is stipulated (USDI-BLM 1990). The ¼-mile buffer around the edge of occupied or unknown status leks located on or within ¼ mile of the ARPA covers 8,124 acres or 3 % of the ARPA. Twenty of the eighty-eight leks in the ARPA are located on private and state lands which are not protected in any way from disturbance. In addition, the BLM places a two-mile lek buffer in a seasonal stipulation preventing disturbance to protect nesting and early brood-rearing habitat. Potential greater sage-grouse nesting habitat (habitat associated with 88 leks) covers 191,017 acres or 71% of the ARPA. Of this acreage, 36% is on private and state lands which are also not protected.

According to Call (1974), Braun et al. (1977), Hayden-Wing et al. (1986), and others, approximately 50% of nests are usually located within a two-mile radius of the strutting grounds. Using data collected at seven sites across Wyoming between 1994-2003, Holloran (2005) documented 45% of nests occur within a three km (approximately two-mile) buffer and 64% of the nests occurred within a five km (approximately three-mile) buffer. In addition, he also reported a correlation between nest distance from lek and success probability, suggesting increased success rates for nests > 8.5 km from a lek (61% success > 8.5 km, 44% success < 8.5 km). All research indicates that greater sage-grouse nest in suitable habitat beyond the two-mile buffer. It is likely that hens from the active leks use most of the project area for nesting and brood-rearing, which in terms of suitable habitat amounts to 92% of the ARPA. Greater sage-grouse leks and associated nesting habitats on the project area occur mostly within the big sagebrush vegetation types. Areas with medium height sagebrush and tall residual cover of bunchgrasses provide nesting habitat (Crawford et al. 2004). Suitable brood-rearing habitat consists of various height sagebrush communities and riparian areas that provide abundant forbs, insects, and succulent mesic vegetation (Crawford et al. 2004).

Winter concentration areas have not been identified and mapped yet. If any winter concentration areas are identified in the future, there would be a timing restriction applied to surface disturbing and other disruptive activities to reduce stress to wintering birds from November 15 to March 14.

Severe winter relief habitat is used during the worst of winters. Severe winter relief habitat locations were located in the ARPA, covering a total of 200 acres. Twenty-six of these acres are on private lands and are not protected. Details of the protocol used in locating and describing the severe winter relief areas and results of the study are contained in a report submitted to the BLM in 2004 (HWA 2004). This study is on-going and the results will be used to identify physical and vegetative characteristics of severe winter relief habitat patches.

Columbian Sharp-tailed Grouse. The BLM has placed the Columbian sharp-tailed grouse on the BLM Wyoming State Director's Sensitive Species List (USDI-BLM 2002a). It is one of six sub-species of sharp-tailed grouse found in North America. In Wyoming, Oedekoven (1985) documented leks on flats or slight swales of mixed shrubland habitat. Breeding and nesting habitat consisted of herbaceous vegetation types and wintering areas were found in mixed upland shrublands and wooded riparian zones along the western edge of the Sierra Madre Range. This area partially overlaps the ARPA. Habitat types associated with the distribution of the species in the northwestern United States include sagebrush-bunch grass, meadow-steppe, mountain-shrub, and riparian zones (Giesen and Connelly 1993).

Home ranges of Columbian sharp-tailed grouse are relatively small and their activities tend to be concentrated around active leks (Oedekoven 1985). Individuals typically move up to one mile from an active lek for nesting, and up to 3.1 miles to wintering areas (Oedekoven 1985, Giesen and Connelly 1993). Columbian sharp-tailed grouse lek locations were obtained from the WGFD and six leks have been documented on or within one mile of the ARPA, which comprise 27% of the leks within the Rawlins Field Office. Potential Columbian sharp-tailed grouse nesting habitat (habitat located within one mile of a lek) covers 4,956 acres or 1.8% of the ARPA (Appendix M: Columbian sharp-tailed grouse leks nesting and brood-rearing habitat). Leks are not located on BLM lands, however 785 acres of nesting and brood-rearing habitat are. In order to protect Columbian sharp-tailed grouse breeding grounds, the BLM places a ¼-mile buffer around leks where CSU is stipulated (USDI-BLM 1990). It is likely that hens from the active leks use nesting and brood-rearing habitat within the ARPA. Wintering habitat for sharp-tailed grouse (serviceberry/mixed mountain shrub habitat) totals 287 acres, of which 278 acres are on BLM.

3.7.1.6 Raptors

As indicated in the WOS (WGFD 2003a), the WYNDD (2003), and the Atlas of Birds, Mammals, Reptiles and Amphibians in Wyoming (WGFD 1999) raptor species known to occur on and near the ARPA include: Northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), broad-winged hawk (*Buteo platypterus*), rough-legged hawk (*Buteo lagopus*), ferruginous hawk (*Buteo regalis*), golden eagle (*Aquila chrysaetos*), bald eagle (*Hiliaeetus leucocephalus*), prairie falcon (*Falco mexicanus*), peregrine falcon (*Falco peregrinus*), American kestrel (*Falco spavarius*), long-eared owl (*Asio otus*), short-eared owl (*Asio flammeus*), great-horned owl (*Bubo virginianus*), and burrowing owl (*Athene cunicularia*). The topography of the ARPA includes low bluffs and cliffs that provide suitable sites for raptor nesting. The entire project area contains suitable habitat for raptor hunting or foraging.

The total number of nest sites located on and within one mile of the ARPA is 542 (Appendix M: Raptor nest locations). Nest sites actually within the project boundary are 357. The nest sites included: burrowing owl (2), Cooper's hawk (6), ferruginous hawk (132), golden eagle (67), great horned owl (12), northern goshawk (1), American kestrel (7), long-eared owl (1), northern harrier (3), prairie falcon (23), red-tailed hawk (51), Swainson's hawk (7), sharp-shined hawk (1), and unknown raptor (44). The BLM also identified 60 additional nests that have deteriorated and are no longer present that are classified as historical. It is possible that some of the older raptor nests in the BLM records that have not been checked for many years may have also deteriorated beyond being suitable for raptor nesting.

Inactive raptor nest sites may be used in subsequent years; therefore, all nests in good condition have the potential to be active in any given year. All raptors and their nests are protected from take or disturbance under the Migratory Bird Treaty Act (16 USC, § 703 et seq.) and Wyoming Statute (WRS 23-1-101 and 23-3-108). Golden and bald eagles are also afforded additional protection under the Bald Eagle Protection Act, amended in 1973 (16 USC, §669 et seq.).

3.7.1.7 Combinations of Wildlife Concerns

The ARPA falls entirely within the Rawlins-to-Baggs Geographical Area described in the RFO draft RMP, 2004. The species richness and habitat diversity in this area is one of the greatest in the RFO. The areas within the ARPA where wildlife resource concerns overlap are illustrated on Appendix M: Overlapping Wildlife Concerns. One hundred thirteen combinations of overlapping wildlife resource concerns were identified within the ARPA. The majority (over 90%) of the ARPA contains at least one wildlife resource concern.

3.7.2 Fish

See Sections 3.8 for discussions on fish species.

3.8 SPECIAL STATUS PLANT, WILDLIFE AND FISH SPECIES

Special status species include: (1) threatened, endangered, species proposed for listing by the FWS (Under the ESA of 1973 as amended), candidate species; and (2) sensitive species identified by the BLM Wyoming State Sensitive Species List (USDI-BLM 2002a).

3.8.1 Threatened, Endangered, Proposed, or Candidate Species of Plants, Wildlife and Fish

The FWS has determined that nine species, which are listed under the ESA as threatened, endangered or proposed, or as candidate or petitioned species pursuant to the ESA, are potentially present within the RFO (USDI-FWS 2004a; Table 3-32). Additionally, ten species that are found downstream of the RFO in the Platte River and Colorado River systems may potentially be impacted if water depletions occur. More detailed information on threatened, endangered, and proposed species is presented in the Biological Assessment (BA) (Appendix G).

3.8.1.1 Plant Species

No federally listed threatened, endangered, or candidate plant species are known to occur on the ARPA. However, four listed plants that may be potentially affected by the proposed action include blowout penstemon (*Penstemon haydenii*), Ute-ladies'-tresses (*Spiranthes diluvialis*), Colorado butterfly plant (*Gaura neomexicana ssp. coloradensis*), and western prairie fringed orchid (*Platanthera praeclara*) (USDI-FWS 2004a).

Blowout penstemon: Blowout penstemon, an FWS endangered species, is known to occur in certain habitats south of the Ferris Mountains in the northern part of Carbon County. The plant has the potential to occur on the project area (Fertig 2001, USDI-FWS 2002), especially in the Sand Hills area where a few, active sand dunes are known to exist. However, the species was not found during field surveys of this area by WYNDD personnel in June 2000 (Fertig 2000).

Ute ladies'-tresses: The known locations of the species in Wyoming include Converse, Goshen, Laramie, and Niobrara Counties. This species is not known to occur within the ARPA and the likelihood of it occurring in the ARPA is low due to the following reasons: (1) much of the ARPA is very arid and there are few perennial streams, (2) the elevation of the project area is near the upper limit for the species, (3) very few moist riparian area meadows are present, (4)

Table 3-32. Threatened, Endangered, Proposed, Candidate, or Petitioned Species Potentially Present within the RFO or that May Potentially be Impacted by the Proposed Project.

Species	Scientific Name	Status
Plants		
Blowout penstemon	*Penstemon haydenii*	Endangered
Ute-ladies'-tresses	*Spiranthes diluvialis*	Threatened
Colorado butterfly plant	*Gaura neomexicana ssp. coloradensis*	Threatened
Western prairie fringed orchid*	*Platanthera praeclara*	Threatened
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Canada lynx	*Lynx canadensis*	Threatened
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Threatened
Birds		
Bald eagle	*Halieaeetus leucocephalus*	Threatened
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate
Whooping crane*	*Grus americana*	Endangered
Interior least tern*	*Sterna antillarum*	Endangered
Piping plover*	*Charadrius melodus*	Threatened
Eskimo curlew*	*Numenius borealis*	Endangered
Amphibians		
Wyoming toad	Bufo baxteri	Endangered
Fish		
Bonytail**	*Gila elegans*	Endangered
Colorado pikeminnow**	*Ptychocheilus lucius*	Endangered
Humpback chub**	*Gila cypha*	Endangered
Razorback sucker**	*Xyrauchen texanus*	Endangered
Pallid sturgeon*	*Scaphirhynchus albus*	Endangered

* water depletions in the Platte River system may affect these species found downstream of the ARPA.
** water depletions in the Colorado River system may affect these species found downstream of the ARPA.

the transition from stream margins to upland vegetation is abrupt, and (5) the species has only been located in eastern and southeastern Wyoming (Fertig 2002).

Colorado butterfly plant. This species is known to occur in Laramie County in southeastern Wyoming, in southwestern Nebraska and in northeastern Colorado. This species is not known and is not expected to occur on or near the ARPA.

Western prairie fringed orchid. This species is known to occur in Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, and Oklahoma; and in Manitoba Province, Canada (NatureServe 2003).

A small portion of the ARPA drains into the Platte River system and according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the western prairie fringed orchid; however, no depletions would occur as a result of this project.

3.8.1.2 Wildlife Species

Black-footed Ferret. There are no recorded sightings of black-footed ferrets within the project area (WGFD 2003a, WYNDD 2003). A total of 6,309 acres of white-tailed prairie dog colonies were identified within the ARPA (Appendix M: White-tailed prairie dog colonies). In addition, 115 acres of prairie dog towns connected to towns within the ARPA or towns located adjacent to the ARPA were identified. Aerial mapping and ground surveys indicated that the area and density of active prairie dog colonies may be sufficient to support black-footed ferrets and that the species could theoretically be present within the ARPA. Black-footed ferret surveys would be necessary prior to ground disturbing activities within prairie dog towns that meet FWS requirements for black-footed ferret surveys (Biggins et al. 1989, USDI-FWS 1989).

Between October 2000 and October 2004, nocturnal black-footed ferret surveys were conducted on prairie dog towns located in the Dry Cow Creek POD (HWA 2000a), Sun Dog POD (HWA 2000b, HWA 2001a), Blue Sky POD (HWA 2001b and HWA 2002a), and the Cow Creek Seismic Project Area (HWA 2002b) in accordance with FWS Black-Footed Survey Guidelines (USDI-FWS 1989). No black-footed ferrets or their sign were observed during the surveys.

Canada Lynx. Although Wyoming comprises part of the species' historic geographical range, no lynx sightings have been documented in the ARPA or within a six-mile buffer (WGFD 2003a). In a collaborative effort, the BLM and WYNDD completed a lynx habitat suitability map for the State of Wyoming (Beauvais et al. 2001); according to the habitat map, lands within the ARPA provide low to poor quality lynx habitat.

Preble's Meadow Jumping Mouse. In Wyoming, Preble's meadow jumping mouse is found within riparian habitat corridors east of the Laramie Range Mountains and south of the North Platte River (USDI-FWS 2004a). The ARPA is located more than 100 miles west of the known distribution of the Preble's meadow jumping mouse and this species is not expected to occur on the project area.

Bald Eagle. Although no bald eagle nests or nesting habitat occurs on the project area, nesting habitat does occur several miles south of the project and along the Little Snake River. Bald eagles have been observed on the project area primarily during December, January, and February (WGFD 2003a). The majority of bald eagle sitings within the project area are in the southern portion of the ARPA, close to the Little Snake River. Bald eagles may utilize the project area for foraging during winter months because a large portion consists of winter range for antelope, mule deer, and elk.

Yellow-billed Cuckoo (West of the Continental Divide). Currently, the yellow-billed cuckoo west of the Continental Divide is considered a candidate species for listing under the ESA. The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats, therefore it is unlikely that the yellow-billed cuckoo occurs in the project area and it has not been documented on the ARPA (WGFD 2003a, WYNDD 2003).

Whooping Crane. A small portion of the ARPA drains into the Platte River system and according to the FWS (USDI-FWS 2004a), water depletions in the Platte River system may contribute to the destruction or adverse modification of designated critical habitat for the whooping crane, however, no depletions would occur as a result of this project. Habitat for the whooping crane does not occur on the ARPA.

Interior Least Tern. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the interior least tern; however, no depletions would occur as a result of this project. No habitat for the interior least tern is found on the ARPA.

Piping Plover. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions may contribute to the destruction or adverse modification of designated critical habitat for the northern Great Plains breeding population of the piping plover; however, no depletions would occur as a result of this project. No suitable habitat for the piping plover occurs on the ARPA.

Eskimo Curlew. A small portion of the ARPA drains into the Platte River system and, according to the FWS (USDI-FWS 2004a), water depletions to the Platte River system may potentially affect the Eskimo curlew; however, no depletions would occur as a result of this project. No suitable habitat for the Eskimo curlew occurs on the ARPA.

3.8.1.3 Amphibian Species

Wyoming Toad. The Wyoming toad did not historically, and does not currently occur in or near the ARPA.

3.8.1.4 Fish Species

Four federally endangered fish species may occur as downstream residents of the Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2004a). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development (e.g. dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USDI-FWS 1993). The last sighting of any of these fish species in the Little Snake River was of a single Colorado pikeminnow in 1990. Habitat for these species is not present within the ARPA, these fish species are not likely to be found in the main stem Little Snake River and its tributaries within the ARPA, and critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity and/or quality to these tributaries to the Colorado River warrant their inclusion in this NEPA document.

One federally endangered fish species, the pallid sturgeon (*Scaphirhynchus albus*), may occur as a downstream resident of the Platte River system in Nebraska. Habitat for this species is not present within the ARPA and critical habitat for this species has not been designated in Wyoming. However, the potential for project-related reductions in water quantity and/or quality to tributaries of the Platte River warrant its inclusion in this NEPA document.

Colorado Pikeminnow. The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of Colorado Basin rivers. The species was once abundant in the main stem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the City of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995). Subsequent survey attempts to collect Colorado pikeminnow from this area of the Little Snake River by WGFD personnel failed to yield any other specimens.

Bonytail. Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be the rarest of the endangered fishes in the Colorado River System.

The bonytail historically inhabited portions of the upper and lower Colorado River basins. Today, in the upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Humpback Chub. Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999).

The humpback chub was historically found throughout the Colorado River System, and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68% of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

Razorback Sucker. The razorback sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

Pallid Sturgeon. The pallid sturgeon is a native fish found in the Mississippi/Missouri River system. The pallid sturgeon is present in the Platte River, a tributary to the Missouri River, located downstream from a portion of the ARPA. According to the FWS (USDI-FWS 2004a), water depletions in the Platte River system may potentially affect the pallid sturgeon; therefore, this species is included in this document. Suitable habitat for the pallid sturgeon consists of large turbid rivers with sand or gravel bottoms. The pallid sturgeon is threatened by habitat degradation such as decreased turbidity, which can be caused by impoundments. There is no habitat for the pallid sturgeon located on the ARPA.

3.8.2 Sensitive Plant, Wildlife and Fish Species

The BLM has developed a sensitive species list for public lands in Wyoming. The objective of the designation is to ensure the overall welfare of these species is considered when undertaking actions on public land and that those actions do not contribute to the need to list the species under the provisions of the Endangered Species Act (ESA). The BLM Sensitive Species List is meant to be dynamic and would be reviewed annually with recommendations from BLM and appropriate non-BLM authorities for additions and deletions (USDI-BLM 2002a). The following species occur on the BLM Sensitive Species List in the RFO and some may occur on or near the ARPA.

3.8.2.1 Sensitive Plant Species

Eight plant species of special concern may potentially occur on or near the RFO management area (USDI-BLM 2002a). None of these species have known occurrences within the project area (WYNDD 2003). Suitable habitats for four of the eight species are absent in the ARPA and four have the potential to occur. The names, sensitivity status, probability of occurrence of these species are listed in Table 3-33: Sensitive Plant Species.

Nelson's milkvetch. This plant is a regional endemic of southwest and central Wyoming, northeast Utah, and Northwest Colorado. The known Wyoming occurrences are found in sparsely vegetated sagebrush and juniper communities. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Gibben's beardtongue. In Wyoming, the known occurrences of Gibben's beardtongue are confined to extreme southwest Carbon County and extreme southeast Sweetwater County near the state line. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Pale blue-eyed grass. In Wyoming, the plant is known from the Laramie, North Platte, and Great Divide Basins in Albany and Carbon Counties. This plant has the potential to occur on the project area, however, the species has not been found within the ARPA.

Laramie false sagebrush. The species is endemic to southeast Wyoming (Albany and Carbon Counties) but has also been reported in Converse and Natrona Counties. This species has not been found and is not expected to occur in or near the ARPA.

Laramie columbine. Laramie columbine is found within crevices of granite boulders and cliffs. This species has not been found and is not expected to occur in or near the ARPA.

Cedar Rim thistle. Cedar Rim Thistle is endemic to the Wind River and Green River basins of Central Wyoming. This plant has the potential to occur in the project area, however, the species has not been found within the ARPA.

Weber's scarlet gilia. This species has not been found and is not expected to occur in or near the ARPA.

Persistant sepal yellowcress. This species has not been found and is not expected to occur in or near the ARPA.

Table 3-33. Sensitive Plant Species with Potential to Occur On or Near the Atlantic Rim Project Area.

Common Name	Scientific Name	Status[1]	Habitat	OP[2]
Laramie columbine	*Aquilegia laramiensis*	G2/S2, FSR2	Crevices of granite boulders and cliffs 5400 to 8000'	N
Nelson's milkvetch	*Astragalus nelsonianus*	G3/S3	Alkaline clay flats, shale bluffs, pebbly slopes and volcanic cinders in sparsely vegetated sagebrush, juniper & barren clay slopes 6,500 to 8,200'	P
Cedar Rim Thistle	*Cirsium aridum*	G2Q/S2	Barren, chalky hills, gravelly slopes, and fine textured, sandy-shaley draws 6700 to 7200'	P
Weber's Scarlet Gilia	*Ipomopsis aggregata ssp. weberi*	G5T1T2 Q/S1, FSR2	Openings in conifer forests and scrub oak woodlands 8500 to 9600'	N
Gibben's beardtongue	*Penstemon gibbensii*	G1/S1	Barren south-facing slopes on loose sandy-clay derived from Brown's Park formation; may occur in grass-dominated sites with scattered shrubs; semi-barren fringed sagebrush/thickspike wheatgrass communities with 15-20% vegetation cover, or ashy slopes amid *Cercocarpus montanus*; may also occur on outcrops of Green River Formation on steep yellowish sandstone-shale slopes below caprock edges.	P
Persistant sepal yellowcress	*Rorippia calcycina*	G3/S2S3	River banks and shorelines, usually on sandy soils near high water line	N
Pale blue-eyed grass	*Sisyrinchium pallidum*	G2G3/ S2S3	Wet meadows, stream banks, roadside ditches & irrigated meadows 7,000 to 7,900'	P
Laramie false sagebrush	*Sphaeromeria simplex*	G2/S2	Cushion plant communities on rocky limestone ridges & gentle slopes 7,500 to 8,600'	N

Sources: USDI-BLM (2002a), WYNDD (2003).

[1] **- Definition of status**

G Global rank: Rank refers to the range-wide status of a species.

T Trinomial rank: Rank refers to the range-wide status of a subspecies or variety.

S State rank: Rank refers to the status of the taxon (species or subspecies) in Wyoming. State ranks differ from state to state.

1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.

2 Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.

3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).

4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.

5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

? Questions exist regarding the assigned G, T, or S rank of a taxon.

[2] **OP -** occurrence potential**:** **P** = potential, **N** = no potential

3.8.2.2 Sensitive Wildlife Species

Long-eared Myotis. Although this species may hibernate in Wyoming, its residency status is currently unknown and it is thought to be uncommon (WGFD 1999). Although a limited amount of sparse juniper woodland occurs on the ARPA, sightings of the species have not been documented and it is unlikely to occur there.

Fringed Myotis. The fringed myotis occupies a variety of desert, grassland, and woodland habitats throughout western North America from British Columbia to southern Mexico. The fringed myotis has been observed to the northeast, east, and west of the project area (WGFD 1999). It could potentially occur in the ARPA to feed, but hibernation is unlikely because of the lack of suitable habitat.

Spotted bat. This bat occurs sporadically across the western United States and has not been documented in the ARPA, but it may occur.

Townsend's big-eared bat. This bat can be found throughout Wyoming and its distribution is likely determined by the availability of roosts such as caves, mines, tunnels, and crevices with suitable temperatures (Clark and Stromberg 1987). The Townsend's big-eared bat has been observed to the north, east, and west of the ARPA (WGFD 1999). It may occur in the project area to feed, but is unlikely to roost there because of the lack of suitable habitat.

Pygmy rabbit. The distribution of this rabbit is across eight western states and has been documented in Sweetwater County, Wyoming. It prefers tall sagebrush and deep, soft soil for burrowing. It has the potential to occur in the ARPA.

White-tailed prairie dog. White-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the western half of Wyoming (Clark and Stromberg 1987). White-tailed prairie dogs towns were mapped on the ARPA. Collectively, a total of 6309 acres of white-tailed prairie dog colonies were identified within the ARPA; (Appendix M: White-tailed Prairie Dog Colonies). In addition, 115 acres of prairie dog towns connected or adjacent to towns within the ARPA were identified.

Black-tailed prairie dog. Black-tailed prairie dogs occupy the grass, shrub-grass, and desert-grass habitats in the northern and eastern Wyoming. This species has not been found and is not expected to occur in or near the ARPA.

Wyoming pocket gopher. The Wyoming pocket gopher is endemic to southeastern Sweetwater County and southwestern Carbon County. Populations in Carbon County are known only from Bridger's Pass but may occur elsewhere (Clark and Stromberg 1987). Based on the known distribution of the species and the availability of suitable habitat, Wyoming pocket-gophers likely occur in the ARPA.

Swift fox. The swift fox inhabits short grass and mid-grass prairies over most of the Great Plains including eastern Wyoming (Clark and Stromberg 1987). Woolley et al. (1995) studies have documented occurrences in Carbon County and Sweetwater County, however, no swift fox were found during his survey in southwestern Carbon County. Swift foxes may potentially occur on the project area.

White-faced ibis. White-faced ibis have been documented in the project area.

Trumpeter swan. In Wyoming, the trumpeter swan is an uncommon resident (WGFD 1999) and the majority occur in the Yellowstone National Park region. Trumpeter swans have been observed to the east and to the north of the ARPA (WGFD 2003a), but suitable habitat does not occur in the ARPA.

Northern goshawk. Northern goshawks are known to occur adjacent to the ARPA (WGFD 2003a).

Ferruginous hawk. The ferruginous hawk is a common species in south-central Wyoming and is known to occur and nest on the project area.

Peregrine falcon. Bird populations in and around the project area may be abundant and diverse enough to support peregrines. Peregrine falcons may at times migrate through the project area, but nesting by this species in or near the project area is unlikely due to the lack of cliffs high enough to provide suitable nesting habitat. Peregrine falcons have been observed in the ARPA (WGFD 2003a).

Greater sage-grouse. See Section 3.7.1.5.

Columbian sharp-tailed grouse. See Section 3.7.1.5.

Mountain plover. Observations of mountain plovers within and adjacent to the ARPA have been recorded by the WGFD (WGFD 2003a) and BLM wildlife biologists.

Long-billed curlew. There have been three recorded observations of this species approximately two miles northeast of the ARPA and one recorded observation in the east-central portion of the ARPA (WGFD 2003a).

Yellow-billed cuckoo (East of the Continental Divide). The last record of a yellow-billed cuckoo being detected on a Breeding Bird Survey (BBS) route in Wyoming was from 1995 (USGS Patuxent Wildlife Research Center 2004). The ARPA does not include any large riparian areas with well-developed cottonwood/riparian habitats, therefore it is unlikely that the yellow-billed cuckoo occurs in the project area and it has not been documented in the ARPA (WGFD 2003a, WYNDD 2003).

Burrowing owl. Burrowing owls are known to occur on the ARPA (WGFD 2003a).

Sage thrasher. This bird is considered a sagebrush obligate and is generally dependent on large patches and expanses of sagebrush steppe for successful breeding. Sage thrashers have been observed throughout Wyoming, including the ARPA (WGFD 2003a).

Loggerhead shrike. In Wyoming, they are a common summer resident and may be a year-round resident in the southern half of the state. Loggerhead shrikes have been observed on the ARPA (WGFD 2003a).

Brewer's sparrow. The Brewer's sparrow breeds in landscapes dominated by big sagebrush (*Artemisia tridentata*) throughout the Great Basin and intermountain West and winters in sagebrush shrublands and brush desert habitat in the southwestern United States and northern Mexico (Rotenberry et al. 1999). According to the WGFD (WGFD 2003a), Brewer's sparrow is known to occur in the ARPA.

Sage sparrow. The sage sparrow breeds in sagebrush expanses from the northern edges of the Great Basin west of the Rocky Mountains to the chapparal and sagebrush scrub in Baja California (Martin and Carlson 1998). Sage sparrows are known to occur throughout the ARPA (WGFD 2003a).

Baird's sparrow. Based on the distribution of this species and its preferred habitat, it is unlikely that it would occur in the ARPA during the breeding season, but may occur as a summer resident (WGFD 1999) or during migration (Johnsgard 1986) to wintering sites (DeGraaf et al. 1991). Two observations of Baird's sparrow were recorded by the WGFD approximately two miles northeast of the ARPA in 1981 (WGFD 2003a).

Northern leopard frog. A member of the true frog family (*Ranidae*), the northern leopard frog is an obligate of permanent water in the plains, foothills, and montane zones. Sightings of this species have been documented in all counties of Wyoming and this species has a high probability of occurring in any areas of the ARPA having perennial water (WYNDD 2003).

Great Basin spadefoot. Sightings of this species have been documented in Sweetwater, Lincoln, Fremont, and Natrona counties of Wyoming (Baxter and Stone 1992). The known distribution of the Great-basin spadefoot is west of the ARPA. No observations have been reported in the WOS (WGFD 2003a) near the ARPA. The Wyoming Species Atlas (WGFD 1999) indicates that the species' range encompasses the ARPA; however the species is unlikely to be found on the project area.

Western boreal toad. The range for boreal toads is thought to encompass the Muddy Creek watershed (Baxter and Stone 1992). However, no sightings of this species within six miles of the project area have been reported in the WOS (WGFD 2003a). It appears that habitat within the majority of the ARPA is too arid for this species to persist and thrive, but it may occur in isolated areas where habitat is suitable.

3.8.2.3 Sensitive Fish Species

Fish species that are not listed as endangered or threatened by the FWS, but may be rare or declining within the state, have been included on the BLM Wyoming Sensitive Species List (USDI-BLM 2002a). The intent of the sensitive species status is to ensure that actions on BLM-administered lands consider the welfare of these species and do not contribute to the need to list any other species under the provisions of the Endangered Species Act (USDI-BLM 2001).

Four BLM Wyoming state sensitive fish species are known to occur in portions of streams within or adjacent to the ARPA. These include the roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (WYNDD 2003, USDI-BLM 2002a). The three warmwater fish species (roundtail chub, bluehead sucker, flannelmouth sucker) can be found within the Muddy Creek watershed downstream of the ARPA (Beatty 2005), within the ARPA, and upstream of the ARPA (WGFD 1998, 2004; Bower 2005). The Muddy Creek watershed appears to be the only stream system in Wyoming where populations of these three native, warmwater fish species exist together (WGFD 2004).

The BLM and WGFD are signatory to the *Range-wide Conservation Agreement for Roundtail Chub, Gila robusta, Bluehead Sucker, Catostomus discobolus, and Flannelmouth Sucker, Catostomus latipinnis*. This agreement establishes the BLM's commitment to implement conservation strategies developed at both the range-wide and state-wide scales for these three species. The range-wide conservation strategy for these species identifies the enhancement and maintenance of habitat for roundtail chubs, bluehead suckers, and flannelmouth suckers as a conservation priority.

The BLM, WGFD and the University of Wyoming have recently completed two studies to characterize the abundance, distribution, ecology, habitat requirements and genetics of the three native warmwater fish species within the Muddy Creek watershed (Beatty 2005; Bower 2005). Additional studies are underway to characterize the movement patterns of the three species within and upstream of the ARPA within the upper Muddy Creek watershed. Results obtained through 2005 have indicated that these isolated populations may represent one of the highest conservation priorities for native fishes within Wyoming (Beatty 2005; Bower 2005).

The Colorado River cutthroat trout, which is a native coldwater game fish, has been re-introduced into Muddy Creek upstream of the ARPA and Littlefield Creek, a tributary to Muddy Creek, upstream of the ARPA. Before the introduction was made, all fish in these segments of these creeks were eliminated and a fish barrier was installed on Muddy Creek, immediately upstream of McKinney Creek, to prevent non-native fish from gaining access to the stream. In addition to the Colorado River cutthroat trout, the WGFD is planning to re-introduce all native species into the segment of Muddy Creek upstream of the fish barrier. Colorado River cutthroat trout also occur upstream from the project area in the Little Snake River (Baxter and Stone 1995). This species has been petitioned for listing as threatened or endangered.

Besides Muddy Creek, the majority of other streams on the ARPA are ephemeral and, therefore, do not have the potential to support BLM Wyoming state sensitive fish species on a year-round basis. Studies indicate that the native warmwater species may ascend ephemeral tributary streams to spawn (USDI-FWS 1985, Maddux and Kepner 1988, Weiss et al. 1998). Thus, ephemeral drainages fed by runoff from the project area may provide habitat for sensitive fish on a seasonal basis.

Roundtail Chub. This species is found within the Green River drainage including portions of the Little Snake River drainage and can be found in the Muddy Creek watershed, Carbon County, Wyoming. Roundtail chubs occurring downstream (Beatty 2005), within, and upstream of the ARPA within the Muddy Creek watershed represent the most abundant population of this species known from within Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b; Beatty 2005; Bower 2005). A recent status review indicated that the range of this species has been reduced roughly 55% from historical levels (Bezzerides and Bestgen 2002). Causes for observed declines in the distribution of roundtail chubs include construction of mainstream dams, altered river flows and altered water temperatures (Bezzerides and Bestgen 2002).

During the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, roundtail chubs were most abundant in areas containing deep pools and glides with rocky substrates. Additionally, the abundance of roundtail chubs was positively associated with areas containing remnant pool habitats resulting from extensive stream drying (Bower 2005). Extensive movements of adult roundtail chubs have not been documented within the upper Muddy Creek watershed (Bobby Compton, University of Wyoming, personal communication), though movement of larvae and juveniles through drift has been documented in other portions of the Upper Colorado River Basin (Carter et al. 1986).

Bluehead Sucker. Bluehead suckers are present in the Little Snake, Green River, Snake and Bear River basins in Wyoming (Baxter and Stone 1995, WGFD 1998, WGFD 2004b). This species is found in the Muddy Creek watershed upstream, within, and downstream of the ARPA

(Baxter and Stone 1995, WGFD 1998; Beatty 2005; Bower 2005). Bezzerides and Bestgen (2002) indicate that the range of this species has declined roughly 45% from historical levels. Causes for observed declines in distribution include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Bezzerides and Bestgen 2002). Bluehead suckers within the upper Muddy Creek watershed represent the most abundant population of this species known from within the Colorado River Basin of Wyoming (WGFD 2004b; Bower 2005).

Bluehead suckers were most abundant during the summer and fall of 2003 and 2004 in areas with rocky substrates (gravel – cobble sizes) in close proximity to pool habitats within the upper Muddy Creek watershed. These areas are most common where pool-riffle sequences are present (Bower 2005). Extensive movements of adult bluehead suckers during the spring were observed during 2005 within the upper Muddy Creek study area, presumably in association with spawning (Bobby Compton, University of Wyoming, personal communication).

Flannelmouth Sucker. This species is found primarily in the Yampa, Little Snake, Colorado, Green, and Gunnison rivers and is also common in Muddy Creek in Carbon County, Wyoming, upstream, downstream, and within the ARPA (Bower 2005). Bezzeredes and Bestgen (2002) indicate that the range of this species has declined roughly 50% from historical levels. Similar to the causes identified for the decline of other native Colorado River Basin fishes, causes for observed declines in the distribution of flannelmouth suckers include construction of mainstream dams, altered river flows and water temperatures, and hybridization with the white sucker (Bezzerides and Bestgen 2002).

Habitat features influencing the abundance of flannelmouth suckers during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed included rocky substrates as well as deep pools and runs (Bower 2005). Movements of adult flannelmouth suckers in association with spawning have been documented within the lower Muddy Creek watershed (Beatty 2005).

Colorado River Cutthroat Trout. Colorado River cutthroat trout were the only trout native to the Green River and Little Snake River drainages in Wyoming (Baxter and Stone 1995). Historical records indicate it was present in Muddy Creek in the mid-1800s (Mark Fowden, WGFD, personal communication). Historically, this subspecies inhabited clear-water tributaries of the Colorado River in Colorado, Utah, Wyoming, and probably also in New Mexico and Arizona (Behnke 1992). This species now occupies only a fraction of its former range. Some of the most genetically "pure" of the remaining populations of this trout subspecies are found in the Little Snake River upstream of the ARPA in Carbon County, Wyoming (Baxter and Stone 1995). Colorado River cutthroat trout have been re-introduced into Littlefield Creek and Muddy Creek upstream of the ARPA. The species is generally associated with steep, clear, cold-water streams around rocky areas, riffles, deep pools, and near or under overhanging banks and logs (Binns 1977). Colorado River cutthroat trout have been extirpated from much of their original range through competition with brook trout, rainbow trout, and brown trout, and hybridization with rainbow trout (Binns 1977). Though reintroduced populations exist in close proximity upstream of the ARPA, habitats within and downstream of the ARPA are generally supportive of warmwater, not coldwater fishes. Therefore, this species is unlikely to occur within the ARPA.

3.9 RECREATION RESOURCES

3.9.1 Introduction

Hunting is the main recreation use in the ARPA. The Baggs Herd Unit of mule deer, in the southern half of the ARPA, is one of the most heavily hunted in the state. Hunters also pursue antelope and elk as well as small game and upland birds. The ARPA also attracts recreation visitors driving for pleasure and viewing wildlife. Recreational camping and off-highway vehicle (OHV) use occurs primarily as part of hunting and related activities such as scouting game. Hunting is described in Section 3.9.2.1.

Although there are no counts of recreational visits to the ARPA, overall use is believed to be low, except during and just prior to hunting season which occurs primarily in the fall (USDI-BLM 2000). Low visitation during the rest of the year is due to low population densities in proximity to the area and the historically seasonal nature of the road network. Snowdrifts in winter and rains the rest of the year have made most of the roads intermittently impassable until recent improvements in surfacing on BLM and County Roads. Visitation within the ARPA may increase in response to road improvements. The Sand Hills Area of Critical Environmental Concern (ACEC), about 8,300 acres located within the ARPA, is managed to protect vegetation and wildlife habitat and is a particularly important deer hunting area because of its unique vegetation complex. Vegetation in the area is still recovering from a fire in the early 1990s.

Visitation is also expected to increase with the stabilization and interpretation of the JO Ranch that was recently acquired in a land exchange near the Sand Hills. The Continental Divide National Scenic Trail (CDNST) is within 3 miles of the northeastern boundary of the ARPA, but it is not likely to affect visitation within the project area.

3.9.2 Recreation Resources and Use

The principal recreation resources of the ARPA are the public lands managed by the BLM. This section discusses their use primarily for hunting and secondarily for pleasure driving and wildlife viewing. There are almost no fishing resources in the ARPA, and only a few fishing opportunities near the ARPA boundaries.

The BLM is not able to measure recreation use in the GDRA, including the ARPA, so counts of non-hunting recreation are not available However, BLM personnel have observed that recreational use in the GDRA in general appears to be steady or in a slight upward trend. If favorable conditions for wildlife are sustained in the future, then hunting throughout the GDRA, and similarly within the ARPA, is likely to continue to rise slowly.

A network of many small roads and two-tracks covers the GDRA, including the ARPA, connecting more remote locations to the larger collector roads. These routes are used for recreational purposes, as well as for access to develop and maintain oil and gas wells and range improvements. The road network includes roads maintained by the BLM, counties, and private corporations. Whether improved or not, roads and two-tracks facilitate dispersed recreation and can be expected to affect the potential for dispersed recreation use in the future.

3.9.2.1 Hunting

Big game habitat is found throughout the ARPA (see Section 3.7.1.4). The ARPA attracts hunters for mule deer in particular, but also for elk, antelope, grouse, and cottontail rabbit. The area is dry and lacks large water impoundments, so waterfowl hunting is minimal. Most big and small game hunting occurs on BLM land, with some occurring on private land by permission of the landowner or with outfitters and guides by commercial lease.

Hunting camps are often grouped near the Sand Hills, Cow Creek Butte, Lone Butte, and Five Buttes areas. Other camps are dispersed throughout the hunt areas that include the ARPA. Motels are typically fully booked during hunting season with resident as well as non-resident people who do day trips to hunt. Many other hunters in the ARPA live in Rawlins or Baggs.

Table 3-34 presents data on hunting activity that indicates the level of hunting potentially occurring in the ARPA. Hunting data are available only as totals for the designated hunt areas delineated by the Wyoming Game and Fish Department (WGFD). Data in the table are the totals for the hunt areas that include the ARPA because information is not available for smaller areas within the hunt areas (Woolley 2003). The ARPA is a significant portion of these hunt areas. The area covered by the hunt areas generally extends from I-80 south to the Wyoming-Colorado border and from Wyoming State Highway (SH) 789 east to SH 71 and the Continental Divide in the Medicine Bow National Forest. The areas include land in a variety of ownerships and a range of types and quality of huntable habitat.

Hunting seasons in the ARPA are in the early fall through winter. Mule deer, elk, antelope and sage grouse are generally hunted from September through November. Rabbits and predators are hunted in late fall and winter. Most hunting in the ARPA is of local or regional importance, with many local hunters finding it convenient and economical to hunt for sport and for game meat in the area. Hunting in the ARPA is also attractive to a national clientele that finds it appealing because they can hunt multiple big game species from a single camp on a single trip to Wyoming.

3.9.2.2 Fishing

Resources for sport fishing are limited in and near the ARPA. Upper Muddy Creek, its tributaries McKinney Creek and Littlefield Creek (both outside the ARPA), and Savery Creek (outside the ARPA) are perennial streams considered to be locally to regionally important trout fisheries. About 15 reservoirs and ponds, ranging from 0.5 to 20 acres, are present within the ARPA. Four or five of these man-made impoundments, generally designed to supply water for livestock and wildlife, are stocked annually with rainbow trout by the WGFD (1998).

Larger sport-fishing resources outside but in the vicinity of the ARPA include Rim Lake (seven miles south of Rawlins and about four miles east of the ARPA), Teton Reservoir (thirteen miles south of Rawlins and about eight miles east of the ARPA), and the Little Snake River (2 miles south of the ARPA between Baggs and Savery). Visits to these fishing resources are rarely if ever related to a recreational visit to the ARPA.

The new High Savery Dam and Reservoir Project of the Wyoming Water Development Commission (about 34 miles south of Rawlins and 10 miles east of the ARPA) is now full. The fishery in the 480-acre reservoir will be managed by the WGFD for recovery of the Colorado River cutthroat trout, and recreation facilities will include a boat ramp (Hand 2004).

Table 3-34. Indicators of Hunting Activity by Species in the WGFD Hunt Areas that Include the ARPA, 2002.

Game Species	Hunt Area(s) Involved	Total Active Hunters	Average Non-Resident Hunters	Average Hunter Success	Average Days per Hunter	Number of BLM Permitted Commercial Outfitters
Mule Deer	82 Baggs, 84 Atlantic Rim	2,784	40%	54%	4.3	13 5
Antelope	53 Baggs, 55 Red Rim, 108 Bridger Pass	453	22%	98%	3.1	9 4 3
Elk	21 Baggs, 108 South Rawlins	5,022	14%	38%	6.1	13 2
Birds & Small Game*	25 Sierra Madre	509	NA	NA	2.5	NA

* About 51 percent sage-grouse hunting and 47 percent cottontail rabbit. The remainder is dove hunting. Individual hunters may hunt more than one species. Seasons may overlap.
NA: Data not available.
Note: Waterfowl hunting is minimal in the ARPA.
Source: WGFD 2002; Blankenship Consulting LLC.

3.9.2.3 Other Recreation

Besides hunting, recreationists visit the area for pleasure driving, wildlife viewing and mountain biking. Pleasure driving occurs seasonally to view changing aspen in late September and early October. Wildlife viewing occurs primarily in the fawning season in late May and June. Raptors, sage grouse and other birds in the ARPA attract some bird watching, and “rock hounding” generates a small amount of recreational use.

Recreational camping and off-highway vehicle (OHV) use, which are popular elsewhere in the GDRA, occur in the ARPA primarily during hunting and preseason scouting visits. There are no developed campsites or open areas for off-road OHV use in the ARPA . Recreational camping usually involves the use of trailers at dispersed locations, and OHV use is permitted only on existing roads and two-tracks.

Viewing wild horses is popular in the GDRA and there is a wild horse herd in the Adobe Town Wild Horse Herd Management Area (HMA) west of SH 789, about eight miles west of the ARPA boundary. Animals in this herd are almost entirely confined to the HMA and do not attract recreational wild horse viewers to the ARPA.

3.9.3 Recreation Plans

The BLM and Carbon County have land use planning concerns, including planning for recreational land use, that may affect the recreation resources available in the ARPA. This section reviews existing plans from these jurisdictions, focusing mainly on the BLM, which is the manager of the largest amount of land within the ARPA.

3.9.3.1 Great Divide RMP Update

The BLM is developing a new Resource Management Plan (RMP) for the Rawlins Field Office that will address the issue of recreation throughout the GDRA, which includes the ARPA. The existing Great Divide RMP, finalized in 1990, needs to be modified because of new data, changing resource conditions, changing uses of BLM lands and the increase in mineral activity.

The existing plan discusses BLM management actions to address several recreation resources in the ARPA or surrounding areas, including maintenance of developed recreation sites like Teton Reservoir, and planning for rehabilitation and mitigation of ORV use in specific problem areas within the Sand Hills area.

<u>JO Ranch Lands</u>

A planning effort with a potential effect on recreation in the ARPA is the expansion of the Sand Hills ACEC to include the JO Ranch Lands, approximately 1,234 acres in the Cow Creek Valley south of the existing Sand Hills ACEC. The property has been acquired through land exchange by the BLM.

The JO Ranch lands are generally unimproved grazing lands except for the ranch buildings. Recreational uses are primarily associated with pronghorn antelope, mule deer, elk, and sage grouse hunting. Other than fall hunting activity, the area attracts limited numbers of recreationists engaged in back country camping and hiking, rock hounding, wildlife observation, OHV use, outdoor photography, and scenic touring. Future management of the acquired lands will be determined through additional NEPA analyses and planning.

3.9.3.2 Carbon County Land Use Plan

According to a survey in the Carbon County Land Use Plan, fishing, hunting, overnight camping and nature appreciation are the four most important outdoor recreational activities to Carbon County residents. The plan notes that important outdoor recreational activities occur at facilities or on lands that are developed or managed by other agencies, so the plan encourages coordination to allow substantive input by the county into agency planning (Carbon County Board of Commissioners et al. 1998). The land use plan contains no specific recreation plans for land within the ARPA.

3.10 VISUAL RESOURCES

The following description of the affected environment is based on the BLM land classification program for visual resources, Visual Resource Management (VRM) (USDI-BLM 1980). Previous on-site visits, recent photographs, field notes compiled by other ID team members, conversations with BLM personnel, and interpretive work from topographic maps were used to characterize visual resources within the affected environment.

The Atlantic Rim Project Area (ARPA) is in the Rawlins-to-Baggs area managed by the BLM Rawlins Field Office. The entire geographical area is characterized by diverse upland conditions interlaced with perennial and ephemeral stream systems and riparian zones.

Diversity of topography, soils, and climate creates a range of vegetation communities in the ARPA. These communities include aspen, six types of sagebrush, juniper, mountain shrub, saline desert shrub, and riparian/wetlands. The level of plant and wildlife values within the ARPA is reflected in the special management areas, Jep Canyon ACEC and the Sand Hills ACEC, which are managed for wildlife habitat.

The Atlantic Rim itself is the most distinctive landform within the ARPA. Panoramic views are seen from the crest of the Atlantic Rim and from other high points like Wild Horse Butte and Muddy Mountain. Moving generally west from the Atlantic Rim, a combination of varied topography, buttes, and sandstone outcrops subdivides the project area into a number of smaller viewsheds. Numerous small drainages dissect the landscape and add diversity.

Some of the vegetation communities within the ARPA are large, homogeneous, continuous, and relatively undisturbed tracts. They include large blocks of continuous grass, sagebrush, and tree cover, depending on elevation, soils and water. See Section 3.5 Vegetation.

The predominant vegetation at lower elevations of the ARPA generally changes from north to south. Beginning with sagebrush and grasses in the northernmost regions near Hogback Lake, dominant vegetation changes to sagebrush, mixed desert shrub, and forbs toward the south. It then changes to a mosaic of plant communities near Dad in the middle of the project area. Continuing southward, sagebrush dominates the landscape, giving way to large grassy-looking areas of saltbush and alkaline sagebrush south of Wild Cow Creek and southeast of Wild Horse Road. At the southernmost end of the ARPA, the rugged topography is dominated by mountain shrub and sagebrush communities.

Juniper woodlands exist at higher elevations to the east and even more commonly in the mountainous areas of the southern ARPA. Vegetation colors in early spring are green and gray-green, changing to gray-green and buff-ochre as grasses and forbs cure in the summer and fall. Reddish brown of the Red Rim and buff colors of the sandstone outcrops add contrast and dominate in areas of steep topography.

Evidence of human modification in the ARPA includes improved and unimproved roads, power lines, constructed ponds, irrigated fields on private land in the southern part of the project area, and oil and gas production facilities. Existing disturbance from oil and gas development is about 604 acres. This disturbance—about 0.2% of the 270,080 total acres in the ARPA—consists of un-reclaimed area from prior development of well pads, compressor stations, and containment ponds. Overall, the scenic quality of the area as seen from State, County and BLM roads is not significantly impaired by an abundance of permanent facilities.

The ARPA's visual resources are accessible to a range of users from the existing network of public roads within the ARPA. These roads are mainly Carbon County and BLM roads, with branch roads that serve existing gas development facilities. Users of the road network include private property owners, hunters, sightseers, wildlife observers and other recreationists, as well as personnel and contractors of oil and gas development operators. Some viewsheds in the ARPA are relatively inaccessible because of the private lands that are interspersed among the public lands. This condition exists primarily in the "checkerboard" part of the ARPA in Townships 17 and 18 in Range 91 where County and BLM roads are limited or do not exist.

In varying degrees, parts of the ARPA are visible from Wyoming State Highway (SH) 71/Carbon County Road (CCR) 401, SH 789, and Interstate 80. SH 71/CCR 401 is an important access road to campgrounds in the Medicine Bow National Forest and Huston Park Wilderness.

Residents of Baggs or Dixon might have views of parts of the ARPA, depending on their location. Approximately 68 percent of the ARPA is visible from one or more of the State, County or BLM roads in or adjacent to the project area.

Management of the ARPA's visual resources falls under the BLM's VRM program. The intent of the VRM program is to preserve scenic values in concert with resource development where resource development is appropriate. BLM VRM specialists have classified the ARPA as VRM Class III (approximately 96% of the project area) and Class IV (approximately 4% of the project area) (Appendix M: Location of VRM Class III and IV Landscapes). According to the VRM rating, the level of change to visual resources allowable within these two classes of landscape is described as follows (BLM Manual 8431 - Visual Resource Contrast Rating, Appendix 2 - VRM Class Objectives):

- Class III – The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

- Class IV – The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Thus for projects in Class III areas, project facilities, surface disturbance and activities that contrast enough to attract viewer attention and are evident in the landscape are allowed, but they should be constructed in a manner that reflects the lines, forms, colors and textures of the characteristic landscape, so as not to dominate the landscape. Whenever possible, existing topography and vegetation should be utilized to screen project activities and facilities. In Class IV areas, activities and facilities are accepted as dominant visual features in the landscape but colors and textures should blend with the landscape and utilize existing screening possibilities.

3.11 CULTURAL AND HISTORICAL RESOURCES

3.11.1 Cultural Chronology of Area

Archaeological investigations in the Great Divide Basin and the Washakie Basin indicate the area has been inhabited by people for at least 12,000 years from Paleoindian occupation to the present. The accepted cultural chronology of the Washakie Basin is based on a model for the Wyoming Basin by Metcalf (1987) and revised by Thompson and Pastor (1995). The Wyoming Basin prehistoric chronology is documented in Table 3-35.

Paleoindian Period

The oldest period for which there is archaeological evidence is the Paleoindian, beginning ca. 12,000 years B.P. and ending around 8500 B.P. This is the transition period from the periglacial conditions of the Wisconsin ice advance during the terminal Pleistocene to the warmer and drier climatic conditions of the Holocene. A savanna-like environment with higher precipitation than occurs today was prevalent in southwest Wyoming. Understanding paleoenvironmental conditions operating at the end of the Pleistocene and into the Holocene will provide insights into the articulation between human populations and the environment (Thompson and Pastor 1995). Paleoindian sites are rare in southwest Wyoming. However, isolated surface finds of Paleoindian projectile points are not uncommon and suggest that site preservation may be a major factor affecting the number of known sites. The Paleoindian tool assemblage includes lanceolate points, gravers, and end-scrapers.

Table 3-35. Prehistoric chronology of the Wyoming Basin.

Period	Phase	Age (B.P.)
Paleoindian		12,000 - 8500
Great Divide		8500 - 6500
Early Archaic	Opal	6500 - 4300
Pine Spring		4300 - 2800
Late Archaic	Deadman Wash	2800-2000/1800
Uinta		2000/1800 - 650
Late Prehistoric	Firehole	650 - 300/250

Source: Metcalf (1987), as modified by Thompson and Pastor (1995)
B.P. is before present

Archaic Period

Settlement and subsistence practices, in southwest Wyoming, remained largely unchanged from the end of the Paleoindian period through the Archaic and continued until at least the introduction of the horse, or even until Historic Contact. Reduced precipitation and warmer temperatures occurred ca. 8500 B.P. The environmental change at the end of the Paleoindian period led to a pattern of broad spectrum resource exploitation which is reflected in the subsistence and settlement practices of the Archaic period. The resource exploitation became more diverse. The Archaic period is divided into the Early and the Late periods and subdivided in the Great Divide and Opal and the Pine Spring and Deadman Wash phases, respectively. Large side- and corner-notched dart points and housepits are found during the Archaic period. The presence of ground stone implements suggests a greater use of plant resources during the Archaic period. Faunal assemblages from Archaic components document increased use of small animals (Thompson and Pastor 1995).

At the Yarmony site in northern Colorado, at least one housepit has been investigated which produced radiocarbon dates of ca. 6300 B.P. (Metcalf and Black 1991). The Yarmony housepit is a large, semi-subterranean, two-room dwelling containing four slab-lined storage bins, interior hearths and other floor features. Large side-notched points have not been recovered from components dated to the Great Divide phase in the Wyoming Basin. The High Point site (Murray 2001) is a multi-component residential camp occupied during the Altithermal period and one of the only Early Archaic housepit sites discovered to date within the interior basin, located west of the study area. Most other Archaic housepit sites are located along the margins of the basins or in the uplifted areas. Radiocarbon analysis of the High Point site (48CR1790) places the occupations in the Great Divide and the Opal phases of the Early Archaic period. The earliest dated context for side-notched points are Component I at Maxon Ranch (6400-6000 B.P.), west of the study area. Large side-notched points from the Great Basin and Colorado Plateau occur as early as 7000 years B.P. Radiocarbon dates have been recovered from one open camp site and a burial within the study area. Site 48CR698, a prehistoric open camp, dates to the Deadman Wash phase of the Late Archaic period at 2190 B.P. Site 48CR4001, the Cornwell Burial site, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P.

Late Prehistoric Period

The Late Prehistoric period 2000/650 B.P. is subdivided into the Uinta and the Firehole phases. Large-scale seed processing and an increase in the number of features including roasting pits is noted in the Late Prehistoric period as is the presence of pottery and the introduction of bow and arrow technology. A characteristic of the Uinta phase is clusters of semi-subterranean structures dating to ca. 1500 B.P. At least two different types of structures have been identified: a more substantial, cold weather habitation is present at the Nova site (Thompson 1989) and a less substantial, warm weather structure serving more as a windbreak, is present north of the study area, at the Buffalo Hump site (Harrell 1989). Radiocarbon dates have been recovered from two open camp sites in the study area. Site 48CR907, a prehistoric camp, dates to the Uinta phase of the Late Prehistoric period at 1520 B.P. Two dates were recovered from Site 48CR2785. Both dates are from the Uinta phase of the Late Prehistoric period, 1680 and 1880 B.P.

The Firehole phase is distinguished from the preceding Uinta phase by a dramatic decline in radiocarbon dates possibly related to a decline in population density. The South Baxter Brush Shelter site (Hoefer et al. 1992) and Firehole Basin 11 site (Metcalf and Treat 1979) are sites located west of the study area attributed to the Firehole phase.

Proto-Historic Period

The Proto-Historic period begins sometime after 300 years B.P. with the first European trade goods to reach the area, and ends with the development of the Rocky Mountain fur trade 150 years ago. The Wyoming Basin was the heart of Shoshone territory during this period, with occasional forays into the area by other groups such as the Crow and Ute (Smith 1974). The most profound influence on native cultures during this time was the introduction of the horse enabling Native Americans to expand their range. All forms of rock art denoting horses, metal implements, and other Euro-American goods are associated with the Proto-Historic period. These include the Upper Powder Spring Hunting Complex site west of the study area (Murcray 1993). Metal projectile points have been recovered from both surface and subsurface contexts in southwest Wyoming.

Historic Period

Historic use of the area is limited by the formidable topographic relief. Steep canyons, inadequate water supply, badlands, and escarpments make the area inhospitable for settlement with only limited ranching activities present. Seven historic ranches have been recorded in the study area and grazing/sheepherding activities (n=21) have also been documented. Table 3-36 represents the historic chronology of the area. Fur trapping and trading was not an important occurrence in the study area due to lack of perennial streams. The Overland Trail crosses the mid-portion of the study area trending east to west. The Cherokee Trail transects the southern portion of the study area, trending east to west. The Rawlins to Baggs Road transects the center of the study area, trending northeast to southwest.

Table 3-36. Historic chronology of the Great Divide Basin and the Washakie Basin.

Phase	Age A.D.
Proto-Historic	1720-1800
Early Historic	1800-1842
Pre-Territorial	1842-1868
Territorial	1868 – 1890
Expansion	1890 – 1920
Depression	1920 – 1939
Modern	1939 - Present

Source: Massey 1989

3.11.2 Summary of Extant Cultural Resources

The Atlantic Rim Project Area (ARPA) encompasses 422 sections of land for a total area of 270,080 acres. The Cultural Records Office in Laramie provided information on the previous work conducted and sites recorded in the project area. Records at Western Archaeological Services (WAS) were consulted. There have been 315 cultural resource projects conducted and 425 sites recorded in the project area (Prior to 2003). A Class III block inventory was completed in conjunction with preparation of the Atlantic Rim EA (Goodrick 2000). A 1600 ac survey was conducted of the Dry Cow Creek area, and two 40 ac blocks and one 10 ac block sample inventories were conducted in the Deep Creek area for a total of 90 acre, and three 40 ac blocks were sampled in the Cottonwood Creek area, for a total of 120 acres. The overall site density within the three individual blocks varied. The highest number of sites was located along drainages and near the major topographic land forms. Limited amounts of field work have resulted in the documentation of cultural resources through survey, test excavations, examination of ethnographic records, and historic record research. No excavations have been conducted in the ARPA.

In southwest Wyoming, sand deposits (sand shadows and sand sheets) are recognized as highly likely to contain cultural material. The topographic setting of the recently inventoried Dry Cow Creek block is conducive to prehistoric occupation. The block is bisected by Dry Cow Creek and the terrain is capped with Aeolian sand deposits. The topography gently slopes to the west and the south toward Dry Cow Creek which contains limited amounts of water year round. Deep Creek and Cottonwood Creek retain limited amounts of water year round with the area surrounding the creeks characterized by rugged terrain with steep slopes dissected by deep ephemeral drainages and little soil deposition. These types of settings usually do not have high site densities. It would be more likely to encounter sites along the perennial drainages. The overall site density in the study area varies with the highest number of sites located along drainages and near the major topographic land forms. Ephemeral drainages that flow into the study area from several escarpments such as Atlantic Rim, Hogback Ridge, Wild Horse Butte, Lone Butte, China Butte, Deep Creek Butte, and Cow Creek Butte as well as Doty Mountain and Muddy Mountain, flow into the major drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. Numerous springs are present and would be areas likely to contain cultural resources.

“There is also a potential for Native American sensitive sites or Traditional Cultural Properties (TCP) in the study area. The definition of a TCP, according to National Register Bulletin 38 (guidelines for Evaluating and Documenting Traditional Cultural Properties) is “those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice." The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs and practices. Examples of properties possessing such significance include:

- A location associated with the traditional beliefs of a Native American group about its origins, its cultural history, or the nature of the world;
- An urban neighborhood that is the traditional home of a particular cultural group, and that reflects its beliefs and practices;
- A location where Native American religious practitioners have historically gone, and are known or thought to go today, to perform ceremonial activities in accordance with traditional cultural rules of practice; and
- A location where a community has traditionally carried out economic, artistic, or other cultural practices important in maintaining its historic identity

There is also the potential for Native American rock cairns and alignments along the ridges in the study area which do not conform to the strict definition of a TCP but are considered sensitive, none-the-less.

Two projects near the study area have investigated prehistoric site distribution and site density in the Savery Creek drainages. In *Archaeological Investigations Within the Little Snake River Basin Colorado and Wyoming*, H.D. Hall (1987) "reevaluated the nature and distribution of aboriginal sites" in Savery Creek, Slater Creek, Ridge and Valley geographic zones, Juniper Ridge, and the Little Snake Valley, located immediately southeast of the current study area. The Savery Creek investigations indicate that sites are generally located in the valley bottom or lower valley terrain, on gentle inclines, near water and near major confluences.

In the *Class III Cultural Resource Inventory and Evaluation of Eleven Prehistoric Sites within the High Savery Locality at the Proposed High Savery Dam and Reservoir Alternative, Carbon County, Wyoming,* – Latham (1999) states, "The analysis domain is characterized by non-dissected to moderately dissected uplands with mostly moderate-to-steep slopes and broad-to-narrow benches and flood plains along the many streams that pass through the area". Most of the prehistoric sites within the analysis domain are situated on benches or ridges overlooking one of the main tributaries.

3.11.3 Site Types

Sites (n=425) recorded in the project area include: prehistoric sites (n=327), historic sites (n=71), and prehistoric/historic sites (n=27). The total percentage for site types is: prehistoric sites (77%), historic sites (17%), and sites with prehistoric and historic components (6%). Of the recorded cultural resources, 32% are recommended eligible (n=136) for nomination to the NRHP, 34% are recommended not eligible (n=145) for nomination to the NRHP, and 34% remain unevaluated (n=144). Table 3-37 is a summary of known cultural resources in the ARPA categorizing the sites into prehistoric open camps, prehistoric lithic debris, historic sites, and prehistoric/historic sites. Site types previously identified, recently located, or predicted to be in the ARPA are discussed below.

Table 3-37. Summary of prehistoric and historic sites located in the Atlantic Rim Project Area.

Site Eligibility					
Site Types	**No. of Sites**	**No. of Sites Eligible**	**No. of Sites Not Eligible**	**No. of Sites Unevaluated**	**% of Total Sites**
Prehistoric burial	1	1	0	0	
Habitation/hearths/FCR	230	97	55	78	
Prehistoric camp/ceramics	1	1	0	0	
Prehistoric rock shelter	1	1	0	0	
Prehistoric petroglyphs	1	1	0	0	
Prehistoric cairns	8	0	5	3	
Prehistoric stone circles	14	4	3	7	
Prehistoric camp/ground stone	2	2	0	0	
Prehistoric camp/quarry	2	2	0	0	
Total Prehistoric Camps	**260**	**109**	**63**	**88**	**61**
Lithic scatters	62	2	27	33	
Lithic scatter/ceramics	1	0	0	1	
Lithic scatter/ground stone	1	0	1	0	
Lithic scatter/quarry	3	3	0	0	
Total Lithic Debris	**67**	**5**	**28**	**34**	**16**
Historic trails	4	3	1	0	
Stage stations	6	5 - (1 listed)	0	1	
Historic inscriptions	3	2	0	1	
Historic cairns	3	0	2	1	
Historic debris/trash	25	1	21	3	
Historic ranches	7	0	1	6	
Irrigation ditches	1	0	1	0	
Ranching/herding/corrals debris	21	2	17	2	
Post Office	1	0	1	0	
Total Historic Sites	**71**	**13**	**44**	**14**	**17**
Prehistoric camp/historic debris	18	9	3	6	
Prehistoric lithic scatter/historic debris	9	0	7	2	
Total Prehistoric/Historic Sites	**27**	**9**	**10**	**8**	**6**
Total Sites	**425**	**136**	**145**	**144**	**100**

3.11.4 Prehistoric Sites

Three hundred twenty-seven prehistoric sites have been documented in the ARPA (Prior to 2003). The site types include prehistoric camps, lithic scatters, quarries, human burials, rock art, both pictographs and petroglyphs, rock alignment sites, rock shelters, stone circles, and pottery/ceramic sites

Prehistoric camps contain evidence of a broad range of activities including subsistence-related activities. Cultural remains include formal features such as fire hearths, stone rings, cairns, rock art, lithic debris, chipped stone tools, quarries, evidence of milling/vegetable processing activities including ground stone, and pottery. Single as well as long-term occupation may be represented.

Lithic scatters consist of sites containing lithic debris such as debitage or stone tools and quarries. No features or feature remnants are found at the site. The sites are interpreted as representing short-term activities.

Quarries are sites where lithic raw material was obtained and initially processed. Primary and secondary lithic procurement areas are geologic locations where chert and quartzite cobbles have been redeposited and later used by prehistoric inhabitants for tool manufacture. Three of the quarry sites in the project area are included in the lithic scatter sites and two are part of prehistoric camp sites.

Human burials, rock art, both pictographs and petroglyphs, rock alignment sites, and rock shelters have been identified as sensitive or sacred to Native Americans. Few of these types of sites have been located in all of southwestern Wyoming. One human burial is documented in the project area. The Cornwell Burial, Site 48CR4001, dates to the Pine Spring phase of the Late Archaic period at 3250 B.P. One petroglyphs site, 48CR398, is located on the west-face of a ridge overlooking Muddy Creek. One rock shelter, 48CR1755, is located on a southwest-facing ridge of an ephemeral drainage of Muddy Creek. The burial and the petroglyphs are recommended eligible for inclusion on the NRHP, while the rock shelter remains unevaluated.

Stone circle sites have been identified in the data base for the project area. The stone circle sites are generally found on ridges overlooking seasonal drainages in the project area. Prehistoric cairns are reported in the project area. The cairns are located on ridges sometimes overlooking water sources.

Pottery/ceramics are documented in the project area. Pottery is associated with the Uinta phase of the Late Prehistoric period. There are numerous pottery sites in southwestern Wyoming and northwestern Colorado. Pottery is associated with one lithic scatter and one prehistoric camp includes pottery.

Prehistoric/historic site types include prehistoric camp/historic debris scatters (n=18) and prehistoric lithic scatters/historic debris scatters (n=9). These multi-occupation sites exhibit mixed surface components.

3.11.5 Excavation Data

No sites have been extensively tested or excavated in the project area. However, several excavations have been conducted in the surrounding area contributing data about prehistory and history of the area.

3.11.6 Historic Sites

Seventy-one historic sites have been documented in the ARPA. Site types include historic trails, stage roads, stage stations, ranches, cairns, and debris. Three of the historic sites are linear trails/roads that cross portions of the project area. The Overland Trail (48CR932) crosses the middle portion of the study area, the Cherokee Trail (48SW3680/48CR3651) crosses the southern portion of the study area, and the Rawlins to Baggs Road (48CR3648) transects the mid-portion of the study area from a north/south direction. The Overland Trail, the Cherokee Trail, and the Rawlins to Baggs Road are recommended eligible for inclusion on the NRHP. Contributing segments of the historic routes are depicted in Appendix M. Two historic roads identified by the BLM on the GLO maps include the Rawlins to JO Ranch Road and the Rawlins to Browns Hill Road. Neither road has been field inspected or recorded. Historic transportation routes (i.e. trails, roads, and railroads) command a great amount of management attention because of their overall historic importance in western settlement and expansion and their pervasive presence within the ARPA.

The Cherokee Trail (48SW3680/48CR3651) was used in the 1850s by members of the Cherokee Tribe moving from the Oklahoma Reservation to the California gold fields. A Southern Variant of the Cherokee Trail trends southwest, crossing Savory Creek staying south of Ketchum and Five Buttes. The trail then crosses the South Fork of Cherokee Creek and then Smiley Draw, remaining south of Cherokee Creek. The road continues west, keeping Wild Horse Butte to the south, descending to the Muddy Creek drainage and continuing west through Blue Gap Draw. As with any of the westward migratory trails of the mid 1800s, variants have been documented. Reasons for variations in routes include inaccessibility at certain times of year or members of the group may have traveled the route previously and found an easier or more direct avenue to water. As is the case with many historic linear properties, the route of the Cherokee Trail needs to be verified in the field. Where possible, on the ground inspection should be supplemented by diaries of early pioneers that followed the westward migration routes. Many of the diaries include pertinent information such as distances traveled, landmarks, water sources, and feed for the stock. “

“The Cherokee Trail has received a great deal of attention by writers and even the film industry. LeRoy Hafen, in his work *The Overland Mail,* contends that the pioneering efforts of the Cherokee Indians led to the eventual development of the Overland Trail. Louis L’Amour romanticized the trail in his novel *The Cherokee Trail*. And in the 1960s a television series entitled “Cherokee Trail” drew attention to this road through southern Wyoming. The net result of the combined effort of novelists, historians, and the media has been to create a highly romanticized trail that is still not well understood in terms of the people who traveled this trail and the location of the actual route of this road taken by Cherokees traveling west from Oklahoma to California in 1850" (Gardner 1999).

Excerpts from Cherokee Trail diarist found in *Cherokee Trail Diaries* (Fletcher et al. 1999) document stops along the southern variant of the Cherokee Trail. Mitchell (1850):

> “June 30 Sunday ...frosty and plenty of ice We took an object west (possibly Five Buttes) at a great distance west to travel to and had great trouble in getting to it Too many bluffs & bad branches in the way In the evening we got out of the mountains & got to a bad Swamp creek runing south (This is Muddy Creek north of Baggs, WY) Supposed to be a for of elk head (Little Snake) 7 of our men were dissatisfied with the corse we were travling & left us taking a more South corse”

While supplemental information from diaries and journals is desirable, it is not required in making the determination of whether or not a certain segment of trail or its setting is contributing or non-contributing to its eligibility.

The Overland Trail is recommended eligible for inclusion on the NRHP. According to Gardner et al. (1993) only one trail guide, published in 1859, for the Overland Trail is known to exist. Written by O. Allen, it states:

“This road is only practicable for light vehicles from Bridger’s Pass to Fort Bridger, inasmuch as heavy teams cannot cross the frail bridges erected over Muddy Creek. . . . Summit of Bridger’s Pass - Good grass may be found along the water courses and valleys through the section of the country. Bridger’s Pass is a deep cut in the mountains, about one mile wide and 18 long, terminating in a narrow gorge or Canyon along Muddy Creek, some twelve or thirteen miles long. This Pass is always practicable, even in winter, when other passes are entirely closed. . . . .Muddy Creek - this stream furnishes abundance of speckled trout; cherries, and currents abundant in the fruit season; from this point the road continues down the valley of Muddy Creek, and crosses the creek six times to avoid rocky points at short distances along the creek. 4 miles”

Historic inscriptions have been found along the Overland Trail. Two of these sites are located three miles west of Doty Mountain and one is located three miles south of Baldy Butte. All three sites are located on the west-face of the ridge overlooking Muddy Creek.

The Rawlins to Baggs Stage Road (48CR3648) was a route used to freight goods, mail, and passengers from Rawlins to Baggs, Wyoming, and further south into northern Colorado. According to Rosenberg (1994) the route was first used in 1881 and was known as the Rawlins to White River, the Rawlins, and the Snake River Road. The route was later labeled the Baggs to Rawlins Road (1916). The road is depicted on Masi’s Itinerary Map of Wyoming (1875) and Holt’s Map of Wyoming (1883). The road transects the project area in a northeast to southwest direction. Stage stations were established along the route with service to ranching communities in the Little Snake River Valley. There is a strong association between the road and the history of the Ute White River Agency and the Ute Massacre. The Rawlins to Baggs Stage Road extends north of Baggs generally along the same route as Wyoming Highway 789. The Stage Road continues north and east toward Rawlins, crossing Muddy and Dry Cow creeks. Mark Miller (1997) in *Hollow Victory: The White River Expedition of 1879 and the Battle of Milk Creek,* discusses Major Thornburgh’s trek from Rawlins to the White River Agency Ute Reservation in an effort to address a complaint registered by Agent N. Meeker. His route followed a segment of an old stage road. “Thornburgh’s command marched from Soldier Wells to Snake River Crossing on Wednesday, September 24. Their route crossed Dry Cow Creek, then Muddy Creek again, and followed the valley south along the west bank of the stream.” Historic trails rarely follow a single route across the landscape. Instead, numerous parallel or alternate routes may be evident as a result of travelers adjusting to specific conditions along the trails. Trail trace varies dramatically in its condition. The segments may be in original condition or may have been subject to disturbance by previous construction projects, other human influences (recreation or off highway travel, etc.) or natural factors including erosion. Historic trail setting is characterized as those elements of integrity of location, feeling and association that contribute to the eligibility of the trails or associated sites.

Stage stations were important to westward migration. The Washakie Stage Station (listed on the NRHP) and Sulphur Springs Stage Station, were stops along the Overland Trail. Gardner et al. (1993) states: “Construction of stage stations at Sulphur Springs, Washakie, and Duck Lake more than likely took place in 1862." This time frame coincides with Ben Holladay beginning his Overland Stage venture to connect Denver, Colorado, with Salt Lake City, Utah. “Home” stations offered travelers with more amenities than “swing” stations where a change of horses occurred and travelers meals were offered. Robert Foote, giving testimony to Senator

Cameron, during a request for reimbursement for destruction caused by Native Americans states: "Stations from Sulphur Springs west to Fort Bridger were built from stone" (Gardner et al. 1993). Along with the construction of the stage stations was the stringing of the telegraph wires. Freighters as well as emigrants used these routes. The Sulphur Springs Station was also utilized by the Rawlins to Baggs Road. Other Stage Stations documented in the AR Study Area associated with the Rawlins to Baggs Road include Muddy Creek Station, Solder Wells Station, Willow Station and 16 Mile Station.

Historic ranches recorded in the project area include the JO Ranch, the Lisco Ranch, J. Peterson Ranch, Olsen Cabin, Hay Gulch Ranch, 20 Mile Ranch, and the Pool Ranch. The JO Ranch dates to the occupation by J. Rankin in the 1890s. Rankin was a guide for the US Army in 1879. He made the 28 hour ride from the besieged troops of the Thornburg Expedition to the telegraph lines in Rawlins, Wyoming. Ranching/stock herding sites in the area are generally sheepherder camps exhibiting hole-in-top cans and purple glass. Refuse left behind from tending herds is usually located on terrain with a good view to watch over the herds as well as water. One irrigation ditch has been recorded in the ARPA. The Mesa Irrigation Ditch is located in the southern reaches of the ARPA.

Historic cairns, often associated with sheep herding, are located on ridges or high points, sometimes overlooking seasonal drainages.

Historic debris/trash sites are found distributed throughout the project area. These scatters usually include trash associated with emigration and ranching/herding activities.

3.11.7 Summary

The subsistence and settlement patterns in the project area reflect a hunter-gatherer lifeway. Research into the subsistence and settlement patterns used during the Archaic period indicates summer occupations in the mountains, winter occupations in the foothills, and spring and fall movements utilizing all available zones (Creasman and Thompson 1997). Subsistence patterns in the Archaic period and the Late Prehistoric period are similar in that they are based on seasonal movement throughout the basins and foothills in response to the availability of floral and faunal resources (Creasman and Thompson 1988). A wide diet breadth is evident in extensive procurement and processing of small mammals. By 450 B.P. (Shimkin 1986), or possibly earlier (Bettinger and Baumhoff 1982), Numic-speaking Shoshonean groups occupied the Wyoming Basin and continued to reside there until Euro-American expansion relegated them to reservations beginning in 1868.

Cultural resources are found along the major ephemeral drainages and along the lower benches of escarpments that dominate the terrain in the project area. Sensitive areas include drainages such as Muddy Creek, Cherokee Creek, Wild Cow Creek, Sixteen Mile Draw, Cottonwood Creek and Deep Creek along with their tributaries. The numerous springs in the project area would be likely to contain cultural resources. Seasonal drainages flow into the project area from several escarpments such as Atlantic Rim, Hogback Ridge, Wild Horse Butte, Lone Butte, China Butte, Deep Creek Butte, and Cow Creek Butte as well as Doty Mountain and Muddy Mountain. Certain topographic settings have higher archaeological sensitivity such as eolian deposits (sand shadows and sand sheets), alluvial deposits along major drainages, and colluvial deposits along lower slopes of ridges. A sample inventory of the three distinct blocks indicates a higher site density in the Dry Cow Creek portion where the topographic relief gently slopes toward Dry Cow Creek (Goodrick 2000). No sites were located in the central and southern portions where terrain is steeply dissected by deep ephemeral drainages. The sampling included ridges, drainages, and areas with limited sand deposits. Previous investigations along the Savery Creek drainages, east of the project area, support a higher site potential along streams.

Historic use of the project area was limited by terrain and lack of perennial water sources. Three known trails and six stage stations are located within the project area. Ranches, irrigation, grazing and limited ranching activities are identified by the historic debris scatters and historic record.

3.12 SOCIOECONOMICS

The primary geographic area of analysis for potential socioeconomic effects of the Proposed Action and alternatives is Carbon County, Wyoming and the communities of Baggs, Dixon and Rawlins and the community of Wamsutter in Sweetwater County, Wyoming.

This section characterizes these socioeconomic conditions in Carbon County: the economy and population, housing resources, community services, selected local and state government revenues and selected attitudes, opinions and lifestyles. Detailed information about socioeconomic conditions in the Rawlins Resource Area is available in the *Socioeconomic Profile – Rawlins* document available on the BLM's Rawlins Resource Management Plan website at http://www.rawlinsrmp.com/documents/RawlinsSocioeconomicProfile1-30-03.pdf.

3.12.1 Economic Conditions

The Carbon County economy is largely natural resource based. Basic industries, which bring revenue into the county, include oil and gas production and processing, coal mining, electric power generation, agriculture (primarily ranching and logging), some manufacturing, and transportation (primarily the Union Pacific railroad). Those portions of the retail and service sectors which serve travelers, tourists and recreation visitors are also basic. In addition, the Carbon County economic base includes state and federal government employment; for example the Wyoming State Prison at Rawlins is a major employer in the county.

Employment and earnings are two common measures of economic activity. As shown in Figure 3-4, Carbon County full and part-time employment by place of work totaled 9,666 full and part-time jobs in 2000, which was two percent less than the 1990 level and about 29 percent lower than the1980 level of 13,616 jobs (WDAI 2003a). The 1980 peak reflected a period of intensive natural resource development in the petroleum and coal and uranium mining industries. Completion of infrastructure development and a weakening of commodity prices in all of these industries ushered in a period of economic and employment decline for Carbon County and for the State of Wyoming as a whole. More recently, there was some employment volatility between 1990 and 2000: the low point of 9,344 jobs occurred in 1993 and two years later, in 1995, the high point occurred with 9,883 jobs. Between 2000 and 2002, total employment was relatively stable.

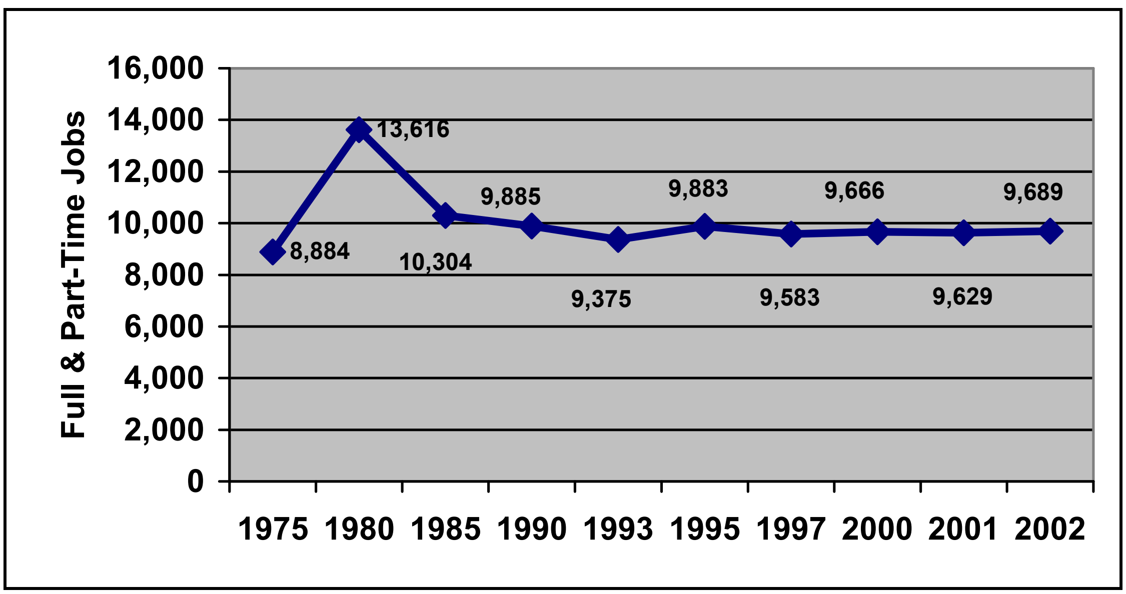
Mining sector employment, which includes direct oil and gas jobs, decreased 67 percent from 1990 to 2000, from 934 to 311 jobs and the 2000 level of mining employment was 91 percent lower than the 1980 level of 3,563 mining jobs. Mining sector jobs lost another 24 percent between 2000 and 2002. The mining sector losses over the past decade and the volatility in total employment are attributed to the shutdown of the Rosebud and Seminoe # 2 mines (USDI-BLM 1999) and more recently the closure of the RAG Shoshone mine near Hanna (Rawlins

Daily Times 2000a). Although the number of direct mining jobs in Carbon County is relatively low, mining, including the oil and gas sector, still generates a substantial number of indirect jobs in the construction, transportation and service sectors and additional induced jobs in all sectors of the economy.

Some economic sectors gained jobs between 1990 and 2000. Among the largest gainers were agricultural services and forestry, which increased from 106 to 260 jobs, a 145 percent increase, although that sector fell to 143 jobs by 2002, a 45 percent loss in just two years, reflecting the closure of the Louisiana Pacific mill in Saratoga. Other gaining sectors were construction, which increased from 595 to 693 jobs between 1990 and 2000, a 16 percent gain, and then remained relatively stable between 2000 and 2002, and services, which increased by 16 percent from, 1,848 to 2,141 jobs during the period.

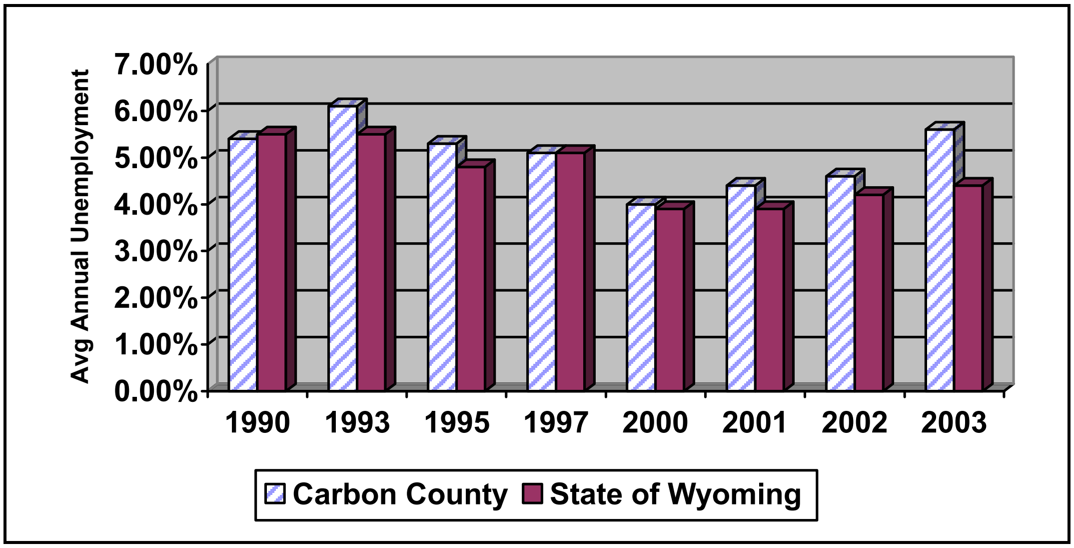
Unemployment rates in Carbon County have varied considerably in recent years, generally tracking with the unemployment rate for the state of Wyoming as a whole, although often slightly higher. Between 1990 and 2002, the county's average annual unemployment rate ranged from a low of four percent in 2000 to a high of 6.1 percent in 1993 (Figure 3-5). In 2003, the unemployment rate averaged 5.6 percent, or 451 unemployed persons in a total labor force of 8,121 (Blodgett 2003). This increase in unemployment was due in large part to the closure of the Louisiana Pacific mill. The size of the Carbon County labor force (people working or actively looking for work) decreased nine percent between 1990 and 2003 (Wyoming Department of Employment 2004).

Figure 3-4. Carbon County full and part-time employment by place of work: 1975 – 2002.



Source: WDAI 2003a

Figure 3-5. Average annual unemployment rates 1990 – 2003. Carbon County and State of Wyoming.

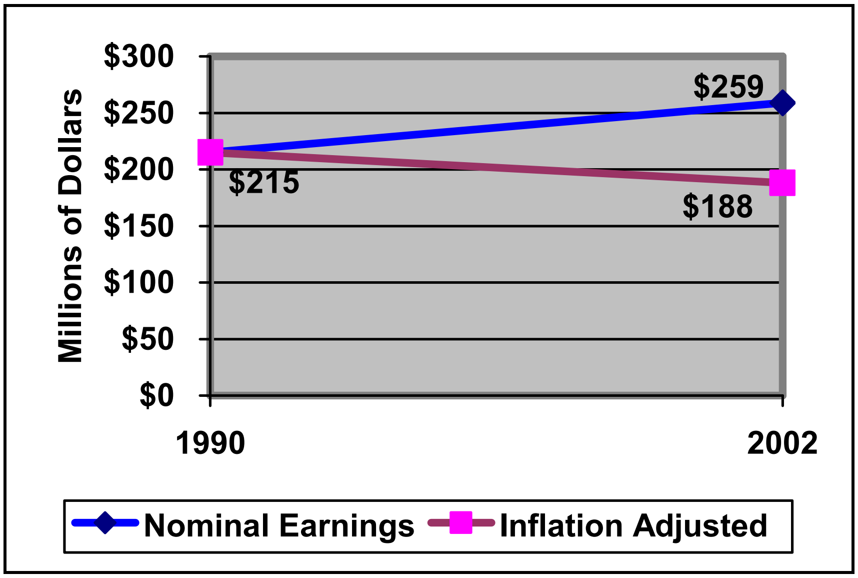


Source: Wyoming Department of Employment 2004

Although in the recent past there have been a substantial number of under-employed persons in Carbon County (PFResources 2000), there have been few experienced workers available for oil and gas drilling and completion jobs in recent years. Most drilling and completion companies bring crews with them and hire some entry-level workers locally and many gas field service companies bring workers from other states who relocate to Carbon or Sweetwater counties on a temporary, seasonal basis. However, there are qualified local contractors and employees available for gas field construction and service work (Blodget 2003, 2004).

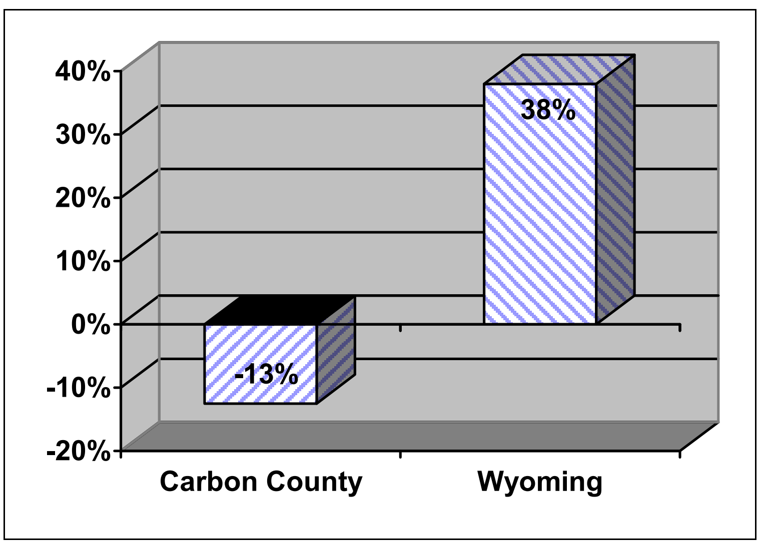
Between 1990 and 2002, total earnings associated with jobs located in Carbon County increased 20 percent, from $215 million to $259 million (Figure 3-6). However, when adjusted for inflation, real Carbon County earnings decreased by 12.5 percent during the 12 years ending in 2002. For the same period, inflation-adjusted earnings increased 38 percent for the state of Wyoming as a whole (Figure 3-7, WDAI 2003b). This general economic contraction reflects both a loss of jobs and a shift in jobs from higher paying mining jobs to generally lower paying agricultural and service jobs.

Figure 3-6. Total Carbon County earnings by place of work: 1990 – 2002.



Source: WDAI 2003b

Figure 3-7. Change in inflation-adjusted Carbon County earnings contrasted with Wyoming & US: 1990 – 2002.

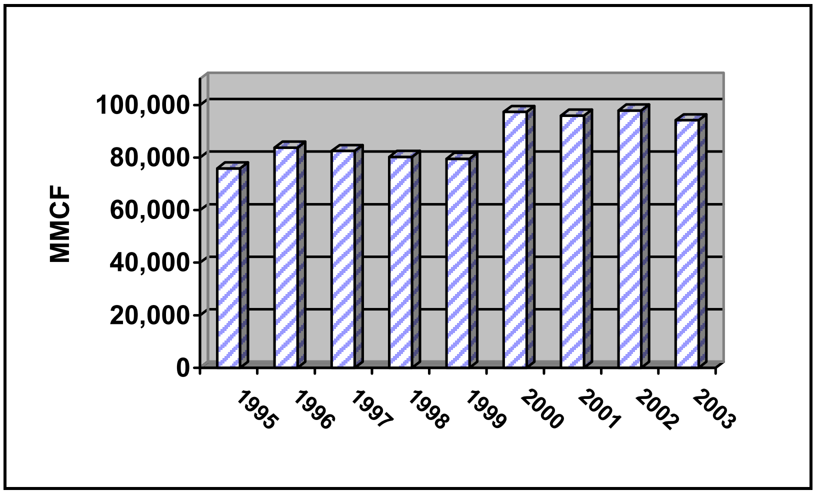


Source: WDAI 2003b

3.12.1.1 Oil and Gas Activity

As shown in Figure 3-8, Carbon County natural gas production increased, from 75,851 MMCF in 1995 to 94,183 MMCF in 2003, an increase of 24 percent, although production in 2000 through 2002 was somewhat higher than 2003 production. Carbon County oil production in 2003 was 1.6 million barrels or about 23 percent higher than the 1995 level of 1.3 million barrels, although 2002 production was about 0.1 million barrels higher. During 2003, there were a total of 1,248 producing oil and gas wells in Carbon County, and the county produced 5.14 percent of total gas produced in Wyoming and 3.05 percent of total oil.

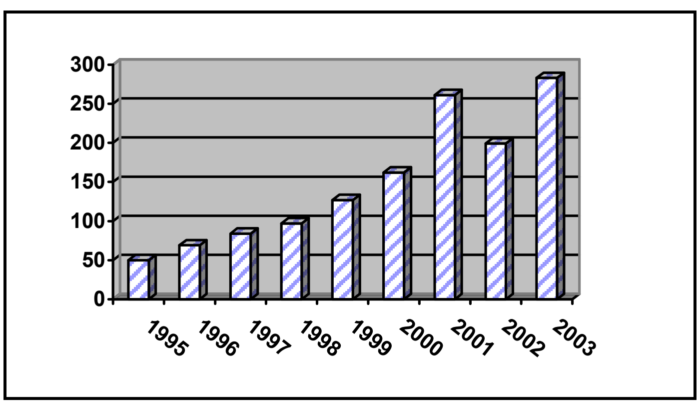
Figure 3-8. Carbon County natural gas production: 1995 – 2003.



Source: WOGCC 1995 – 2003

The outlook for future oil gas production is in part reflected in the number of approved applications for drilling permits (APD) that are logged each year. The number of approved APDs has increased substantially in Carbon County in recent years, from 50 in 1995 to 284 in 2003 and 199 in 2002 (Figure 3-9), or levels of approved drilling four or five times the level of the mid nineties (WOGCC 1995-2003). Increased drilling activity generally leads to increased production in the county if drilling efforts are successful and commodity prices remain at economic levels.

Figure 3-9. Carbon County APDs: 1995 – 2003.



Source: WOGCC 1995, 2003

3.12.1.2 Economic Activities in the Vicinity of the Proposed Action

Economic activities currently occurring on and near the ARPA include oil and gas exploration (Vosika-Neuman 2000), cattle grazing (Warren 2000) and outdoor recreation including the hunting of mule deer, antelope, elk and upland birds, and to a substantially lesser degree, off road vehicle use and camping (usually related to hunting) and pleasure driving/wildlife viewing (see Section 3.9). Some lands within the ARPA are used by outfitters, and some ranchers lease their lands to outfitters and allow hunting for a fee (Carrico 2004).

The RFO is in the process of modifying the GDRMP, which, when modified, will be called the Rawlins Resource Management Plan (RRMP). Appendix 35 of the RRMP DEIS contains assumptions about direct expenditures, total economic activity, employment and earnings associated with grazing and recreation activities in the GDRA for the modified management plan. Tables 3-38 and 3-39 present those estimates.

Table 3-38. Economic Estimates for Grazing.

	Cattle Grazing	Sheep Grazing
Direct Expenditures Per AUM	$35.29	$21.62
Total Economic Impact Per AUM	$64.36	$42.36
Earnings Per AUM	$18.77	$5.83
Jobs Per AUM	0.000709	0.0009513

Source: Taylor 2004
All monetary values in 2000$

Table 3-39. Economic Estimates for Recreation.

	Nonresident OHV*/Day	Nonresident Hunting Day	Nonresident General Day
Direct Expenditures	$119.13	$116.31	$40.55
Total Economic Impact	$158.80	$155.97	$50.69
Total Employment	.003276	.005153	.001294
Total Earnings	$49.30	$50.80	$14.58

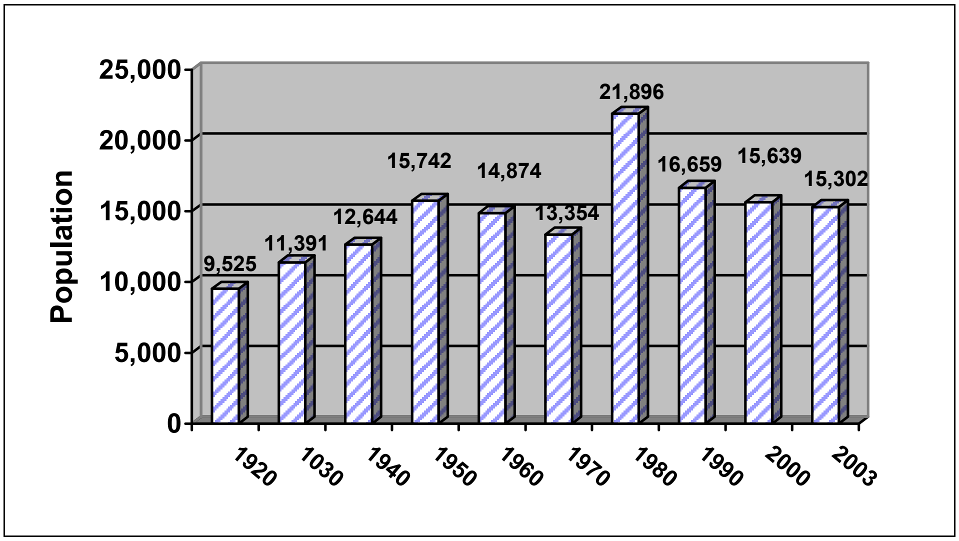
* Off-Highway Vehicle
Source: Taylor 2004
All monetary values in 2000$

3.12.2 Population

The population statistics in this section reflect census data and estimates prepared by the State pf Wyoming. In all potentially affected communities, there has been a substantial transient workforce in recent years. Because these workers do not establish permanent residence in the communities and stay in temporary housing they are not counted in population estimates. But in all affected communities, the total number of persons residing in the community at certain times of the year is substantially higher than is reflected in the following population statistics.

Carbon County's population growth and decline parallels the employment growth and decline cycle outlined at the beginning of this section. Figure 3-10 depicts the ups and downs of Carbon County's population since 1920. The population peaked in 1980 (mirroring the employment peak shown in Figure 3-4) and has decreased 29 percent since then to 15,639 in 2000, down from 21,896 in 1980 (WDAI 2001). According to official state estimates for 2003, Carbon County population continued to decline, losing another 337 people or about 2 percent since 2000 (WDAI 2002b).

Figure 3-10. Carbon County population: 1920 – 2003.



Sources: WDAI 2001 & 2003

Population in the City of Rawlins, the county seat and the largest community in Carbon County, mirrored the county trend between 1990 and 2000, although Rawlins has gained some population in the last two years as the county has continued to decline. Rawlins lost an estimated 842 persons between 1990 and 2000, ending the period at 8,538, though Rawlins officials believe the city's population was undercounted in the 2000 census (Kilgore 2002). Between 2000 and 2003, Rawlins grew slightly to an estimated 8,665 according to state estimates (see Table 3-40).

Other communities near the ARPA are small and have undergone small changes. The Town of Baggs, which, along with Dixon, is one of the closest communities to the ARPA, gained 76 residents (28 percent) between 1990 and 2000, but only gained 10 persons between 2000 and 2003, ending the period at 358 persons. The Town of Dixon, several miles east of Baggs, has been relatively stable over the last 14 years, fluctuating between 65 and 80 residents.

In Sweetwater County, the Town of Wamsutter grew by an estimated 22 persons between 1990 and 2003 according to Wyoming Department of Administration and Information estimates, although Wamsutter officials believe the number is substantially higher, both in resident population and in transient population (primarily oil and gas workers who stay in town for several weeks or months at a time) which may reach 200 or more at times (Carnes 2004).

Table 3-40. Population Estimates for Communities Near the ARPA: 1990, 1995, 2000, and 2003.

Community	1990	1995	2000*	2003
Rawlins	9,380	9,063	8,538	8,665
Baggs	272	258	348	358
Dixon	70	67	79	80
Wamsutter	240	241	261	262

Sources: 2000 Census as reported in WDAI 2003, WDAI 2001 & 2003

3.12.3 Housing Resources

As of fall of 2005, available (vacant) housing was scarce in western Carbon County and eastern Sweetwater County.

This housing inventory focuses on both long and short-term housing resources available to accommodate growth due to gas development. Operations personnel and some field development personnel would require long term housing, given the size and duration of the drilling and field development phase of the project. However, most CBNG drilling and field development activities are relatively short duration tasks performed primarily by contractors. Currently, drilling and completion activities occur less than six months out of each year, resulting in a temporary, transient workforce, and demand for temporary housing such as motel rooms and spaces for mobile homes, recreational vehicles (RVs) and rig camps near the project area.

Recently, larger self-contained worker camps have been constructed or proposed in unincorporated portions of the county, including a camp along WY 789 north of Dad that currently houses about 80 workers and can be expanded to house a total of 150 workers (Adams 2005). This site is also permitted for another camp, but is more likely that a second camp would be developed about six miles south of this area if demand arises. BP is also developing a 400 bed housing facility near Wamsutter.

Carbon County is in the process of reviewing rural subdivision regulations, which may make development of housing in unincorporated portions of the county easier. During the 2000 to 2004 period, residential building permits in Carbon County averaged about 38 per year.

3.12.3.1 Baggs/Dixon Area

In the Baggs/Dixon area, temporary housing resources include rental houses, duplexes, apartments, motels and spaces in mobile home parks. During recent years, rental units have rarely been available; most have waiting lists (Herold 2005, Hicks 2005). A 26-space mobile home park in Baggs is equipped to accommodate RVs and mobile homes. Within the park there are several mobile homes for rent, but again, these are rarely vacant. There is a four-space mobile home park in Savery and a number of mobile home lots scattered throughout the Little Snake River Valley (Grieve 2000, 2002, 2003).

There are two motels in Baggs with a total of 64 rooms, most of which can accommodate more than one occupant. Both motels routinely accommodate oil and gas industry workers as well as tourists, travelers and hunters (Willis 2000, Hawkins 2000). There is substantial turnover in these units but demand exceeds availability during the drilling and hunting seasons.

3.12.3.2 Wamsutter

Temporary housing resources in Wamsutter include three mobile home parks. One has 26 spaces (Englehart 2000, 2002), one has 70 spaces, most equipped to serve RVs (Waldner 2000, 2002), and the third is a recently reopened park with 52 spaces (Waldner 2004). Some drilling and gas service contractors have put rig camps in these mobile home parks; a rig camp typically accommodates 10 to 12 workers (two shifts of 5 or 6 workers each). There are also two motels in Wamsutter (Carnes 2003).

There has recently been a limited amount of subdivision activity and housing construction in Wamsutter (Carnes 2005). A local developer/mobile home park owner is in the process of applying for a permit to develop additional RV spaces (Waldner 2005).

3.12.3.3 Rawlins

In Rawlins, temporary housing resources include 19 motels and 4 RV parks (Hiatt 2000) and, as of fall 2005, three new motels are being constructed with a total of 200 rooms. For longer-term housing, there are 18 mobile home parks with over 550 pads (City of Rawlins 1998); about half of which were vacant during the fall of 2005. The 2000 census listed 285 units in two to four-unit housing structures in Rawlins and 467 units in structures with over 5 units (US Census Bureau 2002); there are rarely vacancies in these housing types. Although Rawlins has some vacant single-family houses, most of the affordable units are substandard, and would require some rehabilitation to make them attractive to buyers (Kilgore 2005).

3.12.4 Community Facilities and Services

3.12.4.1 Carbon County

The Carbon County Sheriff's Department provides law enforcement services for Carbon County including the ARPA. The department has 14 full-time and 2 part-time sworn deputies, including 7 who are stationed in Rawlins (Colson 2002). The department recently completed construction of a new jail.

Memorial Hospital of Carbon County would provide emergency response services in the ARPA. The hospital has 14 full and part-time emergency medical technicians (EMTs) and three ambulances based at the hospital in Rawlins (Hightree 2002).

Carbon County also provides road construction and maintenance services on roads, which provide access to and within the ARPA (see Transportation, Section 3.13).

3.12.4.2 Rawlins

Most of the infrastructure of the town of Rawlins was sized to accommodate a larger population than it currently has. The sewer system could accommodate a population of 25,000, more than twice the city's current population. With the completion of the new water supply pipeline in 2002, the water system also has excess capacity. In general, the Rawlins Community Development Director believes the community could accommodate 14,000 people with few changes to the current infrastructure (Kilgore 2002, 2004).

3.12.4.3 Baggs Area

The Carbon County Sheriff's Department provides law enforcement services in the part of Carbon County near the ARPA. Currently, coverage is provided by two full-time and one part-time deputies. The deputies provide coverage for the Town of Dixon and the community of Savery. There is one Wyoming Highway Patrol officer stationed in the area and the Town of Baggs has two police officers (Colson 2000, Herold 2004).

Medical services in Baggs are provided at a county-owned clinic, staffed by a physician's assistant who is supported by other medical and administrative personnel. Emergency response is provided by six volunteer EMTs who staff two county-owned ambulances.

Seriously injured patients are transported to Craig or Rawlins, depending on the location of the accident. Casper-based Flight-for-Life is also available if needed (Herold 2000).

Sewer and water services in the Town of Baggs would require expansion to accommodate substantial population growth. The town is limited on water supply and the water treatment plant is currently at capacity. When the recently completed High Savery reservoir is full, the Town will receive 300 acre feet per year, which would provide water supply for a population of 700. The town recently performed some improvements to its water system infiltration gallery, and is currently deciding on a design for a new treatment plant. The town's sewage treatment system has had some problems meeting discharge standards for ammonia, and may require some improvements to the aerated lagoon system. The town recently completed a utility master plan as a prelude to improving these systems. Other community facilities in Baggs are adequate for existing demand and can accommodate some population growth (Herold 2000, 2002, 2004).

3.12.4.4 Wamsutter Area

Law enforcement in the Wamsutter area is currently provided by the Sweetwater County Sheriff's Department; a deputy patrols the town daily. Two Wyoming Highway Patrol officers also live in the town. The Town of Wamsutter has positions for two part-time police officers, but the positions are currently vacant and the Town has not been able to hire officers for the positions for some time (Schroeder 2005). Emergency response services are provided by 15 volunteer EMTs operating one ambulance and 10 volunteer firefighters operating two fire trucks.

The volunteer fire and ambulance services provide coverage to surrounding oil and gas operations, and both services may have difficulty responding to more than one emergency at the same time. BP America recently provided a $68,000 grant toward purchase of a new ambulance; other energy and pipeline companies have also contributed funds. The town has an ongoing effort to recruit new volunteers for both the fire and ambulance service.

In general, sewer, water and school facilities can serve a larger population than Wamsutter now has. The town is in the second phase of a program to improve the water distribution system. The town also is developing a new library and has identified a variety of street and infrastructure improvements, vehicles and staff (Carnes 2002, 2004, Williams 2001, Rawlins Daily Times 2001). Although the transient drilling and field development population in Wamsutter can be substantial from time to time, their demands on local government facilities and services have generally been minor (Wyoming Business Council et al. 2002). Note that Wamsutter will host parts of two large pipeline construction workforces during late 2005 and 2006 (see Section 5.12) and BP America is constructing a 400 bed worker camp on the outskirts of the town in late 2005.

3.12.4.5 Carbon County School District #1

Carbon County School District (CCSD) #1 serves Rawlins, Sinclair, Baroil and the Little Snake River Valley, including the communities of Baggs and Dixon. The district's facilities were built in the late 1970s when Carbon County had many more residents, so there is excess capacity in some schools in Rawlins and Baggs. Elementary schools in Rawlins are nearing capacity; a few students could be added to each class but the addition of a substantial number of new students would require the use of modular classrooms. The Rawlins middle school could accommodate and additional 50 students and the Rawlins high school could absorb almost 1,000 students. The district plans to construct a new elementary school in Rawlins to replace the existing elementary schools and to remodel the existing middle school. Schools in Baggs could absorb additional students, particularly if they are distributed relatively evenly across all grades.

Funding operating costs for new students can be a burden because of Wyoming's school funding formula. The Wyoming School Foundation Program provides a guaranteed level of funding to every school district in the state. If a district's local property tax revenues do not equal the guaranteed level, the State makes up the difference. If the district's revenues exceed the guaranteed level, as is the case for CCSD #1, the excess is rebated to the state for use in other districts.

The Foundation Program formula computes school district operating budgets on a three-year moving average. Therefore, if CCSD #1 has a substantial increase in enrollment in any one year, the district may not be allowed to fully increase its operating budget for the additional students for three years, unless the increase in enrollment equals or exceeds 10 percent of the district's previous year enrollment. If the district were to receive a substantial number of students in any one year, but less than a 10 percent increase over the previous year, the district would be required to hire new teachers and fund other operating increases without a corresponding increase in revenues (Blankenship 2002).

Property tax revenues accruing to District #1 may exceed the recapture limit in the near future however, which would allow the district to keep local revenue which exceeds that limit, although there are both time restrictions and spending restrictions associated with this revenue.

3.12.5 Local Government and State Government Revenues

Local and state government fiscal conditions which would be affected by development in the ARPA include ad valorem property tax revenues of Carbon County, CCSD #1 and certain special districts; sales and use tax revenues of the state, county and municipalities; state severance taxes; and federal mineral royalty distributions.

3.12.5.1 Ad Valorem Property Tax

Carbon County assessed valuation in fiscal year (FY) 2002 was about $515 million; this yielded total property tax revenues (to all taxing entities) of $32.4 million. In FY 2003, total assessed valuation had fallen to $382 million, which yielded total property tax revenues of $24.6 million. Much of this decline in property tax valuation and revenue can be attributed to lower prices for natural gas. FY 2003 assessed valuation (from FY 2002 natural gas production) totaled about $199 million, 44 percent lower than 2002 natural gas valuation. Total 2003 mill levies within the ARPA included 58.5 mills for the county, state and local schools and the weed and pest district. Special district mill levies are also assessed and would add another 3 or 4 mills, depending on the tax district. Countywide, natural gas production accounted for about 66 percent of total assessed valuation in 2002 and about 52 percent in 2003 (WTA 2002 and 2003).

3.12.5.2 Sales and Use Tax

Fiscal Year 2002 sales and use tax collections in Carbon County totaled about $18.5 million, including collections from a four percent statewide sales and use tax and a one-percent general purpose local-option sales and use tax, total FY 2003 collections fell to $14.5 million, a 22 percent reduction (WDAI 2003b). In FY 2003, Carbon County added a specific-purpose local option sales and use tax of one percent to fund construction of a new jail and other capital facilities (WDOR 2003).

3.12.5.3 Severance Taxes

Wyoming assesses severance taxes against certain minerals produced in the state. These taxes include a six percent severance tax on natural gas. In FY 2002, severance tax distributions totaled $299 million. In FY 2003, severance tax distributions climbed to $429 million, a 43 percent increase over the previous year (WDAI 2003c). Much of the increase in severance tax revenues was attributable to natural gas price increases. Of the total, 43 percent was attributable to severance taxes on natural gas in 2002 and 54 percent was attributable to natural gas in 2003.

3.12.5.4 Federal and State Mineral Royalty Distributions

The federal government collects a 12.5 percent royalty on oil and natural gas extracted from federal lands. Fifty percent of those royalties are returned to the state where the production occurred. In Wyoming, the state's share is distributed to a variety of accounts, including the University of Wyoming, the School Foundation fund, the Highway fund, the Legislative Royalty Impact Account, and to cities, towns and counties. In FY 2002, a total of $349 million in federal mineral royalty funds were distributed to Wyoming entities, in FY 2003, total mineral royalties increased to $476 million, a 36 percent increase (WDAI 2003d).

The State of Wyoming collects royalties of either 16 2/3 percent or 12 ½ percent on natural gas produced from state owned lands. The revenues generated by trust lands and minerals are dedicated to common (public) schools and certain other designated public institutions such as the Wyoming State Hospital.

3.12.6 Local Attitudes, Opinions and Lifestyles

Ranchers who own property and have grazing permits within the ARPA will be among those directly affected by the proposed natural gas development. The Little Snake River Conservation District (LSRCD) lists 13 landowners/grazing permit operators within the ARPA, nine who live in communities in the Little Snake River Valley (LSRV), three who live in Rawlins and one who lives in Saratoga. Although there are some houses and mobile homes located in the ARPA, none are occupied full-time (Carrico 2004, Hicks 2004).

Currently, cattle grazing is the primary economic activity in the ARPA, although some horses are also raised and in earlier times, the area was primarily used for sheep grazing. The more labor-intensive requirements of sheep grazing, coupled with higher labor costs, resulted in a shift towards cattle, although some sheep are still raised in the grazing allotments which include portions of the ARPA (see section 3.6.1). Some of the ranches and grazing operations located in the ARPA have been in the same family for several generations. In addition to grazing, some ranchers lease their land to hunting outfitters, or allow hunting access for a fee. Some ranches and grazing allotments have installed range improvements, including water features which benefit and attract wildlife as well as cattle.

Ranching has been the primary economic activity in the LSRV since the establishment of European settlements in the area and has been the dominate use of the land. Ranching-related activities, such as rodeos and roping competitions are among the important and long enduring social interactions in the valley (Hicks n.d.).

Resource extraction, primarily oil and more recently, natural gas, has been an important component of the economy of the LSRV. Some oil and gas service companies are located in the valley, and natural gas development employees frequently use motels, mobile home parks and campgrounds in the LSRV while working in nearby oil and gas fields (Blevins et al. n.d., Herold 2004). A recent social assessment conducted for the Medicine Bow National Forest Plan update identified grazing permits, water rights, and to a lesser degree access to public lands as important issues for LSRV residents (Blevins et al. n.d.).

A 1996 survey conducted in conjunction with the preparation of the Carbon County Land Use Plan investigated resident attitudes and opinions regarding land use, oil and gas development, natural resource conservation and use and other topics. Just over 300 residents completed the survey (Carbon County Board of Commissioners and Carbon County Planning Commission 1998).

The most frequently listed land use issues of importance were water resource conservation and concern for government regulation of land use. These issues were followed closely by availability of water to support future land uses, economic viability of ranching, timber and oil and gas industries, and the need to conserve wildlife habitat.

County-wide, 54.9 percent of survey respondents (based on a weighted average because some respondents gave more than one response) indicated that conservation of land, water and wildlife resources was more important than increased oil and gas production, while 36.9 percent indicated that increased oil and gas production was more important.

Among Baggs residents, the reverse was true. About 54 percent rated increased oil and gas production as more important than conservation of land, water and wildlife resources while 36 percent rated resource conservation as more important. The land use plan attributes this difference in attitude to Baggs' greater economic dependence on future oil and gas employment.

Concerning management of federal lands, the largest number of respondents (69.5 percent) indicated that more federal lands within the county should be designated for the purpose of conserving fish and wildlife habitat and surface and groundwater resources. In addition, 60.8 percent of respondents indicated that more land should be designated for public recreation, 48.8 percent indicated more land should be leased for oil and gas industry exploration and production, 48.7 percent indicated more land should be leased for commercial mining, and 44.5 percent indicated more land should be made available to local timber companies for commercial timber harvest.

Coalbed natural gas development was not considered by the survey, so resident attitudes and opinions specific to CBNG are not known (Hewitt 2001).

3.12.7 Environmental Justice

Executive Order (EO) 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" was published in the *Federal Register* (59 FR 7629) on February 11, 1994. EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Table 3-41 presents the percentage of minorities in areas near the ARPA. Minorities are 10.3 percent of the population in the analysis area that includes the ARPA and populations within five miles of the ARPA boundary. This is 0.8 percentage points lower than the state average of 11.1 percent. The percentage of minorities in Carbon County overall is higher than the state average because of the presence of the Wyoming State Penitentiary. Near the southern boundary of the ARPA, Baggs and Dixon have relatively low minority percentages of 7.5 percent and 5.1 percent, respectively. The Hispanic or Latino population is the largest minority group.

Table 3-42 presents the percentage of persons in poverty in ARPA and surrounding communities. For this analysis, the local area that includes the ARPA is larger than the analysis of minorities because of the data available from the U.S. Census Bureau.

Table 3-41. Percentage of Minorities in the State of Wyoming, Carbon County, the ARPA, and Selected Communities.

	Minority Persons in 2000 as % of Total Population	Percentage Points Above/Below the State Average
Wyoming	11.1	
Carbon County	17.6	6.4
ARPA and Areas Nearby [1]	10.3	-0.8
Baggs	7.5	-3.7
Dixon	5.1	-6.1

[1] Defined as Block Group 2 of Carbon County Census Tract 9676, excluding blocks generally east of the Atlantic Rim, the Bridger Pass Road, and the Little Savery Creek and Savery Creek drainages. Baggs, Dixon, and areas near Rawlins that are south of I-80 and west of Wyoming State Highway 71 are included in the analysis area.
Source: U.S. Census Bureau, Census 2000, Summary File 1

Persons in poverty are 14.1 percent of the population in the analysis area that includes the ARPA. This is higher than the overall rates for Carbon County and the state of Wyoming. However, the high poverty rate is mainly due to having to include the Wyoming State Penitentiary in the analysis area, which also includes Baggs, Dixon and other parts of Carbon County south of I-80 and west of the North Platte River.

Table 3-42. Percentage of Persons in Poverty in the State of Wyoming, Carbon County, the ARPA, and Selected Communities.

	Persons in Poverty in 1999 as % of Total Population	Percentage Points Above/Below the State Average
Wyoming	11.4	
Carbon County	12.9	1.5
ARPA and Communities Nearby[1]	14.1	2.7
Baggs	14.9	3.5
Dixon	8.0	-3.4
Rawlins	13.7	2.3
Sinclair	4.7	-6.8

[1] Defined as Block Group 2 of Carbon County Census Tract 9676, which includes Baggs, Dixon, areas near Rawlins and Sinclair south of I-80, and other parts of Carbon County south of I-80 and west of the North Platte River.
Source: U.S. Census Bureau, Census 2000, Summary File 3

3.13 TRANSPORTATION

The regional transportation system serving the project area includes an established system of interstate and state highways and county roads. County roads and improved and unimproved BLM and private roads serve local traffic on federal land. Access to the ARPA is provided by a combination of Interstate and State highways and Carbon County and BLM roads (Appendix M: Federal, State, County, and BLM Roads).

3.13.1 Highway Access to the Project Site

The Wyoming Department of Transportation (WYDOT) measures annual average daily traffic (AADT) and collects accident statistics on federal and state highways. Table 3-43 displays these data for the highways that provide access to the ARPA. WYDOT also assigns levels of service to highways in the state system. Levels of service (LOS A through LOS F) are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort and convenience) that characterize the operational conditions within traffic streams and the perceptions of those conditions by motorists. LOS A represents the best, or free flowing, travel conditions and LOS F represents the worst, or total stoppage of traffic flows. The LOS ratings for the highways accessing the ARPA, where designated, are also shown in Table 3-43.

3.13.2 County Road Access to and within the Project Area

A number of Carbon County roads provide access to and within the ARPA. The traditional use of these county roads is to access federal, state and private lands for livestock management, recreation and more recently, oil and gas exploration and production purposes. The county has improved several county roads, including CCR 608 (Wild Cow Road) and CCR 605N (Twenty Mile Road - North), to better serve oil and gas development and production. Except for these two roads, county roads within the project area are minimally maintained and are not plowed during winter (Evans 2002).

Table 3-43. Highway Access Routes to the ARPA.

Highway	1991 AADT	2001 AADT	2002 AADT	Projected 2012 AADT	Level of Service	Average Accidents 1996–2000
I-80 (Junction WY 789)	7,590 (3,580 trucks)	12,000 (6,260 trucks)	11,760 (6,460 trucks)	15,000	A	123.4
WY 789 (Creston Jct. - Baggs)	720 (240 trucks)	890 (210 trucks)	860 (210 trucks)	800	B	18.8
WY 70 (Dixon west)	530 (65 trucks)	490 (40 trucks)	480 (30 trucks)	550		14.8
WY 71 (I-80 south)	200 (30 trucks)	150 (30 trucks)	180 (20 trucks)	160		3.2

Source: WYDOT 2000, 2001, 2002

The following provides a more detailed description of county roads providing access to and within the ARPA:

CCR 605N (Twenty Mile Road North), a 24.3-mile two-lane gravel road, provides access to federal, state and private land southwest of Rawlins. During the summer of 2001, the road was extensively improved under a cooperative effort between PEDCO and the Carbon County Road and Bridge Department. The road was re-shaped and widened, 21 culverts were installed and over 800 loads of gravel were applied. The southern end of CCR 605 N is defined by a locked gate on private land.

CCR 608 (Wild Cow Road) is a 22-mile two-lane improved and unimproved gravel and native material road which travels northeast and then southeast from the Dad intersection on WY 789, providing access to the southern part of the ARPA. CCR 608 connects with CCR 503, the McCarty Canyon Road, near the southeast border of the ARPA.
`

CCR 503 (McCarty Canyon Road) totals 37.2 miles in length and travels north from Dixon into the ARPA. Approximately 13 miles of CCR 503 are within the ARPA. After leaving the ARPA, the road travels north to its intersection with CCR 505, which eventually connects to WY 71 via CCR 401. The McCarty Canyon road is spot graveled and experiences moderate traffic.

CCR 501 (Cherry Grove Road) is an 8.6 mile road that provides access to the ARPA from the unincorporated community of Savery. CCR 501 runs along the southeastern border of the ARPA and intersects with CCR 752. The first 4.3 miles of CCR 501 have been improved with gravel.

CCR 752 (Stock Drive Road) connects to CCR 561N north of Savery. After it enters the eastern boundary of the ARPA, CCR 752 travels northwest for about two miles between CCR 501 and CCR 503.

3.13.3 BLM Roads within the Project Area

BLM roads providing access within the ARPA include BLM 3305, 3308 and 3309.

BLM 3305 connects with CCR 608 about five miles east of Dad, and continues northeast, providing access to the Sand Hills and the eastern side of Doty Mountain via unnamed roads and two-tracks.

BLM 3308 provides access from BLM Road 3305 to the Deep Gulch area and Cow Creek Butte areas.

BLM 3309 travels northeast from WY 789, providing access to the Wild Horse Basin area and connects to CCR 608.

3.14 HEALTH AND SAFETY

Existing health and safety concerns in and near the ARPA include hazards associated with oil and gas exploration and operations. Workers generally are exposed to the occupational hazards of oil and gas operations in the fields and at ancillary facilities. Two types of workers are employed in oil and gas fields: oil and gas workers, who had an annual accident rate of 4.0 per 100 workers in 1998, and special trades contractors, who had a non-fatal accident rate of 8.9

per 100 workers (USDL-BLS 2000). These rates compare with an overall private-industry average for all occupations of 6.2 per 100 workers.

There are also risks associated with existing natural gas pipelines, although these risks are statistically very small. Injuries associated with gas transmission pipelines nationwide averaged 14 per year from 1990 through 1996, fatalities averaged one per year and incidents such as ruptures averaged 79 per year (USDOT 1998). There are also risks associated with hazardous materials that are used and stored at oil and gas facilities; injury and incident rates are not available for these risks. The BLM, OSHA, USDOT and Wyoming OGCC each regulate safety aspects of oil and gas operations.
Existing risks within the ARPA also include those associated with vehicle travel on improved and unimproved county, BLM and oil and gas field roads; with firearms accidents during hunting season and from the casual use of firearms such as plinking and target shooting; and with natural events such as flash floods, landslides, earthquakes and range fires, which can also result from human activities

3.15 NOISE

The ARPA is located in a sparsely-populated rural setting having modest sound disturbances. The principal sound source within the ARPA is the wind. Vehicle traffic on WY 789 and WY 70, jet aircraft overflights at high altitudes, localized vehicular traffic on county, BLM and two-track roads in the Project Area, and nearby oil and gas drilling and field development activities also cause sound disturbances within the Project Area.

The EPA has established an average 24-hour noise level of 55 dBA as the maximum noise level that does not adversely affect public health and welfare. No definitive data has been established concerning noise levels that affect animals. No regulations concerning quantitative noise levels have been established by the State of Wyoming.

3.16 WILD HORSES

The RFO management area is home to approximately 1,650 wild horses, the largest population of wild, free-roaming horses (*Equis caballus*) outside of Nevada (UDSI-2003a). BLM has the responsibility to protect, manage, and control wild horses pursuant to the Wild Horse and Burro Act of 1971 (Public Law 92-195). The wild horse program is responsible for monitoring both the land and the herds, removing excess animals, and preparing animals for adoption. In Wyoming, BLM maintains and manages about 3,000 wild horses in sixteen herd management areas (HMAs). The BLM establishes an appropriate management level (AML) for each HMA. The AML is the population objective for the HMA that will ensure a thriving ecological balance among all the users and resources of the HMA.

Three wild horse HMAs are located within the RFO management area, however, none of the three are within the boundaries of the proposed ARPA. The Lost Creek and Stewart HMAs are generally located northwest of Rawlins with the larger Adobe Town HMA primarily located in southern Sweetwater County. The Stewart Creek HMA is generally located northwest of Rawlins, with its southeast boundary beginning near the intersection of U.S. Hwy. 287 and Carbon County Road 63 (about 14 miles northwest of Rawlins). The Lost Creek HMA lies within the Great Divide Basin to the west of the Stewart Creek HMA. A fenced border separates the two HMAs.

The nearest of the three HMAs to the ARPA is the Adobe Town HMA. The eastern border of the Adobe Town HMA extends to within five miles of the western boundary of the ARPA west of State Highway 789. Daily or seasonal movement of wild horses from the Adobe Town HMA to the ARPA is effectively prevented by the state-maintained, limited access fencing along Highway 789. The presence of wild horses on the project area is highly unlikely and is not considered to be an issue.

3.17 SPECIAL MANAGEMENT AREAS

Special management areas are designated to protect or preserve certain qualities or uses in areas that best provide them. The environment in these areas is unique in some regard, so that it is desirable to apply different management to the areas than is applied to the surrounding public lands. This section identifies the various special management areas (Appendix M: Special Management Areas Overview) within the ARPA and addresses the qualities or uses that have resulted in their designation. The types of special management designation within the ARPA include Areas of Critical Environmental Concern (ACECs), cultural resource management areas, cooperative fish and wildlife management areas, and other unique geographical areas.

3.17.1 Rawlins to Baggs Geographic Area

The area is bounded on the north by Interstate 80, on the east by State Highway 71 and Carbon County road 401, on the south by State Highway 70, and on the west by State Highway 789. This area contains unique and valuable vegetation and wildlife resources that require special management emphasis. The natural resources within the area draw a high number of recreationists, who enjoy the area for its wildlife, historic and cultural values, and being able to get away to secluded places. This area has a combination of diverse upland habitat conditions intertwined with perennial and ephemeral stream systems and riparian habitat combine to support a higher than normal wildlife species richness. The most important factor is the mosaic mix of these communities in close proximity to one another, based upon the diversity of topography, soils, and climate. Vegetation communities within this area include six types of sagebrush, aspen and juniper woodland, mountain shrub, saline desert shrub, and riparian/wetland communities.

South-central Wyoming is a unique area within the contiguous United States and contains vast tracts of undisturbed wildlife habitat. There is an abundance and richness of wildlife that includes big game, raptors, greater sage-grouse and Columbian sharp-tailed grouse, neotropical birds, Colorado River cutthroat trout, and native warmwater fish species such as roundtail chubs, bluehead suckers, and flannelmouth suckers. This diversity is also observed in the proximity of seasonal ranges to crucial winter ranges, the overlapping winter ranges of several big game species, and important birthing areas for antelope, mule deer, and elk. Raptor species include a wide variety of hawks, eagles and owls, as well as healthy populations of two BLM state sensitive species, ferruginous hawks and burrowing owls. This area is the only place in Wyoming where Columbian sharp-tailed grouse occur, and their range is expanding northward. There are few locations elsewhere in Wyoming that support a higher density of greater sage-grouse.

The upper Muddy Creek drainage bisects the middle of this region, and once supported Colorado River cutthroat trout in the days when Jim Bridger first explored routes for settlers that followed. These trout were recently reintroduced into the upper watershed and will soon expand to much of their former habitat. This species, as well as native warmwater fish species, may benefit sufficiently to preclude the need to list these species for additional protection under ESA.

These plant and wildlife values are reflected in several smaller portions being proposed as SMAs including the Upper Muddy Creek Watershed/Grizzly area, Red Rim-Daley area, Jep Canyon ACEC,and the Sand Hills ACEC. However, piece-meal protection of the higher value areas would not adequately protect all the wildlife species that use and depend on this area.

This is a popular dispersed recreation destination, particularly for hunters because they can hunt multiple big game species. There is a sufficient road network to provide recreational access. The scenic quality of the area is not impaired by an abundance of permanent facilities.

Cultural values in this area include the Overland and Cherokee historic trails, the Rawlins to Baggs freight road, and the historic JO Ranch, in addition to numerous other significant cultural properties. The historic trails and roads are important reminders of settlement in this area.

3.17.2 Cow Butte/Wild Cow Area

The Cow Butte/Wild Cow area encompasses 40,414 acres of mostly public land within the ARPA. It is bounded on the north by the Sandhills ACEC and Upper Muddy Creek Watershed/Grizzly Area and on the south by the Browns Hill and Dad county roads. The area includes portions of the Cow Creek, Deep Gulch, Wild Cow and Cherokee Creek drainages. Vegetation types are diverse and intermixed, and include aspen woodland, mountain shrubs, riparian habitat, and mountain, basin and Wyoming big sagebrush. These communities provide important habitat for many wildlife species, including greater sage-grouse, Columbian sharp-tailed grouse, red-tailed and Swanson's hawks, kestrels, antelope, mule deer and elk. The western portion is elk crucial winter range where south and west slopes drop off to lower elevation plateaus. Recreation use primarily occurs during hunting seasons in the fall when this general region is one of the most heavily hunted areas in the State of Wyoming.

Existing disturbances within the ARPA portion of this SMA include improved and two-track roads, fences and water developments. Unimproved two-track roads, particularly on moderate to steep slopes, are a management concern due to the gullies and accelerated erosion associated with them. Portions of the fences in the Deep Gulch, Grizzly and Wild Cow allotments were constructed with mesh wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle.

3.17.3 Historic Trails

Transportation routes (i.e., trails, roads, and railroads) command a great amount of management attention, due to their overall historic importance in western settlement and expansion and their presence over long distances within the Rawlins Field Office area. Some of these properties exist within the ARPA and are encountered on a frequent basis during cultural resource inventories within the area.

The Overland Trail

The Overland Trail roughly follows upper Muddy Creek through the ARPA. The trail was the principal mail and stage route west from 1862 to 1868 and its use continued thereafter as an emigrant road. Only three of the stage stations built along the trail occur on currently administered public lands including the Midway, Sage Creek, and Washakie Stations. The Washakie station, located within the ARPA along Muddy Creek, is listed on the NRHP and still retains some of the original structure. Today, evidence of the trail remains in the form of ruts and swales as well as associated artifacts.

The Rawlins to Baggs Freight Road

The Rawlins to Baggs freight road was a 19th century road connecting Rawlins and the town of Baggs to the southwest and continuing on to the White River Ute Indian Agency at Meeker, Colorado. Originally the route was used for freight but mail and passenger services were added as the region became more populated. The military used the road to transport troops and supplies from Fort Steele to Meeker during a massacre in 1879. The Rawlins to Baggs freight road parallels the 20-mile road out of Rawlins. Portions of the road are in excellent condition with deep swales and ruts present.

3.17.4 Upper Muddy Creek Watershed/Grizzly Area

The Upper Muddy Creek Watershed/Grizzly area includes 20,996 acres within the ARPA. The rugged terrain includes 9,200 acres (44%) with slopes in excess of 8%. This area contains those portions of the Muddy Creek watershed above the Weber headcut stabilization structure as well as those portions of the Savery Creek watershed within the Grizzly allotment. The Grizzly allotment is currently managed as a wildlife habitat management area in cooperation with the Wyoming Game and Fish Department. All allotments in this area have part of a Coordinated Resource Management (CRM) effort since 1992, led by the Little Snake River Conservation District, which has worked to improve grazing management and overall resource conditions. This group also mapped roads within the watershed to help define problems caused by roads, and found nearly 5,000 miles of un-improved two-tracks, or an average of about 4.6 miles/square mile for the watershed east of Hwy. 789 that includes the ARPA.

The area contains unique fish habitats that support a rare community of native Colorado River Basin fishes including Colorado River cutthroat trout, bluehead sucker, flannelmouth sucker, roundtail chub, mountain sucker, and speckled dace. The presence of this relict native fish community has resulted in the Muddy Creek watershed being listed as a top priority for aquatic habitat management by the Wyoming Game and Fish Department (WGFD 2004). Ongoing cooperative research and management efforts aim to develop and implement biologically meaningful conservation strategies for this unique fish community. This community may represent the highest conservation priority for native fishes within Wyoming (Bower 2005).

Additionally, elk crucial winter range and a corridor for elk and mule deer movement among seasonal ranges make the Muddy Creek corridor critical for big game. The high relief topography and wind deposition of snow provide a diversity of vegetation communities including aspen that provide important wildlife habitats for other species of high value such as greater sage-grouse and raptors.

Existing disturbances within this portion of the ARPA include existing improved and two-track roads, fences and water developments, and instream structures such as an irrigation diversion and headcut stabilization structure (Bower 2005). Unimproved two-track roads, particularly on moderate to steep slopes, are a management concern due to the gullies and accelerated erosion associated with them. Portions of the fences in the Fillmore, Grizzly and Sulphur Springs allotments were constructed with mesh wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle. Existing disturbances have led to the inclusion of two segments of Muddy Creek on the State's 303d list of impaired waterbodies. These segments were listed as impaired due to physical habitat degradation.

3.17.5 Sand Hills ACEC and Proposed JO Ranch Expansion

The Sand Hills ACEC and the JO Ranch Expansion protects about 5,024 acres of public land within the ARPA for its unique vegetation complex, wildlife habitat values, and recreational opportunities. The silver sagebrush/bitterbrush plant community, which is interspersed with patches of serviceberry, chokecherry and aspen, occurs on a deep sand soil, and is the largest representation of this vegetative mix within the State of Wyoming. This area provides crucial winter range for mule deer and elk, and nesting and foraging habitat for raptors, greater sage-grouse, and Columbian sharp-tailed grouse populations.

Recreation in this area is primarily associated with hunting activities. The high amount of vehicle use in these vegetation communities and fragile soils has resulted in a high road density (in some areas reaching nine miles of road per square mile).

The JO Ranch expansion increases the size of the current Sand Hills ACEC to 12,700 acres. The BLM acquired about 1,200 acres along Cow Creek, which includes the historic JO Ranch and the Rawlins to Baggs Freight Road. The JO Ranch is a unique example of continuous ranching activities over 100 years in the Washakie Basin. This property includes a flood irrigation system along the valley bottom which has resulted in high quality riparian habitat important for wildlife. The JO Ranch also served as a stage stop along the Rawlins to Baggs Freight Road, an historic route that connected northern Colorado with the Union Pacific Railroad line in Rawlins.

Existing disturbances within the ARPA portion of this SMA include improved and two-track roads, fences and water developments. Two-track roads are a management concern due to their high density and the disturbance and displacement of big game that occurs from vehicles. Portions of the fences in the Deep Gulch and JO Pastures allotments were constructed with mesh wire or five/six strands of barbed wire for control of domestic sheep that also restrict the movement of smaller, younger wildlife species, and antelope in general which like to pass under fences. Since these allotments have all been converted to cattle grazing, there is no longer a need for this type of fence since three and four wire strand barbed fence adequately controls cattle.

3.17.6 Red Rim/Daley Area

The Red Rim-Daley (3,190 acres within the ARPA) area is a Wyoming Game and Fish Department Cooperative Wildlife Habitat Management Area and is located approximately 15 miles southwest of Rawlins. The Red Rim area contains both the Daley Ranch allotment and the Daley Ranch Pasture. The area contains scenic values comprised of tilted red sandstone sediments and erosion features. The area provides yearlong habitat for greater sage-grouse and crucial winter range for pronghorn, as well as important nesting substrate for a wide variety of raptors. However, the portion of the Red Rim/Daley Area overlapping into the ARPA is relatively small at 12.3% and the public land portion of the Red Rim/Daley Area within the ARPA is only about 2%. Due to this small area and location along the edge of the ARPA boundary, in addition to the values described above being protected by existing timing stipulations and BMP's on public land, there will be no further discussion of this area in this document.